Department of Energy
National Nuclear Security Administration
Nevada Site Office
P.O. Box 98518
Las Vegas, NV 89193-8518

MAY 19 2006

Michael J. Elges, Chief
Bureau of Air Pollution Control
Department of Conservation
And Natural Resources
Division of Environmental Protection
901 South Stewart Street
Carson City, NV 89701-5429

DIVINE STRAKE EXPERIMENT, NEVADA TEST SITE (NTS) AIR QUALITY OPERATING PERMIT AP9711-0549.01

References: (1) Ltr, Elges to Brock, dtd 4/7/2006
(2) Ltr, Brock to Elges, dtd 4/27/2006
(3) Ltr, Elges to Brock, dtd 4/28/2006

In the above referenced letters, your organization requested additional information regarding Divine Strake, an experiment being conducted at the NTS by the Defense Threat Reduction Agency. In telephone conversations, members of your staff advised the National Nuclear Security Administration Nevada Site Office (NNSA/NSO) of air quality concerns related to Divine Strake that have been expressed by the public. Because of this, during the experiment NNSA/NSO will have an air monitoring network operated by Bechtel Nevada and an independent air monitoring network operated by Desert Research Institute. Attached is a set of documents providing information related to the potential air quality impacts of Divine Strake, including plans for the air monitoring discussed above.

If there are any questions, please call Michael G. Skougard or Kenneth A. Hoar. Mr. Skougard can be reached at (702) 295-1759 and Mr. Hoar at (702) 295-1428.

Kenneth AHoar
for R. T. Brock
Assistant Manager
for Safety Programs

EPT:KAH-6335
ENV 04-01

Attachment:
As stated

cc w/o atch:
M. A. DeBurle, NDEP, Carson City, NV

cc w/o atch:
E. C. Calman, BN, Mercury, NV
P.M. Radack, BN, Mercury, NV
D. S. Shafer, DRI, Las Vegas, NV

bcc w/o atch:
C. B. Iverson, HSCTT, NNSA/NSO, Las Vegas, NV
L. M. Cohn, EPT, NNSA/NSO, Las Vegas, NV

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Attachment A

Divine Strake

The Department of Defense's Defense Threat Reduction Agency will conduct an experiment, Divine Strake, scheduled to be conducted on June 2, 2006 at the U.S. Department of Energy's Nevada Test Site.

It will consist of the detonation of 700 tons (TNT equivalent to 593 tons) of the explosive ammonium nitrate-fuel oil (ANFO) on the ground above an existing tunnel at the site constructed for other research efforts. ANFO is commonly used in mining and blasting operations, and the amount of explosive being used in the experiment was selected to cause various levels of damage to the tunnel.

Divine Strake is designed to assess the capability of computer codes to predict the ground-shock environment and associated tunnel response to the detonation. This experiment supports the Tunnel Target Defeat Advanced Concept Technology Demonstration (TTD ACTD), which is intended to improve the warfighters' confidence in their ability to plan to defeat hardened and deeply buried targets.

The program objectives for this experiment include:

- Improve the warfighter's ability to plan for the defeat of strategic hard & deeply buried targets
- Improve understanding of weapons effectiveness versus collateral effects
- Large-scale high explosive simulation demonstration above a tunnel complex
- Reduce geotechnical targeting uncertainties
- Supply relevant full-scale data base for code validation
    - Ground Shock – insitu, complex layered and jointed rock (limestone)
    - Tunnel Response - light damage (spall) to severe damage (collapse)
- Provide test beds to develop improved weaponeering algorithms (Attack planning tool-IMEA)

The experiment objectives are:

- Plan and conduct a large-scale high explosive demonstration test to create the proper ground shock environment to damage an existing tunnel complex
- Provide site characterization data defining in-situ properties and 3-D variations within the test bed
- Geotechnical characterization & pre-test predictions
    - To fill important targeting gap
- Provide test data defining:
    - Charge source performance (limited)
    - Free-field ground motions and asymmetries
    - Tunnel near-field environment and response
- Support the evaluation and validation of attack planning tool capabilities, including:
    - Fast-running ground shock and tunnel damage models
    - First principles target response and damage calculations

Attachment B

CHEVRON HS DIESEL 2

CUSTOMER BENEFITS

Chevron HS Diesel 2 delivers value through:

- **Reliable cold starting**
- **Quiet combustion**
- **Excellent available power and economy**
- **Long fuel filter life**
- **Reliable cold flow properties**
- **Long storage life**

FEATURES

Chevron HS Diesel 2 is a high quality regular grade diesel fuel.

It meets the requirements of ASTM D 975, Standard Specification for Diesel Fuel Oils, for Grade No. 2 D. This is a "high sulfur" fuel with a maximum sulfur content of 0.50 mass %. This product is dyed red at the refinery to indicate it does not comply with the U.S. Environmental Protection Agency (EPA) regulations for "highway diesel". This product does not comply with California Air Resources Board (CARB) regulations for "vehicular diesel".

Chevron HS Diesel 2:

- meets the fuel requirements of major engine manufacturers,
- is area blended for cold weather use,
- has high heat content, and
- exhibits good thermal stability.

FUNCTIONS

The high cetane number of Chevron HS Diesel 2 provides quiet combustion and quick starting at low temperatures. The high heat content permits engines to achieve rated power output and optimum fuel economy. Area blending assures a minimum risk of wax plugging of fuel filters and an absence of cold pumping problems. Chevron HS Diesel 2 has excellent storage stability.

APPLICATIONS

Chevron HS Diesel 2 meets the requirements of all major manufacturers of high speed diesel engines.

PRODUCT AND MSDS NUMBERS

CPS Number	*272102*
MSDS Number	*6894*

Attachment C

NITROGEN PRODUCTS

TECHNICAL INFORMATION

AMMONIUM NITRATE

MSDS #1020

N-01-02-01-03

Industrial Grade

Ammonium Nitrate, % by weight	98.8
Organic Coating, % by weight	≤ 0.1
Moisture, % by weight	≤ 0.1
Screen Analysis [a]	
% by weight on 6 mesh	0
% by weight through 20 mesh	≤1
Bulk Density [b], typical, poured	
g/cc	0.80
lbs/cu ft	50

[a] As manufactured. Screen Analysis changes with with handling.

[b] As manufactured. Bulk density as received may be higher [0.84 g/cc (52 lbs/cu ft)] depending on types and amounts of handling prior to receipt.

Transportation, Storage and Handling

•Always keep prilled ammonium nitrate dry. Choose transportation. processing and storage containers or equipment without openings though which water or moisture can enter.

•Always keep doors, hatches and lids closed when not in use. Inspect all tanks and bins regularly for cracks and leaks.

•Industrial grade prilled ammonium nitrate is susceptible to breakage from moisture, humidity, heat, temperature cycling, pressure and pneumatic or mechanical handling. Fines can result producing possible caking or lumping as well as decreased product flow characteristics/increased bulk density.

•Always design storage and process facilities to minimize repeated pneumatic and mechanical handling. Whenever possible, choose mechanical rather than pneumatic methods to off-load or otherwise transfer ammonium nitrate prills

•Always use an air transfer pressure of 7–8 psig to maintain prill quality where bulk deliveries are transferred to storage by pneumatic conveyance. Never exceed 8-10 psig air pressure.

•For recommended good practices in transporting, storing, handling and using this product, see the Safety Library Publications of the Institute of Makers of Explosives.

•Oxidizers must be transported, stored, handled and used in conformity with all applicable federal, state, provincial and local laws and regulations.

Product Description

DYNO NOBEL AMMONIUM NITRATE prills are industrial grade and specifically designed to be used as a solid oxidizer ingredient for explosive compositions such as ANFO, WR ANFO, Heavy ANFO Emulsion and Watergels. They are small-sized, low-moisture content, non-setting, porous spheres (prills) which have an average diameter range between 0.055 to 0.078 in (1.4 to 2.0 mm). The particle density of the prills is such that, when liquid fuel is properly applied to and mixed with them, the prills absorb the fuel uniformly which enhances reactivity.

DYNO NOBEL AMMONIUM NITRATE is available in bulk by railcar or truck.

Application Recommendations

•Always use liquid hydrocarbon fuels with flash point greater than that of #2 Diesel Fuel [125°F] for mixing with Dyno Nobel Prilled Ammonium Nitrate to manufacture ANFO. Use proper proportion of Fuel Oil to optimize performance and minimize toxic after-blast fumes. Never use waste oil in ANFO for mining applications unless authorized by MSHA.

•Typical density range for ANFO containing Dyno Nobel Ammonium Nitrate mixed and delivered to the borehole by mobile bulk delivery equipment is 0.85 – 0.87 g/cc.

•Always check with the bulk emulsion explosive or matrix manufacturer to ensure compatibility before using ANFO containing Dyno Nobel Prilled Ammonium Nitrate in Heavy ANFO or repumpable emulsion/ ANFO blends,.

Product Disclaimer

Dyno Nobel Inc. and its subsidiaries disclaim any warranties with respect to this product, the safety or suitability thereof, or the results to be obtained, whether express or implied, INCLUDING WITHOUT LIMITATION, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE AND/OR OTHER WARRANTY. Buyers and users assume all risk, responsibility and liability whatsoever from any and all injuries (including death), losses, or damages to persons or property arising from the use of this product. Under no circumstances shall either Dyno Nobel Inc. or any of its subsidiaries be liable for special, consequential or incidental damages or for anticipated loss of profits.

DYNO
Dyno Nobel

NITROGEN PRODUCTS

TECHNICAL INFORMATION

MSDS #1020

AMMONIUM NITRATE

N-01-02-01-03

Industrial Grade

Transportation, Storage and Handling

- Always use equipment especially designed to blend and load ANFO, Heavy ANFO or repumpable emulsion/ANFO blends. Bulk delivery equipment should be calibrated periodically to ensure quality.
- Always purge all hoses, piping, augers and especially bins or tanks that have integral augers before discontinuing loading or mixing. Ammonium Nitrate Prill left in process equipment can make start up difficult and even cause damage.
- Always consider air vibrators for bins, bulk trucks and railcars to assist with the flow of material.
- Always choose bins and tanks that are designed to keep the weight of the bulk material from compacting into transfer augers that are located directly beneath them.
- Always empty and clean bulk tanks and bins routinely to prevent product build-up on walls.
- Always minimize inventory during warm weather and high humidity conditions. Packaged product may harden with temperature cycling; bulk material may cake, lump or break down (fines).
- Always rotate inventory by using the oldest product first.

Hazardous Shipping Description

Ammonium Nitrate 5.1 UN1942 III

or

Ammonium Nitrate Fertilizer 5.1 UN2067 III

OXIDIZER 5.1

Product Disclaimer

Dyno Nobel Inc. and its subsidiaries disclaim any warranties with respect to this product, the safety or suitability thereof, or the results to be obtained, whether express or implied, INCLUDING WITHOUT LIMITATION, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE AND/OR OTHER WARRANTY. Buyers and users assume all risk, responsibility and liability whatsoever from any and all injuries (including death), losses, or damages to persons or property arising from the use of this product. Under no circumstances shall either Dyno Nobel Inc. or any of its subsidiaries be liable for special, consequential or incidental damages or for anticipated loss of profits.

DYNO

Dyno Nobel

Material Safety Data Sheet

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

DIESEL FUEL No. 2

Product Use: Fuel
Product Number(s): CPS220122 [See Section 16 for Additional Product Numbers]
Synonyms: 15 S Diesel Fuel 2, Alternative Low Aromatic Diesel (ALAD), Calco LS Diesel 2, Calco ULS DF2, Calco ULS Diesel 2, Chevron LS Diesel 2, Chevron ULS Diesel 2, Diesel Fuel Oil, Diesel Grade No. 2, Diesel No. 2-D S15, Diesel No. 2-D S500, Diesel No. 2-D S5000, Gas Oil, HS Diesel 2, HS Heating Fuel 2, Light Diesel Oil Grade No. 2-D, LS Diesel 2, LS Heating Fuel 2, Marine Diesel, RR Diesel Fuel, Texaco Diesel, Texaco Diesel No. 2, Ultra Low Sulfur Diesel 2
Company Identification
Chevron Products Company
Marketing, MSDS Coordinator
6001 Bollinger Canyon Road
San Ramon, CA 94583
United States of America

Transportation Emergency Response
CHEMTREC: (800) 424-9300 or (703) 527-3887
Health Emergency
ChevronTexaco Emergency Information Center: Located in the USA. International collect calls accepted. (800) 231-0623 or (510) 231-0623
Product Information
MSDS Requests: (800) 689-3998
Technical Information: (510) 242-5357

SPECIAL NOTES: This MSDS covers all Chevron and Calco non-CARB Diesel No. 2 Fuels. The sulfur content is less than 0.5% (mass). Red dye is added to non-taxable fuel. (MSDS 6894)

SECTION 2 COMPOSITION/ INFORMATION ON INGREDIENTS

COMPONENTS	CAS NUMBER	AMOUNT
Diesel Fuel No. 2	68476-34-6	100 %wt/wt
Distillates, hydrodesulfurized, middle	64742-80-9	0 - 100 %wt/wt
Distillates, straight run middle (gas oil, light)	64741-44-2	0 - 100 %wt/wt
Kerosine	8008-20-6	0 - 25 %wt/wt
Kerosine, hydrodesulfurized	64742-81-0	0 - 25 %wt/wt
Distillates (petroleum), light catalytic cracked	64741-59-9	0 - 50 %wt/wt
Naphthalene	91-20-3	0.02 - 0.2 %wt/wt
Total sulfur	None	0 - 0.5 %wt/wt

Information on ingredients that are considered Controlled Products and/or that appear on the WHMIS Ingredient Disclosure List (IDL) is provided as required by the Canadian Hazardous Products Act (HPA, Sections 13 and 14). Ingredients considered hazardous under the OSHA Hazard Communication Standard, 29 CFR 1910.1200, are also listed. See Section 15 for additional regulatory information.

SECTION 3 HAZARDS IDENTIFICATION

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EMERGENCY OVERVIEW

- COMBUSTIBLE LIQUID AND VAPOR
- HARMFUL OR FATAL IF SWALLOWED - MAY CAUSE LUNG DAMAGE IF SWALLOWED
- CAUSES SKIN IRRITATION
- MAY CAUSE CANCER BASED ON ANIMAL DATA
- TOXIC TO AQUATIC ORGANISMS

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IMMEDIATE HEALTH EFFECTS
Eye: Not expected to cause prolonged or significant eye irritation.
Skin: Contact with the skin causes irritation. Skin contact may cause drying or defatting of the skin. Symptoms may include pain, itching, discoloration, swelling, and blistering. Contact with the skin is not expected to cause an allergic skin response. Not expected to be harmful to internal organs if absorbed through the skin.
Ingestion: Because of its low viscosity, this material can directly enter the lungs, if swallowed, or if subsequently vomited. Once in the lungs it is very difficult to remove and can cause severe injury or death. May be irritating to mouth, throat, and stomach. Symptoms may include pain, nausea, vomiting, and diarrhea.
Inhalation: Mists of this material may cause respiratory irritation. Symptoms of respiratory irritation may include coughing and difficulty breathing. Breathing this material at concentrations above the recommended exposure limits may cause central nervous system effects. Central nervous system effects may include headache, dizziness, nausea, vomiting, weakness, loss of coordination, blurred vision, drowsiness, confusion, or disorientation. At extreme exposures, central nervous system effects may include respiratory depression, tremors or convulsions, loss of consciousness, coma or death.

DELAYED OR OTHER HEALTH EFFECTS:
Cancer: Prolonged or repeated exposure to this material may cause cancer. Whole diesel engine exhaust has been classified as a Group 2A carcinogen (probably carcinogenic to humans) by the International Agency for Research on Cancer (IARC). Diesel exhaust particulate has been classified as reasonably anticipated to be a human carcinogen in the National Toxicology Program's Ninth Report on Carcinogens. The National Institute of Occupational Safety and Health (NIOSH) has recommended that whole diesel exhaust be regarded as potentially causing cancer. Diesel engine exhaust is known to the State of California to cause cancer. Contains naphthalene, which has been classified as a Group 2B carcinogen (possibly carcinogenic to humans) by the International Agency for Research on Cancer (IARC).
See Section 11 for additional information. Risk depends on duration and level of exposure.

SECTION 4 FIRST AID MEASURES

Eye: No specific first aid measures are required. As a precaution, remove contact lenses, if worn, and flush eyes with water.
Skin: Wash skin with water immediately and remove contaminated clothing and shoes. Get medical attention if any symptoms develop. To remove the material from skin, use soap and water. Discard contaminated clothing and shoes or thoroughly clean before reuse.
Ingestion: If swallowed, get immediate medical attention. Do not induce vomiting. Never give anything by mouth to an unconscious person.
Inhalation: Move the exposed person to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention if breathing difficulties continue.
Note to Physicians: Ingestion of this product or subsequent vomiting may result in aspiration of light hydrocarbon liquid, which may cause pneumonitis.

SECTION 5 FIRE FIGHTING MEASURES

See Section 7 for proper handling and storage.

FLAMMABLE PROPERTIES:
Flashpoint: (Pensky-Martens Closed Cup) 52 °C (125 °F) (Min)
Autoignition: 257 °C (494 °F)
Flammability (Explosive) Limits (% by volume in air): Lower: 0.6 Upper: 4.7

EXTINGUISHING MEDIA: Use water fog, foam, dry chemical or carbon dioxide (CO2) to extinguish flames.
PROTECTION OF FIRE FIGHTERS:
Fire Fighting Instructions: For fires involving this material, do not enter any enclosed or confined fire space without proper protective equipment, including self-contained breathing apparatus.
Combustion Products: Highly dependent on combustion conditions. A complex mixture of airborne solids, liquids, and gases including carbon monoxide, carbon dioxide, and unidentified organic compounds will be evolved when this material undergoes combustion.

SECTION 6 ACCIDENTAL RELEASE MEASURES

Protective Measures: Eliminate all sources of ignition in the vicinity of the spill or released vapor. If this material is released into the work area, evacuate the area immediately. Monitor area with combustible gas indicator.
Spill Management: Stop the source of the release if you can do it without risk. Contain release to prevent further contamination of soil, surface water or groundwater. Clean up spill as soon as possible, observing precautions in Exposure Controls/Personal Protection. Use appropriate techniques such as applying non-combustible absorbent materials or pumping. All equipment used when handling the product must be grounded. A vapor suppressing foam may be used to reduce vapors. Use clean non-sparking tools to collect absorbed material. Where feasible and appropriate, remove contaminated soil. Place contaminated materials in disposable containers and dispose of in a manner consistent with applicable regulations.
Reporting: Report spills to local authorities as appropriate or required.

SECTION 7 HANDLING AND STORAGE

Precautionary Measures: Liquid evaporates and forms vapor (fumes) which can catch fire and burn with explosive force. Invisible vapor spreads easily and can be set on fire by many sources such as pilot lights, welding equipment, and electrical motors and switches. Fire hazard is greater as liquid temperature rises above 29C (85F).
Do not get in eyes, on skin, or on clothing. Do not taste or swallow. Do not breathe vapor or fumes. Do not breathe mist. Wash thoroughly after handling. Keep out of the reach of children.
Unusual Handling Hazards: WARNING! Do not use as portable heater or appliance fuel. Toxic fumes may accumulate and cause death.
General Handling Information: Avoid contaminating soil or releasing this material into sewage and drainage systems and bodies of water.
Static Hazard: Electrostatic charge may accumulate and create a hazardous condition when handling this material. To minimize this hazard, bonding and grounding may be necessary but may not, by themselves, be sufficient. Review all operations which have the potential of generating and accumulating an electrostatic charge and/or a flammable atmosphere (including tank and container filling, splash filling, tank cleaning, sampling, gauging, switch loading, filtering, mixing, agitation, and vacuum truck operations) and use appropriate mitigating procedures. For more information, refer to OSHA Standard 29 CFR 1910.106, 'Flammable and Combustible Liquids', National Fire Protection Association (NFPA 77, 'Recommended Practice on Static Electricity', and/or the American Petroleum Institute (API) Recommended Practice 2003, 'Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents'.
General Storage Information: DO NOT USE OR STORE near heat, sparks, flames, or hot surfaces . USE AND STORE ONLY IN WELL VENTILATED AREA. Keep container closed when not in use.
Container Warnings: Container is not designed to contain pressure. Do not use pressure to empty container or it may rupture with explosive force. Empty containers retain product residue (solid, liquid, and/or vapor) and can be dangerous. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose such containers to heat, flame, sparks, static electricity, or other sources of ignition. They may explode and cause injury or death. Empty containers should be completely drained, properly closed, and promptly returned to a drum reconditioner or disposed of properly.

SECTION 8 EXPOSURE CONTROLS/PERSONAL PROTECTION

GENERAL CONSIDERATIONS:
Consider the potential hazards of this material (see Section 3), applicable exposure limits, job activities, and other substances in the work place when designing engineering controls and selecting personal protective equipment. If engineering controls or work practices are not adequate to prevent exposure to harmful levels of this material, the personal protective equipment listed below is recommended. The user should read and understand all instructions and limitations supplied with the equipment since protection is usually provided for a limited time or under certain circumstances.

ENGINEERING CONTROLS:
Use process enclosures, local exhaust ventilation, or other engineering controls to control airborne levels below the recommended exposure limits.

PERSONAL PROTECTIVE EQUIPMENT

Eye/Face Protection: No special eye protection is normally required. Where splashing is possible, wear safety glasses with side shields as a good safety practice.

Skin Protection: Wear protective clothing to prevent skin contact. Selection of protective clothing may include gloves, apron, boots, and complete facial protection depending on operations conducted. Suggested materials for protective gloves include: Chlorinated Polyethylene (or Chlorosulfonated Polyethylene), Nitrile Rubber, Polyurethane, Viton.

Respiratory Protection: Determine if airborne concentrations are below the recommended occupational exposure limits for jurisdiction of use. If airborne concentrations are above the acceptable limits, wear an approved respirator that provides adequate protection from this material, such as: Air-Purifying Respirator for Organic Vapors.

When used as a fuel, this material can produce carbon monoxide in the exhaust. Determine if airborne concentrations are below the occupational exposure limit for carbon monoxide. If not, wear an approved positive-pressure air-supplying respirator.

Use a positive pressure air-supplying respirator in circumstances where air-purifying respirators may not provide adequate protection.

Occupational Exposure Limits:

Component	Country/ Agency	TWA	STEL	Ceiling	Notation
Diesel Fuel No. 2	ACGIH	100 mg/m3	--	--	Skin A3
Diesel Fuel No. 2	CVX	--	1000 mg/m3	--	--
Kerosine	ACGIH	200 mg/m3	--	--	Skin A3
Kerosine	CVX	--	1000 mg/m3	--	--
Kerosine, hydrodesulfurized	ACGIH	200 mg/m3	--	--	Skin A3
Kerosine, hydrodesulfurized	CVX	--	1000 mg/m3	--	--
Naphthalene	ACGIH	10 ppm (weight)	15 ppm (weight)	--	Skin A4

NOTE ON OCCUPATIONAL EXPOSURE LIMITS: Consult local authorities for acceptable provincial values in Canada. Consult the Canadian Standards Association Standard 94.4-2002 Selection, Use and Care of Respirators.

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

Attention: the data below are typical values and do not constitute a specification.

Color: Varies depending on specification
Physical State: Liquid
Odor: Petroleum odor
pH: Not Applicable
Vapor Pressure: 0.04 kPa (Approximate) @ 40 °C (104 °F)
Vapor Density (Air = 1): >1
Boiling Point: 175.6°C (348°F) - 370°C (698°F)
Solubility: Soluble in hydrocarbons; insoluble in water
Freezing Point: Not Applicable
Melting Point: Not Applicable
Specific Gravity: 0.8 - 0.88 @ 15.6°C (60.1°F) (Typical)
Viscosity: 1.9 cSt - 4.1 cSt @ 40°C (104°F)
Odor Threshold: No Data Available
Coefficient of Water/Oil Distribution: No Data Available

SECTION 10 STABILITY AND REACTIVITY

Chemical Stability: This material is considered stable under normal ambient and anticipated storage and handling conditions of temperature and pressure.

Incompatibility With Other Materials: May react with strong acids or strong oxidizing agents, such as chlorates, nitrates, peroxides, etc.

Hazardous Decomposition Products: None known (None expected)

Hazardous Polymerization: Hazardous polymerization will not occur.

Sensitivity to Mechanical Impact: No.

SECTION 11 TOXICOLOGICAL INFORMATION

IMMEDIATE HEALTH EFFECTS
Eye Irritation: The eye irritation hazard is based on evaluation of data for similar materials or product components.
Skin Irritation: The skin irritation hazard is based on evaluation of data for similar materials or product components.
Skin Sensitization: This material did not cause skin sensitization reactions in a Buehler guinea pig test.
Acute Dermal Toxicity: LD50: >5ml/kg (rabbit).
Acute Oral Toxicity: LD50: > 5 ml/kg (rat)
Acute Inhalation Toxicity: 4 hour(s) LC50: > 5mg/l (rat).

For additional information on the acute toxicity of the components, call the technical information center.

ADDITIONAL TOXICOLOGY INFORMATION:
This product contains gas oils.
CONCAWE (product dossier 95/107) has summarized current health, safety and environmental data available for a number of gas oils, typically hydrodesulfurized middle distillates, CAS 64742-80-9, straight-run middle distillates, CAS 64741-44-2, and/or light cat-cracked distillate CAS 64741-59-9. CARCINOGENICITY: All materials tested have caused the development of skin tumors in mice, but all featured severe skin irritation and sometimes a long latency period before tumors developed. Straight-run and cracked gas oil samples were studied to determine the influence of dermal irritation on the carcinogenic activity of middle distillates. At non-irritant doses the straight-run gas oil was not carcinogenic, but at irritant doses, weak activity was demonstrated. Cracked gas oils, when diluted with mineral oil, demonstrated carcinogenic activity irrespective of the occurrence of skin irritation. Gas oils were tested on male mice to study tumor initiating/promoting activity. The results demonstrated that while a straight-run gas oil sample was neither an initiator or promotor, a blend of straight-run and FCC stock was both a tumor initiator and a promoter.
GENOTOXICITY: Hydrotreated & hydrodesulfurized gas oils range in activity from inactive to weakly positive in in-vitro bacterial mutagenicity assays. Mouse lymphoma assays on straight-run gas oils without subsequent hydrodesulphurization gave positive results in the presence of S9 metabolic activation. In-vivo bone marrow cytogenetics and sister chromatic exchange assay exhibited no activity for straight-run components with or without hydrodesulphurization. Thermally or catalytically cracked gas oils tested with in-vitro bacterial mutagenicity assays in the presence of S9 metabolic activation were shown to be mutagenic. In-vitro sister chromatic exchange assays on cracked gas oil gave equivocal results both with and without S9 metabolic activation. In-vivo bone marrow cytogenetics assay was inactive for two cracked gas oil samples. Three hydrocracked gas oils were tested with in-vitro bacterial mutagenicity assays with S9, and one of the three gave positive results. Twelve distillate fuel samples were tested with in-vitro bacterial mutagenicity assays & with S9 metabolic activation and showed negative to weakly positive results. In one series, activity was shown to be related to the PCA content of samples tested. Two in-vivo studies were also conducted. A mouse dominant lethal assay was negative for a sample of diesel fuel. In the other study, 9 samples of No 2 heating oil containing 50% cracked stocks caused a slight increase in the number of chromosomal aberrations in bone marrow cytogenetics assays. DEVELOPMENTAL TOXICITY: Diesel fuel vapor did not cause fetotoxic or teratogenic effects when pregnant rats were exposed on days 6-15 of pregnancy. Gas oils were applied to the skin of pregnant rats daily on days 0-19 of gestation. All but one (coker light gas oil) caused fetotoxicity (increased resorptions, reduced litter weight, reduced litter size) at dose levels that were also maternally toxic.

This product contains naphthalene. GENERAL TOXICITY: Exposure to naphthalene has been reported to cause methemoglobinemia and/or hemolytic anemia, especially in humans deficient in the enzyme glucose-6-phosphate dehydrogenase. Laboratory animals given repeated oral doses of naphthalene have developed cataracts. REPRODUCTIVE TOXICITY AND BIRTH DEFECTS: Naphthalene did not cause birth defects when administered orally to rabbits, rats, and mice during pregnancy, but slightly reduced litter size in mice at dose levels that were lethal to the pregnant females. Naphthalene has been reported to cross the human placenta. GENETIC TOXICITY: Naphthalene caused chromosome aberrations and sister chromatid exchanges in Chinese hamster ovary cells, but was not a mutagen in several other in-vitro tests.CARCINOGENICITY: In a study conducted by the National Toxicology Program (NTP), mice exposed to 10 or 30 ppm of naphthalene by inhalation daily for two years had chronic inflammation of the nose and lungs and increased incidences of metaplasia in those tissues. The incidence of benign lung tumors (alveolar/bronchiolar adenomas) was significantly increased in the high-dose female group but not in the male groups. In another two-year inhalation study conducted by NTP, exposure of rats to 10, 30, and 60 ppm naphthalene caused increases in the incidences of a variety of nonneoplastic lesions in the nose. Increases in nasal tumors were seen in both sexes, including olfactory neuroblastomas in females at 60 ppm and adenomas of the respiratory epithelium in males at all exposure levels. The relevance of these effects to humans has not been established. No carcinogenic effect was reported in a 2-year feeding study in rats receiving naphthalene at 41 mg/kg/day.

This product may contain significant amounts of Polynuclear Aromatic Hydrocarbons (PAH's) which have been shown to cause skin cancer after prolonged and frequent contact with the skin of test animals. Brief or intermittent skin contact with this product is not expected to have serious effects if it is washed from the skin. While skin cancer is unlikely to occur in human beings following use of this product, skin contact and breathing, of mists, vapors or dusts should be reduced to a minimum.

SECTION 12 ECOLOGICAL INFORMATION

ECOTOXICITY

96 hour(s) LC50: 21-210 mg/l (Salmo gairdneri)
48 hour(s) EC50: 20-210 mg/l (Daphnia magna)
72 hour(s) EC50: 2.6-25 mg/l (Raphidocellus subcapitata)
This material is expected to be toxic to aquatic organisms.

ENVIRONMENTAL FATE

On release to the environment the lighter components of diesel fuel will generally evaporate but depending on local environmental conditions (temperature, wind, mixing or wave action, soil type, etc.) the remainder may become dispersed in the water column or absorbed to soil or sediment. Diesel fuel would not be expected to be readily biodegradable. In a modified Strum test (OECD method 301B) approximately 40% biodegradation was recorded over 28 days. However, it has been shown that most hydrocarbon components of diesel fuel are degraded in soil in the presence of oxygen. Under anaerobic conditions, such as in anoxic sediments, rates of biodegradation are negligible.

SECTION 13 DISPOSAL CONSIDERATIONS

Use material for its intended purpose or recycle if possible. This material, if it must be discarded, may meet the criteria of a hazardous waste as defined by USEPA under RCRA (40CFR261), Environment Canada, or other State, Provincial, and local regulations. Measurement of certain physical properties and analysis for regulated components may be necessary to make a correct determination. If this material is classified as a hazardous waste, federal law requires disposal at a licensed hazardous waste disposal facility.

SECTION 14 TRANSPORT INFORMATION

The description shown may not apply to all shipping situations. Consult 49CFR, or appropriate Dangerous Goods Regulations, for additional description requirements (e.g., technical name) and mode-specific or quantity-specific shipping requirements.

TC Shipping Description: GAS OIL,3,UN1202,III

DOT Shipping Description: GAS OIL, Combustible Liquid, UN1202,III

SECTION 15 REGULATORY INFORMATION

REGULATORY LISTS SEARCHED:

01-1=IARC Group 1
01-2A=IARC Group 2A
01-2B=IARC Group 2B
35=WHMIS IDL

The following components of this material are found on the regulatory lists indicated.

Naphthalene	01-2B, 35

CHEMICAL INVENTORIES:

All components comply with the following chemical inventory requirements: AICS (Australia), DSL (Canada), EINECS (European Union), IECSC (China), KECI (Korea), PICCS (Philippines), TSCA (United States).

WHMIS CLASSIFICATION:

Class B, Division 3: Combustible Liquids
Class D, Division 2, Subdivision A: Very Toxic Material - Carcinogenicity

Class D, Division 2, Subdivision B: Toxic Material -
Skin or Eye Irritation

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all of the information required by those regulations. (See Hazardous Products Act (HPA), R.S.C. 1985, c.H-3,s.2).

MSDS PREPARATION:

This Material Safety Data Sheet has been prepared by the Toxicology and Health Risk Assessment Unit, ERTC, P.O. Box 1627, Richmond, CA 94804, (888)676-6183.

Revision Date: 08/30/2005

SECTION 16 OTHER INFORMATION

Additional Product Number(s): CPS225114, CPS225115, CPS225150, CPS266176, CPS270005, CPS270094, CPS270095, CPS270096, CPS271006, CPS272093, CPS272102, CPS272126, CPS272152, CPS272185, CPS272190, CPS272195, CPS272593, CPS272601, CPS272693, CPS272793, CPS273003, CPS273030, CPS273053, CPS275000

REVISION STATEMENT: This is a new Material Safety Data Sheet.

ABBREVIATIONS THAT MAY HAVE BEEN USED IN THIS DOCUMENT:

TLV - Threshold Limit Value	TWA - Time Weighted Average
STEL - Short-term Exposure Limit	PEL - Permissible Exposure Limit
	CAS - Chemical Abstract Service Number
ACGIH - American Conference of Government Industrial Hygienists	IMO/IMDG - International Maritime Dangerous Goods Code
API - American Petroleum Institute	MSDS - Material Safety Data Sheet
CVX - ChevronTexaco	NFPA - National Fire Protection Association (USA)
DOT - Department of Transportation (USA)	NTP - National Toxicology Program (USA)
IARC - International Agency for Research on Cancer	OSHA - Occupational Safety and Health Administration

The above information is based on the data of which we are aware and is believed to be correct as of the date hereof. Since this information may be applied under conditions beyond our control and with which we may be unfamiliar and since data made available subsequent to the date hereof may suggest modifications of the information, we do not assume any responsibility for the results of its use. This information is furnished upon condition that the person receiving it shall make his own determination of the suitability of the material for his particular purpose.

Attachment D

DOE/NV-317 (Rev. 1)
UC-702

DOE/NV-317 (Rev. 1)
UC-702

RADIOLOGICAL EFFLUENTS RELEASED FROM U.S. CONTINENTAL TESTS 1961 THROUGH 1992

AUGUST 1996

UNITED STATES DEPARTMENT OF ENERGY

NEVADA OPERATIONS OFFICE

Test:	**MARSHMALLOW**		
Date:	06/28/62	**Sponsor:**	DoD/LRL
Time:	1000 PDT	**Depth of Burial:**	1,020 ft
Location:	NTS U16a	**Purpose:**	Weapons Effects
Type:	Tunnel	**Yield:**	Low
Release Detected:	Onsite Only	**Type of Release:**	Uncontrolled

Uncontrolled Release at R+12 Hours, in Curies: 3.5 x 10^{4}

Release Summary: An uncontrolled test release due to a stemming failure occurred at H+5 minutes and continued for several days. The estimated release at the time of release was approximately 1.0 x 10^{6} curies.

References: (A) (E) (F) (H) (K) (L) (AY) (DA)

Test:	**SACRAMENTO**		
Date:	06/30/62	**Sponsor:**	LRL
Time:	1430 PDT	**Depth of Burial:**	500 ft
Location:	NTS U9v	**Purpose:**	Weapons Related
Type:	Shaft	**Yield:**	Low
Release Detected:	Onsite Only	**Type of Release:**	Drillback

Drillback Release Activity at Time of Release: Slight

NOTE: See statement in explanatory information on "qualitative onsite release data."

References: (A) (C) (E) (F) (H) (AY) (DA)

Test:	**SEDAN**		
Date:	07/06/62	**Sponsor:**	LRL
Time:	1000 PDT	Depth of Burial:	635 ft
Location:	NTS U10h	**Purpose:**	Plowshare
Type:	Crater	**Yield:**	104 kt
Release Detected:	Offsite	**Type of Release:**	Test/Crater

Test Release at R+12 Hours, in Curies: 1.5 x 10^{7}

Isotopes Identified in the Release: ^{7}Be, ^{24}Na, ^{56}Mn, ^{103}Ru, ^{131}I, ^{132}I, ^{133}I, ^{135}I, ^{132}Te, ^{140}Ba/^{140}La, ^{181}W, ^{187}W, ^{188}W, and tracers

Test:	**PALANQUIN**		
Date:	04/14/65	**Sponsor:**	LRL
Time:	0514 PST	**Depth of Burial:**	280 ft
Location:	NTS U20k	**Purpose:**	Plowshare
Type:	Crater	**Yield:**	4.3 kt
Release Detected:	Offsite	**Type of Release:**	Test/Crater

Test Release at R+12 Hours, in Curies: 1.1×10^7

Isotopes Identified in the Release: ^{91}Sr, ^{91m}Y, ^{95}Zr/^{95}Nb, ^{97}Zr/^{97}Nb, ^{99}Mo, ^{99}Tc, ^{131}I, ^{133}I, ^{135}I, ^{135}Xe, and ^{140}Ba/^{140}La

Cloud Direction: Northerly to Pine Creek Ranch, Nevada

Maximum Activity Detected in Air Offsite: 23,000 picocuries of gross beta activity per cubic meter of air at Clark Station, Nevada (populated site); highest concentration in an unpopulated site, 87,000 picocuries of gross beta activity per cubic meter of air at Highway 6, eight miles east of the Tonopah Test Range Road

Maximum Gamma Exposure Rate Detected Offsite: 3 mR/h at Stone Cabin Ranch, Nevada

Maximum Iodine Level Detected Offsite: 32,000 picocuries of ^{135}I per cubic meter of air, 16,000 picocuries of ^{133}I per cubic meter of air, and 4,100 picocuries of ^{131}I per cubic meter of air at Clark Station, Nevada (populated site); highest concentration in an unpopulated site, 12,000 picocuries of ^{131}I per cubic meter of air, 65,000 picocuries of ^{133}I per cubic meter of air and 160,000 picocuries of ^{135}I per cubic meter of air at Highway 6, eight miles east of the Tonopah Test Range Road; highest ^{131}I concentration in milk, 11,000 picocuries per liter at Martin Ranch near Eureka, Nevada; no children present

Maximum Distance Radiation Detected Offsite: 0.03 mR/h at Council, Idaho

Release Summary: The planned test release occurred at the surface ground zero area at H hour and lasted for one minute.

References: (C) (E) (H) (M) (AT) (DK) (GY) (KS)

Test:	**GUM DROP**		
Date:	04/21/65	**Sponsor:**	DoD/LRL
Time:	1400 PST	**Depth of Burial:**	1,000 ft
Location:	NTS U16a.02	**Purpose:**	Weapons Effects
Type:	Tunnel	**Yield:**	Less than 20 kt
Release Detected:	Onsite Only	**Type of Release:**	Controlled and Drillback

Drillback Release Activity at Time of Release, in Curies: 3.5×10^1

^{133}Xe in curies: 3.5×10^1

^{133m}Xe in curies: 5.4×10^{-1}

Release Summary: A drillback release occurred from the ventilation line at 0630 hours on May 26, 1966, and lasted for 13.2 days.

References: (C) (E) (H) (AU) (LO)

Test:	**PILE DRIVER**		
Date:	06/02/66	**Sponsor:**	DoD/LASL
Time:	0830 PDT	**Depth of Burial:**	1,519 ft
Location:	NTS U15a.01	**Purpose:**	Weapons Effects
Type:	Tunnel	**Yield:**	62 kt
Release Detected:	Onsite Only	**Type of Release:**	Uncontrolled

Uncontrolled Release at R+12 Hours, in Curies: 3.7×10^4

Isotopes Identified in the Release: ^{135}Xe

Release Summary: An uncontrolled test release occurred as the result of seepage from the surface ground zero area at H+12 hours and lasted for 11 hours.

References: (B) (E) (H) (L) (P) (R) (AU) (LP)

Test:	**DOUBLE PLAY**		
Date:	06/15/66	**Sponsor:**	DoD/LRL
Time:	1000 PDT	**Depth of Burial:**	1,050 ft
Location:	NTS U16a.03	**Purpose:**	Weapons Effects
Type:	Tunnel	**Yield:**	Less than 20 kt
Release Detected:	Offsite (Uncontrolled Only)	**Type of Release:**	Controlled, Uncontrolled and Drillback

Controlled Release Activity at Time of Release, in Curies: 4.0×10^4

Controlled Release Activity at R+12 Hours, in Curies: 2.6×10^4

Uncontrolled Release at R+12 Hours, in Curies: 8.0×10^5

Isotopes Identified in the Release: Noble gases and radioiodines

Cloud Direction: Northeasterly for about 200 miles

Test:	**MINT LEAF**		
Date:	05/05/70	**Sponsor:**	DoD/LRL
Time:	0830 PDT	**Depth of Burial:**	1,300 ft
Location:	NTS U12t.01	**Purpose:**	Weapons Effects
Type:	Tunnel	**Yield:**	Less than 20 kt
Release Detected:	Offsite	**Type of Release:**	Controlled

Controlled Release Activity at Time of Release, in Curies: 9.6×10^5

Controlled Release Activity at R+12 Hours, in Curies: 3.9×10^5

Isotopes Identified in the Release: ^{85m}Kr, ^{131}I, ^{133}I, ^{135}I, ^{133}Xe, ^{133m}Xe, and ^{135}Xe

Cloud Direction: Easterly

Maximum Activity Detected in Air Offsite: 6,000 picocuries of ^{135}Xe per cubic meter of air on Highway 25 Nevada (populated), no gross beta detected

Maximum Gamma Exposure Rate Detected Offsite: 0.02 mR/h near Queen City Summit, Nevada (unpopulated)

Maximum Iodine Level Detected Offsite: No special water, milk, or other samples were collected for this test.

Maximum Distance Radiation Detected Offsite: 0.02 mR/h at Queen City Summit, Nevada

Release Summary: Three controlled releases occurred as follows: (1) during gas sampling between H+4.6 and H+7.5 hours when predominantly fission gases (^{135}Xe and ^{85m}Kr) were exhausted into the ventilation lines and passed through the filter system before being released to the atmosphere; (2) during ventilation of the tunnel complex with the effluent (approximately 98% ^{135}Xe, 2% ^{133}Xe, and less than 1 curie of radioiodines) passing through the filter system between H+24 and H+31 hours; and (3) during ventilation of the tunnel complex at H+166.2 hours until the tunnel was cleared with the effluent (^{133}Xe and ^{133m}Xe) released passing through a filter system.

References: (C) (D) (E) (H) (L) (AA) (ET) (FE) (HU) (HV)

Test:	**DIAMOND DUST**		
Date:	05/12/70	**Sponsor:**	DoD/LASL
Time:	0700 PDT	**Depth of Burial:**	728 ft
Location:	NTS U16a.05	**Purpose:**	Vela Uniform
Type:	Tunnel	**Yield:**	Less than 20 kt
Release Detected:	Onsite Only	**Type of Release:**	Controlled

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LB. Rich, B. L. (LRL); Memo to W. R. Woodruff, UC/LRL, Subject: Interim Report - U10k, CORDUROY Event (Deleted); January 13, 1966.*

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Attachment E

TR-0221-11

EOSAEL 87

Volume 11

COMBINED OBSCURATION MODEL FOR BATTLEFIELD-INDUCED CONTAMINANTS

COMBIC

October 1987

by

D. W. Hoock
R. A. Sutherland
D. Clayton

Distribution authorized to DoD and DoD Contractors only;
Specific Authority: AR 530-1 (31 October 1987).
Other requests for this document shall be referred to
U.S. Army Atmospheric Sciences Laboratory.

U.S. Army Laboratory Command
Atmospheric Sciences Laboratory
White Sands Missile Range, NM 88002-5501

1.11 The COMBIC Model for High-Explosive and Vehicular-Generated Dust

HE and vehicular-produced dust obscuration are fundamentally more difficult to model than smoke due to the variations in the natural sources. COMBIC models HE dust generated by static uncased, static cased, and live-fire munitions detonated at any depth or height of burst and for any angle of impact, that is, munition orientation. A model is provided to extend the crater volume prediction to include any user-defined munition and to treat various soil types. A sod depth correction has been added to reduce the computed volume of ejecta from the crater and the amount of dust accordingly. COMBIC approaches the problem of the broad range of sizes of dust particles by dividing the model into clouds of three size ranges. A very large particle "mode" has been added that accounts for the ballistic soil and large agglomerates that remain airborne for only a few seconds. This change was required to better model the effects on millimeter wavelengths. A large particle mode component is included to partly address the dust size distribution from 20μm to 200μm, which falls out somewhat more slowly than the very large mode. Finally, a small size "persistent" mode that remains suspended for long periods and contributes the most extinction per unit mass is included.

Sizes (3)
$x > 200 \mu m$
$20 \mu m < x < 200 \mu m$
$x < 20 \mu m$

A submunition option allows the approximate treatment of explosive subunits that form separate craters. The barrage option treats large numbers of munitions impacting over a small area and relatively continuous time interval as a simplified continuous source of dust. The vehicular dust option models the movement of the source and provides scaling relationships for the amount of dust as a function of vehicle speed, weight, and silt content.

He Dust clouds have 5 subclouds:

HE-generated dust clouds are treated as five subcloud components: (1) a buoyant small particle puff, (2) a buoyant, large particle stem that settles out with time, (3) a nonbuoyant puff to model the small particle dust skirt, (4) a connecting small particle stem between the skirt and the buoyant clouds and (5) a very large particle puff that follows a ballistic trajectory. Carbon particulates produced during the detonation process are partitioned among the buoyant clouds and stem.

A major problem in modeling HE dust is to define the quantity of dust lofted into the atmosphere. Measurements[69 70] show that the size distribution is extremely broad with an appreciable mode of particles larger than 20μm. Size distribution measurements performed at different locations also suggest that the airborne distributions of small particles are not as strongly correlated to the percentage of clay (less than 2μm diameter), silt (2μm to 70μm diameter), and sand (greater than 70μm diameter) of the parent soil as one might expect.

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[69] R. G. Pinnick et al, 1982, Vehicular Dust and Fire Products Particle Size and Concentration Measurements in BIC-1 and BIC-2, Internal Report, US Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM

[70] R. G. Pinnick, G. Fernandez, and B. Hinds, 1982, "Explosion Debris Particle Size Measurements in DIRT-III," DRCPM-SMK-T-001-82, OPM Smoke/Obscurants Proceedings of Smoke Symposium VI, Aberdeen Proving Ground, MD

This difference may be due in part to the soil analysis technique that breaks up soil agglomerates, to the agglomeration of particles by explosive shock, and to other factors. The definition of dust optical properties in terms of extinction per unit mass is also made difficult by the wide range of particle sizes. Particles much larger than the wavelength of interest contribute a large part to the mass but only a small part to the extinction. They also settle out of the cloud, and thus the size distribution is time dependent. The characterization of dust clouds is, therefore, more empirical than for smoke.

Modeling begins with the prediction of the crater volume that is the source of most of the HE-generated dust. The crater volume is dependent on the explosive yield, which is measured in terms of the equivalent yield of TNT; the depth of burst; soil type; charge orientation; and means of delivery. The COMBIC model is that developed by Thompson.[13 71] The apparent crater volume is assumed to scale for any explosive yield W (although Thompson's argument in choosing 1.111 over 1 is that the charges are "small," 1000 lb or less) as

V_{ac} = Volume crater (m³)
W = lbs TNT equivilent (lbs.)
S_{ac} = Crater Scaling factor.

$$V_{ac} = S_{ac} W^{1.111} , \qquad (214)$$

1.111 for charges < 1000 lbs New
1.000 for charges > 1000 lbs New

where W is in pounds of TNT, and V_{ac} is in m³. The apparent crater scaling factor S_{ac} contains all other dependent factors. DRTRAN,[2] an earlier EOSAEL dust model on which some of COMBIC is based, used polynomial fits to scaled crater depth and radius as a function of burst depth and soil conditions. Thompson found that the curves could be reduced to a single representation for static uncased charges. Figure 11 shows the resultant curve, and table 12 presents the multiplicative scale factors for the various soil types. For equal yield, soil type, and burst depth, significant differences occur between craters formed by uncased and cased explosives and those formed by static explosions and live-fire delivery. From a first principle's approach, the fraction of energy carried away by the shell casing fragments, F_s, was determined in terms of the work done by expanding combustion products to be 37.5 percent of the total yield.

* 37.5% of total yield lost to shell casing fragments

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[13] J. H. Thompson and J. G. DeVore, 1982, ASL-DUST, Version II: A Tactical Battlefield Dust Cloud and Propagation Code, Kaman Tempo Report KT-82-007, contractor report for the US Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM

[71] J. Thompson, 1980, ASL-DUST: A Tactical Battlefield Dust Cloud and Propagation Code, 2 volumes, ASL-CR-80-0143-1,2, US Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM

[2] L. D. Duncan, ed, 1981, EOSAEL 80, Volume I - Technical Documentation, ASL-TR-0072, US Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM

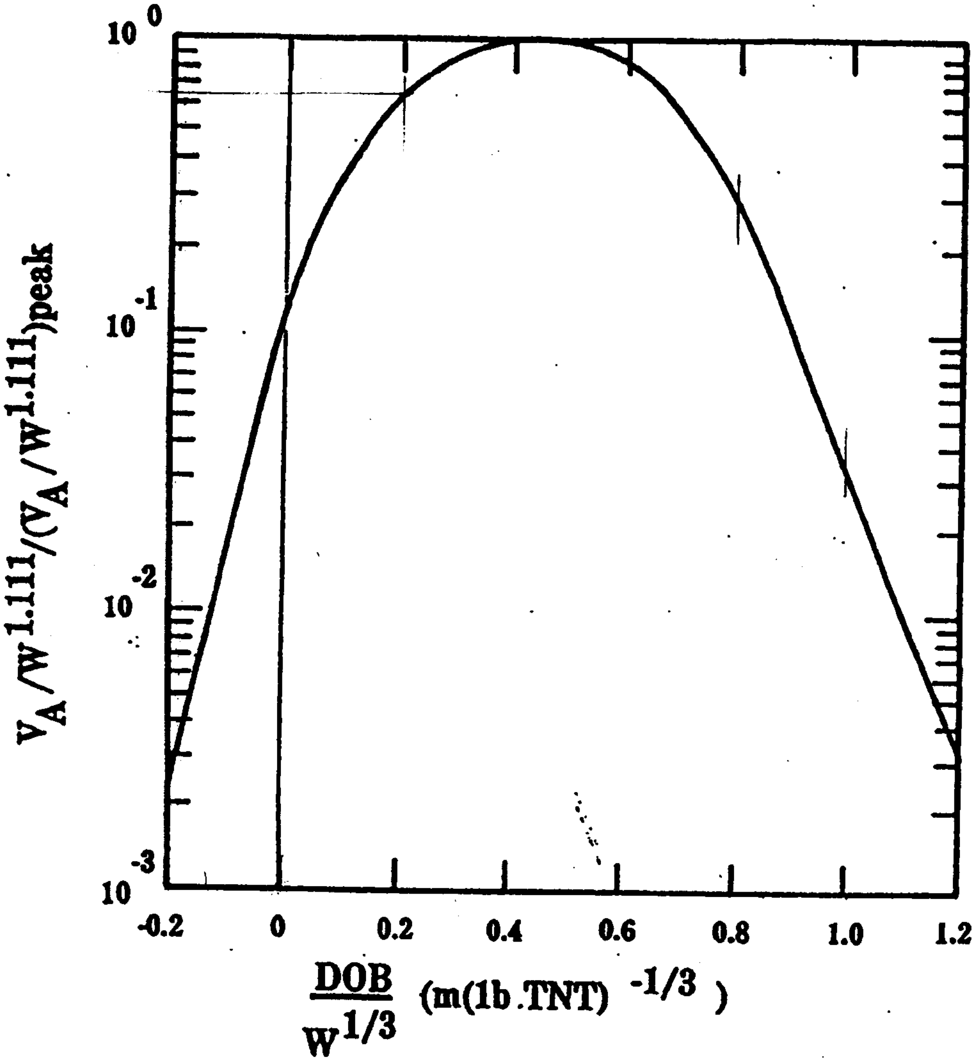

Figure 11. Universal apparent crater volume for bare charges.
(no shell casing)

TABLE 12. SOIL DEPENDENT PARAMETERS - MAXIMUM CRATER SCALING FACTORS AND AIRBORNE DUST FRACTIONS OF APPARENT CRATER VOLUME

Soil Type and Code	S_{ac} Bare Charge Peak Scaled Crater Volume m³ (lb TNT)$^{-1.111}$	Fraction of Apparent Crater Mass in			
		100 µm – 1 cm Ballistic Cloud	10–100 µm Large-Particle Stem	< 10 µm Small-Particle Fireball	Small-Particle Stem
Rock	0.0175	.09914 0.15857	.06 .05824 0.05943.	.0003 .00029 1.19 × 10⁻³	.00090
* Dry cohesive soils	0.0218	.05470 0.0968? (5.470%)	.03223 0.0421? (3.223%)	.00253 0.001 9.87 × 10⁻³]? (0.253%)	.00734 (0.734%)
Dry sandy soil	0.0654	.04825 0.09290	.02844 0.03415	.00148 0.00571	.00423
Dry to moist sandy soils	0.1550	.07204 0.11996	.04238 0.04692	.00088 0.00454	.00366
Wet sand and moist cohesive soils	0.3050	.11842 0.19546	.07358 0.07704	.00063 0.00346	.00283
Wet cohesive soils	0.6980	.20137 0.32389	.12163 0.12252	.00017 0.00089	.00072

*The partitioning applies to the fraction of total apparent crater mass (1500 kg/m³) which becomes airborne.

→ < 10% of ejecta soil is smaller than 100 µm

When the munition is assumed to be a tapered cylinder with flat ends, the quantity and energy of fragments impacting the crater region can be determined.

This determination depends on the length and diameter of the casing, the depth or height of the munition, and the orientation of the munition. Two limiting cases are considered. The fraction of energy coupled to the ground, F_{ch}, for a horizontal munition at any depth and the fraction, F_{cv}, for a vertically oriented munition at any depth are each modeled. The value for any intermediate orientation is then assumed to be

$$F_c = \left[(F_{ch} \cos \theta)^2 + (F_{cv} \sin \theta)^2\right]^{1/2} . \tag{215}$$

*Dry cohesive soil best matches UTTR/TTU Loam/clay soil type (more so than rock or sand).

When the apparent crater volume is assumed to be proportional to the total energy coupled into the ground, the yield coupled into the ground must be

$$W_g = [F_s F_c + (1 - F_s) F_b] W \quad , \qquad (216)$$

where F_b is the normalized crater scaling profile, figure 11, for depths above 0.45 m (lb TNT)$^{-0.33}$ and 0.947 otherwise. The model then iteratively finds the yield of the uncased charge that, at the same depth as the munition, produces the same yield W_g coupled to the ground. The apparent crater volume produced by this equivalent bare charge must, assuming that equal energy coupling into the ground lofts equal amounts of dust, be in fact the apparent crater volume. The final function of the crater model is to provide an estimate of the difference in volume between static and live-fire delivered munitions. Based on the observed asymmetry of live-fire produced craters and the increase in volume with inclination angle θ, the modeled dependence is

$$\underset{(\text{live})}{V_{ac}} = (0.4 + 0.6 \sin \theta) \underset{(\text{static})}{V_{ac}} \quad . \qquad (217)$$

If the casing dimensions are for submunitions and the total yield W is distributed equally among the submunitions, then the total of the N_s crater volumes is

$$V_{ac} = N_s S_{ac} (W/N_s)^{1.111} \quad . \qquad (218)$$

The crater scaling factor S_{ac} implicitly depends on the depth, orientation, and yield of a single submunition. It may optionally be input by the user as a yield factor on the MUNT input record.

COMBIC now uses sod depth to correct the volume of the crater to that containing soil. The method parallels that used in the original EOSAEL DRTRAN[2] model. The corrected volume is

$$V'_{ac} = V_{ac} \left[1 - \frac{d_{sod}}{.38 \, V_{ac}^{1/3}} \right]^3 \qquad (219)$$

where the sod thickness (depth) is in meters, input optionally on the TERA record.

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[2] L. D. Duncan, ed, 1981, EOSAEL 80, Volume I - Technical Documentation, ASL-TR-0072, US Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM

The total lofted fraction of dust from the apparent crater is only a small fraction of the apparent volume. Large detonations are reported to result in dust volumes that range from a few tenths of a percent to 30 percent[72] of the apparent crater volume. Preliminary results from measurements at a test at Fort Carson in 1983,[73] for example, show a range of values of 0.3 to 1.7 percent of measured crater volumes produced airborne dust. Table 12 shows the fractions of the apparent crater volume that are assumed to be in each of the modeled dust subclouds from HE. These are the fractions that would be input on an optional "SUBA" record, for example. The values were chosen partly from comparisons with data. They were also required to follow certain observed features in measured dust, as well. Measured size distributions[69,70,74] are not entirely consistent, but they do tend to suggest that the mass of dust less than 10μm radius (the "small particle mode") and that from 10μm to 100μm radius (the "large particle" mode) have the trends and range of values shown in the table. These modes separate in a bi-modal, log-normal, particle size distribution. The very large particle "ballistic" region of the cloud is assumed to cover the range from 100μm up to 1.0 cm. From large HE detonations, the large particle ballistic mode tends to have a power law distribution[75] with exponents 3.75 for cohesive soils, suggesting more large particles, and 4.0 for noncohesive soils. These distributions have been matched at the 100μm point to the large particle mode in determining the mass in the ballistic cloud.

In addition, a nonbuoyant, small particle, surface dust cloud is modeled which is assigned a mass equal to 1.875 times the sum of the masses of the small particle buoyant region and the small particle stem. The small particle regions have 0.3 cm/s fall velocity. The large particle cloud stem is given an average fall velocity of 0.92 m/s, that of a 75μm particle of specific gravity 1.5. The ballistic mode particles follow an initial cloud geometry that injects them upward into the air with a model of the form

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[72] K. E. Gould, 1981, High Explosive Field Tests, DNA 6187F, Defense Nuclear Agency, Washington, DC

[73] K. Long, J. Mason, and B. Durst, 1984, Results of Fort Carson, Colorado Terrain Dust Obscuration Tests using Explosives, EL-84-6, US Army Waterways Experimental Station, Vicksburg, MS

[69] R. G. Pinnick et al, 1982, Vehicular Dust and Fire Products Particle Size and Concentration Measurements in BIC-1 and BIC-2, Internal Report, US Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM

[70] R. G. Pinnick, G. Fernandez, and B. Hinds, 1982, "Explosion Debris Particle Size Measurements in DIRT-III," DRCPM-SMK-T-001-82, OPM Smoke/Obscurants Proceedings of Smoke Symposium VI, Aberdeen Proving Ground, MD

[74] R. G. Pinnick, G. Fernandez, and D. Hinds, 1983, "Explosion Dust Particle Size Measurements," Appl Opt, 22:95-102

[75] R. Seebaugh and H. Linnerud, 1978, Debris Environment Predictions for High Explosive Bursts, Science Applications Inc. Report SAI-79-861-WA, McLean, VA

$$\bar{z}_{v1} = -\frac{1}{4} g t^2 + \frac{1}{2} w_0 t \tag{220}$$

where $\bar{z}_{v1}$ is the centroid height and w_0 the initial upward velocity. The model applies only over the ballistic rise time w_0/g at which point the cloud stops rising. The upward velocity, currently modeled as nonzero only for buried charges, is given by

$$w_0 = 9.9 \ W^{1/6} \ . \tag{221}$$

Following the ballistic rise, the centroid falls back to earth with

$$\bar{z}_{v1} = \frac{1}{4} \frac{w_0^2}{g} - w_{fall}\left(t - \frac{w_0}{g}\right) \tag{222}$$

where

$$w_{fall} = \mathrm{MIN} \begin{cases} \frac{1}{4} g \left(t - \frac{w_0}{g}\right) \\ 4.15 \end{cases} \tag{223}$$

where 4.15 m/s is half the terminal fall velocity of a 1050μm particle. The bottom of the cloud remains at ground level while the top of the cloud initially rises at twice the centroid velocity. That is the reason for the one-half factors in the equations. The vertical radius of the ballistic region equals the centroid height above ground level. The horizontal radius depends on the various cases. For charges above the surface, the centroid height, which is discussed below, is set equal to the surface cloud vertical radius. The horizontal radius also matches the surface cloud. The ballistic cloud immediately begins to fall with the velocity in equation (223) (w_0 is zero). For charges below the surface, however, the horizontal cloud expands with the vertical cloud rise. The horizontal radius up until the end of ballistic rise is

$$R_{hv1} = \bar{z}_{v1} \ \mathrm{MAX} \begin{cases} 1.192 - 20.5 \left(D_b/W^{1/3}\right) \\ .577 \end{cases} \tag{224}$$

following the ballistic rise time limit, the horizontal radius remains fixed. This corresponds to the observed fallback of large dust particles but does not model the actual ballistic ejecta of rocks.

The fraction of energy appearing as heat for thermal rise is taken to be the remainder of total energy not coupled into the ground, including the case fragments:

$$F_h = (0.53 - 0.504\, F_b)\,(1 - F_s) \quad . \tag{225}$$

Use of this "hydro-yield fraction" gives a total thermal energy of

$$Q = 1100\, C\, F_h\, W \quad , \tag{226}$$

where C converts pounds to grams, and 1100 cal/g are provided by the explosive. Q provides the thermal energy for buoyant rise.

Both the crater volume scaling factor S_{ac} and the hydro-yield fraction F_h may be input by the user on the MUNT record to override the built-in models. The data for crater volumes from field tests[76] show that a variation in crater volume up to a factor of two is observed even in the same type of soil and for the same charge yield. The model provides good agreement within this spread, which can partly be attributed to the difficulty in measuring the precise boundaries of the crater. Subsurface soil variations are probably also a factor.

Thus, there are five dust subclouds, a buoyant fireball of small mode particles, a surface cloud of small mode particles, a connecting stem of small mode particles, a stem of large particles that have 0.92 m/s fallout, and an initial ballistic cloud of large particles that rapidly return to earth.

Forty percent of the available carbon from TNT (approximately 0.3 pound of carbon per pound of TNT yield) is by default divided in equal amounts among the fireball and cloud stem regions. The user may override this value by input if the carbon yield is different for the type of explosive considered.

Half the total thermal energy Q is assigned to the large particle and half to the small particle buoyant clouds. The vertical rise of each region is computed with the equations for Gaussian puffs given in the section on the boundary layer model. The large particle region has a height computed by subtracting the total distance fallen over time, t, following the explosion from the height the region would have had if there were no fall velocity. The windspeed for horizontal advection is taken to be that which is appropriate to the fall velocity's adjusted height. The stem cloud centroid position is computed as the average between the small particle buoyant region and the ground level position that the region would have had if it were nonbuoyant. The increase in windspeed with height implies that the nonbuoyant position will lag behind the buoyant position. This shearing effect rotates or "cants" the stem through an angle whose tangent is the difference in downwind distance of the buoyant and nonbuoyant positions divided by the height of the buoyant region. The stem is an oversimplified model of the region of dust that trails the buoyant puff in real world dust clouds. For convenience, since mass

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[76] B. Kennedy, 1980, Dusty Infrared Test-II (DIRT-II) Program, ASL-TR-0058, US Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM

profiles are not produced and stored for Gaussian puffs, no "bleeding" of dust from the buoyant region into the stem is modeled. The storage locations used to hold the mass production profiles as a function of time for continuous Gaussian plumes are used to hold the cant angles as a function of downwind distance for Gaussian puffs.

In addition to the buoyant cloud regions, a nonbuoyant base cloud or "skirt," is also modeled. The base cloud originates in part from the dust ejected near the edge of the crater and in part from shock and fragment-raised dust outside the crater.

The basic size for the initial clouds is determined from the largest of the following:

a. The buoyancy radius

$$R_o = 1.9 \left[\frac{3\,Q}{8\,\pi\,\rho_a\,C_p\,T_a}\right]^{1/3} \tag{227}$$

b. The radius of a volume equal to that of the crater

$$R_{ac} = \left[\frac{3\,V_{ac}}{4\,\pi}\right]^{1/3} . \tag{228}$$

c. The volume at which the dust density equals the air density

$$R_d = \left[\frac{3\,M_a}{4\,\pi\,\rho_a}\right]^{1/3} . \tag{229}$$

These results are then adjusted for the observed cloud shape that depends on burst depth. Buried charges produce higher clouds, while airbursts produce lower, wider clouds. The horizontal-to-vertical radius ratio is taken to be a minimum of one and a maximum of four, with intermediate values between these limits given by

$$S_h = 2.25\,N_s^{\,1/3} - \frac{10.4\,D_b}{W^{1/3}} . \tag{230}$$

The source sigmas are then specified in terms of the basic values

$$\sigma_z = \frac{R}{2.15\,S_h^{\,1/3}} , \tag{231}$$

and

$$\sigma_x = \sigma_y = S_h\,\sigma_z . \tag{232}$$

The sigmas for the buoyant small particle region and buoyant large particle region are, therefore, initially equal to the basic values. The base cloud has the values

$$\sigma_{0z} = 1.8\ \sigma_z \tag{233}$$

$$\sigma_{0x} = \sigma_{0y} = 1.5\ \sigma_x\ , \tag{234}$$

and the cloud stem

$$\sigma_{0z} = 1.25\ \sigma_z\ , \tag{235}$$

$$\sigma_{0x} = \sigma_{0y} = 1.25\ \sigma_z\ . \tag{236}$$

For the barrage approximation, the dust production model is similar to that for WP smoke. Two continuous Gaussian clouds are produced. One has the vertical rise trajectory of a single, small-particle, buoyant region for an individual munition. The other is nonbuoyant. The mass production is assumed to be uniform over the barrage period. The buoyant cloud is given the total mass of the small-particle buoyant clouds, stem, and 5 percent of the mass of the large-particle region. It is assumed to have zero fall velocity. It is also given 83 percent of the carbon. The nonbuoyant cloud is given the mass of the base cloud plus 5 percent of the mass of the large-particle region and 17 percent of the carbon. The clouds are both assumed to be small-particle mode. The large-particle mode has only 10 percent the mass extinction of the small mode; therefore, the 5 percent rather than 50 percent mass fractions are partitioned to represent the large particles. The barrage source sigmas are computed as in the case for smoke.

Table 7 gives the mass extinction coefficients for the small-particle and large-particle modes. The small-mode mass extinction values are based on field tests.[2] [38] [36] [63] [39] The large-mode values are based on Mie calculations. They should not be taken out of the context of the COMBIC dust model. As mentioned at the beginning of this section, mass extinction for large particles is not in fact a constant when applied to a size distribution of finite width that varies in both space and time in real-world clouds. The carbon mass extinction values are those of the DRTRAN model[2] and represent small particles of mean radius of about 0.2µm. The millimeter wave values are based on a study by Alexander, Brown, and Mott.[77] The appropriate scaling to the ballistic sizes has also been performed using Mie calculations.

Vehicular dust is modeled as a nonbuoyant, continuous Gaussian plume. The source terms are those of the DRTRAN vehicular dust model.[2] [78] The production rate of dust is determined by

$$\dot{M}(t) = a\,N\,S_n\,w_v\,u_v^2 \qquad (237)$$

where $\dot{M}$ is the constant dust production rate in grams per second; N is the arbitrary dimensionless scale factor that may be input by the user but normally has a default value of one; S_n is the percentage silt, w_v is the vehicle weight in tons, and u_v is the vehicle speed in m/s. The scale factor

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[2] L. D. Duncan, ed, 1981, EOSAEL 80, Volume I - Technical Documentation, ASL-TR-0072, US Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM

[38] V. Bowman et al, 1979, Smoke Week II, Electro-Optical (EO) Systems Performance in Characterized Obscured Environments, Eglin Air Force Base, FL, Special Report, DRCPM-SMK-T-001-79, Aberdeen Proving Ground, MD

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[63] M. Maddix, B. L. Williams, and S. Brazelton, 1982, A Survey of Extinction Coefficients Available for Various Transient Aerosols and Selection of Extinction Coefficients for BELDWSS Modeling of Transient Aerosols, RG-82-1, US Army Missile Command, Redstone Arsenal, AL

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[78] R. I. Dyck and J. Stukel, 1976, "Fugitive Dust Emission from Trucks on Unpaved Roads," Environmental Sciences and Technology, 10:1046-1048

Attachment F

COMPARISON OF POLU3WN COMPUTER PROGRAMS
TO OTHER COMPUTER MODELING PROGRAMS

Edward E. Baroody

INTRODUCTION:

The NASA-LEWIS, and other computer programs calculate thermodynamic data, reaction products, etc. for propellants based on the "Free Energy Minimization" method. The POLU3WN is based on the "Equilibrium Constant" method. Although the calculations by either method yields the same data, the equilibrium method is better suited to handle solid reaction products. In addition to the regular thermodynamic data calculated by other computer modeling programs, the POLU3WN is designed with routines, and modifications that are specifically directed toward output data for Open Burn/Open Detonation (OB/OD) computer modeling. Since its release in 1987, additional features have been added, which are described in this report. Also, at the request of the Confined Burn Facility program at NSWC/IH and other users, the program is being greatly modified.

BACKGROUND:

The current POLU3WN program is formatted to run on WINDOWS 98 and NT. It is an update of the original POLU10 computer-modeling program published and sponsored by the Ordnance Environmental Support Office (OESO)⁽¹⁾ at the U.S. Naval Surface Warfare Center, Indian Head, MD. The input data are read into the program by "batch files or screen prompts". Accompanying the main program are auxiliary programs and examples of batch files for each of the different types of calculations the program can perform. Over the years, several modifications of this program under the titles of POLU13A, POLU13G, POLU13L, etc. have been written. The program can also be run in its original MS-DOS mode. After several years of use and feedback from many users, additional features have been added to the program.

Originally, it was mainly used to generate data for facilities that were applying for OB/OD permits. It is also used for other calculations, such as modeling for Confined Burn Facilities. By the end of the year 1998, OESO had sent out over 100 copies of the POLU programs free of charge. Other copies have been issued since 1998. One of the major users of the program is the Department of Defense Toxics Release Inventory-Data Delivery System (DoD TRI-DDS), which is published by Radian International for the DoD(2) and used to predict emissions factors from the combustion of munitions. The following are some of the special features incorporated in the present POLU3WN program:

(*) Open Burn --- Under these conditions the energetic materials are assumed to burn in open fields and use oxygen in the air as an additional oxidizer. The program computes an initial adiabatic flame temperature, reaction products, and other thermodynamic properties. These reaction products are allowed to cool and recalculated again at reduced temperatures, which is printed as output data.

(*) Open Detonation --- The program distinguishes between OB/OD operations. When an OD occurs, a shock wave is produced. The program has a special built in routine to compensate for the loss of energy that goes into the shock wave. This energy loss will cause a drop in the final temperature of the detonation products. Thus the formation of the OD detonation products will occur at lower temperatures than under OB conditions. This special routine compensates for the temperature drop when calculating the final products.

(*) Air as an Ingredient --- OB/OD operations occur in open field sites where the energetic materials (EM) react with the air. For this reason, the input data are designed to incrementally add air to the EM to form a series of EM/air ratio mixtures. This allows for a series of calculations to determine the reaction products for these EM /air ratios.

(*) Reaction Products Units --- The reaction products in NASA–LEWIS and other modeling programs are expressed in units of moles products/mole gas. The POLU3WN program prints out the units of lbs products/lbs EM or lbs products/liter gases produced. These units are more convenient for OB/OD operations. Other units, including moles products/mole gas, will be added.

(*) Underground Detonation --- This option calculates the combustion products for underground detonations under the following conditions:

a.) The energetic materials are buried underground and the force of the detonation is absorbed by the ground.

b.) The explosive force of the buried energetic materials exerts a maximum amount of work against the underground hole.

c.) The temperature of the combustion gases that emerge from the ground is lower than the maximum temperature of the materials when detonated above ground.

The program computes a total heat released, heat lost (due to work against the ground) and residual heat. The calculated residual heat in the gases emerging from the ground is the energy recommended for dispersion modeling in the atmosphere. The theory for this type of calculation is based on the report published by NSWC/IH(3).

(*) Spills --- This option calculates the combustion products when there are spills of chemicals on the ground, storage tank eruptions, highway accidents, etc. These would be circumstances where there are fuels or chemicals burning, but not detonating.

(*) Heat of Detonation --- This calculation is based on reference (3). The heat of detonation is assumed to be the maximum amount of energy released when the energetic materials are detonated and the combustion gases are working against the environment. Dispersion modeling programs, such as The Cramer Company, Salt Lake City Utah, uses these values as input data for the "OBOD" dispersion program, which is available on the EPA web site.

(*) Heat of Explosion --- This calculation determines the heat released when the energetic materials, or other compounds, are ignited in an inert atmosphere of 450 psi of helium, or other inert gases. This is not the same as a heat of detonation described above. The program calculates the two heats differently. These values are also used as input data for dispersion modeling programs.

(*) Heat of Combustion --- This type of combustion refers to materials that are burned in pure oxygen. The heats of combustion are used as an estimation of energy released from heating fuels, jet fuels, or other materials burned in air with the assumption that there is complete oxidation of the materials with oxygen.

(*) Motor --- The routine is used to estimate the combustion in a gasoline motor.

(*) Incinerator Combustion Products --- Numerous requests have been made to determine the combustion products in incinerators. The materials can be energetic or non-energetic, such as solvents.

(*) Temperature --- POLU3WN can be used to determine the correct air/material ratio if a definite temperature is desired.

PRESENT MODIFICATIONS TO POUL3WN:

Since 1987 the POLU programs have been continually modified to meet the needs of the program's users. In a recent survey of the Navy's problems in their pollution programs was a request to update the user interface for POLU3WN(4). To assist in the Confined Burn Facilities (CBF) program at NSC/IH, the following modifications and changes to the program are now in progress.

*) Inert Oxygen --- This will allow the program to treat oxygen as an inert ingredient. It will have the same physical properties, such as heat capacities, heat of formation, entropy constants and density as normal oxygen.
Purpose --- Having the same heat capacity as oxygen, it will absorb heat as an inert gas, such as nitrogen, helium, but will not react with any of the ingredients or other elements in the reaction. The major effect will be on the temperature of the combustion products.

*) Calculation of Heat Loss --- To calculate the heat loss when the gases expand from the chamber to the exhaust pressures.
Purpose --- Heat loss is now calculated by hand from POLU3WN data. This change will show the heat loss as part of the printouts. For convenience, the data will be in both English and metric units.

*) Preset Temperatures --- POLU3WN now calculates and predetermines the flame or chamber temperatures and the exhaust or exit chamber temperatures. This change will allow the user to preset the temperature of the reaction.
Purpose --- Very often the combustion products or other parameters are needed at experimentally determined temperatures, such as in the chamber. The user will be able to calculate thermodynamic data at these determined temperatures. This option can be used at any point in the CBF (chamber, surge tank, delivery vents, etc). For example, if the temperatures are determined in the chamber and in surge tank, the heat loss can be determined at these temperatures. This heat loss can be compared to the theoretical heat loss calculated by the program in normal runs. This feature has other uses, such as evaluating changes in heat capacities, gamma, etc. at determined temperatures.

*) Units in Moles, Total Moles, etc --- Presently, the program prints out the combustion products in (1) grs/lbs) combustion /100 grs/lbs propellant, (2) grs/lbs) combustion /liter gas propellant. The CBF designs require the combustion products be in other units, such as the units of moles (and possibly others).
Purpose --- Calculations in units of moles, and total moles is now calculated by hand. These will be added as an option to the print out, which will save time.

*) English Units --- If requested, the print outs will include English units for design purposes on many of the above changes.
Purpose --- Since the CBF design uses English units, the more common units will be printed out in both the English and metric units.
*) Constant Volume Temperature --- All POLU3WN calculations are done at constant pressure. This option will calculate the temperature at both constant pressure and constant volume conditions. (These will double the computer run time).
Purpose --- When the combustion occurs in a confined volume (such as a calorimeter) constant volume temperature is used. In most CBF designs, constant pressure temperature conditions are used. The program will be able to predict thermodynamics parameters (such as combustion products) under constant volume conditions. When this option is added, other uses will be found for it. For example, the program will be able to determine the differences in enthalpy at constant volume and pressure. Since the constant volume temperatures are always higher, this could be used as an upper flame temperature limit in the CBF.

*) Include Routines from other Programs --- Some of the calculation routines utilized by EXCEL for confined Burn designs will be incorporated into the program.
Purpose --- Many routine calculations that use POLU3WN data as input can be added to save time.

*) Visual Basic Input Files & Documentation --- If not too time consuming and feasible, read input data and documentation by Visual Basic screens.
Purpose --- As the program becomes more complicated it must be user-friendlier. The value of a modified program will be lost if other people do not read the documentation, which will probably include the present users. A lot of effort was devoted to explain the present POLU3WN version. Even so, many users do not take the time to read the documentation. We have become dependent on user-friendly programs. The more detailed the input data screen, the more useful the program and less dependent on documentations. This part will be the one of the most time consuming modifications.

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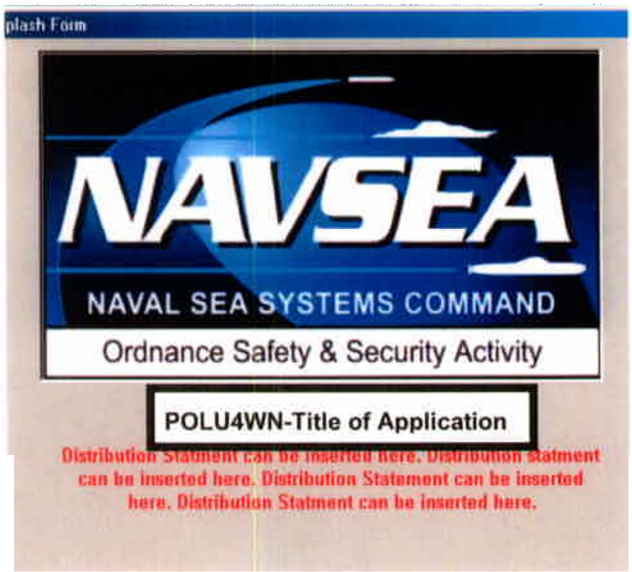
(4) "Navy Pollution Abatement Ashore Program Ordnance and energetic Material Environmental Quality Requirements of the Navy and Marine corps Shore side Facilities", Indian Head Division, Naval Surface Warfare Center, Indian Head, MD 20640-5035, page 17, IHTR 2313, 27 Nov. 2000.

README - POLU4WN PROGRAM



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By
Edward E. Baroody

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PART I. GENERAL INFORMATION ABOUT THE POLU4WN PROGRAM

I. **BACKGROUND.** The POLU4WN Program is designed to run by Graphic User Interface (GUI) on Windows 98, 2000 and XP. It is an update of the original POLU10 computer modeling published by the Ordnance Environmental Support Office (OESO)(1). Several modifications of this program under the update names of POLU13A, POLU13G, POLU13L, etc. have been written that ran on Microsoft's Disk-Operating-System (MS-DOS) system. Previous to POLU4WN, the last update, POLU3WN, was formatted to operate on WINDOWS 95 and 98. After several years of use and feedback from many users, additional features have been added to the program. In addition to Open Burn/Open Detonation (OB/OD) calculations, POLU4WN performs various other calculations as described in the section "TYPES OF CALCULATIONS". POLU4WN doesn't predict volatile organic compounds (VOCs) or semi-volatile organic compounds (SVOCs). From the experimental data studied from various sources, it is estimated that 60 to 70 tons of explosives must be detonated to form one pound of the VOCS/SVOCS.

The FORTRAN Source Program was written by Edward E. Baroody (1) and the Visual Basic Program (VB) 6 was written by Richard E. Williams, Applied Ordnance Technology (AOT), 4473 Indian Head Highway, Indian Head, Maryland, 20640. By the end of the year 2002, over 100 copies of the POLU programs have been distributed. This latest update was prepared at the expense of the Ordnance Environmental Support Office (OESO), U.S. Naval Surface Weapons Center, Indian Head, Maryland (USNSWC/IH).

II. **GETTING STARTED.** It is recommended that a copy of this "README" file be printed. "EXPLANATION OF INPUT DATA" (PART II) is a Graphic Users Interface (GUI) file that explains the input data. The data are divided into sections or TABS (Set Up, Gen Cond, Percentages, Ingredients, Ingredient % and Batch File). To test the program, make a trial run using the default values and the example explained in this GUI file. To help understand the program, section IX also contains examples of input and output files that can be accessed through the "Batch File" TAB.

III. **TYPES OF CALCULATIONS.** This section describes the different types of calculations that POLU4WN can perform. Examples of input files are located at "C:\POLU\BatchFiles*.txt". As explained in the section, "EXPLANATION OF INPUT DATA", they can be accessed and ran through the Graphics User Interface process that is located on the "Batch File" TAB. Examples of output data files from these "*.txt" files are located at "C:\POLU\Samples*.DOC".

1.) *BURN/OPEN DETONATION (OB/OD)* - These are the two original types of calculations the POLU10 and its updates used. The Open Detonation (OD) calculations accounts for a loss of energy that forms the shock wave before the detonation products are formed. The Open Burn calculation utilizes the total amount of energy formed in the burn to calculate the Open Burn products. More details are explained in the original report (1).

2.) *UNDERGROUND DETONATION* - There have been several request for this type of calculation, which is ran under the following conditions:

a. The energetic materials are buried underground and the force of the detonation is absorbed by the ground.
b. The explosive force of the buried energetic materials exerts a maximum amount of work against the underground hole.
c. The temperature of the combustion gases that emerge from the ground is lower than the maximum temperature of the materials when detonated above ground.

The program computes a "TOTAL HEAT RELEASED, HEAT LOST (DUE TO WORK AGAINST THE GROUND) and RESIDUAL HEAT." The calculated residual heat in the gases emerging from the ground is the energy recommended for dispersion modeling in the atmosphere. The theory for this type of calculation is based on the report published by NSWC/IH (2).

The input batch file "UGROUND1.TXT" is an example of this type of calculation. When ran, the output data will be in file "UGROUND1.DOC", which should agree with the enclosed file "C:\POLU\Samples\UGROUND1T.DOC". These files show only the data from the material reacting without air, not a series of reactions in air that is normally done in OB/OD calculations. This is because of the energy loses and the low temperatures of the emerging gases under these conditions. It is unlikely that the gases emerging from the ground will be hot enough to react with the air. For dispersion modeling, the best-case scenario would be to use the gases as calculated emerging from the ground and the "RESIDUAL HEAT" calculated for these runs.

3.) *SPILLS* - This option calculates the combustion products when there are spills of chemicals (For energetic materials use the open burn (OB) calculation for these conditions.) on the ground, storage tank eruptions, highway accidents, etc. These would be circumstances where there are fuels or chemicals burning, but not detonating. The main thing to consider is that the chemicals have an insufficient amount of air present to completely burn the spilled chemicals. Therefore, the calculations would be done with very small percentages of air compared to the material. Some rules of the thumb are as follows:

a. Minimum air to burn the material --- For a large chemical spill burning, the worst-case scenario would probably be a fire with a minimum amount of air reacting with the chemicals.

b. The SPILL11T.DOC--- file shows a series of calculations going up to 10% hexane/90%air. It is uncertain how realistic the calculations are with this lower percent of hexane. Notice how the methane concentration does not change drastically up to 60%hexane/40% ratio. If there is any information as to the approximation of the flame temperature, then use the "Type of Run-Set Temperature and Pressure" option on the "Ingredients" TAB in as described in the "EXPLANATION OF INPUT DATA" section. This should be a good estimation of the combustion product for a spill.

c. Unless there are supporting data or circumstances to suggest otherwise, the material/air wt. ratios probably should be kept below 80% material/20% air.

The input batch file "SPILL11.TXT" is an example of this type of calculation. When ran, the output data will be in file "SPILL11.DOC", which should agree with the enclosed file "C:\POLU\Samples\SPILL11T.DOC".

4.) *HEAT OF DETONATION* - This calculation is based on reference (2). The heat of detonation is assumed to be the maximum amount of energy released when the energetic materials are detonated and the combustion gases are working against the environment. The input batch file "HDET1.TXT" is an example of this type of calculation. When ran, the output data will be in file "HDET1.DOC ", which should agree with the enclosed file "C:\POLU\Samples HDET1T.DOC".

5.) *HEAT OF EXPLOSION* - The heat of explosion is based on the energy released when the energetic materials, or other compounds, are ignited in an inert atmosphere of helium, or other inert gases. Normally, the materials are placed in a calorimeter, pressurized with an inert gas to approximately 450 psi and ignited (not detonated) by a hot wire. The heat released is referred to as the heat of explosion. This is not the same as a heat of detonation described above. The program calculates the two heats differently. The input batch file "HOE1.TXT" is an example of this type of calculation. When ran, the output data will be in file "HOE1.DOC", which should agree with the enclosed file "C:\POLU\Samples HOE1T.DOC".

6.) *HEAT OF COMBUSTION* - This type of combustion refers to materials that are burned in pure oxygen. Do not confuse this calculation with any of the others described above. Normally, the experimental data from a heat of combustion are determined in a calorimeter under pressures of approx. 450 psi of oxygen. These data are used to determine the heats of formation of compounds. Unless you have experience with calorimeters or an idea of what the combustion products are, it is recommended that you use this option only for compounds with the elements Carbon, Hydrogen, Oxygen & Nitrogen (CHON compounds). All four elements do not have to be in the compound. As the percentage of oxygen is added to the compound in the calculations, all of the carbon will eventually be oxidized to carbon dioxide, the hydrogen to water and the nitrogen to nitrogen gas. At this point of the material/oxygen weight ratio, the compound has been completely oxidized and the highest energy released from the oxidation of the compound in oxygen has been obtained. The compounds that burned in pure oxygen assure that all of the carbon is completely burned to carbon dioxide, the hydrogen to water and the nitrogen to gas.

Many of the experimentally determined heats of formation of the CHON compounds in the "INGNUMB.DAT" file were determined by calorimeter at NSWC/IH. (REFS. 3, 4, 5 & 6) and are accessed in the “Ingredients” TAB under “Primary Ingredients”. The heats of combustion determined with POLU4WN using this option should be very close to the values obtained from actual experimental data from a calorimeter. For CHON compounds the heats of combustion from this option should serve as a check for experimentally determined data.

The heat of combustion is sometimes used as an estimation of energy released from heating fuels, jet fuels, or other materials burned in air with the assumption that there is complete oxidation of the materials with oxygen. Such complete oxidations with oxygen from the air are difficult to obtain. For calculations with oxygen from air, use a large percentage of air with the "Open Burn" option.

The input batch files “HCOMB11.TXT, HCOMB1A1.TXT, and HCOMB21.TXT " are examples of these types of calculations. When ran, the output data will be in files "HCOMB1.DOC, HCOMB1A1.TXT and HCOMB21.DOC", which should agree with the enclosed files "C:\POLU\Samples\HCOMB1T.DOC, HCOMB1A1T.DOC and HCOMB21T.DOC”.

<u>MOTOR1</u> --- To estimate the combustion in a gasoline motor, do a series of calculations with gasoline and air. Hexane, octane or a similar hydrocarbon can be used as estimation. A large percentage of air is needed for these calculations. The input batch file "MOTOR1.TXT" is an example of this type of calculation. When ran, the output data will be in file "MOTOR1.DOC ", which should agree with the enclosed file "C:\POLU\Samples\MOTOR1T.DOC".

The following are used in the "Open Burn" option: %Hexane/%air ratios 9/91, 8/92, 7/93, 6/94, 5/94, 4/96, 3/97, 2/98, 1/99 (the fuel/air wt. ratio should be in this range for good combustion). If the exact pressures in the motor's chamber and the exhaust are known, substitute the pressure of the motor's chamber for the 1000 psi and the pressure at the motor's exhaust for the 14.7 psi. This will give better results for the internal combustion in the engine.

8.) *INCEN1 --- DETERMINING AIR/MATERIAL RATIOS TO MEET INCINERATOR* - Numerous requests have been made to determine the combustion products in incinerators. The materials can be energetic or non-energetic, such as solvents. Basically, the difference between these types of calculations and a simple "OPEN BURN" calculation is the air/material weight ratios that are used in the calculations.

The input batch file " INCEN1.TXT" is an example of this type of calculation. When ran, the output data will be in file "INCEN1.DOC", which should agree with the enclosed file "C:\POLU\Samples\INCEN1T.DOC". In "OPEN BURN" in an open field, the high ratio of air/material cannot be obtained as when the air is forced into the incinerator. Under such circumstances, ratios of air/material can be high such as 99/1 as shown in "INCEN1T.DOC". Simply knowing the air/material ratio, the POLU4WN program can be used to calculate the combustion products from a incinerator. If the pressures inside the incinerator and the combustion products exhaust to the outside are known, they can be used instead of 1000 psi, and 14.7 psi. For example if the pressure in the incinerator is known to be 300 psi and exhaust to 40 psi, before it goes to the outside, substitute 300 for 1000 and 40 for 14.7 psi. Otherwise the 1000-psi and 14.7 psi should be close enough.

IV. ENERGY OUTPUT FOR DISPERSION MODELS.

CAUTION: (1) Do not use the data from the calculations in the rows "Enthalpy kcal/gfw" calculated in the output files for dispersion models' calculations. Use "total heat released or residual heat" as explained below.

(2) When the materials contain high percentages of several metals, the energy values calculated by the program (TOTAL HEAT RELEASED, HOE, HEATS OF DETONATION AND EXPLOSION, RESIDUAL) are questionable. One reason is that the species' library does not contain all of the possible species of combustion from such a variety of metals. The program is designed to calculate the heat released for the energetic materials or with mixtures of air or oxygen. The energy released are discussed for the following conditions:

1.) *OPEN BURN* - An example of energy released for dispersion models is the row "TOTAL HEAT RELEASED*" in file C:\POLU\Samples\POLU1T.DOC. As the footnote states:

*THE TOTAL HEAT RELEASED, IN CAL/GR AT STP, IN EACH COLUMN IS FOR 100 GRAMS OF MATERIAL BURNED OR DETONATED, NOT THE MATERIAL WT. LISTED IN "WT. MATERIAL" ROW. USE THESE VALUES IN DISPERSION MODELS.

These values are for the energy released when the material, TNT, is burned and the products given in the column are formed. Both the TNT, AIR, and these products are at standard temperature (298K) and pressure (1 atmosphere). The 765.512 cal/gr in the 100% MATERIAL/0% AIR is the heat released in cal/gram for TNT burned alone without the presence of air at STP.

Notice the TOTAL HEAT RELEASED value of 3573.079 cal/gram in the 20% WT. MATERIAL/80% WT. AIR column. This is not the energy released for this TNT/AIR wt. ratio, but the energy released at STP when one gram of TNT is burned in a 20%TNT/80%AIR wt. ratio.

Another way to explain this value is for a calculation based on 100 grams of TNT and AIR in the reaction where 20 grams of TNT reacts with 80 grams of air. In this case the TOTAL HEAT RELEASED would be 3573.079 cal per 100 grams of TNT burned at this 20%TNT/80%AIR wt. ratio, not for 20 grams of TNT. The values for the TOTAL HEAT RELEASED are based on one gram of material burned. Thus the values in this row can be directly compared with the same units.

When the TOTAL HEAT RELEASED is calculated for 100% of just the material in the OPEN BURN option, it is the same as a heat of explosion as calculated by the POLU4WN program. Compare this value to the TOTAL HEAT RELEASED in the "C:\POLU\Samples\HOET.DOC" file. Notice that the 765.512 cal/gr value is the same when calculating the HOE for an energetic material.

2.) *OPEN DETONATION* - An example of energy released for dispersion models is the row "TOTAL HEAT RELEASED*" in file "C:\POLU\Samples\NG11T.DOC". As the footnote states:

*THE TOTAL HEAT RELEASED, IN CAL/GR AT STP, IN EACH COLUMN IS FOR 100 GRAMS OF MATERIAL BURNED OR DETONATED, NOT THE MATERIAL WT. LISTED IN "WT. MATERIAL" ROW. USE THESE VALUES IN DISPERSION MODELS.

These values are for the energy released when the material, NG, is burned and the products given in the columns are formed. The NG, AIR and these products are at standard temperature (298K) and pressure (1 atmosphere). The value 835.392 cal/gr in the 100%WT. MATERIAL/0% WT. AIR is the heat released in cal/gram for NG burned alone or without the presence of air at STP. Compare this value of 835.393 cal/gr with the 100% WT. MATERIAL/0% WT. AIR column in the file "C:\POLU\Samples\NG2T.DOC" (an OPEN BURN CALCULATION), 1556.680 cal/gr, which is larger. The reason is, that the OPEN DETONATION calculation accounts for the loss in shock wave energy that is assumed to leave the detonation gases before these gases react with air.

3.) *UGROUND DETONATION* - The "UGROUNDT.DOC" file is an example of this type of calculation. There are three rows to explain the energy released from this type of calculation: Total Heat Released, Heat Lost, and Residual Heat.

a. Total Heat Released - Energy in cal/gr at STP. This is the calculated "heat of detonation" for this material. The detonation is assumed to occur without air. It is the amount of energy available to work against the ground in a confined underground detonation. The final temperature of the products formed in most cases under these conditions would probably be below the "frozen temperature" of the gases. Therefore, the composition of the gases would "freeze" or remain the same as they approach ambient temperature. Probably the best scenario is to assume that the gaseous compositions will not change when they come to the surface. The temperature of these gases would be so low that little reaction would occur (with some exceptions, nitric oxide, HCl, etc.) with the air.

b. Heat Lost---(CAL/GR) AT STP - This is the amount of energy assumed lost due to work against the ground.

c. Residual Heat---(CAL/GR) AT STP - This is the energy left in the gases or total heat minus the heat lost after an underground detonation. Use this energy in dispersion models for gases leaving the ground.

The "Total Heat Released" is first calculated. It is assumed that when the combustion gases work against the dirt underground, part of the "Total Heat Released" is lost (listed as "Heat Lost"). The difference between these two values ("Total Heat Released" MINUS "Heat Lost") is the "Residual Heat" that leaves the hole with the combustion gases. The Residual Heat is the energy to use for dispersion model calculations when the combustion gases are mixed with the air.

4.) *HOE* - An example of energy released is the row "Total Heat Released*" in file "C:\POLU\Samples\HOET.DOC". As the footnote states:

*THE TOTAL HEAT RELEASED---IN CAL/GR AT STP. THIS IS THE MAXIMUM HEAT OF EXPLOSION OF THE MATERIAL WHEN IT BURNS IN THE ABSENCE OF AIR.

This option was added to calculate the heat of explosion of energetic materials would release if burned in a calorimeter.

5.) *HDET* - An example of energy released is the row "Total Heat Released*" in file "C:\POLU\Samples HDETT.DOC". As the footnote states:

*THE TOTAL HEAT RELEASED---IN CAL/GR AT STP. THIS IS THE MAXIMUM HEAT OF DETONATION OF THE MATERIAL WHEN IT DETONATES IN THE ABSENCE OF AIR.

This option was added to calculate the maximum heat of detonation of energetic materials as explained in ref.(2). The energy from this type of calculation is NOT used in dispersion models. The heat for dispersion models is calculated using the OPEN DETONATION option. The "HDET" is used to calculate the maximum heat of detonation for energetic materials mainly as comparison values to other energetic materials.

V. EXAMPLES OF INPUT AND OUTPUT FILES.

TYPE FILES	LOCATION
INPUT	C:\POLU\Batch*.txt
OUTPUT	C:\POLU\PoluOut*.DOC
COMPARISON*	C:\POLU\Samples*T.DOC

INPUT FILES	TYPE OF CALCULATION	OUTPUT FILES FILES	COMPARISON FILES
POLU11.TXT	OPEN BURN	POLU11.DOC	POLU11T.DOC
POLU21.TXT	OPEN BURN	POLU21.DOC	POLU21T.DOC
POLU311.TXT	OPEN BURN	POLU31.DOC	POLU31T.DOC
NG11.TXT	OPEN DETON.	NG11.DOC	NG11T.DOC
NG21.TXT	OPEN BURN	NG21.DOC	NG21T.DOC
HOE1.TXT	HEAT OF EXPLO.	HOE1.DOC	HOE1T.DOC".
HDET1.TXT	HEAT OF DETON.	HDET1.DOC	HDET1T.DOC
SPILL11.TXT	SPILLS	SPILL11.DOC	SPILL11T.DOC".
MOTOR1.TXT	MOTOR	MOTOR1.DOC	MOTOR1T.DOC".
INCEN11.TXT	INCEN1	INCEN11.DOC	INCEN11T.DOC
INCEN21.TXT	INCEN2	INCEN21.DOC	INCEN21T.DOC
HCOMB11.TXT	HEAT OF COMB.	HCOMB11.DOC	HCOMB11T.DOC
HCOMB1A1.TXT	HEAT OF COMB.	HCOMB1A1.TXT	HCOMB1A1T.DOC
HCOMB21.TXT	HEAT OF COMB.	HCOMB21.DOC	HCOMB21T.DOC
HCOMB2A1.TXT	HEAT OF COMB.	HCOMB2A1.DOC	HCOMB2A1T.DOC

* Comparison Files --- These are used to verify the test calculations. If the calculations are correct, the “*.DOC” files agree with the comparison “*T.DOC” files.

VI. IDENTIFICATION AND EXPLANATION OF THE FILES TO RUN POLU4WN.

*) POLU4WN Program --- Includes all of the executable files, auxiliary files, VISUAL BASIC Graphic Interface Users (GUI) files, etc needed to run the program.

*) F77L3 ---File from LAHEY Computer Systems (Fortran) used to run program.

*) F77L3.FIX ---File from LAHEY Computer Systems (Fortran) used to run program.

*) F77L3.FIG ---File from LAHEY Computer Systems (Fortran) used to run program.

*) F77L3.LIB ---File from LAHEY Computer Systems (Fortran) used to run program.

*) F77L3.CER ---File from LAHEY Computer Systems (Fortran) used to run program.

*) F77L3.EER ---File from LAHEY Computer Systems (Fortran) used to run program.

*) F77L3.EXE ---File from LAHEY Computer Systems (Fortran) used to run program.

*) POLR16A.EXE --- The executable form of POLR16A.FOR.

*) POLSIZEK.INC---An "INCLUDE" file used in POLR16A FOR.

*) POL13K1.INC---An "INCLUDE" file used in POLR16A FOR.

*) POL13K2.INC---An "INCLUDE" file used in POLR16A FOR..

*) POLCHARA.INC---An "INCLUDE" file used in POLR16A FOR.

*) LAHEY.INC---An "INCLUDE" file used in POLR16A FOR.

*) MATCHO.DAT --- This file contains the chemical formulas and English names of the emission species (or reaction products) that are formed as a result of the thermodynamic calculations. POLR16A.EXE searches this file, compares the symbols of the reaction products formed from the calculations. Both the chemical formulas and English names are listed to identify the chemical formulas by their English names.

*) POLEXCEL.TXT --- The output data from the POLU4WN program can be used for calculations other than what is in the printouts. Quite often users have taken the data from the program's print outs and transferred to Microsoft's EXCEL program for additional calculations. The data in POLEXCEL.TXT are formatted so that it can be directly transferred to Microsoft's EXCEL program for calculations in this program.

*) NEWINGIP.DOC --- This file contains the thermodynamic data that are a combination of all of the ingredients (minus the last ingredient) from the calculation in one line. For example, assume the calculation just completed contains 6 ingredients (minus the last ingredient). The thermodynamic data from the 6 ingredients can be summarized into one line of data (up to six elements). This on line of data can then be used in future calculations instead of reentering the 6 ingredients again.

INFILE12.TXT--- This is a data file read in by POLR16A.EXE. It contains thermodynamic data for the emission species (or reaction products). These data came from JANNAF Thermochemical Tables.

INFILE.11--- This file contains the thermodynamic data for many of the ingredients for the propellants and explosives that are used today. These data are read in the main by POLR16A.EXE. The locations of the data in this file are as follows:

Column Location	Identification of Data
1-20	INGREDIENT NAME-up to 20 characters.
21-30	HEAT OF FORMATION-under "H" field, in cal/g, add dec. pt.
31-37	DENSITY-under "D" field, in lbs/cu., add dec. pt.
38-49	NO. OF ATOMS OF 1ST ELEMENT-under "a" field, add dec. pt.
50-51	1ST ELEMENT SYMBOLS-under "S" field, up to 6, left adjust.
52-63	NO. OF ATOMS OF 2ND ELEMENT-under "a" field, add dec. pt.
64-65	2ND ELEMENT SYMBOLS-under "S" field, up to 6, left adjust.
66-77	NO. OF ATOMS OF 3RD ELEMENT-under "a" field, add dec. pt.
78-79	3RD ELEMENT SYMBOLS-under "S" field, up to 6, left adjust.
80-91	NO. OF ATOMS OF 4TH ELEMENT-under "a" field, add dec. pt.
92-93	4TH ELEMENT SYMBOLS-under "S" field, up to 6, left adjust.
94-105	NO. OF ATOMS OF 5TH ELEMENT-under "a" field, add dec. pt.
106-107	5TH ELEMENT SYMBOLS-under "S" field, up to 6, left adjust.
108-119	NO. OF ATOMS OF 6TH ELEMENT-under "a" field, add dec. pt.
120-121	6TH ELEMENT SYMBOLS-under "S" field, up to 6, left adjust.

EXAMPLE:

```
TNT                -78.      05980     7.C     5.H     3.N     6.O
NAME(20 CHAR)      HHHHHHHDDDDDaaaaaaSSaaaaaaSSaaaaaaSSaaaaaaSSaaaaaaSSaa
```

*) INGNUMB.MBD --- This file contains a list of the "Coded ingredients" stored in POLU4WN program. It is used to retrieve the thermodynamic data for the ingredients used in the calculations.

*) INGNUMB.DAT--- It lists the ingredients available in the ingredient's data library or "INFILE.11". Each ingredient has a number in front of it. When these numbers are assigned to input data files, the program automatically calls in the data for these ingredients. This saves the user the trouble of putting in these data every run. As explained below, ingredients not in this file can be read in directly.

Column Location	Identification of Data
1-7	INGREDIENT NUMBER-number used by program to read in ingredients' data
8-9	SPACE
10-29	INGREDIENT NAME-up to 20 characters.
30-39	HEAT OF FORMATION-under "H" field, in cal/g, add dec. pt.
40-42	SPACE
43-49	DENSITY-under "D" field, in lbs/cu., add dec. pt.
50-61	NO. OF ATOMS OF 1ST ELEMENT-under "a" field, add dec. pt.
62-63	1ST ELEMENT SYMBOLS-under "S" field, up to 6, left adjust.
64-75	NO. OF ATOMS OF 2ND ELEMENT-under "a" field, add dec. pt.
76-77	2ND ELEMENT SYMBOLS-under "S" field, up to 6, left adjust.
78-89	NO. OF ATOMS OF 3RD ELEMENT-under "a" field, add dec. pt.
90-91	3RD ELEMENT SYMBOLS-under "S" field, up to 6, left adjust.
92-103	NO. OF ATOMS OF 4TH ELEMENT-under "a" field, add dec. pt.
104-105	4TH ELEMENT SYMBOLS-under "S" field, up to 6, left adjust.
106-117	NO. OF ATOMS OF 5TH ELEMENT-under "a" field, add dec. pt.
118-119	5TH ELEMENT SYMBOLS-under "S" field, up to 6, left adjust.

120-131	NO. OF ATOMS OF 6TH ELEMENT-under "a" field, add dec. pt.
132-133	6TH ELEMENT SYMBOLS-under "S" field, up to 6, left adjust.

EXAMPLE:

```
893 --     TNT           -78. --     --.05980      7.C      5.H      3.N      6.O
NO. -- NAME(20 CHAR)HHHHHHH--DDDDaaaaaaSSaaaaaaSSaaaaaaSSaaaaaaSSaaaaaaSSaa
```

VII. CAUTIONS.

1.) If the materials that react, like a hydrocarbon, do not have any nitrogen or oxygen, then the program will probably not run or get a diagnostic and questionable results. For example, assume that hexane, C6H14, (the material) is reacted with air. Assume that the usual first run (with two ingredients) consist of:

Hexane = 100
Air = 0.

Four elements, carbon (C), hydrogen (H) from hexane, and nitrogen (N) and oxygen (O) from air are used in the calculation. When the program executes, it searches the species library for any species with these four elements. Since air is zero percent, the amounts of the elements O and N are also zero. Under such conditions the program may not run. To remedy this problem, use the following input data.

Hexane = 99.9 (or possibly 99.99)
Air = 0.1 (or possibly 0.01)
Air = 0.0

The material is now 99.9% hexane and 0.1% air, not just 100% hexane alone. Air is now is part of the material. This 0.1% adds enough air to the material so the percentages of O and N are not zero. Thus, air (entered twice) is not only the last ingredient, but also part of the material burned. In this case the total number of ingredients is three, not two as above. The calculations are very close to using 100% hexane (especially if the program will run with 0.01% air).

2.) Do not use the data from the calculations in the rows "enthalpy kcal/gfw" calculated in the output files in dispersion models. Use "TOTAL HEAT RELEASED" or "RESIDUAL HEAT" as explained in the section "ENERGY OUTPUT FOR DISPERSION MODELS".

3.) When the materials contain high percentages of several metals, the energy values calculated by the program (TOTAL HEAT RELEASED, HOE, HEATS OF DETONATION AND EXPLOSION, RESIDUAL) are questionable. One reason is that the species' library does not contain all of the possible species of combustion from such a variety of metals.

VIII. REFERENCES.

1.) "Computer Predictions of Pollution Products from Open Burn an Detonation of Navy Explosives and Propellants" by Edward E. Baroody, Naval Surface Weapons Center/White Oak, etc., Ordnance Environmental Support Office (OESO), Naval Ordnance Station, Indian Head, Maryland 20640, Jan. 1987.

2.) "Heat of Explosion, Heat of Detonation, and Reaction Products: Their Estimation and Relation to the First Law of Thermodynamics", Edward E. Baroody, Susan T. Peters, U.S. Naval Ordnance Station, Indian Head, Maryland, IHTR 1340, 7 May 1990.

3.) "Heats of Formation of Propellant Compounds", Edward E. Baroody & George Carpenter, Department of the Navy, Naval Ordnance Station, Indian Head, Md., 20640, Report IHTR 368, Oct. 20, 1972.

4.) "Heats of Formation of Propellant Compounds", Edward E. Baroody & G. A. Carpenter, U. S. Naval Surface Warfare Center, Silver Spring, Md., 20810, June 4, 1976, Report NSWC/WOL TR 76-77.

5.) "Heats of Formation of Propellant Compounds", Edward E. Baroody, U. S. Naval Surface Weapons Center, Silver Spring, Md. 20910, Dec. 1, 1982, Report NSWC TR 83-250.

6.) "Heats of Formation of Propellant compounds", Edward E. Baroody, Susan T. Peters, Department of The Navy, Naval Ordnance Station, Indian Head, Md., 20640,Oct. 1, 1987, IHSP 87-252.

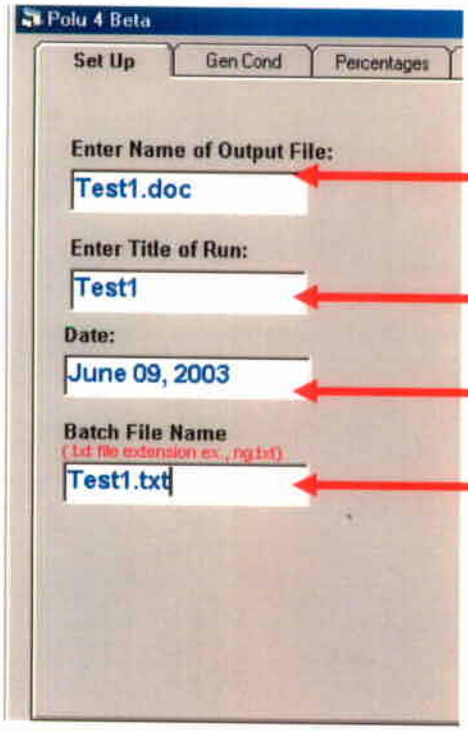
PART II. EXPLANATION OF INPUT DATA

This is a Graphic Users Interface (GUI) file that explains the input data. The data are divided into sections or TABS:

- *) Set Up
- *) Gen Cond
- *) Percentages
- *) Ingredients
- *) Ingredient %
- *) Batch File

To test the program, make a trial run using the default values and the example explained in this GUI file. To help understand the program, section IX also contains examples of input and output files that can be accessed through the "Batch File" TAB.

EXPLANATION OF INPUT DATA



Enter Name of Output File: Test1.doc

Enter Title of Run: Test1

Date: June 09, 2003

Batch File Name (.txt file extension ex., ng.txt): Test1.txt

Replace "Polu.doc" with a convenient name.
Example: "Test1.doc"
Note: The output data are stored in this file.
Default: "Polu.doc"

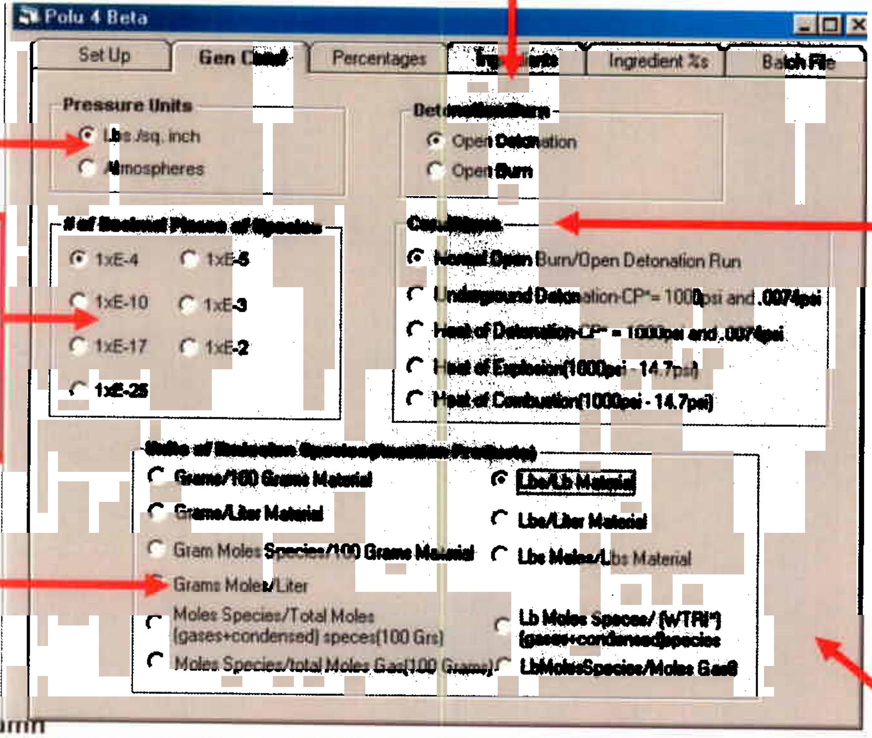
Replace "Polu Test Run" with a convenient name.
Example: "Test1"
Note: This is the name of the run, which will appear on output of run.
Default: "Polu Test Run"

Read in by program

Replace "Batch.txt" with a convenient name.
Example: "Test1.txt"
Note: The input data are stored in this file.
Suggestion: For ease of recognition, use the Output File Name with "txt" extension.
Default: "Batch.txt"

Pressure Units --- The input data requires pressure units. For regular calculations, use "lbs/sq inch".
Note: "Atmospheres" are used for special high-pressure calculations.
Default: "lbs/sq inch"

Detonation/Burn-- POLU4WN has two major types of calculations, "Open Detonation/Open Burn (OD/OB). Use "Open Detonation" if the energetic material is detonated, and "Open Burn" if the material is burned.
Default: Open Detonation



Pressure Units
● Lbs./sq. inch
○ Atmospheres

Detonation/Burn
● Open Detonation
○ Open Burn

# of Decimal Places of Species
● 1xE-4 ○ 1xE-5
○ 1xE-10 ○ 1xE-3
○ 1xE-17 ○ 1xE-2
○ 1xE-25

Conditions
● Normal Open Burn/Open Detonation Run
○ Underground Detonation-CP*= 1000psi and .0074psi
○ Heat of Detonation-CP* = 1000psi and .0074psi
○ Heat of Explosion(1000psi - 14.7psi)
○ Heat of Combustion(1000psi - 14.7psi)

Units of Emission Species(Reaction Products)
○ Grams/100 Grams Material
○ Grams/Liter Material
○ Gram Moles Species/100 Grams Material
○ Grams Moles/Liter
○ Moles Species/Total Moles (gases+condensed) speces(100 Grs)
○ Moles Species/total Moles Gas(100 Grams)
● Lbs/Lb Material
○ Lbs/Liter Material
○ Lbs Moles/Lbs Material
○ Lb Moles Species/ (WTRI*) (gases+condensed)species
○ LbMolesSpecies/Moles Gas8

Conditions --- In addition to Open Burn/Open Detonation (OB/OD), POLU4WN can calculate:

- Emission Species and heat released for underground conditions
- Heat of Detonation
- Heat of Explosion
- Heat of Combustion

These are explained in the "ReadMe" section.
Default: Normal Open Burn/Open Detonation Run

# of Decimal Places of Species---
Controls the decimal places of the emission species printed out.
Default: 1xE-4

Units in Right Column are explained on next page.

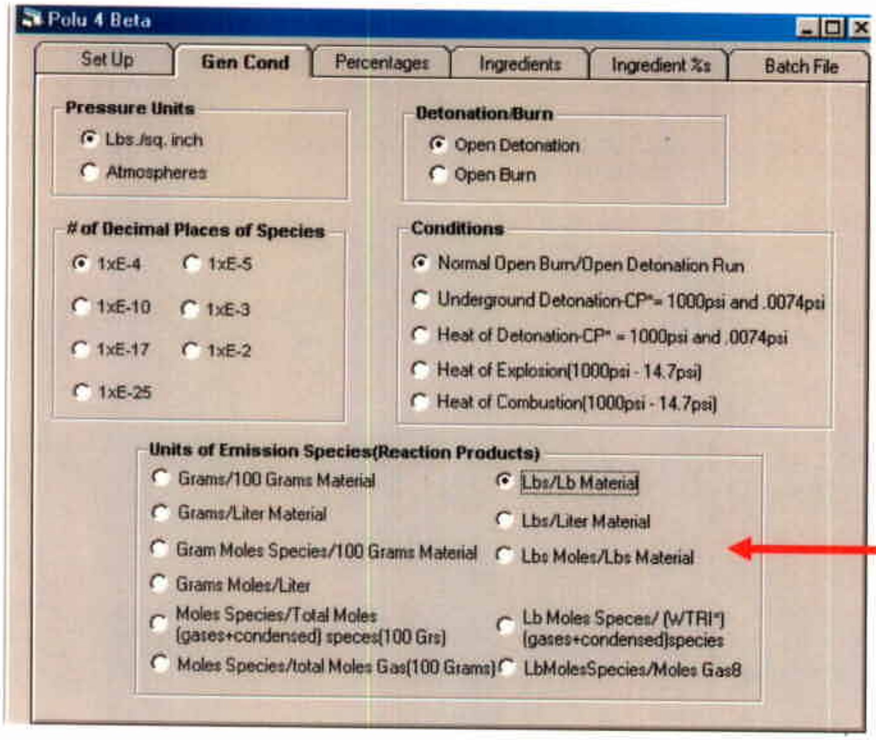
Left Column

Grams/100 Grams Material [a]	The grams of emission species for 100 grams of material that reacts in the calculation are printed in the output.
Grams/Liter Material [b]	The grams of emission species per liter of material formed in the calculation are printed in the output.
Gram Moles Species/ 100 Grams Material	The gram moles of emission species for 100 grams of material that reacts in the calculation are printed in the output.
Gram Moles /Liter [b]	The gram moles of emission species per liter formed in the calculation are printed in the output.
Moles Species/Total Moles (gases + condensed) species (100 grams)	The gram moles of emission species per total moles formed from 100 grams of material that reacts are printed in the output. For this unit, the total moles are the sum of both the gases and condensed species moles.
Moles Species/total Moles Gas (100 Grams)	The gram moles of emission species per total moles formed from 100 grams of material that reacts are printed in the output. For this unit, the total moles is only the moles of gases.

[a] Material - Material is the sum of all the ingredients' weights except the last ingredient, which is normally air.

[b] Liter Material - The liters formed at 298 K and one atmospheric pressure or Standard Temperature and Pressure (STP).

Default: Lbs/Lb Material



Pressure Units
● Lbs./sq. inch
○ Atmospheres

Detonation/Burn
● Open Detonation
○ Open Burn

# of Decimal Places of Species
● 1xE-4 ○ 1xE-5
○ 1xE-10 ○ 1xE-3
○ 1xE-17 ○ 1xE-2
○ 1xE-25

Conditions
● Normal Open Burn/Open Detonation Run
○ Underground Detonation-CP*= 1000psi and .0074psi
○ Heat of Detonation-CP* = 1000psi and .0074psi
○ Heat of Explosion(1000psi - 14.7psi)
○ Heat of Combustion(1000psi - 14.7psi)

Units of Emission Species(Reaction Products)
○ Grams/100 Grams Material ● Lbs/Lb Material
○ Grams/Liter Material ○ Lbs/Liter Material
○ Gram Moles Species/100 Grams Material ○ Lbs Moles/Lbs Material
○ Grams Moles/Liter
○ Moles Species/Total Moles (gases+condensed) speces(100 Grs) ○ Lb Moles Speces/ (WTRI*) (gases+condensed)species
○ Moles Species/total Moles Gas(100 Grams) ○ LbMolesSpecies/Moles Gas8

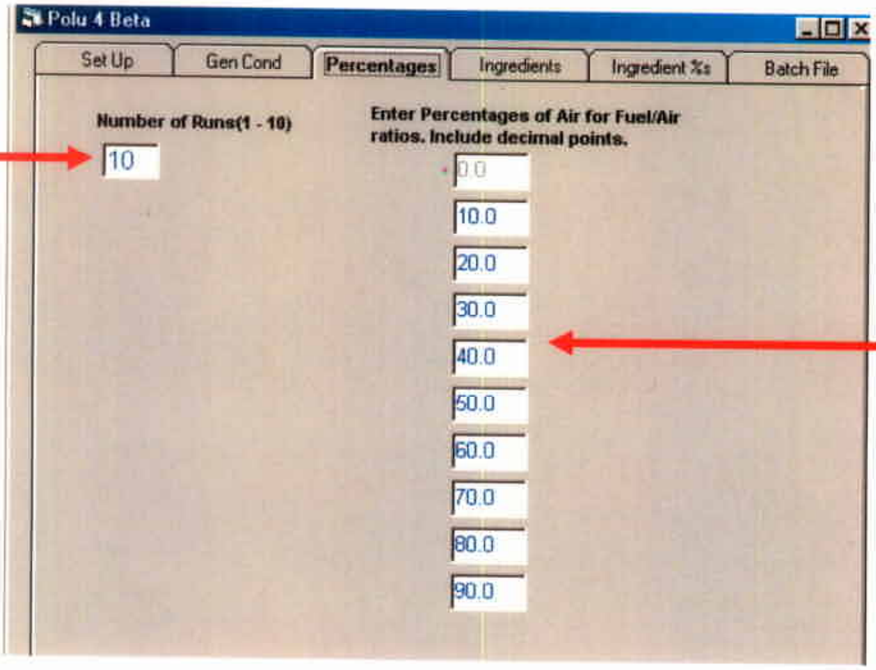
Units Defined in the Right column of "Units of Emission Species (Reaction Products)"

Lbs/Lb Material [a]	**The pounds of emission species for 1 pound of material that reacts in the calculation are printed in the output.**
Lbs/Liter Material [b]	**The lbs of emission species per liter of material formed in the calculation are printed in the output.**
Lbs Moles/Lb Material	**The lbs moles of emission species for 1 pound of material that reacts in the calculation are printed in the output.**
Lb Moles Species/Weight Material Read In [WTRI](gases + condensed) species	**The pound moles of emission species per total moles formed from WTRI of material that reacts are printed in the output. For this unit, the total moles is the sum of both the gases and condensed species moles.**
Lb Moles Species/Moles Gas	**The pound moles of emission species per total moles formed from 1 pound mole of material that reacts are printed in the output. For this unit, the total moles is only the moles of gases.**

[a] Material - Material is the sum of all the ingredients' weights except the last ingredient, which is normally air.

[b] Liter Material - The liters formed at 298 K and one atmospheric pressure or Standard Temperature and Pressure (STP).

Default: Lbs/Lb Material



Number of Runs(1 - 10): 10

Enter Percentages of Air for Fuel/Air ratios. Include decimal points.

0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0

POLU4WN can calculate and print the output data from 1 to 10 runs (or calculations) in one operation. The number of runs is entered here.
Default: 10

POLU4WN automatically changes the percentages of the ingredients in the materials used in the calculations. This is done by inputting the changes in percentages of the last ingredient (normally air) for the "Number of Runs 1-10" above. For example, if 30.0 is entered (the 4th number in the column), the calculation will run using the weight of the air as 30 and the sum of percentages of the ingredients in the material will equal to 70.

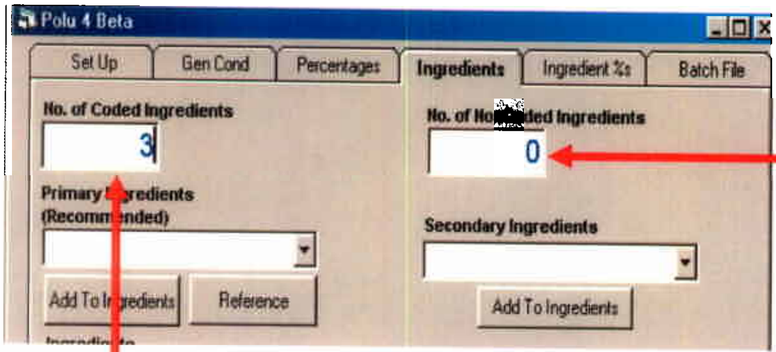
In this example, the percents of air entered are: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90. Thus, the ten calculations will have the following percents of material to air.

MATERIAL	**100**	**90**	**80**	**70**	**60**	**50**	**40**	**30**	**20**	**10**
AIR	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**

MATERIAL is always the sum of all the ingredients' percentages entered except the last one, which is normally air.

Note: Any percentages of air can be used. However, unless you run special calculations, always enter "0" for the 1st percent of air. This is because the 2nd to the 10th percentages are calculated from the 1st percentage of the materials entered, which should be 100.

Default: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90



No. of Coded Ingredients: 3

No. of NonCoded Ingredients: 0

The number of the ingredients' materials used in the calculations is entered here. It must also include air (or the last ingredient as part of the number of ingredients).

Example: If the material consists of HMX and TRINITROTOLUENE, then 3 is entered to include AIR as an ingredient in this run.

Note: The necessary input data for the ingredients are either stored in the program or must be read in. Those ingredients whose data are stored in the program are referred to as "Coded Ingredients". In this example, the input data for HMX, TRINITROTOLUENE and AIR are stored in the program and are "Coded Ingredients".

Default: From 2 to 25 ingredients can be entered.

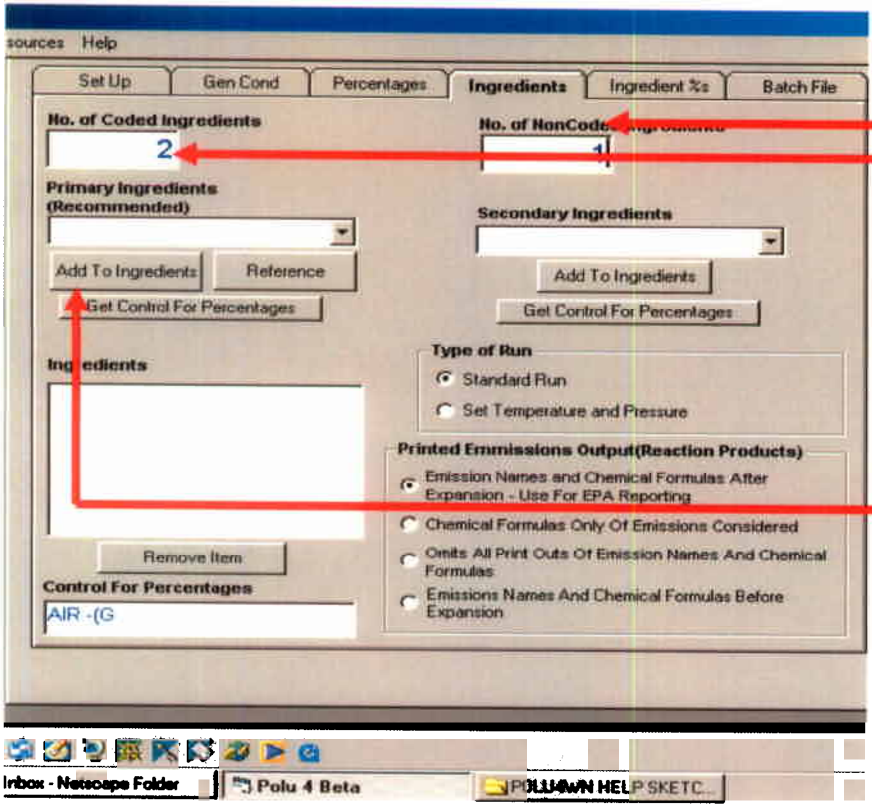
SEE EXAMPLE ON PAGE 18.

"NonCoded Ingredients" are those ingredients used, but no input data for these ingredients are stored in the program. The data must be read in. An example of adding "NonCoded Ingredients" is given below in STEPS A-G. The data below for TRINITROTOLUENE below are used for this example.

Example: If the input data for TRINITROTOLUENE were not stored, then the data below would have to be obtained from sources outside the program and read in. "NonCoded Ingredients" would be set to "1" for TRINITROTOLUENE and "Coded Ingredients" set to "2" for HMX and AIR.

Required input data	Maximum Length of Field	Example
• Name of ingredient	20	TRINITROTOLUENE
• Heat of Formation (cal/gr)	7	-78.0 (fill field)
• Density (lbs/cc)	5	05780 (fill field, no decimal point)
• No. of atoms of element	6	5.0
• Symbol of element	2	H (left adjust)
• No. of atoms of element	6	7.0
• Symbol of element	2	C (left adjust)
• No. of atoms of element	6	3.0
• Symbol of element	2	N (left adjust)
• No. of atoms of element	6	6.0
• Symbol of element	2	O (left adjust)

NOTE: If no "Non Coded Ingredients" are used, omit STEPS A-G, which explains how data for these ingredients are entered.



No. of Coded Ingredients: 2

No. of NonCoded Ingredients: 1

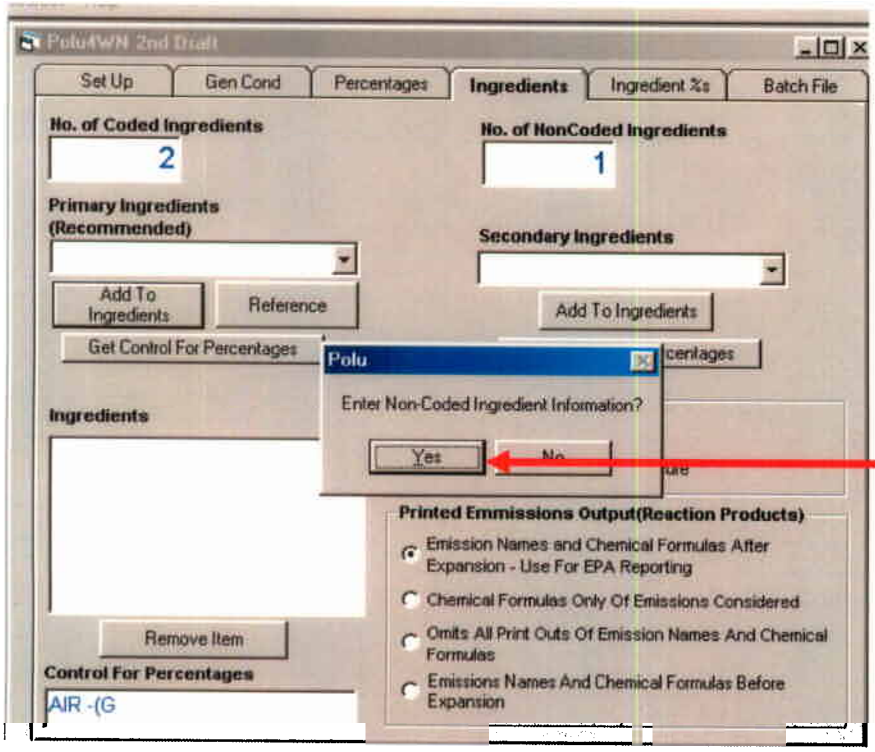
Type of Run:
- ● Standard Run
- ○ Set Temperature and Pressure

Printed Emmissions Output(Reaction Products):
- ● Emission Names and Chemical Formulas After Expansion - Use For EPA Reporting
- ○ Chemical Formulas Only Of Emissions Considered
- ○ Omits All Print Outs Of Emission Names And Chemical Formulas
- ○ Emissions Names And Chemical Formulas Before Expansion

Control For Percentages: AIR -(G

"No. of NonCoded Ingredients --- STEP A --- When there are no thermodynamic data for ingredients, it must be added. In this example it is assumed that the data for TRINITROTOLUENE (given above) are not stored, and must be read in. Thus, "1" is entered in the "NonCoded Ingredients" window. Since there are coded data for HMX and AIR, "2" is entered in the "No. of Coded Ingredients".

STEP B --- Click the "Add to Ingredients" under "Primary Ingredients".



No. of Coded Ingredients: 2

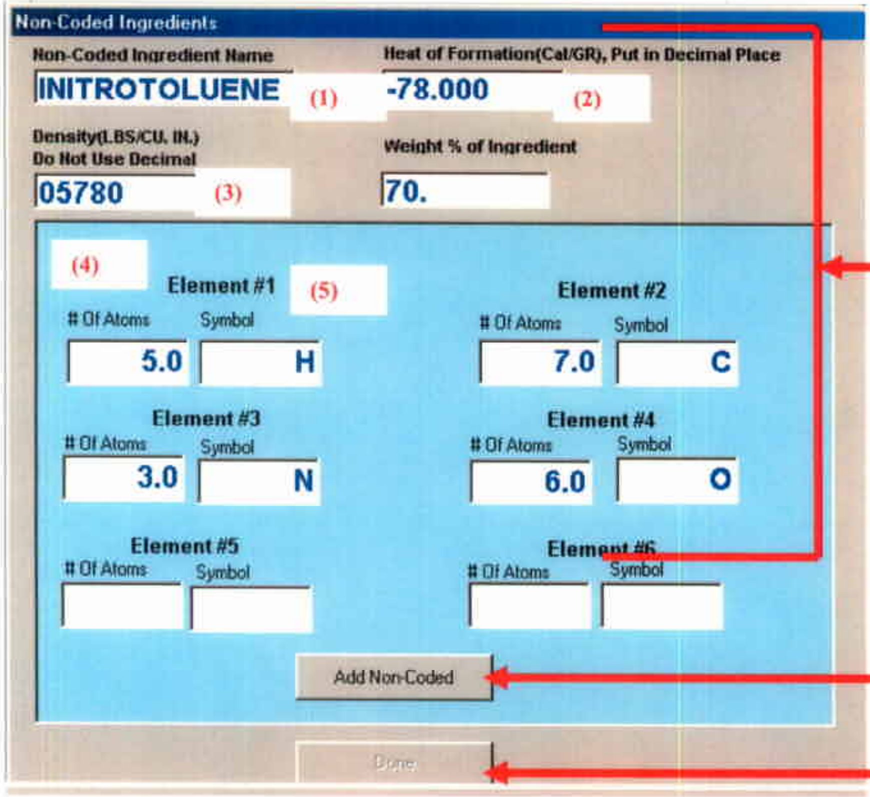
No. of NonCoded Ingredients: 1

Enter Non-Coded Ingredient Information?

Printed Emmissions Output(Reaction Products):
- ● Emission Names and Chemical Formulas After Expansion - Use For EPA Reporting
- ○ Chemical Formulas Only Of Emissions Considered
- ○ Omits All Print Outs Of Emission Names And Chemical Formulas
- ○ Emissions Names And Chemical Formulas Before Expansion

Control For Percentages: AIR -(G

STEP C--Click on "Yes"



Non-Coded Ingredient Name: INITROTOLUENE

Heat of Formation(Cal/GR), Put in Decimal Place: -78.000

Density(LBS/CU. IN.) Do Not Use Decimal: 05780

Weight % of Ingredient: 70.

	# Of Atoms	Symbol
Element #1	5.0	H
Element #2	7.0	C
Element #3	3.0	N
Element #4	6.0	O
Element #5		
Element #6		

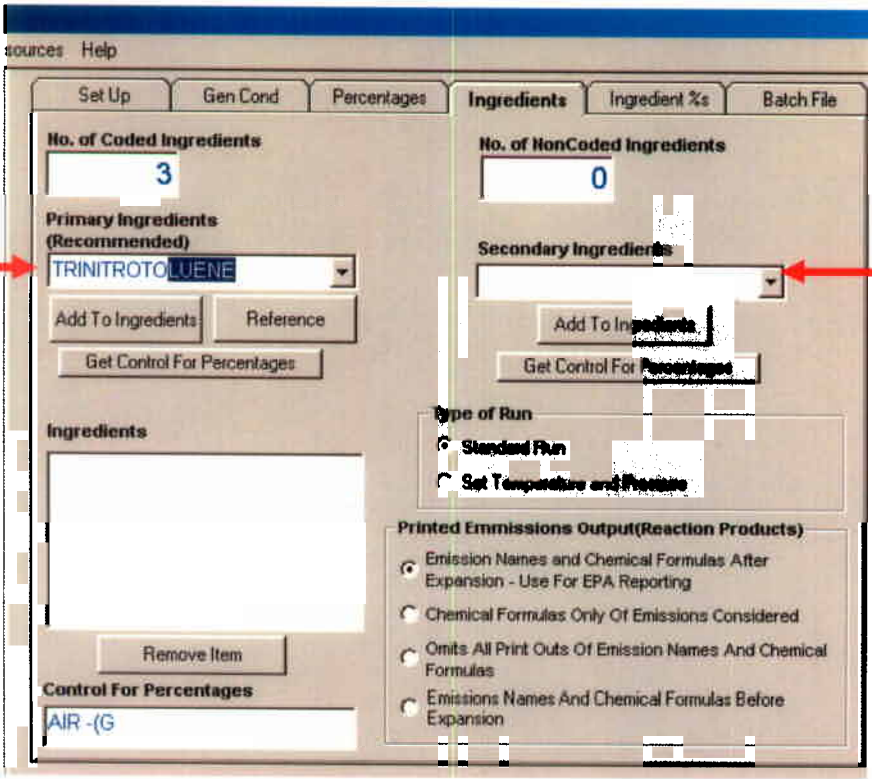
STEP D --- Fill in the data under the proper titles with the data given above for TRINITROTOLUENE.

STEP E --- Click on the "Add NonCoded" button.

STEP F ---When completed, "Add NonCoded" will change to disabled and "Done" will become enabled.

STEP G --- Click on "Done".

Notes:
(1) Name cannot exceed 20 characters.
(2) Fill Heat of Formation field completely with 7 characters (if necessary, with zeros) including negative (or positive) sign and period.
(3) Fill density field with 5 numbers (if necessary, with zeros), no period.
(4) # Of Atoms field cannot exceed 6 characters (5 numbers + period). Period must be included.
(5) Symbols for elements cannot exceed two letters.



No. of Coded Ingredients 3

No. of NonCoded Ingredients 0

Primary Ingredients (Recommended) TRINITROTOLUENE

Secondary Ingredients

Type of Run
● Standard Run
○ Set Temperature and Pressure

Printed Emmissions Output(Reaction Products)
● Emission Names and Chemical Formulas After Expansion - Use For EPA Reporting
○ Chemical Formulas Only Of Emissions Considered
○ Omits All Print Outs Of Emission Names And Chemical Formulas
○ Emissions Names And Chemical Formulas Before Expansion

Control For Percentages AIR -(G

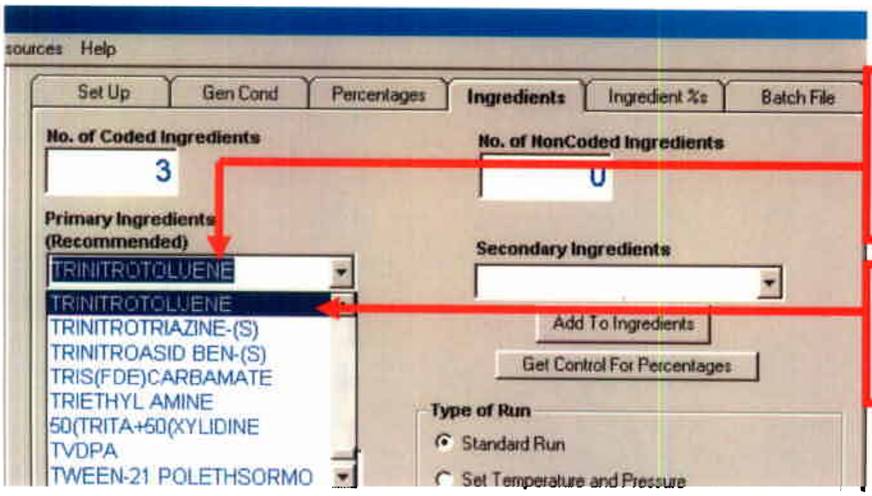
Primary Ingredients
(Recommended)

Example: Select the ingredients TRINITROTOLUENE, HMX, and AIR for a calculation or run.

The Materials' Ingredients are separated into "Primary and Secondary Ingredients".

- **"Primary Ingredients" are those ingredients that contain the most reliable thermodynamic data, such as the Heats of Formation and molecular or empirical formulae. Much of the data for this set was determined experimentally at the Naval Facility, Indian Head, MD from 1960 through 2000, which has had several names over this 40-year period. Its present name is The Naval Surface Warfare Center. In addition, the data for other ingredients came from other well-known laboratories that could be verified. Data for many of the ingredients are estimated.**

- **"Secondary Ingredients" are those ingredients that contain thermodynamic data, such as the Heats of Formation and molecular or empirical formulae that could neither be referenced or verified. Like the "Primary Ingredients" list, much of the data were determined experimentally, but the references are unknown. Both lists contain many of the same ingredients.**



No. of Coded Ingredients: 3

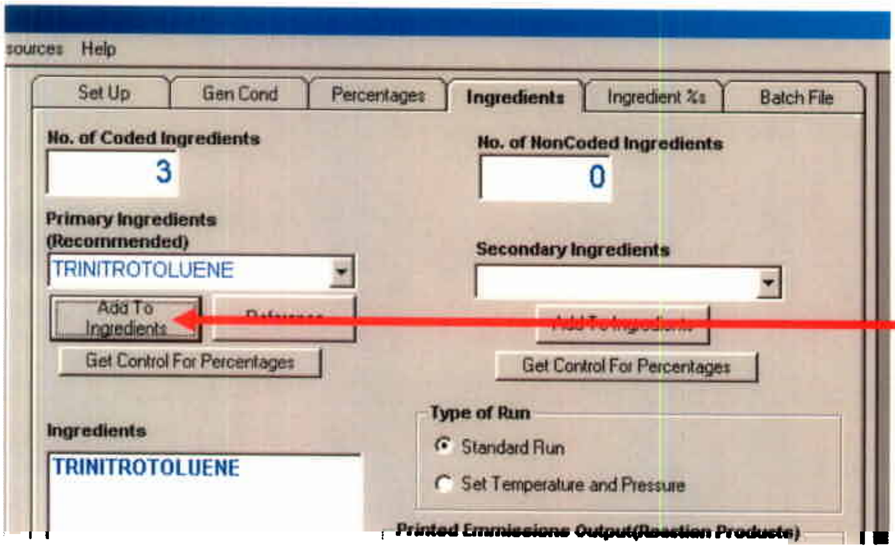
No. of NonCoded Ingredients: 0

Primary Ingredients (Recommended): TRINITROTOLUENE

Secondary Ingredients:

STEP 1 --- Select TRINITROTOLUENE by typing in the name here. You could also use the drop down menu and scroll down until you find TRINITROTOLUENE.

STEP 2 --- Even if you just type the ingredient in, you need to select the drop down menu and click on TRINITROTOLUENE to select it.



No. of Coded Ingredients: 3

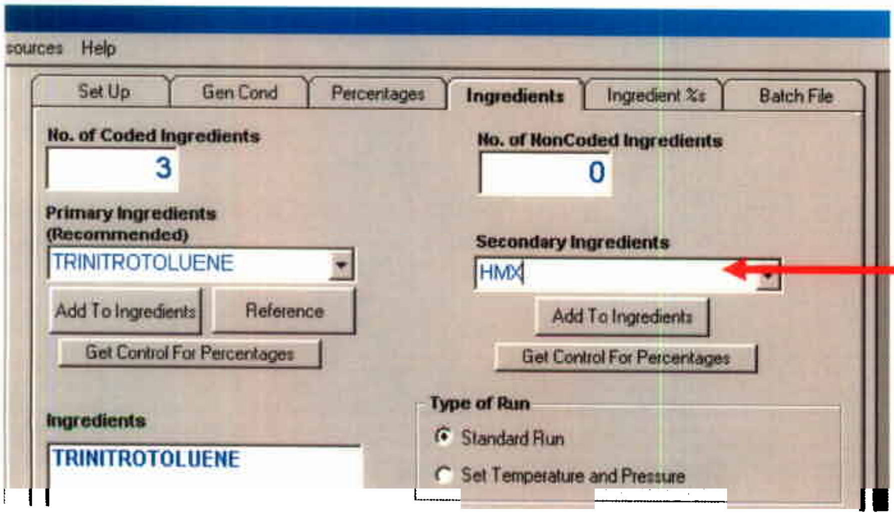
No. of NonCoded Ingredients: 0

Primary Ingredients (Recommended): TRINITROTOLUENE

Secondary Ingredients:

Ingredients: TRINITROTOLUENE

STEP 3 --- Select the "Add to Ingredients" button. TRINITROTOLUENE is selected for the calculation and placed in the "Ingredients" window.



No. of Coded Ingredients: 3

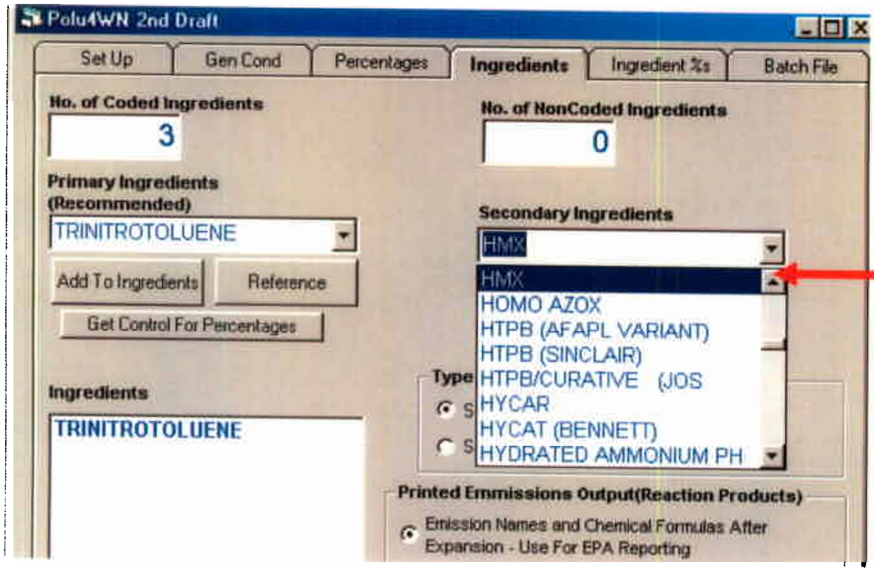
No. of NonCoded Ingredients: 0

Primary Ingredients (Recommended): TRINITROTOLUENE

Secondary Ingredients: HMX

Ingredients: TRINITROTOLUENE

STEP 4 --- Selecting HMX. Type HMX in the "Secondary Ingredients" list. You could also use the dropdown menu and scroll down until you find HMX. Note: HMX is also in the "Primary Ingredients" list, but it is selected from the "Secondary Ingredients" to demonstrate the use of the "Secondary List".



No. of Coded Ingredients: 3

No. of NonCoded Ingredients: 0

Primary Ingredients (Recommended): TRINITROTOLUENE

Secondary Ingredients: HMX

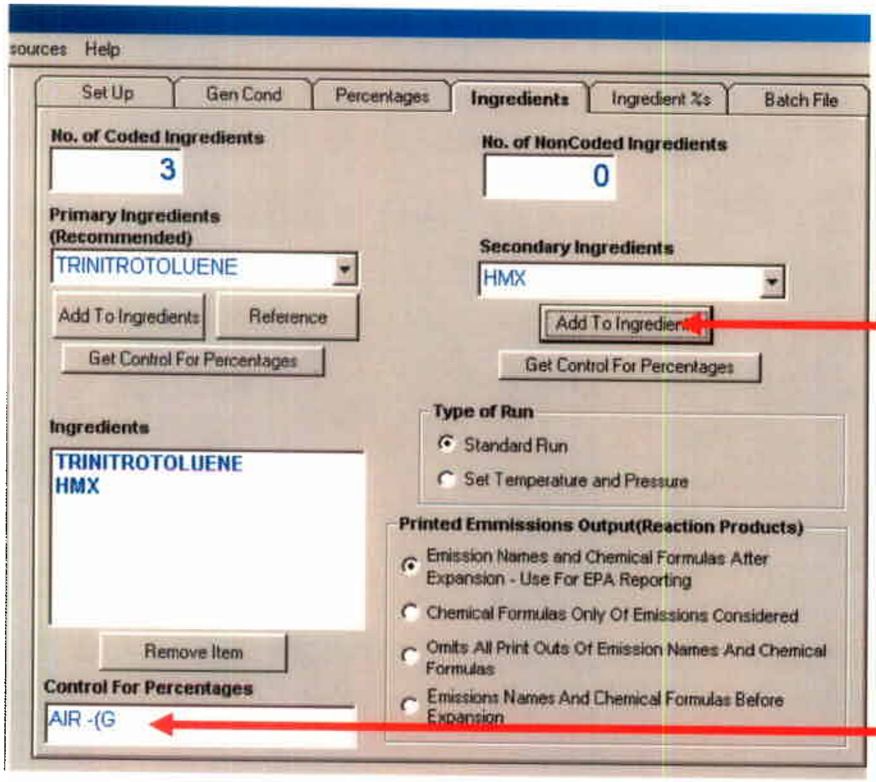
- HMX
- HOMO AZOX
- HTPB (AFAPL VARIANT)
- HTPB (SINCLAIR)
- HTPB/CURATIVE (JOS
- HYCAR
- HYCAT (BENNETT)
- HYDRATED AMMONIUM PH

Ingredients: TRINITROTOLUENE

Printed Emmissions Output(Reaction Products)

● Emission Names and Chemical Formulas After Expansion - Use For EPA Reporting

STEP 5 --- Even if you just type the ingredient in you need to select the dropdown menu and click HMX to select it.



No. of Coded Ingredients: 3

No. of NonCoded Ingredients: 0

Primary Ingredients (Recommended): TRINITROTOLUENE

Secondary Ingredients: HMX

Ingredients:
TRINITROTOLUENE
HMX

Type of Run

● Standard Run

○ Set Temperature and Pressure

Printed Emmissions Output(Reaction Products)

● Emission Names and Chemical Formulas After Expansion - Use For EPA Reporting

○ Chemical Formulas Only Of Emissions Considered

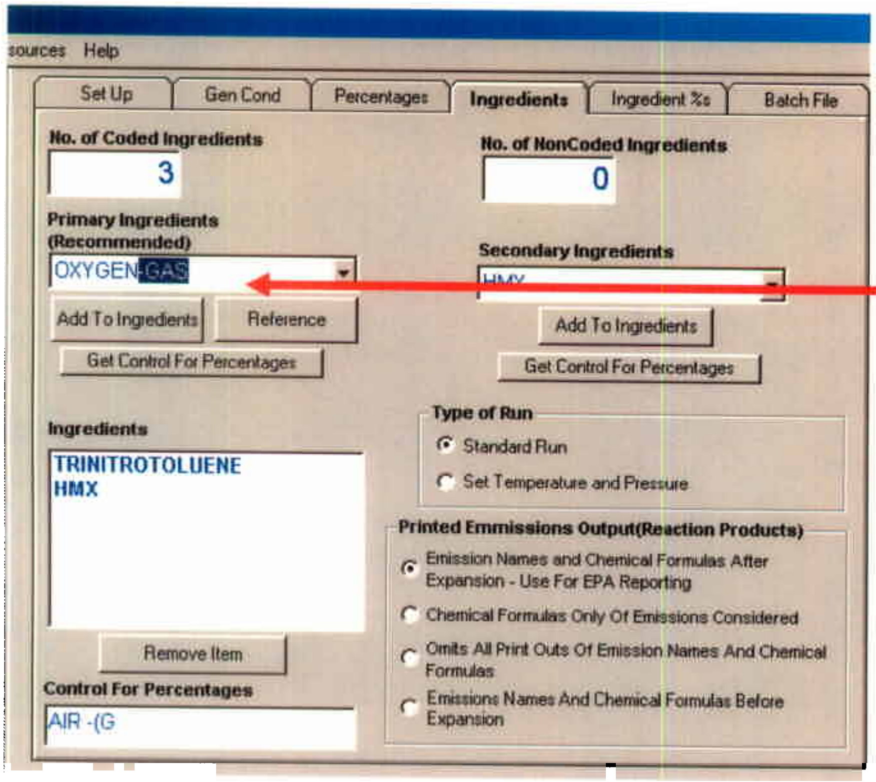
○ Omits All Print Outs Of Emission Names And Chemical Formulas

○ Emissions Names And Chemical Formulas Before Expansion

Control For Percentages: AIR -(G

STEP 6 ---Select the "Add To Ingredients" button. HMX is selected for the calculation and placed in the "Ingredients" window.

Note: The 3rd and last ingredient (AIR) in the example run is automatically selected and listed in the "Control For Percentages". Thus, the three ingredients, TRINITROTOLUENE, HMX, and AIR have been selected.



No. of Coded Ingredients
3

No. of NonCoded Ingredients
0

Primary Ingredients (Recommended)
OXYGEN-GAS

Secondary Ingredients
HMX

Ingredients
TRINITROTOLUENE
HMX

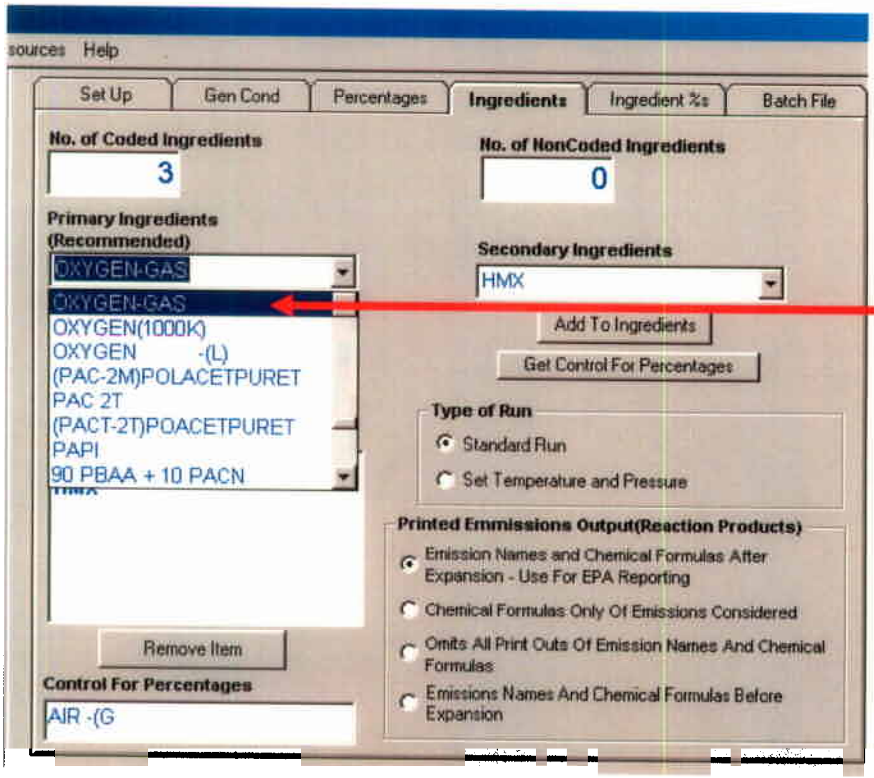
Type of Run
● Standard Run
○ Set Temperature and Pressure

Printed Emmissions Output(Reaction Products)
● Emission Names and Chemical Formulas After Expansion - Use For EPA Reporting
○ Chemical Formulas Only Of Emissions Considered
○ Omits All Print Outs Of Emission Names And Chemical Formulas
○ Emissions Names And Chemical Formulas Before Expansion

Control For Percentages
AIR -(G

STEP 7 (OPTIONAL) Changing the ingredient in the "Control For Percentages" Window with OXYGEN. --- Select OXYGEN-GAS by typing in the name here or use the dropdown menu to find OXYGEN –GAS.

Note: --- For normal calculations, energetic materials are conducted at Open Burn/Open Detonation sites in AIR. Therefore the POLU4WN was designed to control the percentages of air that combines with the energetic materials ("Percentages" TAB). However, AIR can be replaced with some other ingredient. Example: The heats of combustion (an option of POLU4WN) in an oxygen medium would be used as the "Control For Percentges".



No. of Coded Ingredients
3

No. of NonCoded Ingredients
0

Primary Ingredients (Recommended)
OXYGEN-GAS

OXYGEN-GAS
OXYGEN(1000K)
OXYGEN -(L)
(PAC-2M)POLACETPURET
PAC 2T
(PACT-2T)POACETPURET
PAPI
90 PBAA + 10 PACN

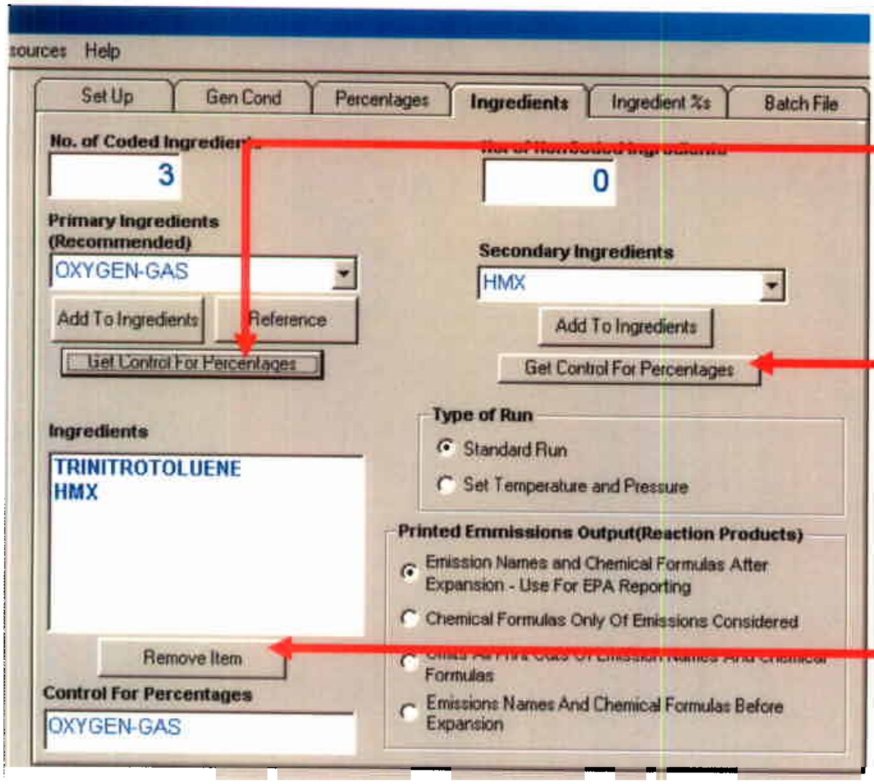
Secondary Ingredients
HMX

Type of Run
● Standard Run
○ Set Temperature and Pressure

Printed Emmissions Output(Reaction Products)
● Emission Names and Chemical Formulas After Expansion - Use For EPA Reporting
○ Chemical Formulas Only Of Emissions Considered
○ Omits All Print Outs Of Emission Names And Chemical Formulas
○ Emissions Names And Chemical Formulas Before Expansion

Control For Percentages
AIR -(G

STEP 8 (OPTIONAL) --- Even if you just typed the ingredient in, you need to select the dropdown menu and click OXYGEN-GAS to select it.



No. of Coded Ingredients: 3

No. of NonCoded Ingredients: 0

Primary Ingredients (Recommended): OXYGEN-GAS

Secondary Ingredients: HMX

Ingredients:
TRINITROTOLUENE
HMX

Type of Run
- ● Standard Run
- ○ Set Temperature and Pressure

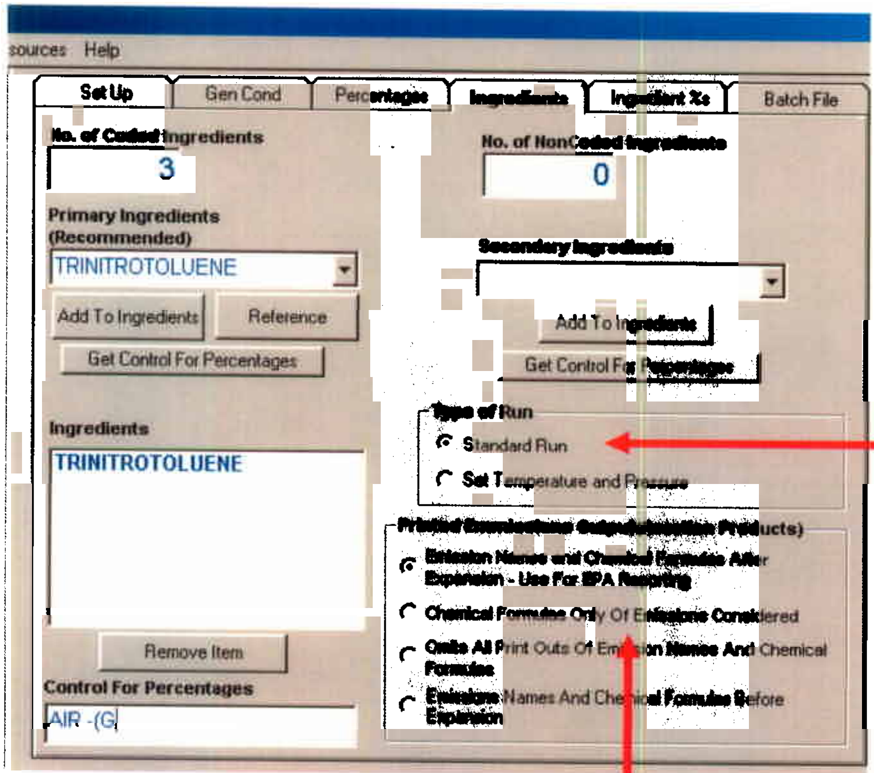
Printed Emmissions Output(Reaction Products)
- ● Emission Names and Chemical Formulas After Expansion - Use For EPA Reporting
- ○ Chemical Formulas Only Of Emissions Considered
- ○ Omits All Print Outs Of Emission Names And Chemical Formulas
- ○ Emissions Names And Chemical Formulas Before Expansion

Control For Percentages: OXYGEN-GAS

STEP 9 (OPTIONAL) ---Select the "Get Control For Percentages" button. OXYGEN-GAS will replace AIR –(G) as the "Control For Percentages" ingredient. The percentages listed under the "Percentages" TAB will control the percentages of OXYGEN in the calculations. AIR has been eliminated from the calculations.

Note: --- If the "Control For Percentages" ingredient is in the Secondary Ingredients list, select "Get Control For Percentages" under "Secondary Ingredients".

Remove Item --- To remove an ingredient from the "Ingredients" column, highlight the ingredient and select the "Remove Item" button.



No. of Coded Ingredients: 3

No. of NonCoded Ingredients: 0

Primary Ingredients (Recommended): TRINITROTOLUENE

Secondary Ingredients:

Ingredients:
TRINITROTOLUENE

Type of Run
- ● Standard Run
- ○ Set Temperature and Pressure

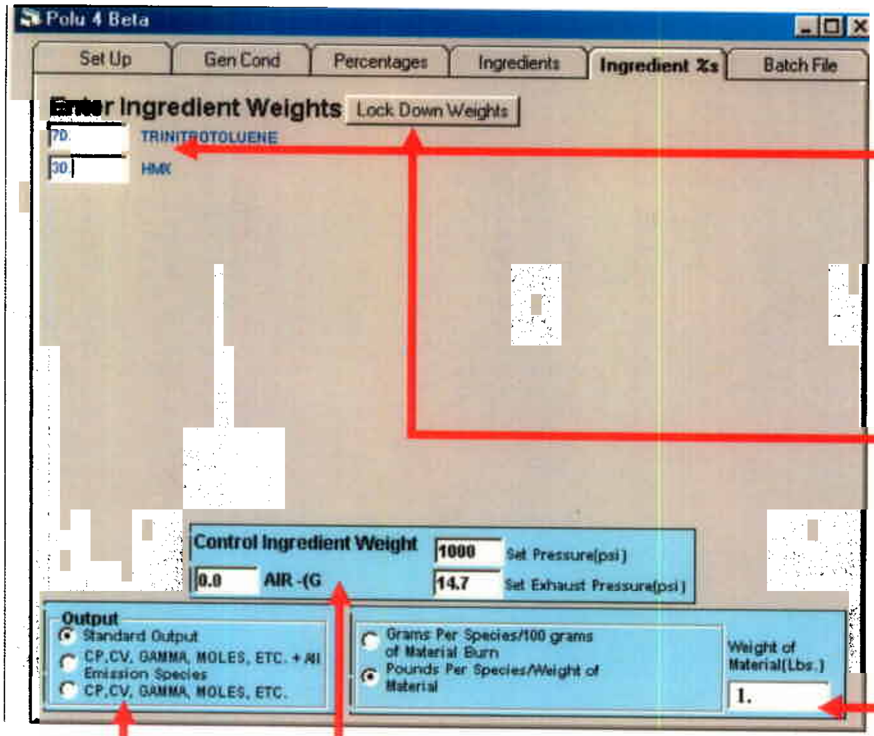
Printed Emmissions Output(Reaction Products)
- ● Emission Names and Chemical Formulas After Expansion - Use For EPA Reporting
- ○ Chemical Formulas Only Of Emissions Considered
- ○ Omits All Print Outs Of Emission Names And Chemical Formulas
- ○ Emissions Names And Chemical Formulas Before Expansion

Control For Percentages: AIR -(G

Type of Run --- POLU4WN has the option of calculating the adiabatic flame temperature of the reaction or it can be set.

- **Standard Run - This option automatically calculates the temperatures needed in the operations. This option is generally used.**
- **Set Temperature and Pressure - For experimental purposes the Temperature and Pressures can be preset (Default pressures are 1000 and 14.7 psi)**

Printed Emissions Output ---
- **Emission Names and Chemical Formulas After Expansion - Use For EPA Reporting - Prints out names and chemical formulas of the emission species after expansion.**
- **Chemical Formulas Only of Emissions Considered - Prints out only the chemical formulas, no names.**
- **Omits all Print Outs of Emission Names and Chemical formulas - Neither names or formulas are given at the end of the run.**
- **Emission Names And Chemical Formulas Before Expansion - Prints out names and chemical formulas of the emission species before expansion.**



Enter Ingredient Weights

70. TRINITROTOLUENE

30. HMX

Control Ingredient Weight

0.0 AIR -(G

1000 Set Pressure(psi)

14.7 Set Exhaust Pressure(psi)

Output

● Standard Output

○ CP,CV, GAMMA, MOLES, ETC. + All Emission Species

○ CP,CV, GAMMA, MOLES, ETC.

○ Grams Per Species/100 grams of Material Burn

● Pounds Per Species/Weight of Material

Weight of Material(Lbs.) 1.

Enter the initial percentage weights for each ingredient.
Example: Assume TRINITROTOLUENE = 70 and HMX = 30.
Note: Set the total sum of all of the ingredients' percentages = 100. This is important because the percentage changes in 2nd-10th calculations are determined from these initial percentages. However, the total sum does not have to be 100, as used in some special calculations.

Once the Ingredients' weights are entered, selecting the "Lock Down Weights" button (optional) locks in these values. Leaving TAB "Ingredients%" will sometimes delete these weights and they have to be reentered. The button will change to "Unlock Weights" showing these values are locked in place.

Control Ingredient Weight --- For normal runs always set this initial percent of AIR = 0.0, the Set Pressure (pressure before expansion) = 1000 psi and Exhaust Pressure = 14.7 psi. For experimental calculations, other values for these three input terms can be used.
Note: When "Set Temperature and Pressure" option is chosen in "Ingredients" TAB, "Set Exhaust Pressure (psi)" changes to "Set Temperature (Degrees Kelvin)". The required temperature value for this option is entered here. No exhaust pressure is required for this option.

Output ---

- Standard Output - Emission species after expansion plus other data are printed out that is standard for EPA reporting.
- CP, CV, GAMMA, MOLES, ETC + All Emission Species - Emission species before and after Expansion, etc. are printed out.
- CP, CV, GAMMA, MOLES, ETC – Emission species after Expansion, etc are printed out.

Note: These options are better understood when ran and compared.

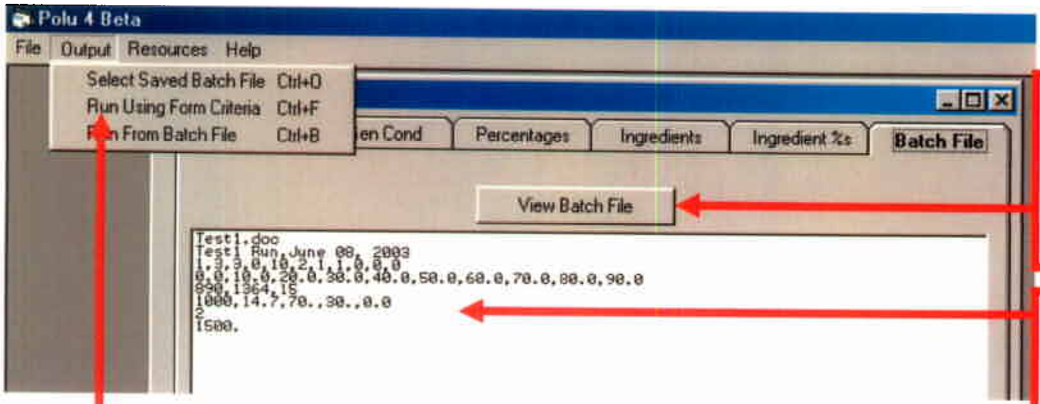
The program using input from TAB "Gen Cond" selects one of these options.

- "Grams Per Species/100 Grams of Material Burned"
- "Pounds Per Species/Weight of Material"

Weight of Material (lbs) - When "Pounds Per Species/Weight of Material" is selected, "Weight of Material (lbs)" is entered.

Example: Assume 1. (Weight Material Read In [WTRI]) is entered. The emission species printed out are from the reaction of 1 lb of material in air. For example, 0.25 pounds of CO_2 in the print out means that much CO_2 is formed from reacting 1 lb of material in air.

Default: 1.



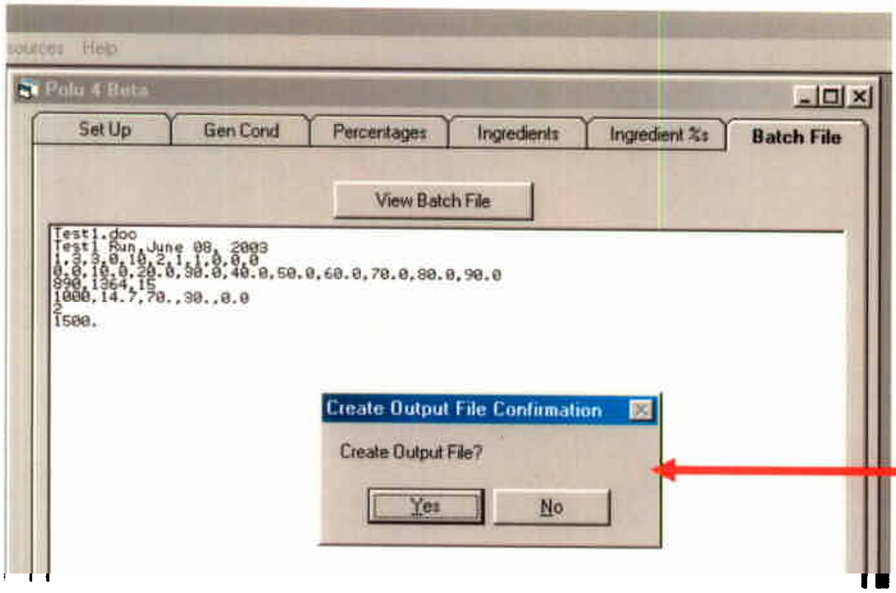
```
Test1.doc
Test1 Run,June 08, 2003
1,3,3,0,10,2,1,1,0,0,0
0.0,10.0,20.0,30.0,40.0,50.0,60.0,70.0,80.0,90.0
890,1364,15
1000,14.7,70.,30.,0.0
2
1500.
```

The "Batch File" TAB is where the calculations are executed.

STEP 1 --- Select the "View Batch File" button.

STEP 2 --- The input data selected in the other TABS are shown in the window. It is used to calculate the run. These data are stored in file "Test1.txt" that was entered in the "Set Up" TAB.

STEP 3 --- Select "Run Using Form Criteria" from the Output menu.

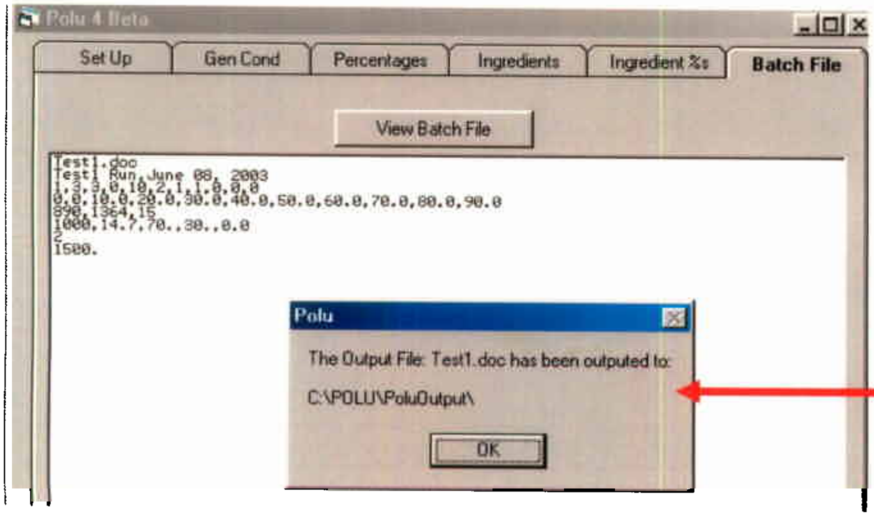


```
Test1.doc
Test1 Run,June 08, 2003
1,3,3,0,10,2,1,1,0,0,0
0.0,10.0,20.0,30.0,40.0,50.0,60.0,70.0,80.0,90.0
890,1364,15
1000,14.7,70.,30.,0.0
2
1500.
```

Create Output File Confirmation

Create Output File?

STEP 4 --- This message will appear. Select "Yes". When completed, the calculations will be stored in Output File, "Test1.Doc", that was entered in the "Set Up" TAB.



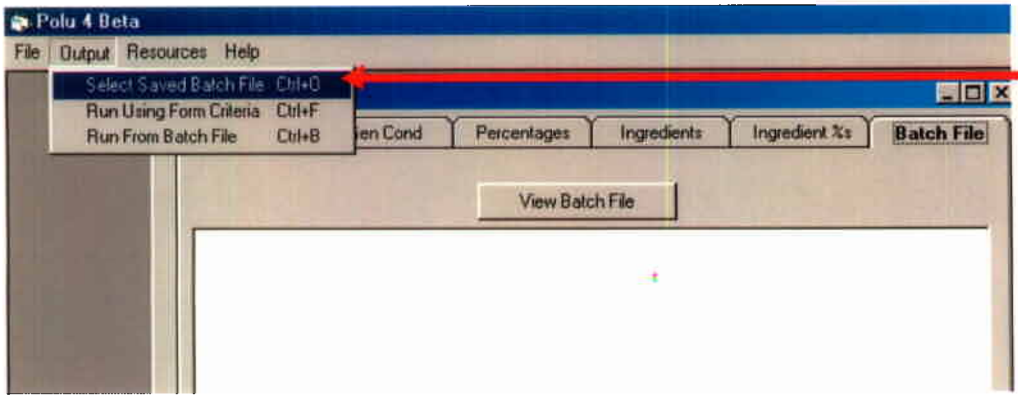
```
Test1.doc
Test1 Run,June 08, 2003
1,3,3,0,10,2,1,1,0,0,0
0.0,10.0,20.0,30.0,40.0,50.0,60.0,70.0,80.0,90.0
890,1364,15
1000,14.7,70.,30.,0.0
2
1500.
```

Polu

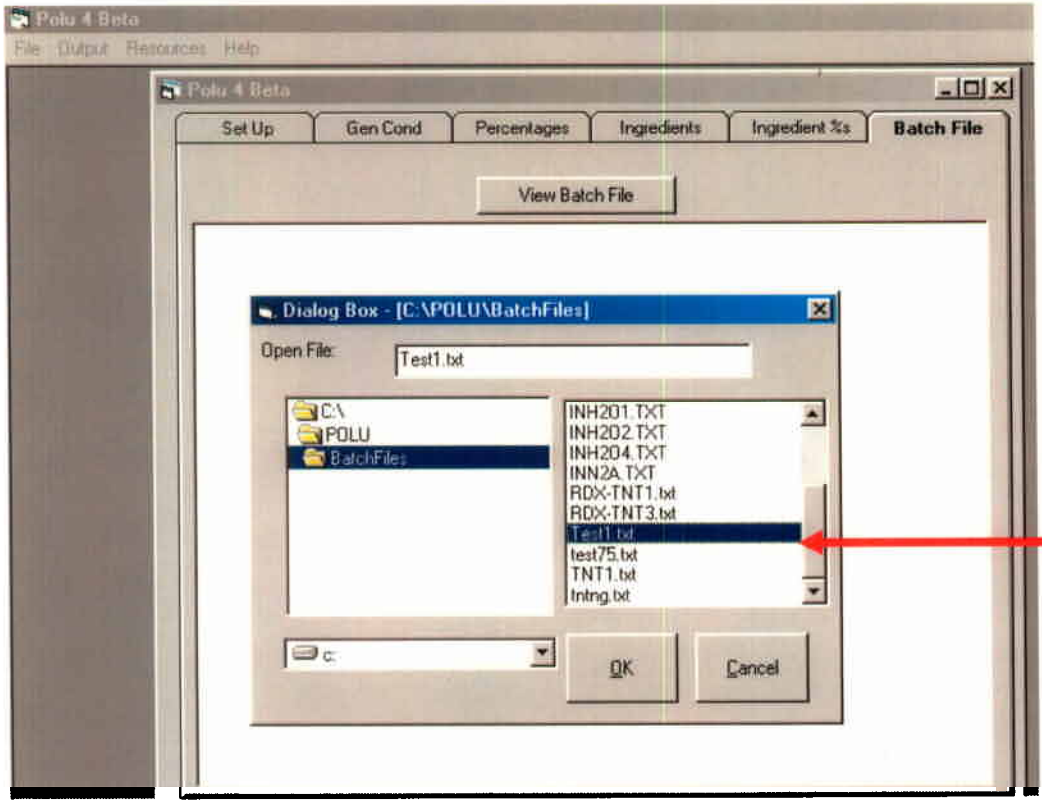
The Output File: Test1.doc has been outputed to:

C:\POLU\PoluOutput\

STEP 5 --- When the calculations have been completed, the output data are stored in file "C:\POLU\PoluOutput\", under the file name "Test1.doc". This is the Output File name entered in the "Set Up" TAB. Select "OK".



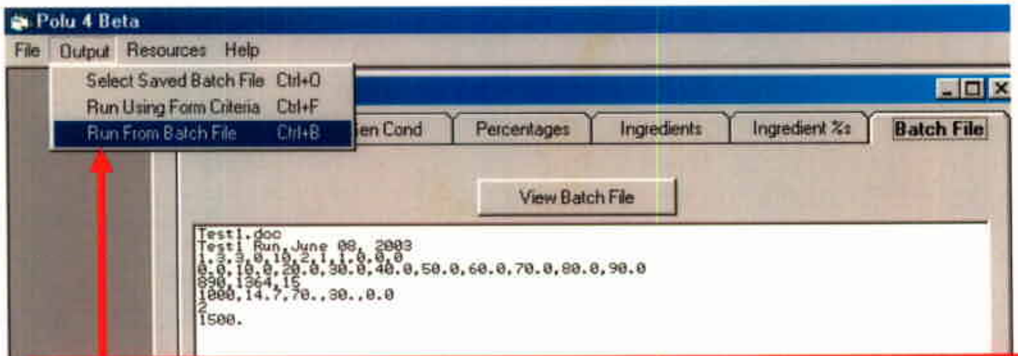
STEP 6 (OPTIONAL) --- Once a "*.txt" file has been created, it can be ran again without out going through the TAB steps.
To rerun the file "Test1.txt" that was created above, select "Select Saved Batch File" from the Output menu.



Open File: Test1.txt

STEP 7 (OPTIONAL) --- The "*.txt" files that have been created and stored in "C:\POLU\BatchFiles", are displayed. Select "Text1.txt" and click "OK".

Note: The examples of "*.txt" files in section "V EXAMPLES OF INPUT AND OUTPUT FILES" are listed here. The output "*.doc" files will be in "C:\POLU\PoluOut", which can be compared to the files in "C\POLU\Samples".



```
Test1.doc
Test1 Run,June 08, 2003
1,3,3,0,10,2,1,1,0,0,0
0.0,10.0,20.0,30.0,40.0,50.0,60.0,70.0,80.0,90.0
890,1364,15
1000,14.7,70.,30.,0.0
2
1500.
```

STEP 8 (OPTIONAL) --- To run the batch file shown in the window, "Test1.txt", select "Run From Batch File" from the Output menu. The calculation will replace "Test1.doc" stored in "C:\POLU\PoluOutput\".
Note: Change "Test1.doc" to say, "Test2.doc" and 70., 30. to 60., 40. in the window. The computer will calculate a new run with TRINITROTOLUENE = 60 and HMX = 40 and store the new data in file "Test2.doc". This "Run From Batch File" option saves time for a series of calculations without going through the TABS to create new, but similar "*.txt" files. You can also go directly to "C:\POLU\BatchFiles", modify an existing "*.txt" file, and use "Run From Batch File" to run the calculation.

SUMMARY OF FILES --- The following output files are stored in the following locations:

***) C:\Polu\PoluOutput\ "*.DOC" --- The output calculations are stored under the name "*.DOC" that was entered in the "Set Up" TAB in the "Enter Name of Output File:" window.**

) C:\Polu\Batch Files\ "*.txt" --- The input data are stored under the name "*.txt" that was entered in the "Set Up" TAB in the "Batch File Name" window.

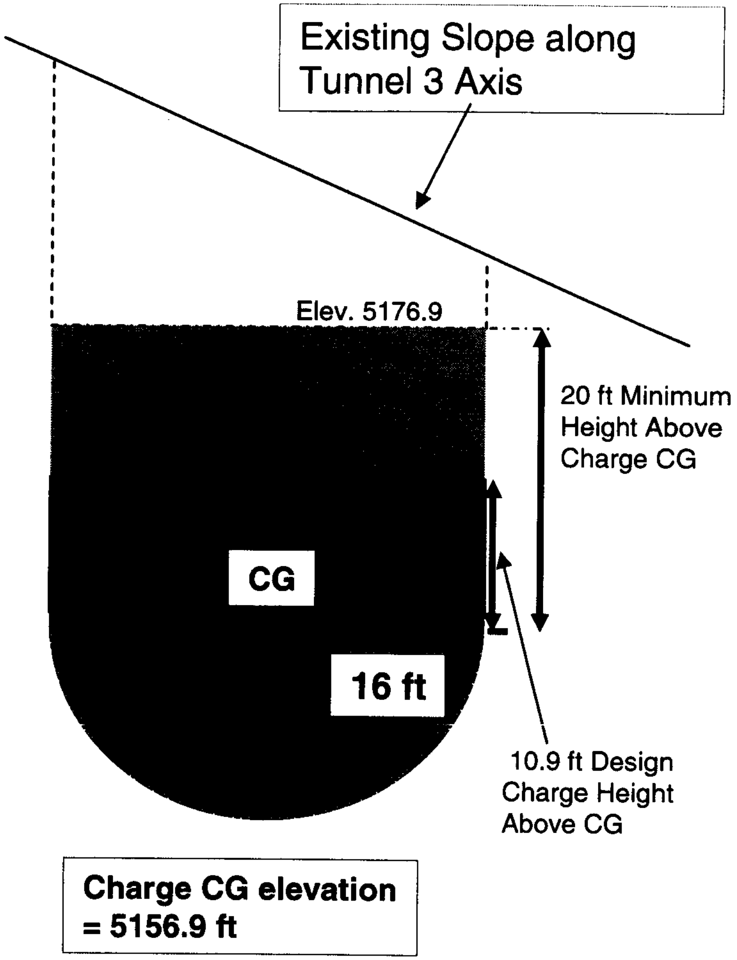
***) C:\Polu\Newingip.doc --- This file is replaced every time POLU4WN is ran. To keep this file from the just completed calculation, it must be saved under another name and preferably in another folder.**

***) C:\Polu\Polexcel.txt -- This file is replaced every time POLU4WN is ran. To keep this file from the just completed calculation, it must be saved under another name and preferably in another folder.**

Attachment G

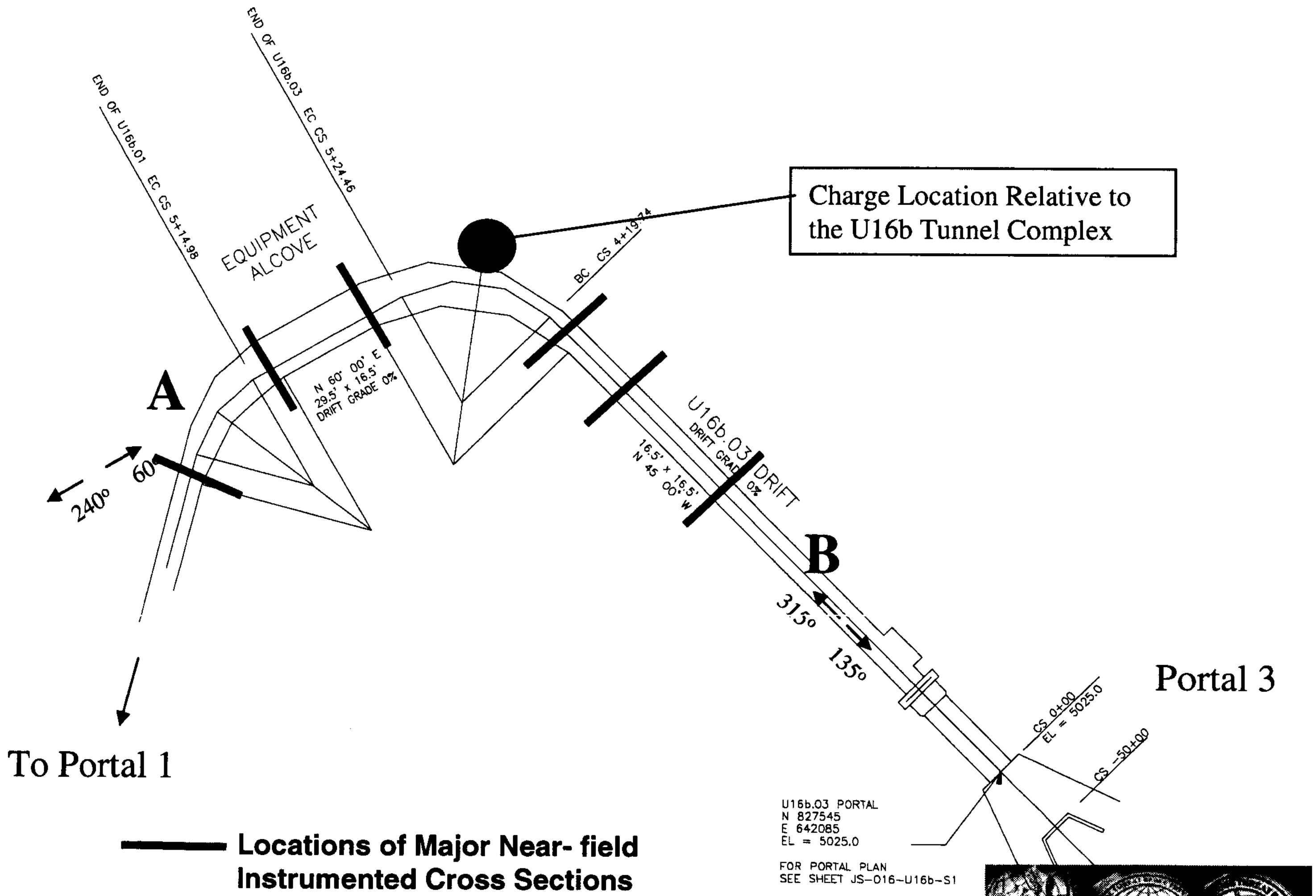
DIVINE STRAKE Charge Configuration

- **Basic Excavation Design:**
  - 32-ft diameter circular excavation, with hemispherical bottom
  - Hemisphere radius is 16 ft
  - Minimum hole height above CG is 20 ft
  - Surface excavation above Elev. 5176.9 ft asl
- **Design Charge Weight is 700 tons (English) ANFO Emulsion (593 tons TNT eq)**



[redacted]

DIVINE STRAKE Tunnel Layout



Charge Location Relative to the U16b Tunnel Complex

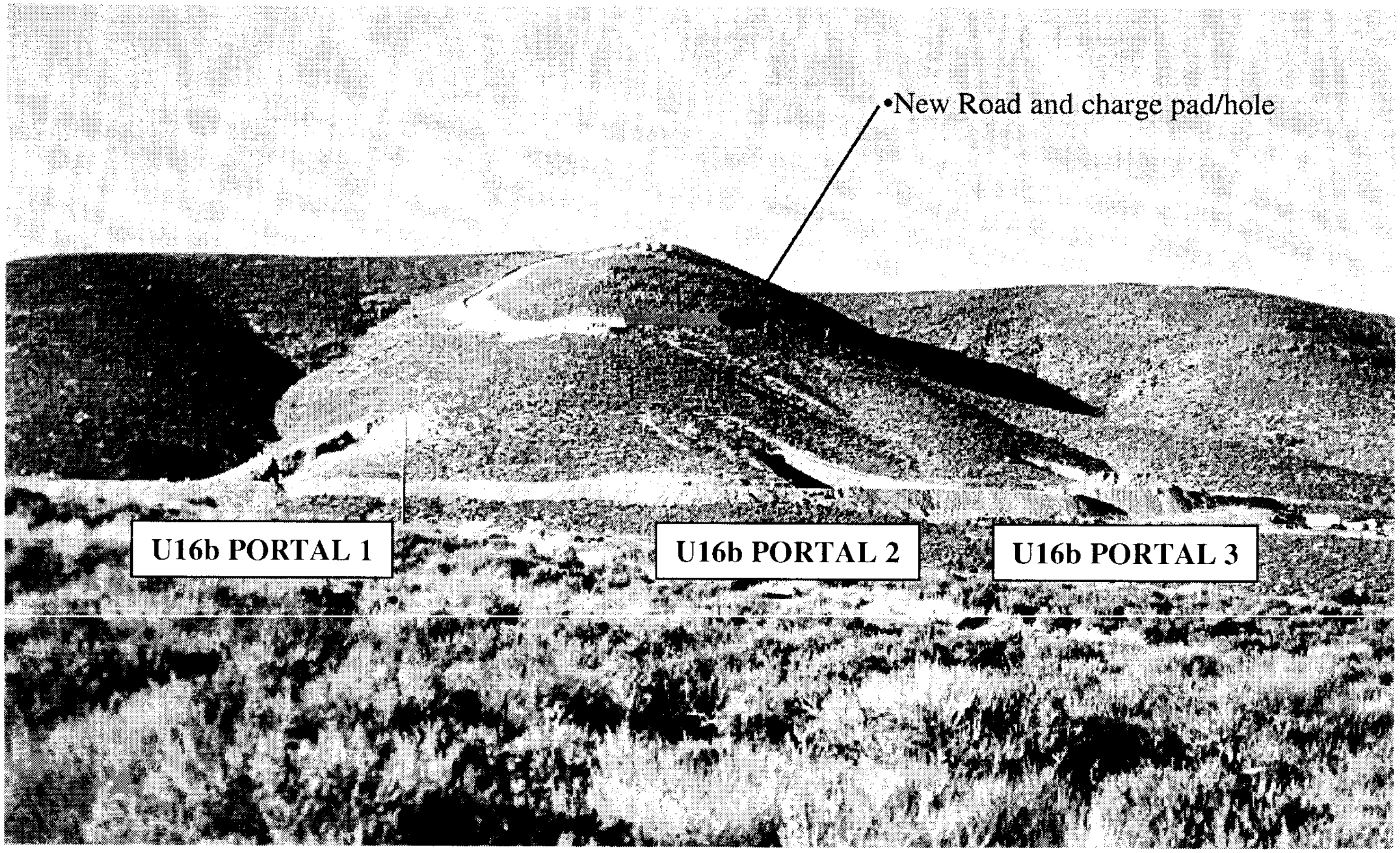
Locations of Major Near- field Instrumented Cross Sections

Rev 1: 7 Dec 05

[redacted]

Making the World Safer

Surface Terrain in U16b Area



Previous Large ANFO Detonations

Pre-Dice Throw	120 t	WSMR	1977
Misers Bluff	7-120 t	Planet Ranch Az	1978
Dice Throw	620 t	WSMR	1979
Distant Runner	2-250 t	WSMR	1981
Mill Race	620 t	WSMR	1982
Pre-Direct Course*	24 t	WSMR	1982
Direct Course*	609 t	WSMR	1983
Minor Scale*	4,744 t	WSMR	1985
Misty Picture*	4,685 t	WSMR	1987
Misers Gold*	2,445 t	WSMR	1989
Distant Image*	2,440 t	WSMR	1991
Non-Proliferation Exp	1,470 t**	NTS	1993

* Single point initiation

** ANFO-Emulsion, confined, 3 initiators

Summary of Potential Airblast Environmental Damage Criteria to Biota and the Predicted Ranges for Divine Strake

Criteria	Peak Overpressure		Range	
	kPa	psi	(ft)	(mi)
Birds in flight injured	68.9	10.0	1084	
Tree breakage (10%)	24.1	3.5	2033	
Human eardrum rupture	20.7	3.0	2251	
Incipient small mammal injury	13.8	2.0	2974	
Noise - Tinnitus (ringing) (163dB)	2.4	0.35	7511	1.4
Noise – OSHA impulsive limit (140dB)	0.2	0.029	71,912	13.6
Noise – Thunder sound (130dB)	0.1	0.015	135,040	25.5

For a calm homogeneous atmosphere, for overpressure below 2.8 kPa, if strong amplifying gradient is present these distances could be as much as 7x greater and if strong reduced gradient is present distances could be 1/3 less.

*Summary of Potential Airblast Environmental Damage Criteria to Structures and the Predicted Ranges for Divine Strake**

Criteria	Peak Overpressure		Range	
	kPa	psi	(ft)	(mi)
Chimney breakage (10% probability)	12.4	1.8	3208	
Major structural damage threshold	6.9	1.0	4932	
Roof damage (10% probability)	2.8	0.4	9895	1.9
Inflight light aircraft damage threshold	1.4	0.2	12,261	2.3
Door Failure (10% probability)	1.0	0.15	16,648	3.2
Broken bric-a-brac threshold	0.69	0.10	23,327	4.4
Broken tile and mirrors threshold	0.62	0.09	25,709	4.9
Wall and plaster cracks threshold	0.41	0.06	37,443	7.1
Cracked Windows Threshold				
- less than 1 in 1000 pop	0.40	0.058	38,294	7.2
- less than 1 in 10,000 pop	0.20	0.029	71,912	13.6

* For a calm homogeneous atmosphere, for overpressure below 2.8 kPa, if strong amplifying gradient is present these distances could be as much as 7x greater and if strong reduced gradient is present, distances could be 1/3 less.

[redacted]

*Summary of Ground Shock Damage Criteria for Structures and Biota and the Predicted Ranges for Divine Strake**

Structures Criteria	Surface Vr+		Range	
	(cm/sec)	(in/sec)	(ft)	(mi)
Structural Weakening Falling plaster, trailers off foundation	22.5	9	495	
Plaster cracking	15.2	6	662	
Fine paint cracks threshold	10.2	4	878	
Cosmetic damage threshold	8.9	3.5	968	
Biota Criteria				
"Human unpleasant" threshold	2.0	0.8	2788	
Normal human perception	0.1	0.04	23,324	4.4
Lower earthquake human perception threshold	0.01	0.004	119,343	22.6

* Predictions using empirical techniques of NVO-1163-239, March, 1974

[redacted]

DIVINE STRAKE ANFO-Emulsion Detonation Products

Compound	Symbol	Amt/kg of Explosive (g/kg)	Total Produced (Mg)
Water	H_2O	504.45	271.62
Nitrogen	N_2	285.80	153.89
Carbon Dioxide	CO_2	171.64	92.42
Methane	CH_4	7.06	3.80
Calcium Carbonate	$CaCO_3$	31.05	16.72

Proposed ANFO-emulsion is well oxygen-balanced, data from SNL TIGER-BKWS code calculations done for the NPT, Jan, 1993.

Attachment H

[redacted]

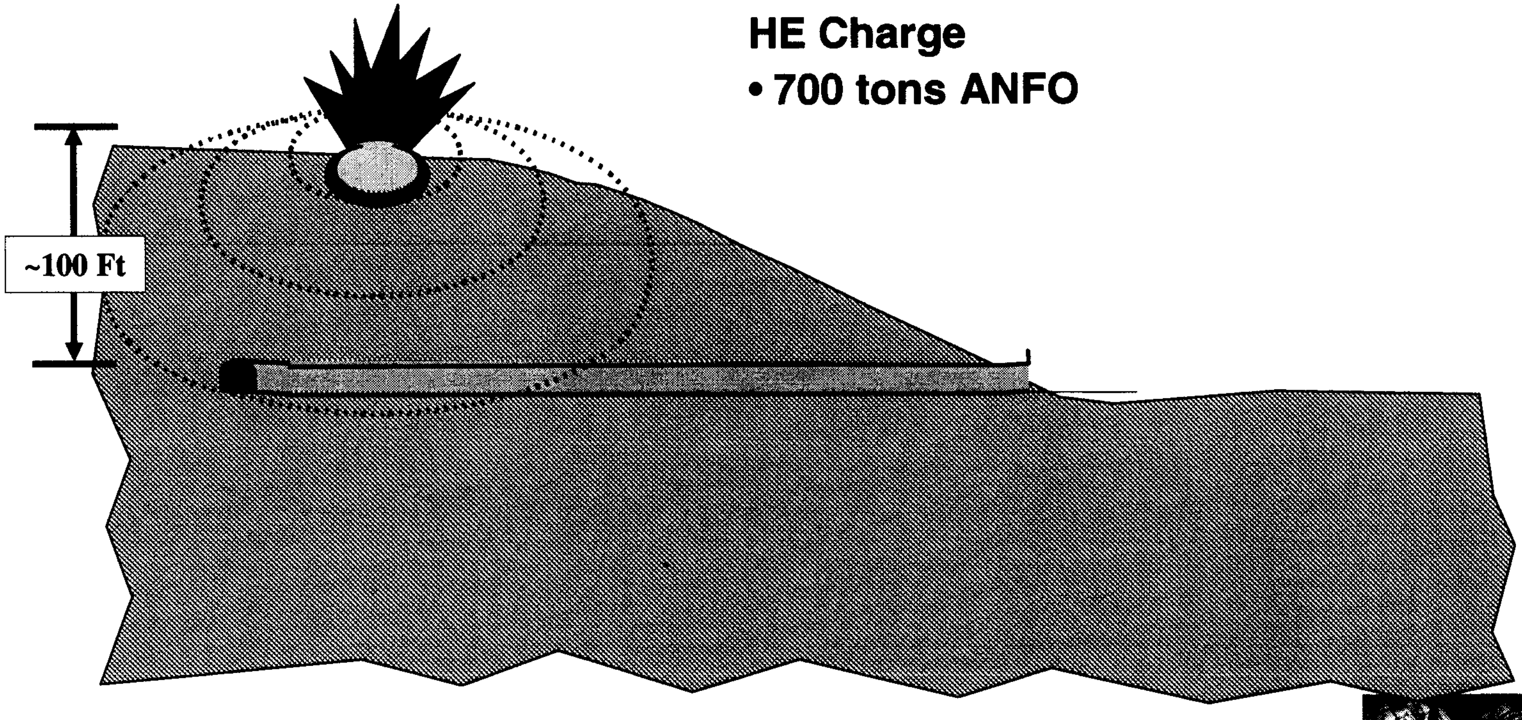
DIVINE STRAKE

Test Objectives

- Plan and conduct a large-scale high explosive demonstration test to create the proper ground shock environment to damage an existing tunnel complex
- Provide site characterization data defining in-situ properties and 3-D variations within the test bed
- Geotechnical characterization & pre-test predictions
  - To fill important targeting gap
- Provide test data defining:
  - Charge source performance (limited)
  - Free-field ground motions and asymmetries
  - Tunnel near-field environment and response
- Support the evaluation and validation of attack planning tool capabilities, including:
  - Fast-running ground shock and tunnel damage models
  - First principles target response and damage calculations

DIVINE STRAKE - [redacted]
Full Scale Demo Test Concept

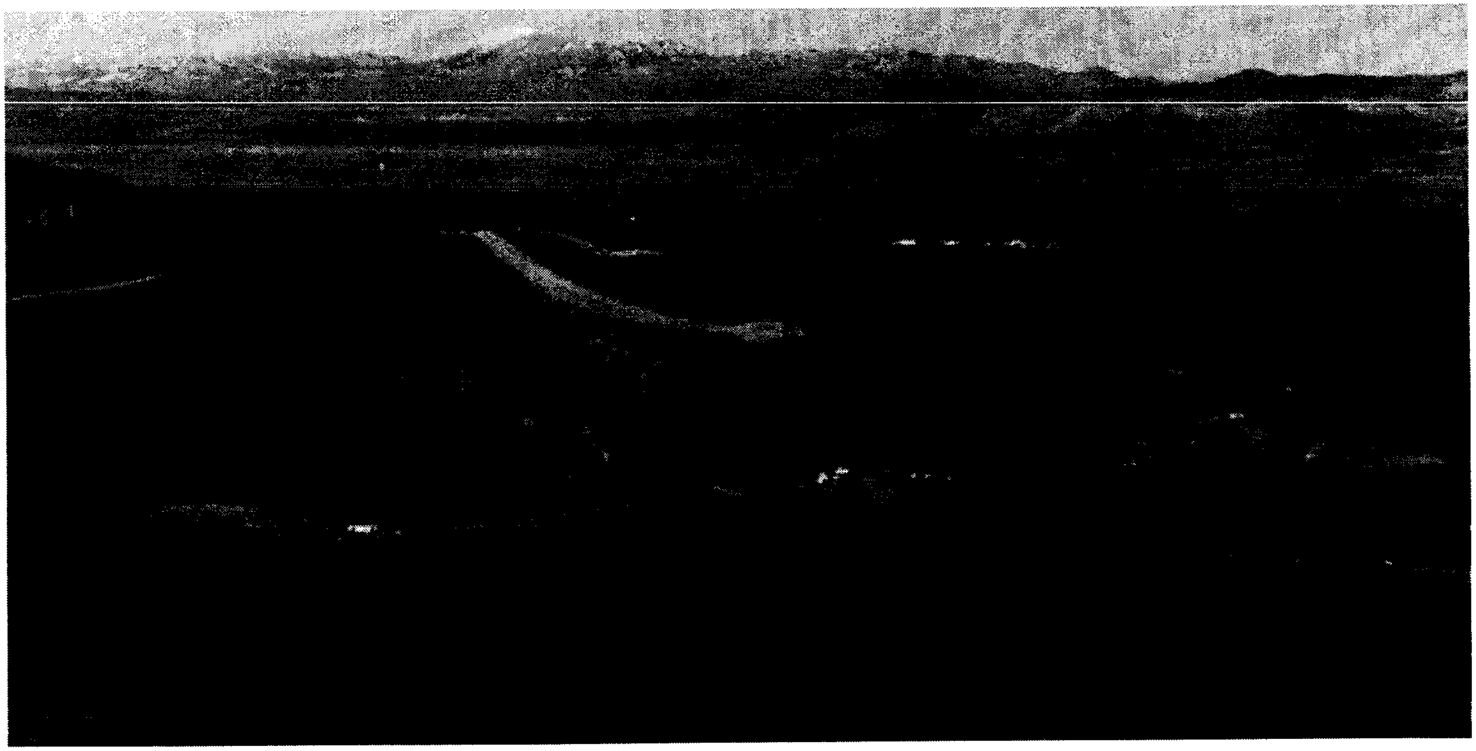
Simulated Shallow Buried ANFO Source
In Limestone Over NTS Tunnel U16b



HE Charge
- **700 tons ANFO**

[redacted]

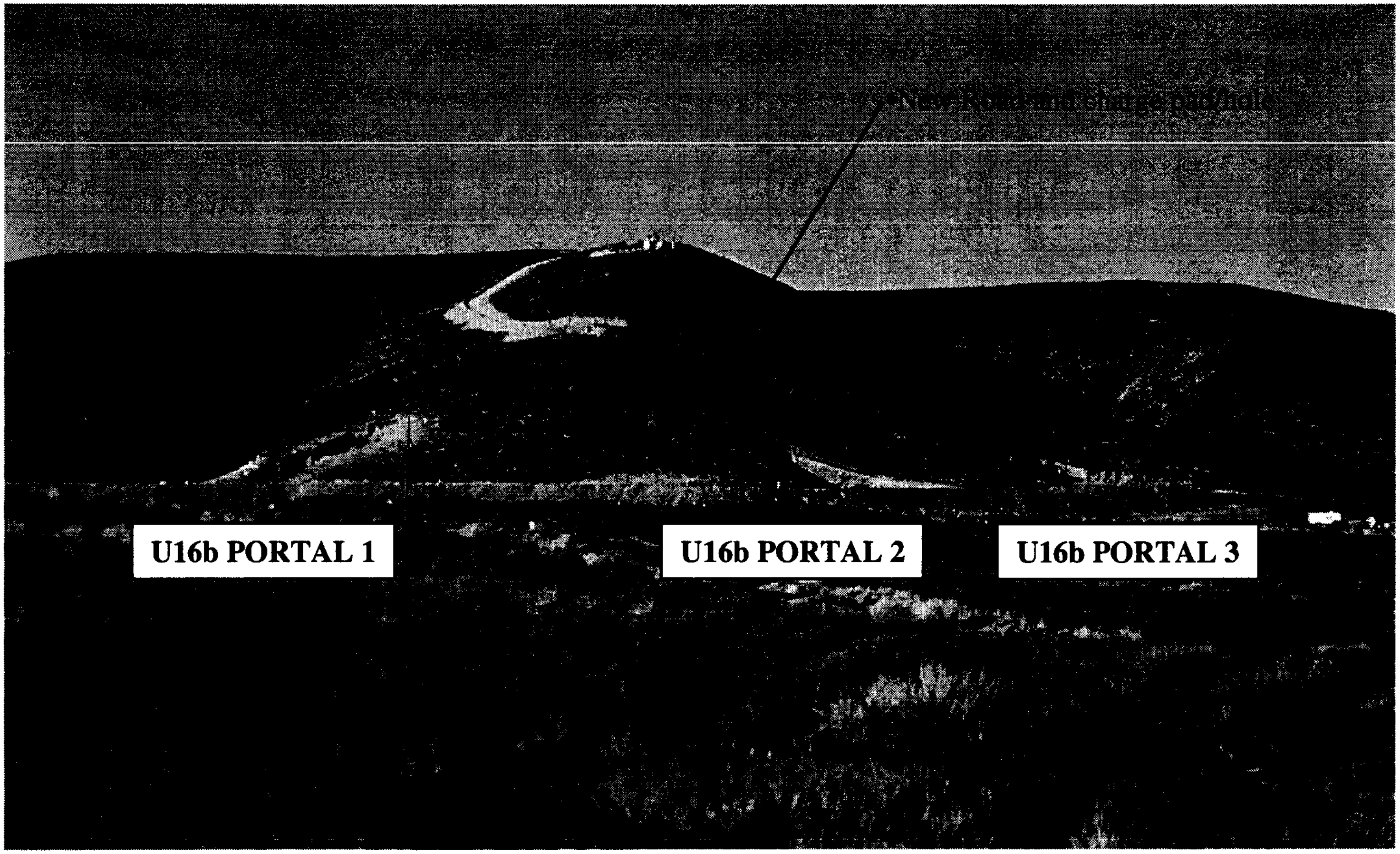
Aerial View of U16b Tunnel Vicinity



VIEW LOOKING NORTHEAST

[redacted]

Surface Terrain in U16b Area



Attachment I

Divine Strake Map - See Ken Hoar or Linda Cohn for Copy

Attachment J

Evaluation of Radiological Monitoring Data In Area 16 of the Nevada Test Site for the Proposed DIVINE STRAKE Experiment

By Thomas D. Enyeart, CHP

This paper summarizes the results of an evaluation performed of radiological monitoring data in the vicinity as well as the actual experiment test bed site for the proposed DIVINE STRAKE explosive detonation planned for Area 16 of the Nevada Test Site (NTS). The specific location of the experiment, above the U16b tunnel, has no history of nuclear testing or other work activities that would have introduced man-made radioactivity into the soils to be affected by the experiment. The U16b tunnel has been previously used for conventional explosives testing, but these experiments have not involved the use of nuclear explosives or radioactive materials.

The following radiological monitoring data was reviewed for this report:

- Aerial survey data for Area 16,
- Ground-level survey data at the proposed experiment site above U16b,
- Environmental air monitoring data downwind of the proposed experiment site,
- Ground-level survey data from the U16a muckpile located approximately 1.1 mile from the proposed experiment site, and
- Ground-level survey data between U16a and U16b.

Aerial survey of Area 16

Aerial radiological surveys have been conducted throughout the history of the NTS to map the fallout from nuclear tests and other experimental activities at the NTS. Aerial surveys of Area 16 were performed in 1970, 1983, 1992, and 1994 (DOE/NV, 1999). The 1970 survey covered only a small portion in the southeastern quadrant of Area 16 and detected no man-made radioactivity. The 1983 survey detected low-level cesium-137 (21 – 25 micro-roentgens per hour) associated with a vent line from the six nuclear tests in tunnel U16a. The 1992 survey detected no man-made radioactivity in Area 16. The 1994 survey also detected low-level cesium-137 (18 – 24 micro-roentgens per hour) in the vicinity of U16a. These aerial surveys performed over Area 16 show no detectable man-made radioactivity in the vicinity of U16b.

Ground-level survey above U16b

The area where the DIVINE STRAKE experiment will be conducted above the U16b tunnel has been excavated to prepare for emplacement of the explosives for the experiment. Thus, the ANFO emplacement will be in virgin rock that has not been exposed to previous testing activities at the NTS. In April 2006, Bechtel Nevada performed a ground-level radiological survey of the area surrounding the experiment emplacement and the excavation materials (BN, 2006). Scan surveys for alpha, beta, and gamma radiation levels showed no radioactivity above natural background levels.

Environmental air monitoring

NTS operates a network of 19 environmental air sampling stations distributed throughout the NTS. One of these stations, identified as the 3545 Substation, is located in Area 16 near U16b. Table 1 summarizes the air monitoring results from this station for the four-year period of 2001 – 2004. For most of the radionuclides that are analyzed, average air concentrations are at least three to four orders of magnitude less than the DOE 5400.5 derived concentration guides (DCGs) that would result in a dose through inhalation of 100 millirem per year based on continuous exposure. Although not shown in the table, the referenced source documents also show that these results, with the exception of the uranium isotopes, are near minimum detectable levels. The uranium isotopes measured are attributed to naturally-occurring uranium in soils. These results are consistent with other radiological surveys that have shown no man-made radioactivity is available for resuspension into the environment from the DIVINE STRAKE detonation.

Ground-level survey of U16a muckpile

The U16a tunnel portal is located approximately 1.1 mile from the U16b tunnel portal. Six nuclear tests were conducted at the U16a tunnel from 1962 to 1971. The U16a muckpile consists primarily of mining debris (rock) generated during tunnel excavation and construction in support of weapons effects testing. In the summer of 2001, corrective action investigation activities were performed at the U16a muckpile, including drive-over and walk-over radiological surveys, sampling of the muckpile contents and underlying native soils, surface sampling, and shallow subsurface sampling. Table 2 summarizes the results of the muckpile radiological sampling and analysis. Man-made radioactivity, including americium-241, cobalt-60, cesium-137, plutonium-238, plutonium-239, and strontium-90, were found above natural background levels at various depths within the muckpile ranging from the surface to 41.5 ft. Because of the distance of the U16a muckpile from U16b and the site of the DIVINE STRAKE experiment (>1 mile), and the scientific predictions of DIVINE STRAKE's area of impact, it is extremely unlikely that any man-made radioactivity from the U16a muckpile would be resuspended into the atmosphere as a result of the experiment.

Ground-level survey between U16a and U16b

In December 2005, Bechtel Nevada performed ground-level radiological surveys of areas between U16a and U16b to assess the potential for migration of radioactive contamination from the U16a muckpile (BN, 2005a & b). Measurements made at over 100 survey points on either side of Mid-Valley Road between U16a and U16b showed no detectable alpha, beta, or gamma radiation above natural background levels. An additional 65 survey points along a gully washout area between U16a and U16b likewise showed no detectable alpha, beta, or gamma radiation above natural background levels.

Conclusions

Based on the results of aerial, ground-level, and airborne radiological surveys performed in the immediate vicinity of the DIVINE STRAKE experiment, there is no evidence of the existence of any man-made radioactivity that could be resuspended into the atmosphere as a result of the experiment. Aerial and ground-level radiological surveys show that the nearest man-made radioactivity is approximately 1.1 mile from the U16b experiment site and is associated with the U16a muckpile. Although the muckpile contains man-made radioactivity above natural background levels, the distance of the muckpile from the site of the experiment makes it extremely unlikely that any man-made radioactivity from the U16a muckpile would be resuspended into the atmosphere as a result of the detonation. Ground-level surveys have also confirmed that no man-made radioactivity from the U16a muckpile has migrated in the direction of U16b.

References

BN, 2005a. Radiological Survey Report for Area 16 (Mid Valley Road Between 16a & 16b Tunnel), Bechtel Nevada, Nevada Test Site, December 7.

BN, 2005b. Radiological Survey Report for Area 16 (U16a & b Gully/Washout), Bechtel Nevada, Nevada Test Site, December 12.

BN, 2006. Radiological Survey Report for Area 16 – 16bTunnel, Bechtel Nevada, Nevada Test Site, April 25.

DOE, 1993. Radiation Protection of the Public and the Environment, DOE Order 5400.5, Change 2, U.S. Department of Energy, Washington, D.C., January 7.

DOE/NV, 1999. *An Aerial Radiological Survey of the Nevada Test Site*, DOE/NV/11718-324, prepared by Bechtel Nevada Remote Sensing Laboratory for the U.S. Department of Energy, Nevada Site Office, December.

DOE/NV, 2002. *Nevada Test Site Annual Site Environmental Report for Calendar Year 2001*, DOE/NV/11718-747, prepared by Bechtel Nevada for the National Nuclear Security Administration, Nevada Operations Office, October.

DOE/NV, 2003. *Nevada Test Site Annual Site Environmental Report - 2002*, DOE/NV/11718-842, prepared by Bechtel Nevada for the National Nuclear Security Administration, Nevada Site Office, October.

DOE/NV, 2004. *Nevada Test Site Environmental Report 2003*, DOE/NV/11718-971, prepared by Bechtel Nevada for the National Nuclear Security Administration, Nevada Site Office, October.

DOE/NV, 2005. *Nevada Test Site Environmental Report 2004*, DOE/NV/11718-1080, prepared by Bechtel Nevada for the National Nuclear Security Administration, Nevada Site Office, October.

DTRA, 2002. *Corrective Action Decision Document for Corrective Action Unit 504: 16a-Tunnel Muckpile, Nevada Test Site*, Defense Threat Reduction Agency, Mercury, Nevada, September.

Table 1. 3545 Substation (Area 16) Air Monitoring results, µCi/mL, 2000 – 2004

Analytes	DOE DCG[1]	2004[2]	2003[3]	2002[4]	2001[5]
Am 241	2.0 x 10^{-14}	2.7 x 10^{-18}	3.5 x 10^{-18}	4.5 x 10^{-18}	1.2 x 10^{-17}
Cs-137	4.0 x 10^{-10}	<6.2 x 10^{-15}	<6.4 x 10^{-16}	<2.5 x 10^{-16}	2.0 x 10^{-14}
H-3	1.0 x 10^{-7}	6.2 x 10^{-13}	7.2 x 10^{-13}	4.6 x 10^{-13}	9.2 x 10^{-13}
Pu-238	3.0 x 10^{-14}	3.1 x 10^{-18}	<9.9 x 10^{-18}	4.9 x 10^{-19}	6.0 x 10^{-19}
Pu-239/240	2.0 x 10^{-14}	3.4 x 10^{-18}	5.9 x 10^{-18}	4.0 x 10^{-18}	2.1 x 10^{-18}
U-233/234	9.0 x 10^{-14}	1.8 x 10^{-16}	8.8 x 10^{-17}	9.7 x 10^{-17}	6.3 x 10^{-17}
U-235/236	1.0 x 10^{-13}	1.7 x 10^{-17}	8.3 x 10^{-18}	6.2 x 10^{-18}	1.1 x 10^{-17}
U-238	1.0 x 10^{-13}	1.8 x 10^{-16}	8.5 x 10^{-17}	8.6 x 10^{-17}	6.8 x 10^{-17}
Gross alpha	NA[6]	1.9 x 10^{-15}	3.7 x 10^{-15}	5.8 x 10^{-15}	5.8 x 10^{-15}
Gross beta	NA[6]	1.8 x 10^{-14}	1.7 x 10^{-14}	1.9 x 10^{-14}	1.8 x 10^{-14}

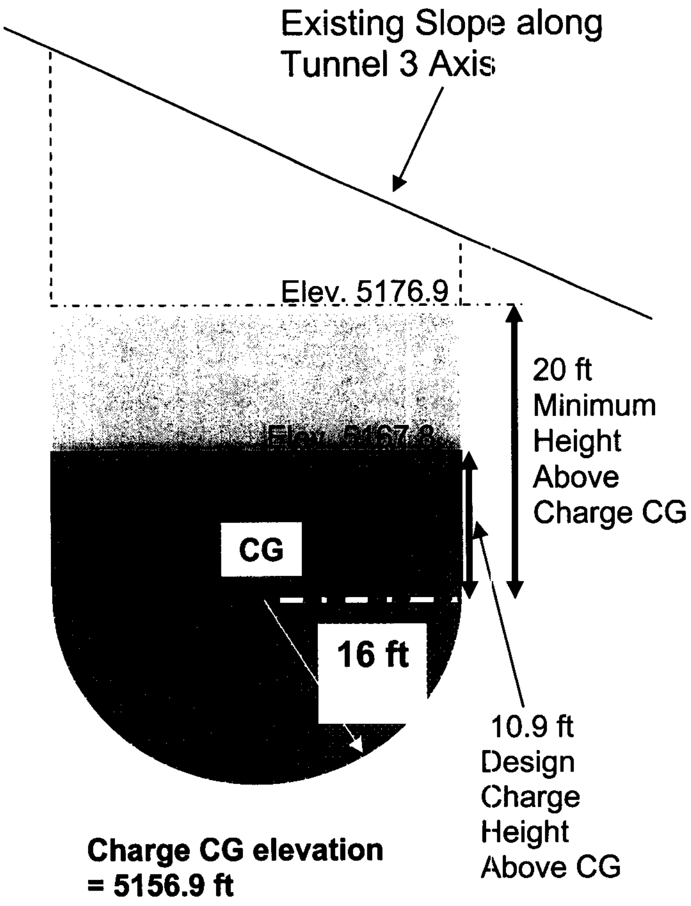
1. DOE 5400.5 Derived Concentration Guide is the concentration of a radionuclide taken into the body under conditions of continuous exposure that would result in a committed effective dose equivalent of 100 mrem per year (DOE, 1993).
2. DOE/NV, 2005.
3. DOE/NV, 2004.
4. DOE/NV, 2003.
5. DOE/NV, 2002.
6. Not applicable.

Table 2. Summary of U16a Muckpile Radionuclide Sampling Results[1]

Radionuclide	Sample Depth Range (ft)	Concentration Range (pCi/g)	Background Concentration (pCi/g)
Am-241	0.5 – 1.5	1.48	0.048
Co-60	0.5 – 41.5	0.77 – 5.3	0.1
Cs-137	0 – 41.5	4.37 – 1770	7
Pu-238	0 – 41.5	0.098 – 20.2	0.002
Pu-239	0 – 41.5	0.444 – 33.2	0.24
Sr-90	0 – 41.5	2.3 – 117	1.17

1. Source: DTRA, 2002

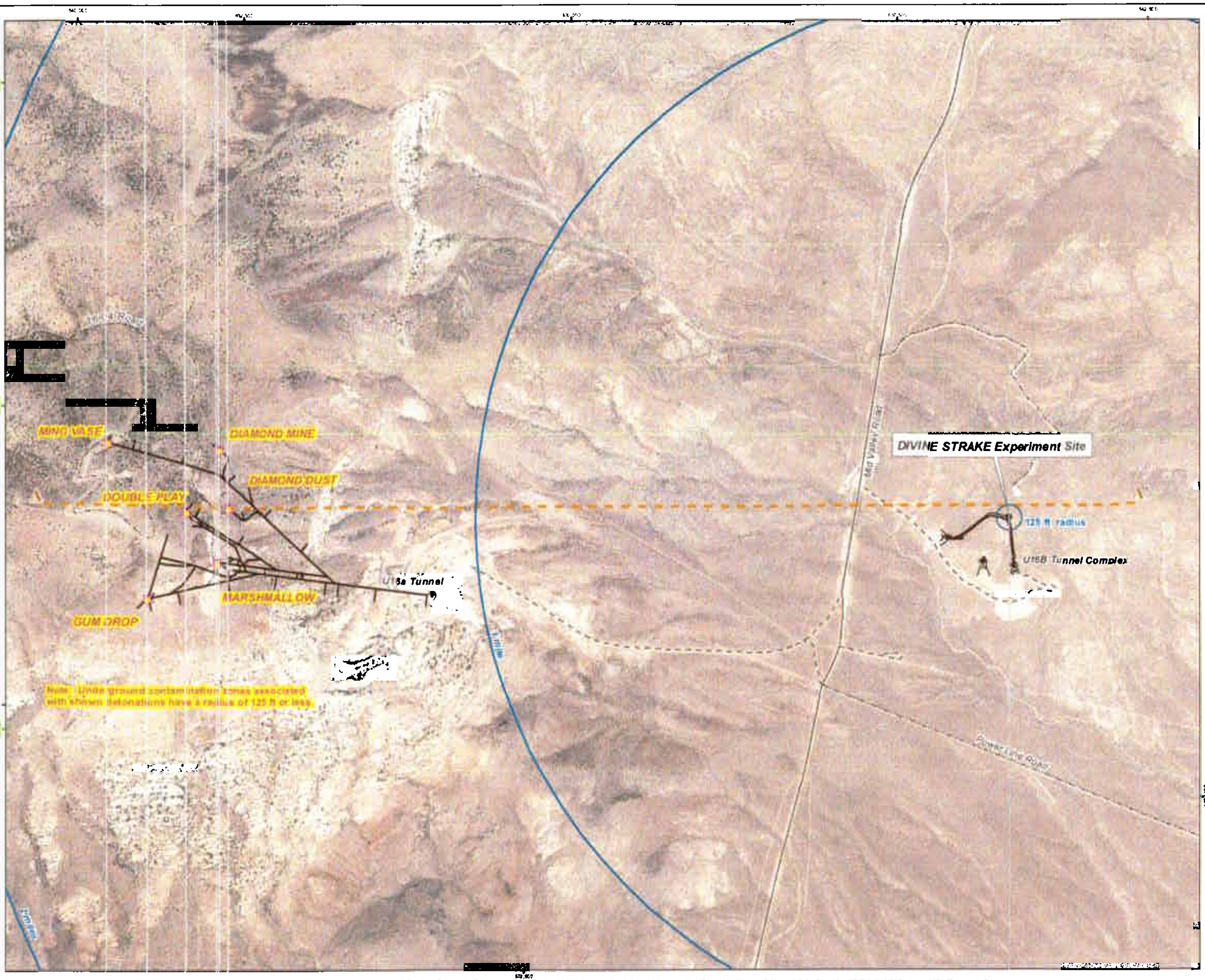
Attachment K



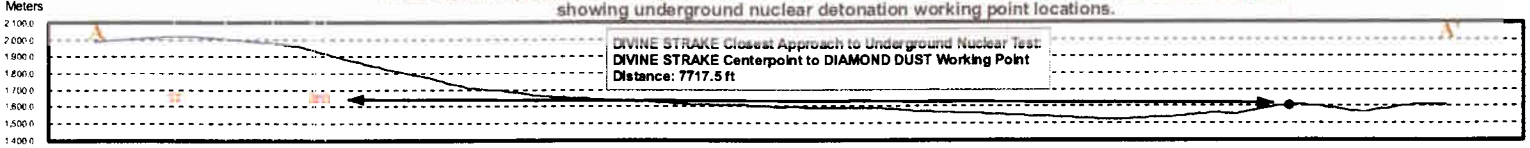
Total volume of material excavated is 15,000 cubic yards.

1000 yards for the hole
14,0000 for the cutting the hillside to build the pad

Attachment L



Cross-sectional profile view along line A-A', from DIVINE STRAKE Experiment Site to U16A Tunnel Complex, showing underground nuclear detonation working point locations.



DIVINE STRAKE Closest Approach to Underground Nuclear Test:
DIVINE STRAKE Centerpoint to DIAMOND DUST Working Point
Distance: 7717.5 ft

DIVINE STRAKE

EXPLANATION

- ● Tunnel Portal (not to scale)
- ☆ Underground Nuclear Detonation

NTS Boundaries

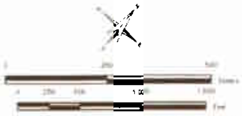
- NTS Boundary
- NTS Operational Areas
- Tunnel Centerline
- Profile line

Road Classification

- Primary highway, paved surface
- Secondary highway, paved surface
- Light-duty road, paved or improved surface
- Ramp
- Unimproved road
- Vehicular trail

Background scene is one-meter resolution orthophoto imagery, acquired in 1998.

Map Date: 4 May 2006
Revision 3



Nevada Central State Plane Projection (meters)
North American Datum 1983

Tick Marks:
Blue are UTM, NAD83, meters
Green are NV State Plane, Central Zone, NAD27, feet
Black are NV State Plane, Central Zone, NAD83, meters

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NNSA
National Nuclear Security Administration

Attachment M

DOE/NV/11718—1240

Divine Strake Experiment

Air Particulates Monitoring and Sampling Plan

Monitoring for PM10 and Potentially Resuspended Radionuclides

May 17, 2006

Revision 0

Prepared for the
U.S. Department of Energy
National Nuclear Security Administration
Nevada Site Office
Under Contract No. DE-AC08-96NV11718

This plan was developed at the request of the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) and the Bechtel Nevada (BN) Hard & Deeply Buried Projects program to address concerns of:

- Resuspension of existing radioactive surface contamination creating a potential for impacting the offsite public.
- Particulate matter with an aerodynamic diameter less than or equal to 10 micrometers (PM10) emissions.

Accordingly, this plan details the deployment of air samplers with the intent of specifically monitoring the dust emitted from the Divine Strake experiment leading to:

- The collection and analysis of air particulate samples for radionuclides.
- The collection and measurement of PM10 during the experiment (U.S. Department of Energy, 2006).

This plan is organized into two sections: the first section outlines the radiological monitoring, and the second section describes the PM10 monitoring.

I. Collection of Particulate Samples for Radionuclide Analysis

Samplers

High-volume air particulate samplers (approximately 40 cubic feet per minute) will be used to obtain samples for analysis. BN Environmental Technical Services (ETS) will operate four brushless motor samplers (Hi-Q, model CF1002BRL) and six standard samplers (Hi-Q, model TF1A) to obtain samples for analysis. Four standard samplers (Hi-Q, model TF1A) will be provided to the Desert Research Institute (DRI) and will be used as defined in the DRI plan. All of the samplers used for BN monitoring are calibrated and will be operated according to BN procedure.

Sampling Locations

Particulates emitted from the Divine Strake experiment have been predicted to travel in a northwesterly direction based on morning wind patterns (see Figure 1 - taken from U.S. Department of Energy, 2006). Afternoon winds have the potential to direct emissions in a northeasterly direction (Figures 2 and 3). Proposed locations for BN ETS high-volume samplers are displayed in Figure 4 and described in Table 1. In general, there are two "arcs" of samplers spanning north of the experiment. The first set of samplers (DS-1 – DS-5) is approximately 3 to 4 miles from the experiment. The second set of samplers (DS-6 – DS-10) is approximately 7.5 to 10.2 miles from the experiment. In addition, BN ETS routine low-volume air samplers will be operating prior to, during, and after the experiment. There will be 17 locations monitored by the routine network, including five "Critical Receptor" stations (term describing locations accepted by the U.S. Environmental Protection Agency [EPA] Region 9 for demonstrating NNSA/NSO Nevada Test Site [NTS] compliance with Title 40 Code of Federal Regulations [CFR] 61, "National Emission Standards for Hazardous Air Pollutants," Subpart H) within the BN ETS routine monitoring network. Figure 5 displays all air particulate sampling locations to be operated by BN ETS during the Divine Strake experiment.

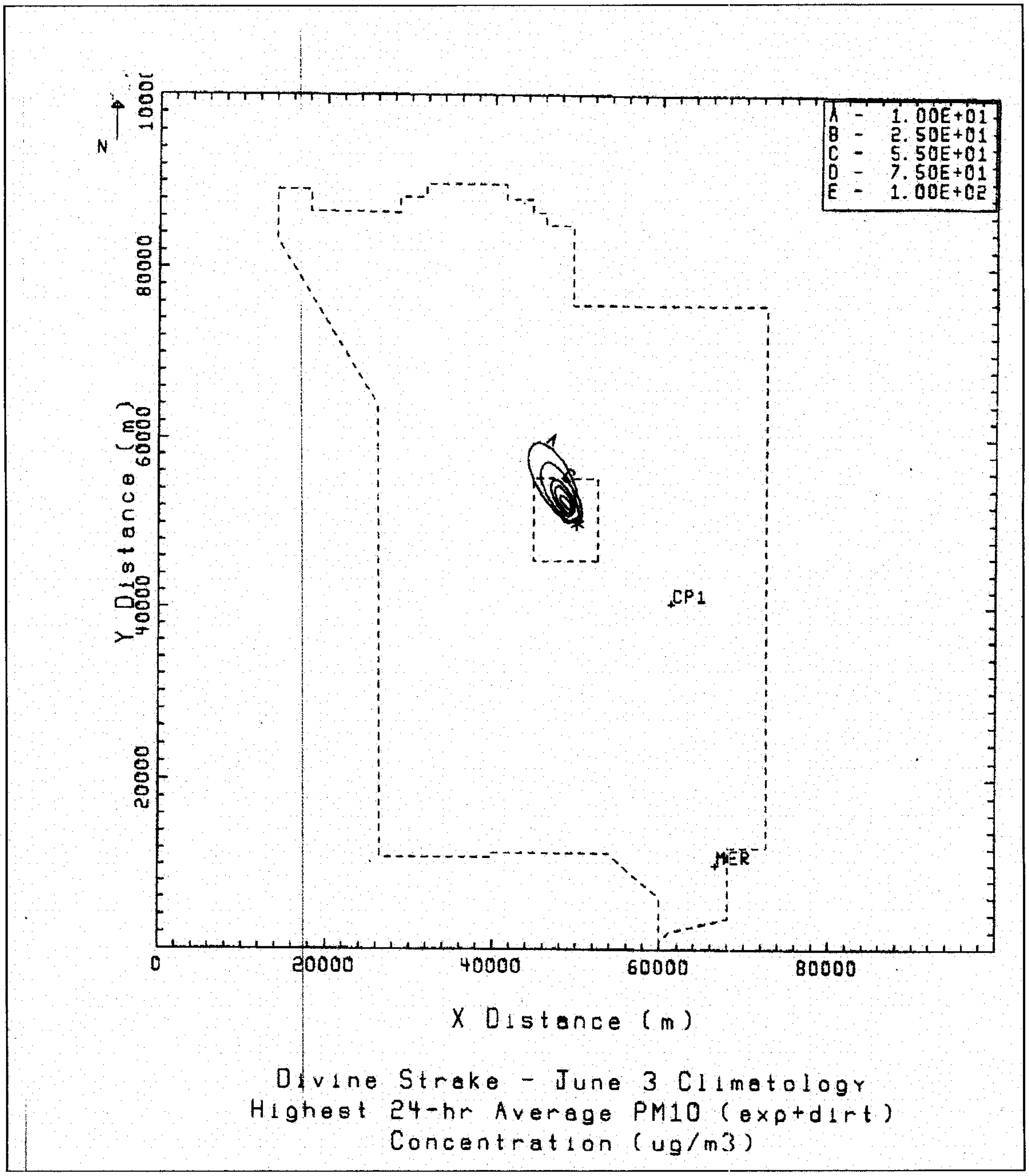


Figure 1. Predicted Dispersal of all Particulates Emitted from the Divine Strake Experiment if Conducted during the Morning, June 3 (taken from U.S. Department of Energy, 2006)

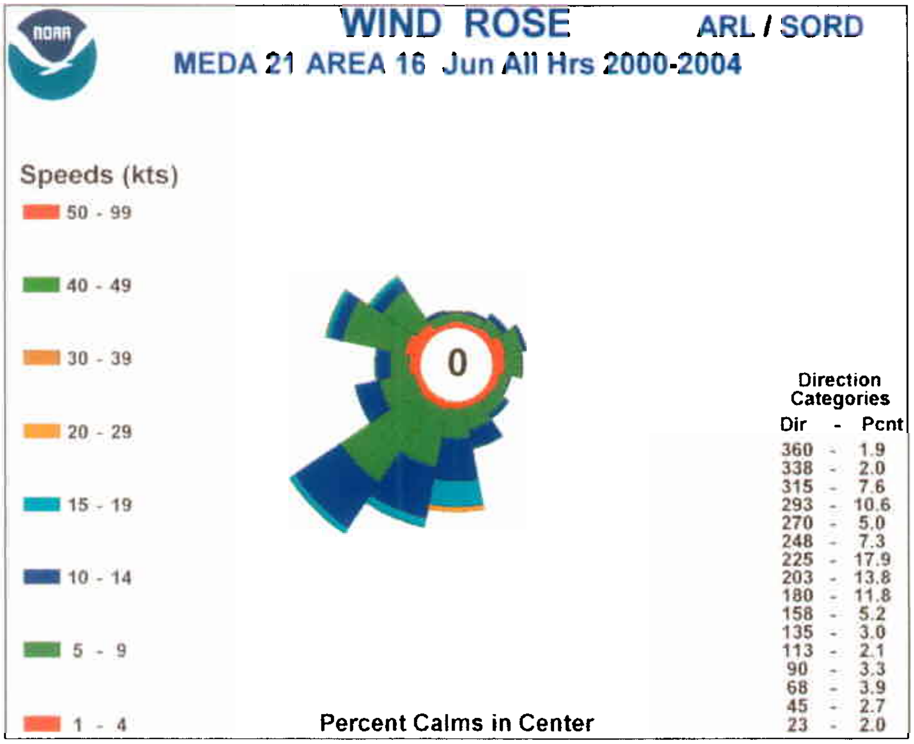


Figure 2. Average Wind Speed and Direction at the National Oceanic & Atmospheric Administration Station in Area 16 for the Month of June

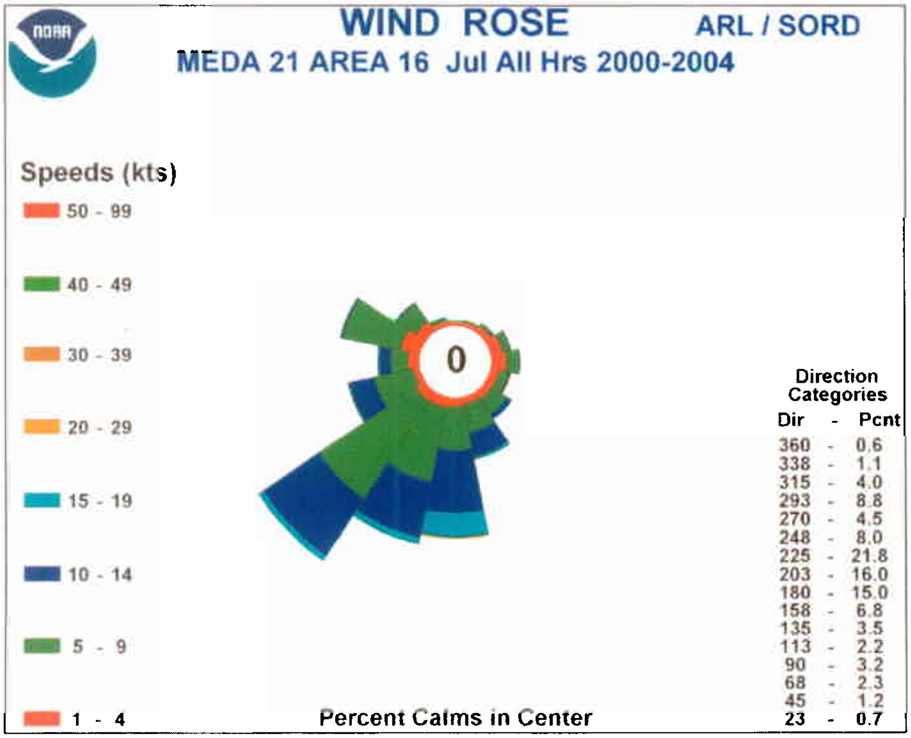
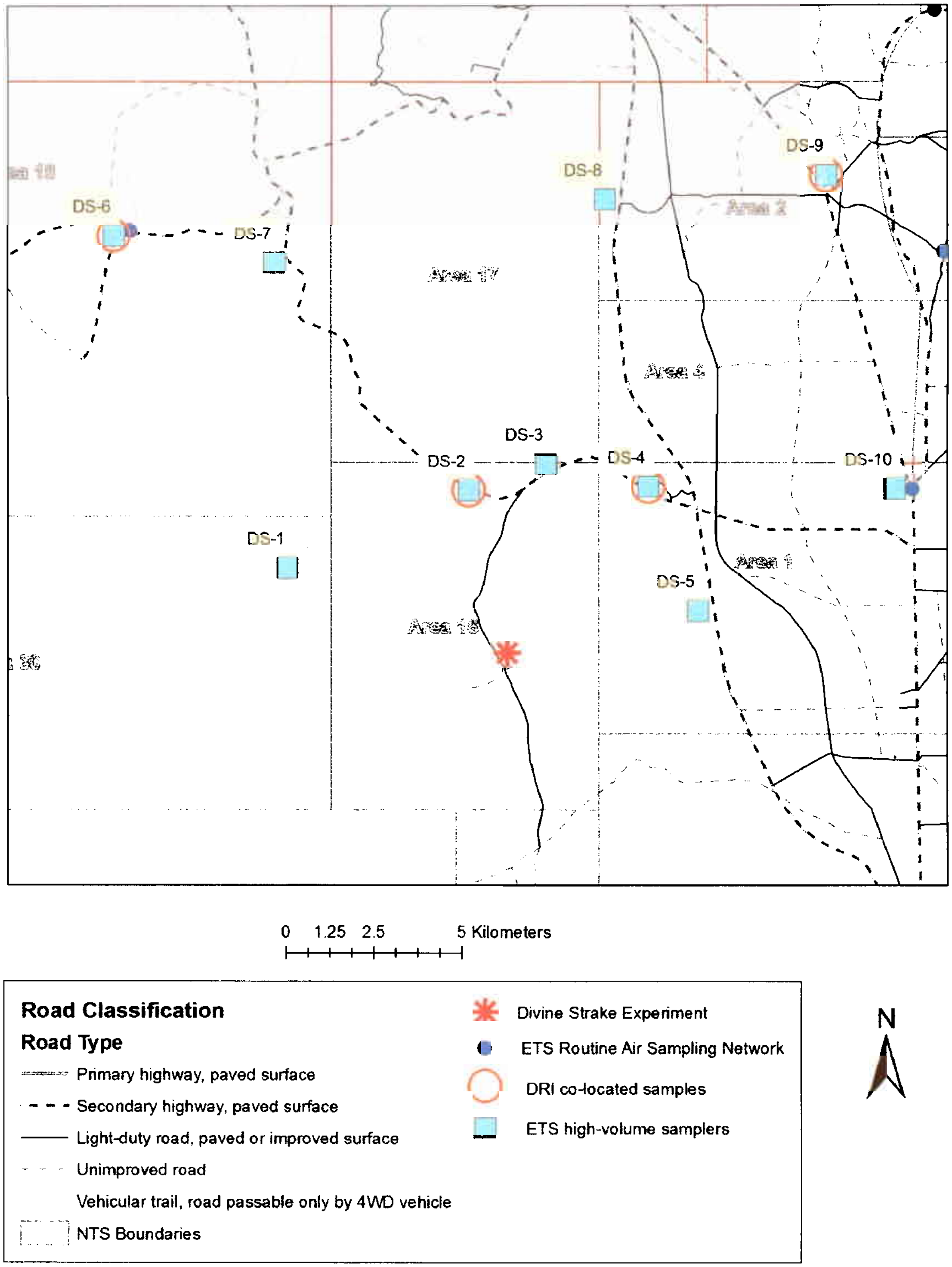


Figure 3. Average Wind Speed and Direction at the National Oceanic & Atmospheric Administration Station in Area 16 for the Month of July

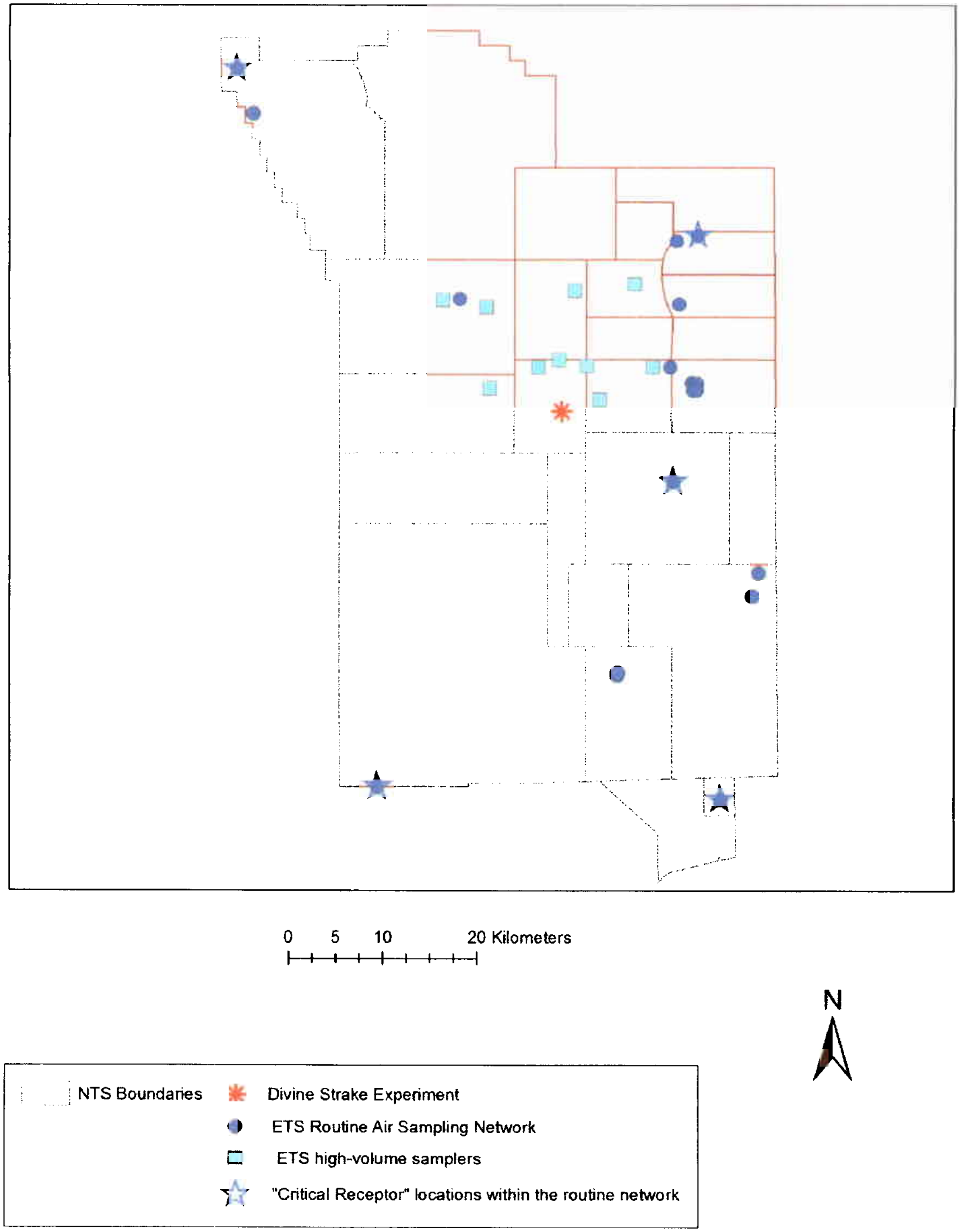


Map created by R. Warren, Bechtel Nevada, Environmental Technical Services, May 16, 2006

Figure 4. Air Sampling Locations

Table 1. Proposed ETS High-Volume Air Sampling Locations for the Divine Strake Experiment

LOCATION	LONGITUDE	LATITUDE	COMMENTS
DS-1	-116.247702	37.043867	
DS-2	-116.189775	37.063483	
DS-3	-116.164983	37.070067	Located next to well UE16-D
DS-4	-116.132200	37.064167	Located at the Area 1 Industrial Complex
DS-5	-116.116717	37.032402	
DS-6	-116.302967	37.128550	3 samplers at this location: 1 high-volume sampler, 1 routine monitoring sampler, and 1 PM-10 sampler
DS-7	-116.251507	37.121524	
DS-8	-116.145845	37.137265	
DS-9	-116.074700	37.143000	2 samplers at this location: 1 high-volume sampler and 1 PM-10 (Lawrence Livermore National Laboratory) sampler
DS-10	-116.053450	37.063263	2 samplers at this location: 1 high-volume sampler and 1 routine monitoring sampler



Map created by R. Warren, Bechtel Nevada, Environmental Technical Services, May 16, 2006

Figure 5. Air Particulate Sampling Locations Operated by ETS during the Divine Strake Experiment

Sampling Period

High-volume air samplers will be placed at least 48 hours before the target experiment, but may be installed earlier in order to perform some degree of ambient environmental monitoring with the objective of distinguishing pre-experiment from post-experiment conditions. A minimum of one pre-experiment 24-hour sample will be collected at each location, or at agreed upon locations, prior to the experiment. Optimally, filters will be exchanged the morning of the experiment. If access to sampler locations is restricted, the samples may run from the previous afternoon/ evening through the experiment day. Samples will be collected 24 ± 6 hours after the experiment, or as agreed upon with the project.

Analysis

BN ETS will use standard screening and analysis procedures for samples collected in support of the Divine Strake experiment. The first step will be to obtain gross alpha and beta screening results, with the screening taking place after radon daughters are allowed to physically decay to negligible levels (5 days).

Subsequently, samples will be submitted to a subcontract analytical laboratory for analysis of gamma-emitting radionuclides, ^{238}Pu, $^{239+240}$Pu, ^{241}Am, and isotopic uranium.

Reporting

Results from all samples collected in support of this experiment will be compared to evaluate potential impacts. In addition, the June 2006 data from the established routine site-wide air sampling network supporting NTS compliance with 40 CFR 61 Subpart H will be compared to evaluate impacts on compliance.

All reports will be provided to the BN Hard & Deeply Buried Projects management, with further distribution provided at their direction.

II. PM10 Monitoring and Analysis

Samplers

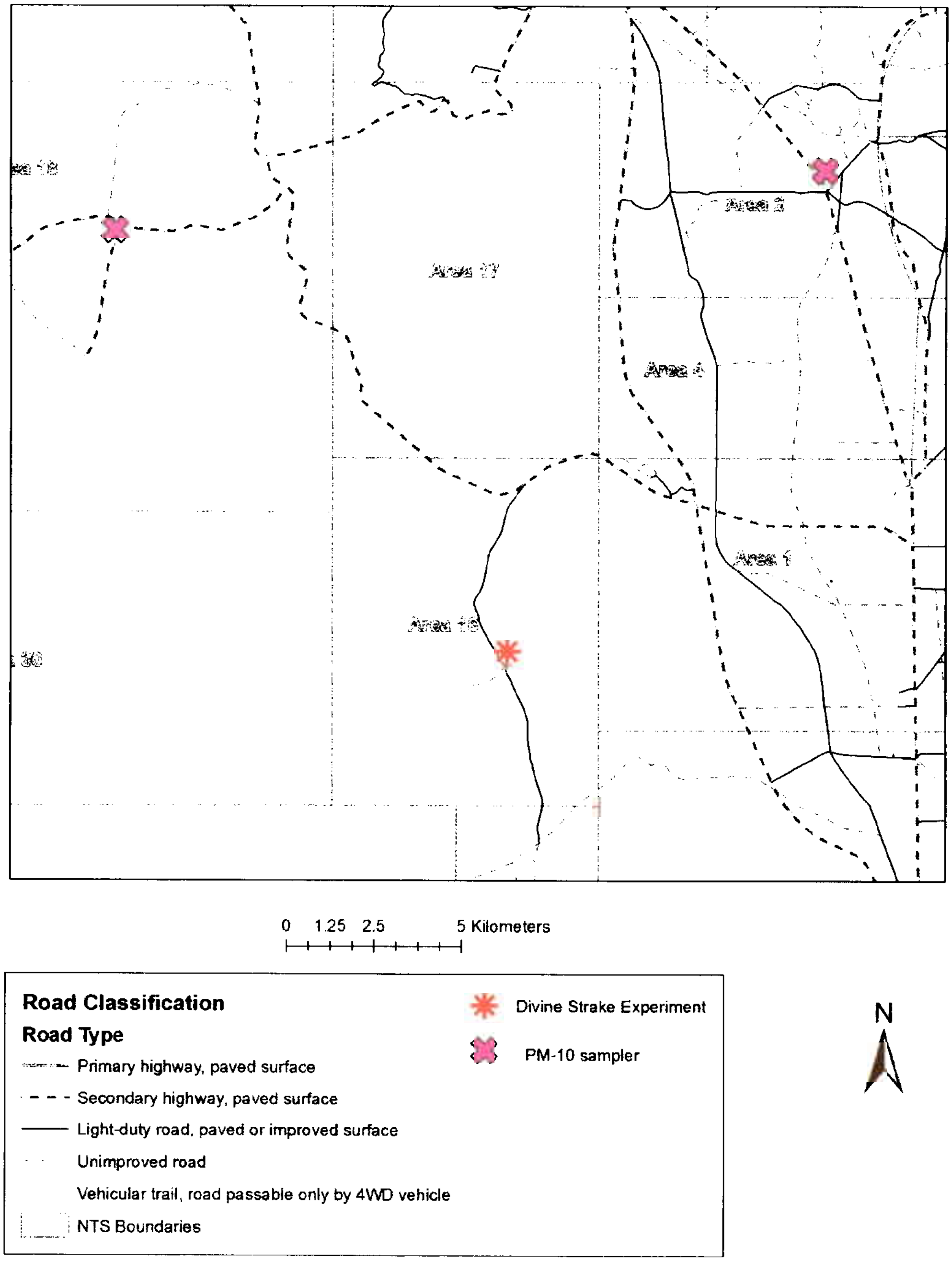
Two PM10 monitors will be used to measure PM10 during the experiment. The monitors that were installed for the Big Explosives Experimental Facility (BEEF) and the Nonproliferation Test and Evaluation Complex (NPTEC) will also be used for the Divine Strake experiment. Calibration and operation of the monitors and meteorological monitoring systems, and data collection, will follow the procedures identified in the BEEF PM10 monitoring plan and the NPTEC PM10 monitoring plan, as applicable.

Sampling Locations

The PM10 monitoring systems will be placed at a safe distance and location such that the physical units as well as the sensitive electronics will not be adversely affected by the detonation. Two locations will be used in an attempt to be downwind of the experiment (Figure 6). During the summer, the BEEF PM10 continuous ambient particulate monitor is located near Substation 2-1, located at 37.1430 N and 116.0747 W, which is approximately 3.5 miles NNE of the BEEF. Power is available at this location. This location is also favorable for the Divine Strake experiment (10.1 miles to the NE) and, therefore, the BEEF PM10 monitor will remain in place for monitoring this experiment. The second location will be approximately 10.3 miles NW of the Divine Strake site in the event that prevailing winds are from the SSE. PM10 sampling locations are also described in Table 1.

Sampling Period

The PM10 monitors will be placed at least 24 hours prior to the target experiment. The monitoring will commence in accordance with BEEF and NPTEC requirements, i.e., on the day of the release, and in accordance with the EPA specification 24 ± 1 hour (1440 minutes ± 60 minutes) sampling period requirement, such that the sampling begins and ends within ½ hour of midnight.



Map created by R. Warren, Bechtel Nevada, Environmental Technical Services, May 16, 2006

Figure 6. PM-10 Samplers Operating on the NTS during the Divine Strake Experiment

Reporting

Data output from the continuous ambient air particulate monitor is obtained via Serial Interface. The format and content of the data reported from the continuous ambient particulate monitor will conform to the Nevada Ambient Air Quality Monitoring Guidelines as revised June 10, 2003, or as agreed to with the Bureau of Air Pollution Control.

Reference

U.S. Department of Energy. 2006. Large-Scale, Open-Air Explosive Detonation, DIVINE STRAKE, at the Nevada Test Site. DOE/EA-1550. U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, Las Vegas, NV.

DRI
Desert Research Institute

COST ESTIMATE SUMMARY FY2006

ESTIMATE ID: Independent Monitoring **DATE:** 5/12/2006

SUBJECT: Independent Monitoring for Divine Strake **STATUS:** Draft

ESTIMATOR: Charlotte Franky **TYPE OF ESTIMATE:** Conceptual/Budget

---

STATEMENT OF WORK

DRI will conduct independent monitoring of the U.S. Department of Defense, Defense Threat Reduction Agency (DTRA) Divine Strake experiment. The monitoring will be based on a Sampling and Analysis Plan and will include particulate air monitoring on the NTS, co-located with Bechtel Nevada monitoring sites; and off-NTS monitoring, focused around the Community Environmental Monitoring Program (CEMP) stations that DRI manages for the NNSA/NSO. The off-site monitoring will include the deployment of up to three MiniVol air samplers to supplement the CEMP network. Pre-event DRI forecasts of winds aloft and predicitons of possible direction of particulate cloud movement, to be done in conjunction with NOAA SORD, will be used to determine the most important CEMP stations and where the MiniVol air samplers will be deployed.

Deliverables:
--Monthly Status Reports
--Sampling and Analysis Plan
--A separate report on the results of the independent monitoring or input to an overall report.
--Presentation material on results of the Monitoring

COST ESTIMATE SUMMARY FY2006

ESTIMATE ID: Independent Monitoring **DATE:** 5/12/2006

SUBJECT: Independent Monitoring for Divine Strake **STATUS:** Draft

ESTIMATOR: Charlotte Franky **TYPE OF ESTIMATE:** Conceptual/Budget

---

ASSUMPTION DESCRIPTION

METHODOLOGY
Based on historical methods, and current air monitoring practices used at the DRI CEMP locations.

ASSUMPTIONS
--That DRI on-site monitoring can be covered by a modification to existing DRI REOPs No. 0014, a secondary REOPs to the Balance of Plant.
--That all necessary equipment for on-site monitoring will be provided to DRI.
--That 2 DRI vehicles will be required for on-site monitoring (Task 3), and that 3 DRI vehicles will be required for off-site monitoring (Tasks 4 & 5).
--That once personnel are deployed in the offsite, there will be no more than a one-day delay in conducting the test.
--That accelerated gross alpha/beta and gamma analysis will only be done for the on-site and additional off-site particulate filter samples. Normal lab turn-around will be sufficient for remaining samples.
--That no laboratory analysis that requires chemical digestion of air particulate filters for speciation of alpha or beta emitters will be necessary.
--If the test is delayed to later than June 23, that DRI will have sufficient backup personnel should some of personnel currently assigned to the monitoring for the scheduled date become unavailable.

LABOR REQUIREMENTS
Task 1. REOP/Sampling and Analysis Plan
Complete DRI REOP and Sampling and Analysis Plan

16 hours Senior Scientist,	DRI016-S090
16 hours Environmental Scientist	DRI006-S020
8 hours Social Scientist,	DRI011-S080
8 hours Atmospheric Scientist I,	DRI029-S090
4 hours Technical Editor/Writer	DRI021-P160

Task 2. Winds Aloft Forecasting
Forecast size and direction of cloud using NOAA's HYSPLIT 4.7 model in both trajectory and concentration calculation modes.
(70 hours to prep and run HYSPLIT model, 8 hours to collect/analyze data.)

30 hours Atmospheric Scientist I	DRI029-S090
8 hours Atmospheric Scientist II	DRI024-S090
40 hours Post Doc	DRI019-S020

Task 3. On-Site Monitoring
DRI will operate and collect samples from 4 high-volume air particulate samplers.

40 hours Environmental Scientist	DRI023-S020
40 hours Field Technician	DRI015-T110

Task 4. Off-Site Monitoring - CEMP

DRI will operate the CEMP to collect air particulate samples that are representative of the period of the test for an arc of stations from the NW to the NE of the NTS.

48 hours Environmental Scientist	DRI023-S020
40 hours Field Technician	DRI015-T110

Task 5. Off-Site Additional Monitoring

DRI will deploy 3 additional low-volume air samplers at offsite locations.

10 hours Atmospheric Scientist I	DRI029-S090
24 hours Atmospheric Scientist II	DRI024-S090
40 hours Post Doc	DRI019-S020
40 hours Field Technician	DRI015-T110

Task 6. Laboratory Analysis

Labor - non-DRI

Task 7. Report Preparation and Presentation

Prepare monthly status reports, independent monitoring results report, and presentation material.

12 hours Senior Scientist	DRI016-S090
8 hours Environmental Scientist	DRI006-S020
8 hours Social Scientist	DRI011-S080
20 hours Atmospheric Scientist I	DRI029-S090
8 hours Technical Editor/Writer	DRI021-P160
12 hours Health Physicist	DRI028-P080
20 hours Office Technician	DRI013-T110

Task 8. Project Management

Attend meetings, coordinate among DRI personnel, and coordination of DRI activities on and off the NTS.

20 hours Senior Scientist	DRI016-S090
8 hours Social Scientist	DRI011-S080
8 hours Atmospheric Scientist I	DRI029-S090
8 hours Health Physicist	DRI028-P080

Contract/Project Management:

13.06 hours Contract Management	DRI004-P170
68.54 hours Project Management	DRI005-P170

MATERIAL REQUIRED

Task 3.On-Site Monitoring

Misc. field supplies, $253.50

Task 4. Off-Site Monitoring

Misc. field supplies, $253.50

ESTIMATE ID: Independent Monitoring
DATE: 5/12/2006

SUBJECT: Independent Monitoring for Divine Strake
STATUS: Draft

ESTIMATOR: Charlotte Franky
TYPE OF ESTIMATE: Conceptual/Budget

Task 5. Additional Off-Site Monitoring (low-volume)
Misc. field supplied, $507.00

SUBCONTRACTORS REQUIRED
None

EQUIPMENT REQUIRED
Assume all On-Site equipment is provided.

TRAVEL REQUIRED
Task 1. REOP/Sampling and Analysis Plan
2 Rnd Trip from DRI to NNSA/NSO
2 motorpool days, 60 motorpool miles.

Task 2. Winds Aloft.
None required.

Task 3. On-Site Monitoring.
10 motorpool days (2 vehicles)
1050 motorpool miles
4 nights lodging x 2 people at NTS = 8 nights total
5 days per diem x 2 people = 10 days NTS per diem

Task 4.Off-Site Monitoring
11 motorpool days (2 vehicles)
3000 motorpool miles
5 nights lodging x 1 person, Tonopah
4 nights lodging x 1 person, Tonopah
6 days per diem x 1 person
5 days per diem x 1 person

Task 5. Additional Offsite Monitoring
5 motorpool days (1 vehicle)
1200 motorpool miles
4 nights lodging x 1 person, Tonopah
5 days per diem x 1 person, Tonopah

Task 6. Laboratory Analysis.
No Travel.

Task 7. Report Preparation and Presentation
2 Rnd Trip from DRI to NNSA/NSO
2 motorpool days, 60 motorpool miles.

Task 8. Project Management
2 Rnd Trip from DRI to NNSA/NSO
2 motorpool days, 60 motorpool miles.

1 Rnd Trip from DRI to NTS/CP-1.
1 motorpool day, 250 motorpool miles.

Contingency Travel:
1 Rnd Trip from Reno to Las Vegas
2 days car rental
1 night lodging
2 days per diem

OTHER DIRECT COST REQUIRED
General operating charges for each task are based on historical monthly operating costs for DOE projects. Routine operating costs include communications, postage, copying, etc.

MILESTONES/DELIVERABLES/REPORTING
Deliverables:
--Monthly Status Reports
--Sampling and Analysis Plan and REOPs
--A separate report on the results of the independent monitoring or input to an overall report.
--Presentation material on results of the Monitoring

DRI
Desert Research Institute

COST ESTIMATE SUMMARY FY2006

ESTIMATE ID: Independent Monitoring

DATE: 5/12/2006

SUBJECT: Independent Monitoring for Divine Strake

STATUS: Draft

ESTIMATOR: Charlotte Franky

TYPE OF ESTIMATE: Conceptual/Budget

CATEGORY	UNITS	NUMBER	AMOUNT	TOTAL
LABOR				
Faculty Staff	Hours	544	$51,682.83	
DRI Labor	Hours	0	$0.00	
Other Labor	Hours	0	$0.00	
Contract Management Administration	Hours	81.6	$9,414.88	
				$61,097.71
OTHER COSTS				
Subcontracts				
DS - Subcontract	Summary		$0.00	
				$0.00
Equipment				
DE - Computer Software	Summary		$0.00	
DE - Computer Hardware	Summary		$0.00	
DE - Equipment	Summary		$0.00	
				$0.00
Materials				
DO - Analytic	Sample(s)	0	$0.00	
DO - Supplies/Other	Summary		$5,898.10	
DO - Equipment Rental	Summary		$0.00	
				$5,898.10
Other Operating				
DO - Operating Charges	Hours	625.6	$1,273.81	
				$1,273.81
Travel				
DT - Motorpool	Units	5713	$7,231.51	
DT - Air Transportation	Round Trips	1	$310.96	
DT - Ground Transportation	Days	2	$167.68	
DT- Lodging	Nights	22	$2,308.54	
DT - Per Diem	Days	28	$1,507.48	
DT - Other Travel	Summary		$0.00	
				$11,526.17
TOTAL				$79,795.80

DRI
Desert Research Institute

TASK PLANNING SUMMARY FY2006

Independent Monitoring	REOP/Sampling Plan	Winds Alofi	On-Site Mon	Offsite Mor	Addt'l Offsite Monitoring	Lab Analysis	Report Prep/Presentation	Proj Mgmt			TASK TOTALS	PERCENT
L - Faculty Staff	$6,187.01	$6,534.49	$6,512.94	$7,203.06	$9,722.74	$0.00	$9,251.11	$6,271.48	$0.00	$0.00	$51,682.83	64.77%
L - DRI Staff	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	0.00%
L - Other Labor	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	0.00%
L - CM	$899.95	$1,349.93	$1,384.54	$1,523.00	$1,972.97	$0.00	$1,523.00	$761.50	$0.00	$0.00	$9,414.88	11.80%
S - Subcontract	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	0.00%
E - Comp. Soft.	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	0.00%
E - Comp. Hard.	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	0.00%
E - Equipment	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	0.00%
O - Analytic	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	0.00%
O - Sup./Other	$0.00	$0.00	$253.50	$253.50	$507.00	$4,884.10	$0.00	$0.00	$0.00	$0.00	$5,898.10	7.39%
O - Equip. Rent	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	0.00%
O - Oper. Charge	$121.76	$182.64	$187.33	$206.06	$266.94	$0.00	$206.06	$103.03	$0.00	$0.00	$1,273.81	1.60%
O - Comp. Charge	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	0.00%
T - Motorpools	$174.07	$0.00	$1,567.48	$3,439.15	$1,411.15	$0.00	$174.07	$465.60	$0.00	$0.00	$7,231.51	9.06%
T - Air	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$310.96	$0.00	$0.00	$310.96	0.39%
T - Ground	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$167.68	$0.00	$0.00	$167.68	0.21%
T - Lodging	$0.00	$0.00	$811.20	$912.60	$405.60	$0.00	$0.00	$179.14	$0.00	$0.00	$2,308.54	2.89%
T - Per Diem	$0.00	$0.00	$523.90	$576.29	$261.95	$0.00	$0.00	$145.34	$0.00	$0.00	$1,507.48	1.89%
T -Other	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	0.00%
TASK TOTALS	$7,382.79	$8,067.06	$11,240.88	$14,113.66	$14,548.35	$4,884.10	$11,154.24	$8,404.73	$0.00	$0.00	$79,795.80	100.00%
PERCENT	9.25%	10.11%	14.09%	17.69%	18.23%	6.12%	13.98%	10.53%	0.00%	0.00%	100.00%	
GRAND TOTAL	**$79,795.80**											
BEGIN DATE	5/12/06	5/12/06	5/12/06	5/12/06	5/12/06	5/12/06	5/12/06	5/12/06				
END DATE	9/30/06	9/30/06	9/30/06	9/30/06	9/30/06	9/30/06	9/30/06	9/30/06				

Attachment N

(12) LEVEL II

NWC TP 6037

Theoretical Computations of Equilibrium Compositions, Thermodynamic Properties, and Performance Characteristics of Propellant Systems

by
D. R. Cruise
Ordnance Systems Department

APRIL 1979

DA069832

DDC
RECEIVED
JUN 14 1979
B

NAVAL WEAPONS CENTER
CHINA LAKE, CALIFORNIA 93555

79 06 01 025

Naval Weapons Center
AN ACTIVITY OF THE NAVAL MATERIAL COMMAND

FOREWORD

This report is an update of a previous report by the same title (NAVWEPS 7043, NOTS TP 2934) published in 1960. Since that time the methodology has been changed; the usage has been changed; new applications have been devised; data banks have been established; and automated usage of data banks has been established. A few minor aspects of the original report have remained unchanged.

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(U) *Theoretical Computations of Equilibrium Compositions, Thermodynamic Properties, and Performance Characteristics of Propellant Systems,* by D. R. Cruise. China Lake, Calif., Naval Weapons Center, April 1979, 104 pp. (NWC TP 6037, publication UNCLASSIFIED.)

(U) This report summarizes the methods and equations used in a Naval Weapons Center computer program called the NWC thermochemical program or the propellant evaluation program (PEP). The program is used to calculate high-temperature thermodynamic properties and performance characteristics of propellant systems, and it will handle a maximum of 12 chemical elements and 200 combustion products. Some of the parameters that can be computed with this program are flame temperature, chemical composition, enthalpy, entropy, specific heat ratio and molecular weight of both the combustion chamber and exhaust, frozen and shifting equilibrium, specific impulse, boost velocities, thrust coefficient, characteristic velocity, and exhaust gas velocity. The assumptions made, the limitations imposed, and the input data required for the solution of a specific problem by use of this program are discussed in detail. The appendices provide a working guide for those using the program and give examples of computer inputs.

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Appendices:

INTRODUCTION

The Naval Weapons Center has developed a computer program, often referred to as the NWC thermochemical program or the propellant evaluation program (PEP), for the calculation of high-temperature thermodynamic properties and performance characteristics of propellant systems. This report is a summary of the methods and equations used in the program, which will handle a maximum of 12 chemical elements and 200 combustion products. Flame temperature, chemical composition, enthalpy, entropy, specific heat ratio and molecular weight of both the combustion chamber and exhaust, frozen and shifting equilibrium, specific impulse, boost velocities, thrust coefficient, characteristic velocity, and exhaust gas velocity can be computed with this program. The assumptions made, the limitations imposed, and the input data required for the solution of a specific problem by use of this program are discussed in detail. The appendices provide a working guide for those using the program and give examples of computer inputs.

BACKGROUND

NWC Program Development

The NWC thermochemical program did not come suddenly into being. As early as 1951 thermochemical computations were performed at NWC (formerly NOTS) when Dr. W. S. McEwan and S. Skolnik developed and reported an approach using an analog computer. Dr. D. S. Villars reported his reaction-adjustment method in 1960. The same year H. N. Browne, Jr., completed a program using a method reported by NASA. Mary Williams and Dr. Howard Shomate contributed toward the automation and building of an accurate and usable data bank. In 1964 the author combined some of the ideas of Browne and Villars (who had never collaborated with each other) into the outer skeleton of the Browne program. At the same time a new method of handling condensed species put an end to convergence failures. In 1968 some important suggestions were made by Professors W. R. Smith and R. W. Missen, who had developed their own program at the University of Toronto using the reaction-adjustment method. (A later section of this report is devoted to a discussion of their work.) Since that time the NWC program has continued to evolve in the direction of data automation and new applications.

General Development of Thermochemical Programs

In the past 20 years the computation by high-speed digital computers of high-temperature chemical equilibria has become one of the important applications of computers. It is a challenging application, because of the large sets of nonlinear algebraic equations that must be simultaneously solved and because of the necessity of devising computer codes general enough to handle any particular chemical system[1]. There have been three historic approaches to the problem.

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[1] Western States Section of the Combustion Institute. *Proceedings of the First Conference on Kinetics, Equilibria and Performance of High Temperature Systems*. ed. by G. Bahn and E. Zuckowsky. Washington, D.C., Butterworths Scientific Publications, 1960.

One approach, presented by White, *et al.*. is directly motivated by the free-energy criterion for chemical equilibrium[2]. The resulting numerical procedure is the method of steepest descent, which is a general method for the numerical solution of nonlinear algebraic equations.

The second approach, presented by Brinkley[3], uses equilibrium constants and for purposes of background will be described in some detail. First, a "basis" is chosen. A basis is a subset of molecular species (also called components)[4]. It contains as many species as there are chemical elements, and from it all other species may be formed by chemical reaction. A set of equations then establishes the equilibrium relationship of each nonbasis species to the basis. Another set of equations establishes the gram-atom amount of each chemical element. Both sets of equations are solved simultaneously by the Newton-Raphson method, which is a general method for the numerical solution of nonlinear algebraic equations.

Interesting variations in the latter method are presented by Huff *et al.*[5] and Browne[6]. The latter, in particular, introduces the concept of the "optimized" basis, in which the components are present in the greatest possible molar amounts. Browne's computer code for the equilibrium-constant approach was successfully used from 1960 to 1964 by the Naval Weapons Center, then known as the U.S. Naval Ordnance Test Station (NOTS).

The reaction-adjustment method of Villars is the third approach[7,8]. This, too, was a method suggested early in the development of computer codes but not widely used before the development of the present program. Its theory is simple: The chemical system is divided into a number of subsystems, each relating a nonbasis species to the basis. The subsystem with the greatest discrepancy in its equilibrium relationship is corrected stoichiometrically. In this way the gram-atom amounts (chosen correctly at the start) do not change. The reason for convergence is clear: Each iteration is equivalent to arresting all possible reactions but one and allowing that one to proceed according to the law of mass action. This possible (though not plausible) kinetic model can only lead in the direction of equilibrium.

In its computational aspects the method presented by Villars has both advantages and disadvantages. Unlike the former methods, it does not require the inversion of large matrices. This simplifies the coding and reduces the required computer memory. On the other hand, the speed of the method is greatly dependent on the choice of the basis. It is admittedly quite slow when components are chosen that are present only in small molar amounts.

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[2] W. B. White, S. M. Johnson, and G. B. Dantzig. "Chemical Equilibrium in Complex Mixtures." *J. Chem. Phys.*, Vol. 28 (May 1958). pp. 751-5.

[3] S. R. Brinkley, Jr. "Calculation of the Equilibrium Composition of Systems of Many Constituents," *J. Chem. Phys.*, Vol. 15 (1947). pp. 107-10.

[4] H. J. Kandiner and S. R. Brinkley. 'Calculation of Complex Equilibrium Relations." *Ind. Eng. Chem*., Vol. 42 (1950), pp. 850-5.

[5] National Advisory Committee on Aeronautics. *General Method and Thermodynamic Tables for Computation of Equilibrium Composition and Temperature of Chemical Reactions*. by V. N. Huff, S. Gordon. and V. E. Morrell. Washington, D.C., NACA 1951. (NACA Report 1037.)

[6] Naval Ordnance Test Station. *The Theoretical Computation of Equilibrium Compositions. Thermodynamic Properties and Performance Chcracteristics of Propellant Systems.* by H. N. Browne Jr., M. M. Williams. and D. R. Cruise. China Lake, Calif., NOTS, 1960. (NAVWEPS Report 7043. NOTS TP 2434, publication UNCLASSIFIED.)

[7] D. S. Villars. "A Method of Successive Approximations for Computing Combustion Equilibria on a High Speed Digital Computer," *J. Chem. Phys.*, Vol. 63 (1959). pp. 521-5.

[8] D. S. Villars. "Computation of Complicated Combustion Equilibria on a High-Speed Digital Computer," in *Proceedings of the First Conference on Kinetics. Equilibria and Performance of High Temperature Systems*. ed. by G. Bahn and E. Zuckowsky. Washington. D.C.. Butterworths Scientific Publications. 1960.

It was decided to try Villars' method and to choose an optimum basis by Browne's method. The automatic choosing of the optimum basis is not difficult to code, and it serves two purposes: It greatly speeds convergence, and it relieves the user of the burden of choosing the basis himself.

ORGANIZATION OF REPORT

The next three sections of this report describe the combination of Villars' and Browne's methods for computing a chemical composition at a given pressure and temperature. The description is divided into three parts. The first part presents in detail the basis optimization technique used, which differs only slightly from that reported by Browne. The second part presents the procedures for determining equilibrium, which follow essentially the method of Villars, except for some suitable modifications to increase computing speed. The third part presents certain manipulations with condensed phases that increase the generality of the method. The remaining five sections describe various aspects of the method. For a concise presentation, the procedures are described in the notation of linear algebra.

The appendices describe how to run the program on the computer.

BASIS OPTIMIZATION

Consider a system which contains S chemical elements and N molecular species such that N is greater than S. Relating the species to the elements is a molecular composition matrix C. Here the individual elements c_{ik} state how many atoms of the kth element are contained in a molecule of the ith species.

Let any arbitrary choice of S molecular species be denoted

$$i(j) \qquad 1 \leq j \leq S$$

where the subset of i's chosen is considered to be a function of a dummy index j. A basis is formed by $i(j)$ if and only if the following relationship exists:

$$|B| \neq 0 \tag{1}$$

where the vertical bars denote the determinant of the matrix B and where the elements of B are defined as follows:

$$b_{jk} = c_{i(j),k} \qquad \begin{array}{l} 1 \leq j \leq S \\ 1 \leq k \leq S \end{array} \tag{2}$$

Equation 2 involves three indexes, i, j, and k, where i is not independent because of its functional relationship to j. This equation describes the formation of the square basis matrix B by extracting some of the rows of the larger, composition matrix C, namely those rows corresponding to the chosen species.

The optimization problem requires that $i(j)$ be chosen to form a basis and that the corresponding molar amounts $n_{i(j)}$ be as large as possible. This can be done by a process of trial and error. First the molecular species must be so sorted that the molar amounts are in descending order. Here the species subscript i becomes itself a function of a subscript m, such that

$$n_{i_1} \geqslant n_{i_2} \geqslant \cdots \geqslant n_{i_m} \geqslant n_{i_{m+1}} \geqslant \cdots \geqslant n_{i_N} \tag{3}$$

The basis is now found as follows. First i_1 is chosen to be the first basis species and the i_1st row of the C matrix is put into the first row of the B matrix. Next the j and m indexes are set to the value 2. The third step is to test i_m as an acceptable basis species. This is done by inserting the i_mth row of the C matrix into the jth row of the thus far incomplete B matrix. If there is linear dependence among the rows of the incomplete B matrix, the test fails, and the m index is increased by unity. If there is no linear dependence, i_m becomes the jth basis species, which is to say, $i(j)$ and both the j and m indexes are increased by unity. From here the process returns to the third step until $i(S)$ is determined.

Browne established linear dependence by the following relationship:

$$\left|(B^{inc})\,(B^{inc})^T\right| = 0 \tag{4}$$

where T denotes transposition and B^{inc} is the incomplete B matrix. However, it was found that the test could be performed much faster by using the Gram-Schmidt construction. This construction is expressed as follows:

$$b'_{\ell k} = b_{\ell k} - \left(\sum_{h=1}^{S} b_{\ell h} b_{nh} \Big/ \sum_{k=1}^{S} b^2_{\ell h}\right) b_{nk} \begin{cases} 2 \leqslant \ell \leqslant j \\ 1 \leqslant n \leqslant j - 1 \\ 1 \leqslant k \leqslant S \end{cases} \tag{5}$$

where $b'_{\ell k}$ replaces the element $b_{\ell k}$ and n and ℓ are dummy indexes. If all elements of the jth row are zero after the construction, there is linear dependence, and the test fails. The underlying theory of linear dependence and the Gram-Schmidt construction are presented in Stoll[9] and other texts on linear algebra.

The complete B matrix is determined at the end of the optimization process, and the ν matrix of reaction coefficients is expressed

$$\nu = CB^{-1} \tag{6}$$

Equilibrium constants may then be computed from the elements of the ν matrix as follows:

$$\ell n\, K_i = \frac{-1}{RT}\left[g_i - \sum_{j=1}^{S} \nu_{ij}\, g_{i(j)}\right] \tag{7}$$

where g_i is the standard Gibbs free energy of the ith species at the given temperature T.

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[9] R. Stoll. *Linear Algebra and Matrix Theory*. New York. McGraw-Hill, 1952. Chapter 8, especially section 8.7.

PROCEDURES FOR DETERMINING EQUILIBRIUM

The equilibrium procedure requires that a first estimate of the equilibrium composition be given. This estimate need not closely approximate the final solution, but it must express the desired gram-atom amount of each chemical element. This expression can be accomplished in many ways. One way, easy to code, is to set the molar amount of one monatomic species of each chemical element to the desired gram-atom amount, then set the molar amounts of the rest of the species at zero (or at negligibly small values). This particular way requires that the monatomic species appear in the formulation.

The general iterative procedure assumes that the gram-atom amounts are correct and that the optimum basis has been chosen for the current estimate of the molar amounts. The reaction coefficient matrix, ν, and the array of equilibrium constants, K_i, are therefore available from Equations 6 and 7. A pass is made through the reaction (nonbasis) species to determine whether the proper equilibrium relationships are met. If not, the molar amounts, n_i, are stoichiometrically corrected. The basis is again optimized whenever the current basis is no longer optimum. The details are described below using the conventions of Prigogine[10]

The chemical reaction which yields the ith reaction species from the basis may be written as

$$\sum_{j=1}^{S} \nu_{ij} i(j) \rightarrow i \tag{8}$$

therefore, a stoichiometric change in the extent of reaction, $\Delta\xi$, causes the following alterations in composition.

$$n_i' = n_i + \Delta\xi \tag{9}$$

$$n_{i(j)}' = n_{i(j)} - \nu_{ij}\Delta\xi \qquad 1 \leqslant j \leqslant S \tag{10}$$

where the primed n_i denotes the molar amounts after the change. This change, by definition, does not alter the gram-atom amount of any chemical element.

Basis optimization guarantees that n_i is smaller than any of the $n_{i(j)}$ in the basis for which $\nu_{ij} \neq 0$. In actuality most reaction species are smaller in molar amount by many orders of magnitude than the basis species from which they are formed. The gaseous species more than two order of magnitude smaller are arbitrarily classified as *minor* species, and the rest of the nonbasis species, including condensed species of any molar amount, are classified as *major* species.

The correct equilibrium relationship for the ith reaction is expressed as

$$-\sum_{j=1}^{S} \gamma_{i(j)}\, \nu_{ij}\, \ln\,(An_{i(j)}) + \gamma_i \ln\,(An_i) = \ln K_i \tag{11}$$

---

[10] I. Prigogine and R. Defay. *Chemical Thermodynamics*. translated by D. Everett. London Longmans, Green and Co., 1954.

where the phase parameter γ_i takes the value unity if the ith species is a gas and the value zero if it is condensed, and

$$A = \frac{P}{\sum_{i=1}^{N} \gamma_i n_i}$$

where P is the given pressure. If the current molar guesses are incorrect, the terms on the left will equal some value other than $\ell n\ K_i$ and are denoted $\ell n\ Q_i$. The iterative procedure obviously must adjust the values of n_i until the values of Q_i approach those of K_i within a specified tolerance. The log of the equilibrium constant may be differentiated with respect to the reaction parameter ξ (assuming A to be constant), yielding

$$\left(\sum_{j=1}^{S} \gamma_{i(j)}\ \nu_{ij}^2/n_{i(j)} + \gamma_i/n_i\right) d\xi = d(\ell n\ K_i) \tag{12}$$

An estimate of the stoichiometric correction for a major species is obtained by applying Newton's method of locating roots, which is expressed by the following approximate form of Equation 12:

$$\Delta\xi \cong (\ell n\ K_i - \ell n\ Q_i)/(\sum_{j=1}^{S} \gamma_i\ \nu_{ij}^2/n_{i(j)} + \gamma_i/n_i) \tag{13}$$

Equations 9 and 10 are then applied. (In practice, $\Delta\xi$ is not allowed to take values leading to negative n_i.) All major species are corrected by this method during the iteration pass. This differs from the method used by Villars, who applied the correction only where the discrepancy $|\ell n\ K_i - \ell n\ Q_i|$ was greatest. The modification is justified for two reasons—(1) little additional computing time is required to actually make the correction after the discrepancy is determined, and (2) the basis optimization has minimized the interaction effect that a given correction has on the other equilibrium relationships.

An estimate of the stoichiometric correction for minor species is obtained as follows:

$$n_i' \cong n_i\ (K_i/Q_i) \tag{14}$$

$$\Delta\xi = n_i' - n_i \tag{15}$$

Equation 10 is then applied. This approach assumes that the error in K_i is contained entirely in the value of n_i. This is nearly true for minor species, because a large relative change in n_i is accomplished by a small $\Delta\xi$, and there is no appreciable change in the basis. This separate analysis of minor species also differs from that of Villars. Again there are advantages. Equations 14 and 15 require less computing time than Equation 13. Then, too, the former equations compute the molar amounts of the minor species to a high degree of accuracy (four or more significant decimal places) even when the relative molar amounts are quite small (e.g., 10^{-10} or 10^{-20}). (This is useful in some applications involving ionic species.) It was also found that computer time is saved by correcting the minor species only on every fourth iteration pass, unless convergence is attained among the major species in the meantime. The variable A, defined above, is computed once at the start of every iteration pass.

Convergence was considered to be attained when all *binding* equilibrium relationships passed the following tests:

$$\text{(major species)} \quad |(1 - K_i/Q_i)| \leq 10^{-5} \tag{16}$$

$$\text{(minor species)} \quad |(1 - K_i/Q_i)| \leq 10^{-4} \tag{17}$$

However, not all equilibrium relationships are binding. This is discussed in the next section.

DELETION OF CONDENSED PHASES

The formulation of the chemical equilibrium problem, as usually presented, is not general enough to completely describe the behavior of condensed phases. To overcome this weakness special procedures must be used. The following two procedures are particularly suited to the method of determining equilibrium presented above.

When the computed amount of a condensed species becomes negligibly small (say, 10^{-6}) and $\ell n\ K_i - \ell n\ Q_i$ is negative, no correction is applied, and the equilibrium relationship is no longer binding. In this way a phase is deleted and a degree of freedom is gained in accordance with the phase rule [11].

When a reaction occurs entirely among condensed species, the denominator in Equation 13 is zero. In this situation the phase rule states that at least one of the involved species cannot be present in any molar amount (if we are free to specify pressure and temperature). The situation is handled by ignoring Equation 13 and determining a value of $\Delta\xi$ that takes the sign of $\ell n\ K_i - \ell n\ Q_i$ and that has a magnitude not leading to negative molar amounts when Equations 9 and 10 are applied. This is symbolically expressed as

$$\Delta\xi = \text{sign}\ (\ell n\ K_i - \ell n\ Q_i)\ \min \left[n_i,\ n_{i(1)}/|\nu_{i1}|,\ n_{i(2)}/|\nu_{i2}|, \ldots\ n_{i(S)}/|\nu_{iS}| \right] \tag{18}$$

In this manner the molar amount of at least one condensed species is reduced to zero.

When these procedures were included in the computer code, correct solutions were obtained even in extremely difficult cases. In fact, correct solutions can be obtained where no gas phase is present.

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[11] A. Findlay. *Phase Rule.* New York, Dover, 1951.

NUMERICAL EXAMPLES OF BASIS AND EQUILIBRIUM CALCULATIONS

Consider a system containing 1 gram-atom of carbon and 2 gram-atoms of oxygen. The following combustion species may be chosen and associated with the composition matrix shown below:

$$\begin{array}{cc} \begin{array}{cc} \underline{i} & \underline{\text{Species}} \\ 1 & C \\ 2 & C_3 \\ 3 & O \\ 4 & O_2 \\ 5 & CO \\ 6 & CO_2 \\ 7 & C(\text{graphite}) \end{array} & \begin{array}{c} \begin{array}{cc} \underline{C} & \underline{O} \end{array} \\ \left[\begin{array}{cc} 1 & 0 \\ 3 & 0 \\ 0 & 1 \\ 0 & 2 \\ 1 & 1 \\ 1 & 2 \\ 1 & 0 \end{array}\right] \end{array} \end{array} = C \text{ (composition matrix)}$$

One way to choose the initial composition guess is to set the monatomic gases to the desired gram-atom amounts and the rest of the species to zero as follows:

Species	i	n_i
C	1	1.0
C_3	2	.0
O	3	2.0
O_2	4	.0
CO	5	.0
CO_2	6	.0
C(graphite)	7	.0

Obviously the best basis for these composition values is:

Species	i	$i(j)$
C	1	1
O	2	3

for these are the species in greatest concentration from which all other species may be formed. This is the basis the program would use on the first iteration.

For a more interesting example of a basis calculation, let us say that at a later iteration the current composition guesses are:

Species	i	n_i
C	1	0.4874996
C_3	2	0.0045000
O	3	0.5005000
O_2	4	0.5000000
CO	5	0.4985000
CO_2	6	0.0005000
C(graphite)	7	0.0000004

(If previous calculations are correct, these values will still reflect the proper gram-atom amounts of C and O.)

These may be sorted into the order of decreasing molar concentration:

Species	m	i_m	n_{i_m}
O	1	3	0.5005000
O_2	2	4	0.5000000
CO	3	5	0.4985000
C	4	1	0.4874996
C_3	5	2	0.0045000
CO_2	6	6	0.0005000
C(graphite)	7	7	0.0000004

Species i_1 (O) is immediately chosen as the first basis species and the i_1st (here the third) row is taken from the composition matrix to become the first row of the basis matrix.

$$\begin{bmatrix} 0 & 1 \end{bmatrix} = B^{inc}$$

Next the i_2nd (here the 4th) row of the C matrix is placed into the B matrix:

$$\begin{bmatrix} 0 & 1 \\ 0 & 2 \end{bmatrix} = B \text{ (to be tested)}$$

Although linear dependence is obvious in this case, the program actually performs the Gram-Schmidt construction which transforms the second row as follows:

$$b'_{21} = b_{21} - \left(\frac{\Sigma b_{2h}\, b_{1h}}{\Sigma b_{1h}{}^2}\right) b_{11} = 0 - \frac{0+2}{0+1} \cdot 0 = 0$$

$$b'_{22} = b_{22} - \frac{\Sigma b_{2h}\, b_{1h}}{\Sigma b_{1h}{}^2} b_{12} = 2 - \frac{0+2}{0+1} \cdot 1 = 0$$

Because both elements of the transformed row are zero, O_2 is rejected as a basis species.

Next i_3 (CO) is tested as the basis species. The i_3rd row (here the 5th) of the composition matrix is placed into the second row of the basis matrix:

$$\begin{bmatrix} 0 & 1 \\ 1 & 1 \end{bmatrix} = B \text{ (to be tested)}$$

Gram-Schmidt construction transforms the first element of the second row as follows:

$$b'_{21} = b_{21} - \frac{\Sigma b_{2h}\, b_{1h}}{\Sigma b_{1h}^2}\, b_{11} = 1 - \frac{0+1}{0+1} \cdot 0 = 1$$

This element is non-negative and CO is immediately accepted as a basis species without further calculations. Also, because there are now as many basis species, as there are elements (B is square), the basis is complete and because of the above technique, "optimized."

The results are summarized thus:

Species	j	$i(j)$	m	i_m
O	1	3	1	3
CO	2	5	3	5

The next step is to find the inverse of the B matrix which is

$$B^{-1} = \begin{bmatrix} -1 & 1 \\ 0 & 0 \end{bmatrix}$$

The ν matrix of reaction coefficient is now found as follows:

$$\nu = CB^{-1} = \begin{bmatrix} 1 & 0 \\ 3 & 0 \\ 0 & 1 \\ 0 & 2 \\ 1 & 1 \\ 1 & 2 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} -1 & 1 \\ 1 & 0 \end{bmatrix} = \begin{bmatrix} -1 & 1 \\ -3 & 3 \\ 1 & 0 \\ 2 & 0 \\ 0 & 1 \\ 1 & 1 \\ -1 & 1 \end{bmatrix}$$

The coefficients may be verified by noting that the following chemical equations balance:

i						
1	(-1)	O	+	(1)	CO	$\rightarrow$ C
2	(-3)	O	+	(3)	CO	$\rightarrow$ C_3
3	(1)	O	+	(0)	CO	$\rightarrow$ O
4	(2)	O	+	(0)	CO	$\rightarrow$ O_2
5	(0)	O	+	(1)	CO	$\rightarrow$ CO
6	(1)	O	+	(1)	CO	$\rightarrow$ CO_2
7	(-1)	O	+	(1)	CO	$\rightarrow$ C(graphite)

These coefficients may be used to determine the equilibrium constants for each reaction. For instance for the first reaction

$$\ell n\ K_1 = \frac{-1}{RT}\ [g_C - [(-1)\ g_O + (1)]\ g_{CO}]$$

where g is the given Gibbs free energy at the given temperature T.

Let us say for the sake of an example that $T = 5500$ K and $P = 1$ atm and that the equilibrium constants computed by the above method turn out to be

Reaction	$\ell n\ Ki$ (5500)
1	-1.4
2	-5.95
3	0
4	—
5	0
6	—
7	-3.91

The variable A, which converts molar concentrations to partial pressures, is computed as follows:

$$A = P/\sum_{i=1}^{6} \gamma_i n_i \text{ (summation to be taken only over gases)}$$

$$A = 1/(0.4874996 + 0.0045 + 0.5005 + 0.5 + 0.4985 + 0.0005)$$

$$A = 1/1.9914996 = 0.5022 \text{ (rounded)}$$

Since all products involved are gases, $\ell n\ Q$ for the first reaction is computed thus:

$$\ell n\ Q = -\Sigma\ \nu_{ij}\ \ell n\ (An_{i(j)}) + \ell n\ A\nu_i$$

$$= [(-1)\ \ell n\ (0.5022 \cdot n_{CO}) + (+1)\ \ell n\ (0.5022 \cdot n_O)] + \ell n\ (0.5022 \cdot n_C)$$

$$= + \ell n \left[\frac{0.4975\ (0.5005)\ (0.5022)}{0.4985}\right] = -1.3829$$

The molar amount of C is not less than one hundreth of that of CO or O, so the formula for the correction of a major species is used:

$$\Delta\xi = (\ell n\ K_1 + \ell n\ Q_1)/(\Sigma\ \nu_{ij}^2/n_{i(j)} + 1/n_i)$$

$$\Delta\xi = (-1.4 + 1.3829)/\left(\frac{(-1)^2}{n_O} + \frac{(+1)^2}{n_{CO}} + \frac{1}{n_C}\right)$$

$$\Delta\xi = (-0.0171)/6.055 = -0.0028$$

The corrections in composition are now made as follows:

Species

O $\quad n^{1}_{O} = 0.5005 - (-1)(-0.0028) = 0.4977$

CO $\quad n'_{CO} = 0.4985 - (+1)(-0.0028) = 0.5013$

C $\quad n'_{C} = 0.4975 - 0.0028 = 0.4947$

(These new values may be substituted into the expression for $\ell n\ Q$ above yielding -1.4004, which is a significantly better estimate of $\ell n\ K_1$.)

Next, we turn to the second reaction

$$(-3)\ O + (3)\ CO \longrightarrow C_3$$

Because $nC_3 = 0.0045$ is less than 0.01 of the smallest ($n_O = 0.4977$) concentration of the basis species, C_3 is classified as minor.

The equilibrium constant is given as $\ell n\ K = -5.95$ or $K = 0.002605$ and Q is evaluated by

$$Q_2 = \frac{(0.5022\ n_O)^3\ (0.5022\ n_{C_3})}{(0.5022\ n_{CO})^3}$$

$$= \frac{(0.5022)\ (0.4977)^3\ (0.0045)}{(0.5013)^3} = 0.0002212$$

(Note that the new values of n_O and n_{CO} are used.) The new concentration of C_3 is found by the formula for minor species.

$$= 0.0045 \left(\frac{0.002510}{0.002212}\right) = 0.0053$$

The change in the basis species is then determined

$$\Delta\xi = 0.0053 - 0.0045 = 0.0008$$

$$n'_O = 0.4977 - (-3)\ 0.0008 = 0.5001$$

$$n'_{CO} = 0.5014 - (+3)\ 0.0008 = 0.4990$$

(Again, a reevaluation of Q shows a greatly improved estimate of K.)

The third reaction

$$(1)\ O + (0)\ CO \longrightarrow O$$

simply shows the formation of a basis species from itself and so it is ignored.

Reactions four through six fall into the same categories as the first three and so will not be illustrated here.

The seventh reaction (-1) O + (+1) CO ⟶ C(graphite) shows the formation of a condensed species, and so it is considered to be major even though its concentration is well under 1/100 of the smallest basis species. $\ell n\ Q$ is found as follows:

$$\begin{aligned}\ell n\ Q_3 &= (-1)\ \ell n\ (An_O) + (+1)\ \ell n\ (An_{CO}) \\ &= -\left[(-1)\ \ell n\ (0.5022)(0.5001) + (+1)\ \ell n\ (0.5022)\ (0.4990)\right] \\ &= \ell n\ \frac{0.5001}{0.4990} = 0.0022\end{aligned}$$

(No term involving $n_{C(\text{graphite})}$ appears in this expression because C(graphite) is a nongas.)

Normally this species would be corrected as before for a major species. But the following conditions exist:

$$n_{C(\text{graphite})} < 0.000001, \text{ and } \ell n\ K_7 - \ell n\ Q_7 \text{ is negative}$$

Therefore, no correction is made and the equilibrium relation is not binding.

The procedure outlined is repeated for all species until all binding equilibrium relations are satisfied to a specified tolerance.

THE WORK OF SMITH AND MISSEN

Professors Smith and Missen at the University of Toronto reported further results on the reaction-adjustment method in 1968.[12] Their work points out that a convergence forcer is required for the method. It was an oversight that this had not been reported in the work by the author.[13] A device to force convergence is indeed required.

The NWC program computes limits on $\Delta\xi$

$$\Delta\xi_{\min} \leq \Delta\xi \leq \Delta\xi_{\max} \tag{19}$$

such that negative concentrations do not occur. It forces convergence by narrowing these limits as follows:

$$1/2\Delta\xi_{\min} \leq \Delta\xi \leq 1/2\Delta\xi_{\max} \tag{20}$$

Empirically this has been found to work.

Smith and Missen use a more elegant technique, which in effect tests the results of each reaction adjustment to ensure that the free energy minimum has not been passed over. If this occurs, they reduce the extent of the adjustment.

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[12] W. R. Smith and R. W. Missen. "Calculating Complex Chemical Equilibria by an Improved Reaction-Adjustment Method," *Can. J. Chem. Eng.*, Vol. 46 (1968), pp. 269-72.

[13] D. R. Cruise. "Notes on the Rapid Computation of Chemical Equilibria," *J. Phys. Chem.*, Vol. 68 (1964), pp. 3797-802.

Smith and Missen also report that faster convergence can be achieved by obtaining a better initial estimate of the composition.

Smith and Missen further draw parallels between the reaction-adjustment method and linear programming. This inspired the author to update the basis by the tableau method of linear programming[14] instead of the more time consuming Gram-Schmidt construction previously reported (footnote 13). This updated version works by testing each species after adjustment to determine if it is now larger than any of the basis species with which it reacts. If so, the two are interchanged, and the equations are updated as suggested by the tableau format (footnote 14).

NOTES ON THE PROPELLANT MODEL

A theorem by Duhem (see Chapter XIII of *Chemical Thermodynamics*[10]) states that "Whatever the number of phases, of components, or of chemical reactions, the equilibrium state of a closed system for which we know the initial masses is completely determined by two independent variables." This determination is made by the NWC thermochemical program in the theoretical evaluation of propellant performance. In the mathematics of the program the independent variables chosen are pressure and temperature. Two other variables of interest and possible choices for independent variables are enthalpy and entropy. These too, however, are computed from equilibrium compositions and are therefore dependent on pressure and temperature in this program. Desired value of entropy or enthalpy are achieved by repeating the above determination for various temperatures, and new temperature guesses are obtained by interpolation.

Theoretical propellant evaluation is based on a straightforward thermodynamic model consisting of two processes: (1) constant pressure, adiabatic *combustion* and (2) isentropic, adiabatic *expansion*.

The assumptions behind the combustion process include

1. Reaction kinetics are fast enough that chemical equilibrium is attained before the products leave the combustion chamber and enter the nozzle.*
2. No heat exchange occurs between the propellant system and the surroundings.**
3. Gaseous species individually obey the perfect gas law and collectively obey Dalton's law of partial pressures.

When such assumptions are made, the system enthalpy and the system pressure completely determine the final state and chemical composition of the system after combustion. The solution to this state and composition is found by a computing technique called "enthalpy balance." The method used by the propellant evaluation program is described below.

The system enthalpy itself is determined by the propellant heat of formation, which (excluding heats of mixing) is a linear weighting of the heats of formation of the individual propellant

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[14] G. Hadley. *Linear Programming*, 2nd ed. Reading, Mass., Addison Wesley, June 1963. Pp. 126 ff.

*Real propellants for which this assumption is not valid are said to "burn on the wrong side of the nozzle." This may be referred to as a Type 1 inefficiency and is one of the principle reasons for disagreement between the program and reality.

**In ramjets, the stagnation energy of the incoming air becomes part of the system. This may simply be added to the heat of formation of air.

ingredients. The value of enthalpy does not change during combustion, so this is also the value of the system enthalpy after combustion. By definition, system enthalpy is the heat needed to form the system in its current state from the elements in their most natural state at 298K and one atmosphere.

The assumptions behind the expansion process include: (1a) Reaction kinetics fast enough that chemical equilibrium is maintained throughout expansion, i.e., the shifting hypothesis; (1b) reaction kinetics so slow that no appreciable change occurs in the chemical composition during expansion, i.e., the frozen hypothesis; (2) expansion process is reversible*; (3) no heat exchange between system and surroundings; and (4) gaseous species individually obey the perfect gas law and collectively obey Dalton's law and nongases occupy no volume.

When such assumptions are made, the system entropy and the system pressure completely determine the final state of the system, regardless of the path. The solution of this state and composition is found by a computing technique called entropy balance. The latter differs little from enthalpy balance. (System entropy is referenced to the third law of thermodynamics.)

The need for the techniques described below arise because the chemical equilibrium problem is formulated to calculate composition and state from given pressure and temperature values. The calculation of performance and design parameters, however, demand that the propellant model above be utilized.

The first problem is to find the value of temperature at which a given enthalpy and pressure requirement is satisfied. This provides the "adiabatic flame temperature" and, as a by-product, the system entropy. The second problem is to find the value of temperature which satisfies the system entropy at a given exhaust pressure. In both cases, pressure is entered directly into the equilibrium code and temperature guesses must be introduced until the enthalpy or entropy conditions are satisfied.

Enthalpy and entropy are each monotonic functions of temperature; their functional values always increase with increasing temperature. In ideal cases, they are smooth, nearly linear curves. In less frequent, but certain to occur, cases the curves are actually discontinuous. This occurs at the fusion temperatures of condensed species.

Two numerical methods suggest themselves: Newton's method and the interval-halving method.

Newton's method consists of correcting successive temperature guesses by the following formula:

$$T_i = T_{i-1} - f(T_{i-1})/f'(T_{i-1}) \tag{21}$$

where T_i is the new guess, T_{i-1} is the previous guess, $f(T)$ is $H(T) - H_0$ in the case of enthalpy balance, and $f(T)$ is $S(T) - S_0$ in the case of entropy balance. H_0 and S_0 are the desired values of enthalpy and entropy. The derivative in the case of enthalpy is expressed as $f'(T) = C_p$ and in the case of entropy $f'(T) = C_p/T$.

Newton's method is very rapid when the curve is fairly straight and when a good guess is given. There is no guarantee of its convergence. It definitely will not converge in areas where the curve is discontinuous as mentioned above.

The interval-halving method depends on setting upper and lower temperature limits. That is, first, a temperature for which the enthalpy (or entropy) is too high; and second, a temperature for which the enthalpy (or entropy) is too low. The range of much of the JANAF thermochemical data is 298 to 6,000K. These can be chosen as the limits, because if they do not bound the answer, the computer effort is futile anyway.

---

*This covers a multitude of sins such as no shocking in the nozzle and equal velocities for gas and nongas phases at each point in the flow. Real systems for which this assumption is not valid have what may be referred to as the Type II inefficiency.

The method proceeds as follows: Take the arithmetic mean of the temperature limits $(\overline{T}) = 0.5(T_U + T_L)$ and compute the value of $H(T)$ or $S(T)$ depending on the process. If $H(T)$ is greater than H_0 (or equivalently for S), $\overline{T}$ becomes the new upper limit. Otherwise, it becomes the new lower limit. The process is then repeated. $\overline{T}$ becomes successively a better estimate of the desired temperature, gaining one bit in precision for every iteration. Using the original limits of 298 and 6,000K, about 13 iterations are required to achieve a precision of one degree.

The interval-halving method is the slowest practical approach to the problem. However, it has one overwhelming advantage over other methods: if the answer is contained in the original limits, the method will always converge.

The propellant program combines the two techniques. Temperature bounds are established and modified according to the results of the temperature guesses (a guess too high gives a new upper bound and vice-versa). Guesses are first chosen by the formula for Newton's method. However, they are used only if they do not approach one of the bounds by more than halfway; in this case the halfway point is used.

The program thus uses Newton's method, with an interval-halving "override.' The advantages of both methods are obtained. When the curve is fairly linear, the convergence is rapid; when the curve "misbehaves" convergence is at least certain.

ESTIMATION OF NOZZLE DESIGN PARAMETERS

The NWC thermochemical program evaluates theoretical specific impulse by exact methods: enthalpy balance for the combustion process and entropy balance for the expansion process. The state of the fluid immediately after combustion is completed may be designated by the subscript "1" and the state of the gas after isentropic expansion to the exit pressure may be designated by the subscript "2".

The state variables computed during the first process are T_1, V_1 and S_1 given the chamber pressure, P_1, and the propellant heat of formation, H_1. Those computed during the second process are T_2, V_2 and H_2 given the exit pressure, P_2, and entropy, $S_2 = S_1$.

The state of the gas after the expansion may be computed under either a shifting or frozen hypothesis; in the latter case the chamber composition is retained rather than computing new equilibrium conditions at the exit conditions. Obviously, the values of T_2, V_2 and H_2 differ under the two hypotheses, but the design equations presented below (which use these values as input) are identical for both hypotheses.

The computation of optimum impulse assumes that the expansion ratio of the nozzle is optimum; i.e., the value of pressure predicted at the exit by the continuity equation is the same as the given ambient pressure. In this case, impulse is simply evaluated as follows:

$$I_{sp} = \frac{1}{g_{MKS}}\sqrt{\frac{2J(H_1 - H_2)}{m}} \qquad (22)$$

where $g_{MKS} = 9.80665$ m/s^2, $J = 4186$ (g-joules)/(kg-calories), $m = 100$ g and H is system enthalpy in calories. (The program does not actually require a 100 g reference mass; it is merely a time-honored convention.)

The questions arise: How does one correct the impulse for conditions other than the chamber and exit pressures given? Also, how does one correct for a nozzle that does not have an optimum expansion ratio? Furthermore, how does one determine design parameters such as the thrust coefficient and the optimum expansion ratio itself?

Two comments can be made immediately: (1) As far as the first question is concerned, there is no better way to determine the correction than rerunning the program at the desired pressure conditions; (2) The gamma equations given in textbooks are inaccurate and misleading, especially when applied to shifting flow and when the conventional definition of gamma is used:

$$\gamma = C_p/C_v \tag{23}$$

However, equations of a gamma form may be used effectively, if the values for gamma are fitted to the exact solution of the state variables yielded by the program.

This approach assumes that the equations of state for enthalpy and entropy may be written:

$$H = H_o + \frac{\gamma_c}{\gamma_c - 1}\, nRT \tag{24}$$

$$S = S_o = \frac{\gamma_v}{\gamma_v - 1}\, nR \ln T - nR \ln P \tag{25}$$

where H_o and S_o are arbitrary constants and γ_c and γ_v are the parameters to be fitted.

The perfect gas law, $PV = nRT$, may be substituted into Equations 24 and 25 yielding:

$$H = H_o + \frac{\gamma_c}{\gamma_c - 1}\, PVL \tag{26}$$

$$S = S_o' + \frac{\gamma_v}{\gamma_v - 1}\, nR \ln (PV) - nR \ln P \tag{27}$$

where S_o' is a new arbitrary constant, and L = 24.218 calories/liter-atm. is introduced so as to consistently express enthalpy in calories.

The constants γ_c and γ_v are to be determined as that H_2 and V_2 are correctly predicted from H_1 and V_1 by Equations 26 and 27. The solution may be shown to be

$$\frac{\gamma_c}{\gamma_c - 1} = \frac{H_1 - H_2}{P_1V_1 - P_2V_2}\; \frac{1}{L} \tag{28}$$

$$\gamma_v = \frac{\ln P_2 - \ln P_1}{\ln V_1 - \ln V_2} \tag{29}$$

where H_o and S_o' cancel out. γ_c may be called the *calorimetric gamma* because it predicts the heat content during the expansion. γ_v may be called the *volumetric gamma* because it predicts the changes in volume during the expansion. In fact the familiar relation

$$P_1V_1^{\ \gamma_v} = P_2V_2^{\ \gamma_v}$$

may be derived from Equation 29, assuming $\Delta S = 0$. The two gammas will not, in general, be equal, due to nonuniform heat capacity and changes in composition in real systems.

Design calculations may be based on the continuity equation for one-dimensional flow:

$$\dot{m} = k \rho v A \tag{30}$$

where $\dot{m}$ = mass flux (g/s), k = 1,000 (liters/m^3), ρ = density (g/liter), v = velocity (m/s) and A = duct cross-sectional area (m^2).

Equation 30 may be rewritten in terms of state variables.

$$A/\dot{m} = \frac{V/k}{\sqrt{2mJ\ (H_1 - H)}} \tag{31}$$

using the relationships $H_1 - H = 1/2\ m\ v^2$ and $\rho = \frac{m}{v}$.

Equations 26 and 27 may be substituted into this expression giving

$$A/\dot{m} = f(P) = \frac{\sqrt{\frac{P_1 V_1}{m} \frac{\gamma_c}{\gamma_c - 1}}}{P_1 k \sqrt{2\ L\ J}} \cdot \frac{\left(\frac{P}{P_1}\right)^{-1/\gamma_v}}{\sqrt{1 - \left(\frac{P}{P_1}\right)^{(\gamma_v - 1)/\gamma_v}}} \tag{32}$$

The pressure at the nozzle throat is found by minimizing this expression with respect to P. The solution is

$$P^* = P_1 \left(\frac{2}{\gamma_v + 1}\right)^{\gamma_v/(\gamma_v - 1)} \tag{33}$$

The throat area for unit mass flow is found by substituting P^* back into Equation 32.

$$A^*/\dot{m} = f(P^*) \tag{34}$$

The optimum expansion ratio for the given exit pressure may now be found

$$(A/A^*)\mathrm{opt} = f(P_2)/f(P^*) \tag{35}$$

If the nozzle expansion ratio is not optimum, then the true exit pressure (P_2') is not the same as the given exit pressure (P_2). P_2' may be found implicitly from the given value of the expansion ratio.

$$(A/A^*)\ \mathrm{given} = f(P_2')/f(P^*) \tag{36}$$

The energy of propulsion is then given by:

$$\Delta H = \frac{\gamma_c}{\gamma_c - 1} (L P_1 V_1) \left[1 - \left(\frac{P_2'}{P_1}\right)^{(\gamma_v - 1)/\gamma_v}\right] \tag{37}$$

(In the special (optimum) case where $P_2' = P_2$, then $H = H_1 - H_2$.)

In both optimum and nonoptimum cases, the specific impulse is given by

$$I_{sp} = \frac{1}{g_{MKS}} \sqrt{\frac{2J\Delta H}{m}} + JKLf(P_2')\,(P_2' - P_2) \tag{38}$$

The vacuum specific impulse follows easily:

$$(I_{sp})_{\text{vacuum}} = \frac{1}{g_{MKS}} \sqrt{\frac{2J\Delta H}{m}} + JKLf(P_2')\,P_2' \tag{39}$$

Finally, the thrust coefficient and the characteristic velocities are found by conventional relationships.

$$C_f = g_{MKS}\, I_{sp} \Big/ \left[JKLf(P^*)\, P_1\right] \tag{40}$$

$$C^* = g_{FPS}\, I_{sp} \Big/ Cf \tag{41}$$

where $g_{FPS} = 32.16$ ft/s^2.

The program currently outputs $(I_{sp})_{\text{opt}}$, γ_ν, (A/A), and C_f under both frozen and shifting hypotheses. Corrections for nonoptimum expansion may be obtained under one of the program options.

The program was modified in 1965 so that the computation of γ_c and γ_ν is applied to several regimes. These are separated at points where condensed phases appear and disappear from the system. The values of γ_c and γ_ν vary from regime to regime. Each regime is scrutinized for minimum throat area. If more than one occurs, the smallest is the one chosen.

BOOST VELOCITY

The formula for boost velocity of an idealized missile (one free of gravity and drag) is

$$\Delta U = (I_{sp})\, g\, \ln\left(1 + \frac{\rho}{\rho^*}\right)$$

where the switch density, ρ^*, is given by

$$\rho^* = \frac{\text{Mass of missile - Mass of propellant}}{\text{Volume of propellant}} \tag{42}$$

and ρ is the density of the propellant.

We use lb-mass/in^3 to measure ρ and lb-mass/ft^3 to measure ρ^*, as input to the computer, in abject submission to the illogical common usage. The units are made the same before computing the ratio.

Appendix A

INPUT INSTRUCTIONS FOR THE PROPELLANT EVALUATION PROGRAM (PEP)

The instructions below assume that one is making a batch run and that he has already produced the library tape or file described under PEP Auxiliary Program (Appendix G). It does not describe the optional input of ingredients by serial number; that is described under Automated Input of Ingredient Data (Appendix F). The latter option works for both batch and teletype runs.

The input deck for the equilibrium program consists simply of three groups of cards: (1) the control card, (2) the ingredient composition card(s), and (3) the pressure and weight ratio card(s).

The first 19 columns of the control card contain option switches. Their functions are summarized in Table A-1 at the end of this appendix.

In columns 21 through 26 of the control card appear the first six letters of the name of the person running the problem. Ending in column 30 is the number (not to exceed 10) of propellant ingredients; this number must agree with the number of ingredient composition cards that are to follow the control card (punch no decimal point). Ending in column 40 is the number of runs to be made on that system of ingredients. This number must agree with the number of pressure and weight ratio cards that are to follow the ingredient cards (again, punch no decimal point).

The format of the ingredient composition card is as follows:

Column 1-30	Name of ingredient (alphanumeric)
Column 31-33	Number of atoms of first element in compound (punch no decimal)
Column 34-35	Symbol of first element (left adjust)
Column 36-38	Number of atoms of second element in compound
Column 39-40	Symbol of second element and so on as needed up to six elements and column 60.
Column 63-67	Heat of formation of compound in calories per gram (right adjust with no decimal point)
Column 69-73	Density of compound in pounds per cubic inch (punch decimal point)

This last item may be omitted if boost velocities and density-impulse are not required.

Examples of ingredient composition cards follow:

AMMONIUM DICHROMATE 8H 2N 7O 2CR -1688 .0776

It is possible to introduce arbitrary multipliers into the composition; thus the following is equivalent to the example above:

AMMONIUM DICHROMATE 16H 4N 14O 4CR -1688 .0776

Mixtures may also be entered as single ingredients as follows:

AIR (DRY AT SEA LEVEL) 835N 224O 5AR 0000

The pressure and weight ratio cards each consist of 12 six-column fields. The first field contains the chamber pressure, and the second contains the exhaust pressure. Following these are consecutive weight ratios for the propellant ingredients in the same order in which they appear in the ingredient composition cards. There are, of course, as many cards as there are ingredients. The weights normally are chosen to add up to 100 g, although this is not required. *Decimal points must be punched in all fields used on the pressure and weight ratio cards.*

A complete sample input deck for a well-known hybrid system is listed after Table A-1 Table A-1 contains necessary information that should be studied before using the program.

TABLE A-1. Program Options.

Option no.	Type	Function performed
1	1	Deletes exit calculations
2	1	Includes ionic species in the calculations
3	1	Deletes boost velocities and three pages of nozzle design data
4	1	Inputs pressures in psi instead of atmospheres
5	1	Increases precision of species concentrations one order of magnitude
5	2 or higher	Increases precision even further
6	1	Inputs an extra identification card
7	1	Inputs a pressure-temperature point instead of chamber and exhaust pressures. This allows a P-T-H-S chart to be developed
8	1	Outputs a list of all combustion species considered
9	1	Allows serial number input for ingredients
10	1	Allows modification of H and ρ data
		Option 11-15 are used only for debugging
11	1	Prints out thermo data computed at every temperature guess
12	1	Prints out the first guess of the composition
13	1	Prints out compositions every fourth iteration
14	1	Prints out the log of the equilibrium constants at every temperature guess
15	1	Outputs a code that indicates the classification the program has applied to various species at each iteration
16-19	Leave Blank	For internal use

```
-RUN 419051,1320018A085G,4535419,05,75/0    CRUISE
-ADD PEP*RUN.
0011000000          CRUISE   2         9
SULPHUR                         1S                          +0000 .0474
MOLASSES                       22H  12C  110                -1550 .0574
 1000.  14.7   10.   90.
-FIN
```

Appendix B

PEP TELETYPE USAGE
(Pertains mainly to NWC users)

First obtain a user number for yourself, an identification number for your teletype (TTY), and a job order number for the use of the people in Code 3132. Call Ext. 3019 for a UNIVAC 1110 user number, and call Daryl Vaughn at ext. 3561 for the teletype identification number, if it is not already pasted to your teletype.

Approach the teletype and dial 7 (120 cps), 6 (30 cps), or 5 (10 cps). It should ring once and give a 1,000-cps beep. Type in the teletype identification upon coupling. A secret password is now required at this point (call ext. 3019 for information).

The RUN card is typed next. It starts with @RUN followed by one or more spaces. Then, on the same line, type uuuTTY, mmmmmmmmmm9G, ccccuuu, t, where uuu is your user number, mmmmmmmm is your job order number, cccc is your NWC organizational code, and t is a time estimate in minutes. The TTY and 9G are typed as shown.

After the computer prints out the date, type in @ADD PEP*RUN. exactly as shown. (Do not forget the period.)

The computer will now mumble for 10 or more lines, and then you will be greeted by the PEP program. The program will prompt you for an input and provide a typing guide. The first inputted line contains the options, the name of the user, the number of ingredients, and the number of runs to be performed on that set of ingredients. Type the options under the option number.

Ingredient information may now be entered by serial number. Obtain a list from Code 3245, and send any updates for the list you wish to add. Enter the serial numbers in the order you wish and type them consecutively so they end under the "V's" of the typing guide. (They a thus right adjusted in five-column fields.)

The program will next prompt you for the chamber pressure, the exit pressure, and the weight ratios. The weight ratios are in the same order as the ingredients. Always type the decimal point and remain inside the fields. The end of each field is indicated by a "V" in the typing guide. (Actually the guide stops short of the 12 fields that are possible.) The number of ingredients is limited to 10.

If you wish to start over, hit a carriage return instead of the input discussed above.

Terminate the run by typing @@X TIO and then @FIN instead of the prompted input. After the computer prints out execution time, type @@TERM to sign off.

A "control Z" deletes the previous character (but defeats the typing guide).

A "control X" typed before a carriage return deletes the current line and allows you to start over.

A run may be aborted by hitting the "break" key (on some teletypes this must be followed by hitting a "break release" button, which turns on after you have hit the "break" key). The computer types INTERRUPT LAST LINE and returns. Type @@X TIO and hit carriage return. The run eventually stops.

If a run is deliberately or accidentally aborted, type @XQT CRUISE*QAME to restart the program, instead of @ADD PEP*RUN; it saves time and money.

To save more money, try the following:

1. Delete the long output (option 3), if you do not need it.
2. Punch the information on cards and submit a batch run.
3. If you do not mind the longer turnaround time, submit a batch run with an "N" (night run) option.

Appendix C

COMMENTS ON THE PEP OUTPUT

The program output deliberately has been made concise so that a great deal of information may appear on a single page of a report. However, the conciseness requires that some explanations be given to the uninitiated.

The first line contains the user's name, the date, and the precise time of day. This information is repeated on successive pages so that, if the pages are separated, they are uniquely identified.

The input ingredients are printed next, so that the input may be checked.

The ingredient weights are printed next, and the total system weight follows the individual weights. The total system weight is generally chosen by the user to be 100 g, but whatever the user chooses, the value is important to other outputs described below.

The gram-atom amounts for each chemical element are next. These are based on the given system weight.

The chamber conditions are then printed out with headings. The enthalpy has units of kilocalories per system weight, and the entropy has units of calories/K per system weight. CP/CV is the ratio of specific heats, and GAS identifies the number of moles of gas produced per system weight. Effective molecular weight is obtained by dividing GAS into system weight. Note that although nongases are not included in this computation this is the proper molecular weight to use in gas dynamic equations. The quantity RT/V is equal to the variable designated A in the text and may be expressed as

$$A = \frac{\text{R (0.08205 ℓ-atm/mole/K) T (K)}}{\text{V(system volume in liters)}}$$

The chamber composition follows in units of moles per system weight. If one prefers to obtain partial pressures in atmospheres, multiply each composition by RT/V printed above.

The exhaust plane results follow, in the same format and units as the chamber results just described.

Three lines of performance results appear next. The first contains headings; the second contains the results for a frozen flow (no chemical reactions) through the nozzle; and the third contains results for a shifting flow (reactions in equilibrium) through the nozzle. Impulse is in the units of seconds and is the same in engineering and metric units. Unfortunately, the SI people introduced confusion where none previously existed by changing the definition of impulse to what was previously called the theoretical exhaust velocity. Therefore, to obtain the official SI impulse, multiply the value outputted by 9.806 m/sec.

The next number (IS EX) is the isentropic exponent, which is the number, γ_ν such that

$$PV^{\gamma_\nu} = \text{constant}$$

for isentropic flow near the nozzle throat. The values of IS EX and CP/CV do not agree, because the gas is not perfect.

The variables T* and P* are throat temperature (in K) and pressure (in atmospheres), respectively. The variable CF is the nozzle thrust coefficient. Those who regard characteristic velocity, C*, as a meaningful number may obtain it by the relation

$$C^* = 32.17 \text{ ISP/CF}$$

The variable, ISP*, is the vacuum impulse to be obtained from a sonic nozzle. That term is used in airbreathing propulsion work. The optimum expansion ratio (OPT EX) is the ratio of the nozzle exit area to nozzle throat area at which exit pressure equals ambient pressure. The density impulse is labeled D-ISP, and the exit plane temperature is in K.

Appearing just before the exit temperature (EX T) is A*M., which stands for $A^*/\dot{M}$. This is the ratio of nozzle throat area to mass flow rate expressed as in^2-sec/lb.

Optional output includes boost velocities. These are shown in number pairs: the first is the switch density (see text), and the second is the velocity in feet/second. Inputted densities follow in pounds/in^3. The next output shows the performance of the propellant through nozzles with expansion ratios of 1 to 100. These include three kinds of impulse: optimum (ambient pressure = exit pressure), vacuum (zero exit pressure), and sea level (exit pressure = 1 atmosphere). Units are given in SI units as well as the older English units. Note that all impulses need to be corrected for nozzle half angle.

A final output shows the computer CPU time consumed by the calculations.

```
CRUISE  09/15/78     09:43:43          DH   COMPOSITION

 SULFUR                                 0    1S
 MOLASSES                           -1550   22H   12C  11O

INGRED.WTS.&TOTAL/ GRAM ATOMS/ CHAMBER/ EXHAUST RESULTS/ PERFORMANCE

 10.00000   90.00000 100.00000

 5.784264 H     3.155053 C    2.692132 O      .311857 S

 T(K)  T(F)   P(ATM)    P(PSI) ENTHALPY  ENTROPY   CP/CV    GAS   RT/V
 850. 1071.   68.02   1000.00  -139.52   169.12  1.1654  3.169  21.465

  1.75964 C$        1.26292 H2O         .79298 CO2         .55919 CH4
   .30477 H2S        .20107 H2          .04116 CO          .00209 CSO
  1.25-06 CS2

 T(K)  T(F)   P(ATM)    P(PSI) ENTHALPY  ENTROPY   CP/CV    GAS   RT/V
 501.  442.    1.00     14.70  -156.92   169.12  1.2045  3.059    .327

  2.15012 C$        1.72024 H2O         .56569 CO2         .41894 CH4
   .31181 H2S        .02221 H2          .00005 CO          .00004 CSO

IMPULSE  IS EX      T*      P*      CF    ISP*  OPT EX  D-ISP   A*M.   EX T

 120.2  1.1936   775.  38.48  1.625           8.98     .0  .07401   429.
 123.1  1.1453   797.  39.14  1.628   93.4    9.67     .0  .07566   501.

INGRED. DENSITIES ARE
  .0000    .0000

(CPU  1.79SECS.)
```

Appendix D

BRIEF DESCRIPTIONS OF PEP SUBROUTINES

In the summary below the first item to appear is the subroutine name. Then appears a letter code in parentheses to explain the usage of the subroutine. The meanings of the letters are as follows:

(M) Main program
(I) Input routine
(O) Output routine
(E) Routine directly involved in equilibrium calculations
(P) Routines that evaluate performance
(U) Utility routine

Following the letter code appears the name of the calling subroutine(s) in square brackets. Finally a brief description appears.

A summary of the PEP subroutines follows:

ADJUST (E) [DEFIOJ] Correct errors in gram-atom balance that arise due to truncation errors.
BOOST (P,O) [DESIGN] Computes and outputs boost velocities.
*DATE (U) Calendar date routine.
DEFIOJ (E) [EQUIL] Computes optimal basis.
DESIGN (P,O) [PEP] Computes and outputs performance parameters.
DESNOZ (O) [PEP] Outputs nozzle performance.
EQUIL (E) [HBAL,SBAL] Computes composition for a pressure-temperature point.
FIXBAS (E) [EQUIL] Fixes basis to compensate for phase changes that occur due to temperature change.
GIBBS (D) [EQUIL] Computes enthalpy, entropy, and Gibbs free energies for all species.
GUESS (E) [PEP] Computes initial guess of composition.
HBAL (E) [PEP] Computes constant pressure combustion (P,H point).
IPHASE (P) [DESIGN] Characterizes and locates phase changes.
LINDEP (E) [DEFIOJ] Establishes linear independence of basis.
*LKCLKS (U) [PUTIN] Looks at system clock.
ONED (P) [DESIGN] One-dimensional flow calculations.
OUT (O) [PEP] Outputs temperatures and composition.
PEP (M) Main program puts everything together.
PUTIN (I) [PEP] Main input routine.
RANK (U) Sorts an array into decreasing order of size.
REACT (E) [EQUIL] Computes stoichiometric coefficients and equilibrium constants.
SBAL (P) [PEP] Computes isentropic exhaust state (i.e., a P,S point).

---

*Nonessential system utility subroutines.

SEARCH (I) [PUTIN] Searches combustion data for pertinent species.

*SETCLK (U) Sets the system clock to zero.

SETUP (E) Preliminary analysis of equilibrium situation, computes maximum and minimum shifts in concentration so that negative concentrations do not occur.

SLITE,SLITET (U) Through this routine the program seeks to turn off simulated lights to obtain:
- LITE(1) off--optimum basis
- LITE(2) off--linear independence in basis
- LITE(3) off--temperature convergence
- LITE(4) off--composition convergence

STOICH (E) [PUTIN] Preliminary analysis of elementary composition.

TABLO (E) [TWITCH] Updates optimal basis by the tableau method of linear programming.

TAPEB (I) [SEARCH] Input buffer for combustion data.

THERMO (E) [EQUIL] Computes system enthalpy and entropy.

*TOFDAY (U) Time of day.

TSALT (P) [TSBAL] Computes a T,S point by slow, but reliable method when TSBAL fails.

TSBAL (P) Fast equilibrium computation for specified temperature and entropy (T,S); occasionally fails to converge.

TWID (E) [TWITCH] Computes equilibrium relation for TWITCH to modify.

TWITCH (E) [EQUIL,TSBAL] Main equilibrium subroutine. This is flow-charted below.

---

*Nonessential system utility subroutines.

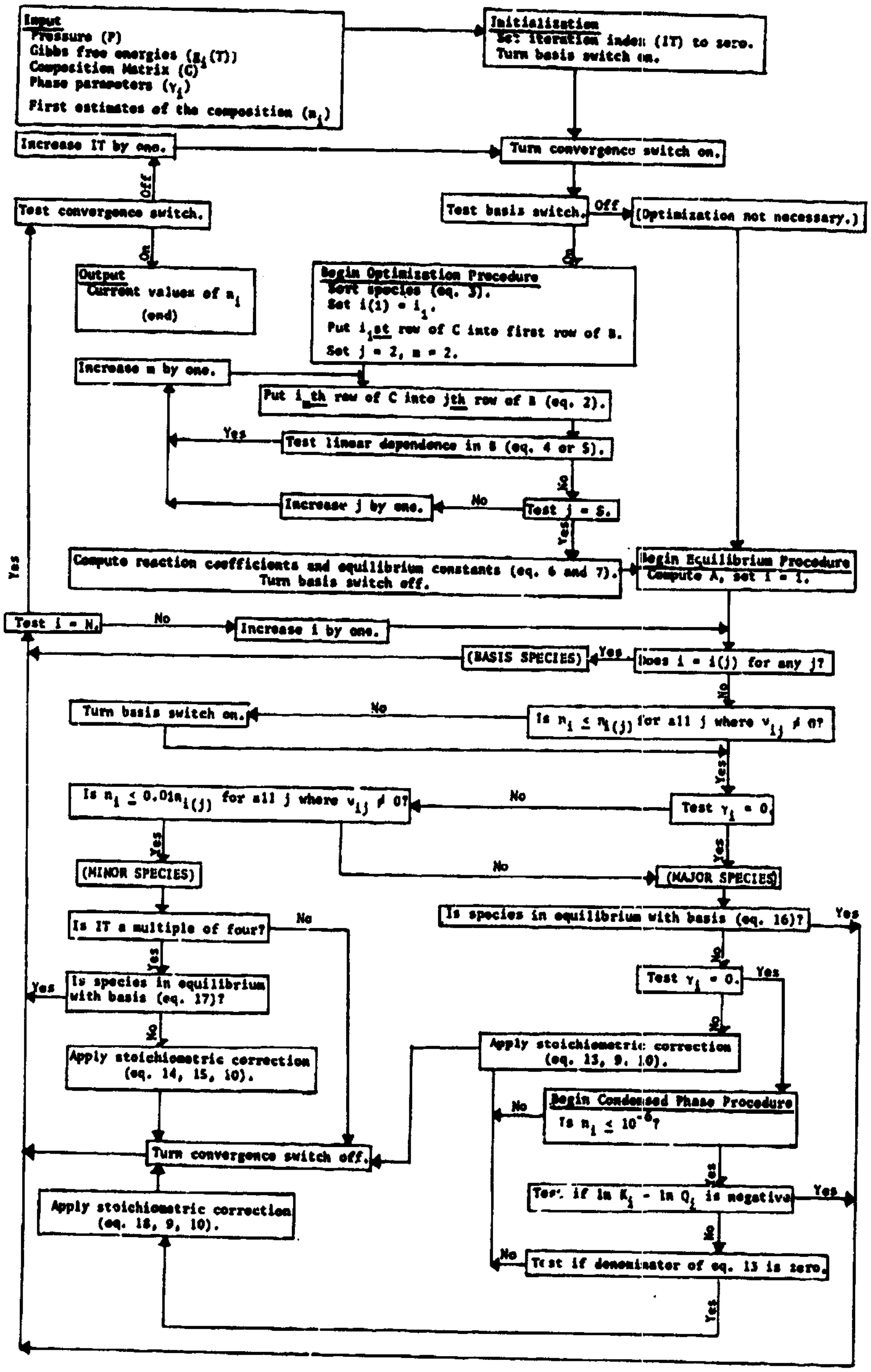

FIGURE D-1. Flow Chart for Computation Procedures.

Appendix E

IDENTIFICATION OF VARIABLES IN COMMON BLOCKS

The following information is provided for those who wish to dig into the equilibrium program.

BLANK COMMON

A	Basis matrix
KR	Option block
AMAT	Ingredient composition matrix
JAT	Atomic numbers
ASPEC	Element names (field data)
IN	Number of ingredients
IS	Number of elements
FIE IE	Ingredient composition
ALP	Gram-atom amounts (α)
W27	System weight
N	Number of combustion species
BLOK	Ingredient names (field data)
DH	Ingredient heats of formation
RHO	Ingredient densities
ISERI	Output identification (field data)
WATE	Ingredient weights
W1(4)	System heat of formation
W1(5)	Chamber pressure
W1(6)	Exhaust pressure
W43	Density
JG	Number of gaseous combustion species
NP	N + 1
VNT	Combustion species concentrations
W47	Temporary
NAME	Temporary
SER	Temporary
FLOOR	Lower limit of concentrations

COMMON/IBRIUM

TL	Lower temperature limits for species data
TU	Upper temperature limits
W3	Molecular weights of species
VNU	Reaction coefficient matrix (ν_{ij})
QA	Temporary variable
TAU	Temporary variable
H	Species enthalpy
SD	Species entropy
Y	Species heat capacity
JC	Iteration index
IR	Storage area for sorting
DMU	Species Gibbs free energies (u_j)
VLNK	Natural log of equilibrium constants
IOJ	Indices for basis species (i(j))
RA	Constant terms for species c_p (L_1)
RB	T term for species c_p (L_2)
RC	T^2 term for species c_p (L_3)
RD	T^3 term for species c_p (L_4)
RE	T^{-2} term for species c_p (L_5)
RF	Reference enthalpies (L_6)
CH	Reference entropies (L_7)
JM	Temporary variable
W48	Temporary variable
CP	System heat capacity
FN	Number of moles of gas in system
C	Species composition matrix
SPECIE	Names of species (field data)
LL	Vectro to keep track of certain computational data concerning combustion species

COMMON/SCRATC/

HN	Temporary storage for compositions. This is used to analyze splits between the liquid and solid phase of a species.
PLOT	Temporary storage for nozzle design results.

COMMON/MOON/

TSTEST	Convergence test for T-S point.

Appendix F

AUTOMATED INPUT OF INGREDIENT DATA

The program (PEPLIB) appears below with data. It allows a user to enter ingredient data, if he is lucky enough to find it on the list, by the serial number that appears to the right. If option 9 is employed, the ingredient serial numbers are punched on a single card following the option card in format (10I5). PEPLIB creates a tape or file which is given label "11" by both PEP and PEPLIB.

The program date is the compilation of propellant ingredient data as of 10 May 1978. It contains many corrections and additions to previous lists.

It is not convenient to the users to reassign serial numbers once assigned to an ingredient. Therefore, note that the oldest data is in alphabetical order. Following that is a supplementary list that is also in alphabetical order. Following that is another list of several dozen ingredients, which are in the order received. Finally, there are two more supplementary lists, one of which is data received from Ed Barooty at NSWC, Indian Head, MD. This is heat of combustion data and is in alphabetical order.

Chemical ingredient names are mostly generic to avoid confusion. Since these are sometimes long, they are sometimes continued on the following line. The proper serial number in that case is on the line which contains the composition.

Program With Truncated Input

```
-ASG,AX CRUISE*PEPLIB//21734
-USE 11,CRUISE*PEPLIB
-FOR,IS   LIBPRO,LIBPRO/A
      DIMENSION A(20), B(2)
      WRITE (6,4)
    4 FORMAT (-1-)
      REWIND 11
      DO 9  J=1,9999
      READ (5,1,ERR=10,END=11)(A(I),I=1,13)
C     1 FORMAT (10A6,2X,A5,1X,A5,1X,A6)
    1 FORMAT (10A6, 1X, F6.0, 1X, A5, 1X, A6)
      ENCODE(19,B) A(11)
   19 FORMAT (F6.0)
      A(11)=B(1)
      WRITE (11,5)(A(I),I=1,12)
    5 FORMAT (10A6,A5,1X,A5,1H))
C     2 FORMAT (12A6,A1,I7)
      JJ=J-1
    9 WRITE (6,3)(A(I),I=1,12),JJ
    3 FORMAT (- -10A6,2X,A5,1X,A5,I7)
      GO TO 11
   10 READ (30,20)(A(L),L=1,14)
      WRITE ( 6,20)(A(L),L=1,14)
   20 FORMAT(13A6,A2)
   11 END FILE 11
      CALL EXIT
      END
-XQT

1EA-5-85 (VICTOR)             378H 243C 102N  860 205F        -0538 1.465    615
2 N!TRO DIPHENYL AMINE         10H  12C   20   2N             +0135 .0535     59
100DER321/43DEH14             810H 596C  22N 1080             -0661
2 NITRO DIPHENYL AMINE         10H  12C   20   2N             +0135 .0535    359
2-TDMECLO4 (INFO 635P)          3C   7H  1CL   6F   4N    50  -0345 .0650  $4001
2-TDMEHCL (INFO 631C)           3C   7H  1CL   6F   4N    10  -0448 .0650  $4002
8C8H18F10N60 (FAPEMON)          8C   8H  18F  10N   60        -0273 .0000  *5003
8C8H18F10N60 (FAPEMON)          8C   8H  18F  10N   60        -0240 .0000  G5004
9C14H12F6N30 (TVOPA)            9C  14H  12F   6N   30        -0385 .0000  G5005
9C14H12F6N30(TVOPA)             9C  14H  12F   6N   30        -0430 .0554  *5006
ACETAMIDE                       2C   5H   10   1N             -1310 .0360
ACETYL TRIETHYL CITRATE        22H  14C   80                  -1257 .0408    008
ACETYLENE                       2C   2H                       +1846 .0263  $5009
ACETYLENE                       2C   2H                       +1892 .0220  *5010
ACETYLENE (GASEOUS)*            2H   2C                       +2081         G 011
ACRYLIC ACID         -HC-       4H   3C   20                  -1282 .0384  * 012
ACRYLIC NITRILE                 3C   3H   1N                   0682 .0000  *1013
ADIPIC ACID           6C  10H   40                            -1480
AIR (DRY AT SEA LEVEL)        835N 2240  5AR                  +0000
AIR  (500K OR 900R)           835N 2240  5AR                  +0049
AIR  (1000R OR 555.56K)       835N 2240  5AR                  +0063
AIR  (750K OR 1350R)          835N 2240  5AR                  +0113
AIR  (1500R OR 833.33K)       835N 2240  5AR                  +0195
AIR  (1000K OR 1800R)K)       835N 2240  5AR                  +0180
AIR  (2000R OR 1111.1K)       835N 2240  5AR                  +0201
AIR  (1250K OR 2250R)K)       835N 2240  5AR                  +0249
```

Program Output

```
                                                                        0               0
1EA-5-85 (VICTOR)               378H 243C 102N  860 205F             -538 1.463         1
2 NITRO DIPHENYL AMINE           10H  12C   20   2N                   135 .0535         2
10CDER32 1/430 EH14             810H 596C  22N 1080                  -601               3
2 NITRO DIPHENYL AMINE           10H  12C   20   2N                   135 .0535         4
2'TDMECL04 (INFO 635P)            3C   7H  1CL   6F   4N    50       -345 .0650         5
2'TDMEHCL (INFO 631C)             3C   7H  1CL   6F   4N    10       -448 .0650         6
8C8H16F10N60 (FAPEMON)            8C   8H  16F  10N   60             -273 .0000         7
8C8H16F10N60 (FAPEMON)            8C   8H  16F  10N   60             -240 .0000         8
9C14H12F6N30 (TVOPA)              9C  14H  12F   6N   30             -385 .0000         9
9C14H12F6N30(TVOPA)               9C  14H  12F   6N   30             -430 .0554        10
ACETAMIDE                         2C   5H   10   1N                 -1310 .0360        11
ACETYL TRIETHYL CITRATE          22H  14C   80                      -1257 .0408        12
ACETYLENE                         2C   2H                            1846 .0263        13
ACETYLENE                         2C   2H                            1892 .0220        14
ACETYLENE (GASEOUS)*              2H   2C                            2081              15
ACRYLIC ACID          -HC-        4H   3C   20                      -1262 .0384        16
ACRYLIC NITRILE                   3C   3H   1N                        662 .0000        17
ADIPIC ACID            6C   10H   40                                -1469              18
AIR (DRY AT SEA LEVEL)          835N 2240  5AR                          0              19
AIR  (500K OR 900R)             835N 2240  5AR                         49              20
AIR  (1000R OR 555.56K)         835N 2240  5AR                         63              21
AIR  (750K OR 1350R)            835N 2240  5AR                        113              22
AIR  (1500R OR 833.33K)         835N 2240  5AR                        135              23
AIR  (1000K OR 1600R)K)         835N 2240  5AR                        160              24
AIR  (2000R OR 1111.1K)         835N 2240  5AR                        201              25
AIR  (1250K OR 2250R)K)         835N 2240  5AR                        249              26
ALUMINUM (PURE CRYSTALINE)       1AL                                    0 .0976        27
ALUMINUM (PURE CRYSTALINE)       1AL                                    0 .0976        28
ALUMINUM DIBORIDE                 2B  1AL                           -1632 .1152        29
ALUMINUM BERYLLIUM (ALLOY)       1BE  1AL                               0 .0874        30
ALUMINUM BERYLLIUM (ALLOY)       3BE  1AL                               0 .0795        31
ALUMINUM BORIDE                  12B  1AL                            -314 .0921        32
ALUMINUM BORON (ALLOY)           12B  1AL                            -600 .0978        33
ALUMINUM BOROHYDRIDE             1AL   3B  12H                       -301 .0199        34
ALUMINUM BOROHYDRIDE             1AL   3B  12H                       -208 .   0        35
ALUMINUM CARBIDE                 4AL   3C   -0   -0   -0             -215 .0852        36
ALUMINUM  FLOURIDE                3F  1AL                            -844              37
ALUMINUM HYDRIDE                 1AL   3H                             -92 .0516        38
ALUMINUM NITRIDE                  1N  1AL                           -1407 .1170        39
ALUMINUM (NON-REACTIVE)          1U4                                    0 .0976        40
ALUMINUM PERCHLORATE             120  1AL  3CL                       -814 .0939        41
ALUMINUMBOROHYDRIDEDIMETHYLAM     2C  19H  1AL   3B   1N             -468 .0265        42
AMINOXYLENE (XYLIDENE)           11H   8C   1N                        -65              43
AMINO TETROZOLE                   3H   1C   5N                        585 .0595        44
AMINE TERMINATED POLYBUTADIENE    6H   4C                              56 .0360        45
AMINO TETROZOLE PERCHLORATE       4H   1C   5N   40  1CL              204 .0668        46
AMMONIUM ACETATE                  2C   7H   20   1N                 -1820 .0422        47
AMMONIUM BICARBONATE              1C   5H   30   1N                 -2580 .0570        48
AMMONIUM CARBONATE                1C   3H   2N   30                 -2340              49
AMMONIUM CHLORIDE                 1N   4H  1CL                      -1410 .0551        50
AMMONIUM CYANATE                  1C   4H   10   2N                 -1245 .0484        51
AMMONIUM FLOURIDE                 4H   1N   1F                      -3000 .0364        52
AMMONIUM FLOUROSILICATE           2N   8H  1SI   6F                 -3530 .0726        53
AMMONIUM FORMATE                  1C   5H   20   1N                 -2105 .0462        54
AMMONIUM GLYCOLLATE               2C   7H   30   1N                 -1410              55
AMMONIUM GLYOXALLATE              2C   7H   40   1N                 -2100              56
AMMONIUM IODIDE                   4H   1N   1I                       -336              57
AMMONIUM NITRATE                  4H   2N   30                      -1090 .0623        58
AMMONIUM NITRATE                  4H   2N   30                      -1090 .0623        59
AMMONIUM OXALATE                  8H   2C   2N   40                 -2160 .0542        60
AMMONIUM OXALATE                  2C   8H   40   2N                 -2160              61
AMMONIUM OXALATE (HYDRATED)       2C  10H   50   1N                 -2400 .0542        62
```

AMMONIUM PERCHLORATE (AP)	1CL	4H	1N	40		-602	.0704	63
AMMONIA TRIBORANE	3B	10H	1N			-867	.0000	64
AMMONIA	3H	1N				-1004	.0244	65
AMMONIA (GASEOUS)*	3H	1N				-649		66
AMMONIATED ALUMINUM IODIDE	1AL	3I	9N	27H	-0	-676	.0000	67
AMMONIATED ALUMINUM IODIDE	1AL	3I	13N	39H	-0	-722	.0000	68
AMMONIATED ALUMINUM IODIDE	1AL	3I	20N	60H	-0	-782	.0000	69
AMMONIATED ALUMINUM IODIDE	1AL	3I	6N	18H	-0	-622	.0000	70
AMMONIATED ALUMINUM IODIDE	1AL	3I	1N	3H	-0	-282	.0000	71
AMMONIATED ALUMINUM IODIDE	1AL	3I	3N	9H	-0	-454	.0000	72
AMMONIATED ALUMINUM IODIDE	1AL	3I	5N	15H	-0	-592	.0000	73
AMMONIATED ALUMINUM IODIDE	1AL	3I	7N	21H	-0	-645	.0000	74
AMMONIATED BERYLLIUM IODIDE	1BE	2I	4N	12H	-0	-642	.0000	75
AMMONIATED BERYLLIUM IODIDE	1BE	2I	6N	18H	-0	-690	.0000	76
AMMONIATED BERYLLIUM IODIDE	1BE	2I	13N	39H	-0	-792	.0000	77
AMMONIATED CALCIUM IODIDE	1CA	2I	1N	3H	-0	-507	.0000	78
AMMONIATED CALCIUM IODIDE	1CA	2I	2N	6H	-0	-570	.0000	79
AMMONIATED CALCIUM IODIDE	1CA	2I	6N	13H	-0	-720	.0000	80
AMMONIATED CALCIUM IODIDE	1CA	2I	8N	24H	-0	-735	.0000	81
AMMONIATED COPPER NITRATE	1CU	4N	60	6H	-0	-630	.0000	82
AMMONIATED COPPER NITRATE	1CU	6N	60	12H	-0	-769	.0000	83
AMMONIATED COPPER NITRATE	1CU	8N	60	18H	-0	-822	.0000	84
AMMONIATED LITHIUM IODIDE	1LI	1I	1N	3H	-0	-608	.0000	85
AMMONIATED LITHIUM IODIDE	1LI	1I	2N	6H	-0	-691	.0000	86
AMMONIATED LITHIUM IODIDE	1LI	1I	3N	9H	-0	-751	.0000	87
AMMONIATED LITHIUM IODIDE	1LI	1I	4N	12H	-0	-799	.0000	88
AMMONIATED LITHIUM IODIDE	1LI	1I	5N	15H	-0	-825	.0000	89
AMMONIATED LITHIUM IODIDE	2LI	2I	11N	33H	-0	-417	.0000	90
AMMONIATED LITHIUM IODIDE	1LI	1I	7N	21H	-0	-857	.0000	91
AMMONIATED MAGNESIUM IODIDE	1MG	2I	2N	6H	-0	-500	.0000	92
AMMONIUM ALUMINUM PERCHLORATE	12H	3N	240	1AL	6CL	-514	.0756	93
AMMONIUM AZIDE	4H	4N				452	. 486	94
AMMONIUM AZIDE	4H	4N				452	.0486	95
AMMONIUM BOROFLUORIDE	4H	1B	1N	4F		-2860	.0668	96
AMMONIUM BROMIDE	4H	1N	1BR			-659	.0678	97
AMMONIUM CYANIDE	2N	4H	1C	-0	-0	0	.0000	98
AMMONIUM DICHROMATE*	8H	2N	70	2CR		-1688	.0776	99
AMMONIUM DICYANAMIDE	2C	4H	4N			121	.0000	100
AMMONIUM FLOURIDE	4H	1N	1F			-1287		101
AMMONIUM FORMATE	5H	1C	1N	20		-2108		102
AMMONIUM IODIDE	4H	1N	1I			-334		103
AMMONIUM PERIODATE	4H	1N	40	1I		-360	.1270	104
AMMONIUM PERCHLORATE	340H	3400	85N	85CL		-590	.0704	105
AMMONIUM SULPHATE	8H	2N	40	1S		-2133	.0643	106
AMYL FERROCENE	20H	15C	1FE			-61	.0422	107
ANILINE	7H	6C	1N			79	.0367	108
ARGON	1AR	-0			0	0	.0644	109
ASTROGELL	30H	15C	10	1AL		-436	.0540	110
AZO'BIS'ISOBUTYRONITRILE'2,2	8C	12H	4N			333	.0000	111
BARIUM CHROMATE	1CR	40				-1347		112
BARIUM NITRATE *	2N	60	1BA			-907	.1170	113
BARIUM PEROXIDE	1BA	20	-0	-0	-0	-689	.1791	114
BASIC LEAD CARBONATE	3PB	2C	80	2H		0		115
BENZENE	6H	6C				143	.0317	116
BERYLLIUM BOROHYDRIDE	2B	1BE	8H			-666	.0218	117
BERYLLIUM HYDRIDE	1BE	2H				-399	.0000	118
BERYLLIUM NITRIDE	3BE	2N	-0	-0	-0	-2464	.0000	119
BERYLLIUM (NON-REACTIVE)	1U2					0	.0668	120
BERYLLIUM (PURE CRYSTALINE)	1BE					0	.0668	121
BIS TRIAMINOGUANIDINIUMDECABOR	2C	28H	10B	12N		180	.0000	122
BISDIFLUOROAMINOHEPTANE	7C	14H	4F	2N		-320	.0426	123
BIS(DMETHYLHYDRAZINO)DECABORA	4C	26H	10B	6N		100	.0404	124
BIS(DIFLUOROAMINO)BUTANE'2,3	4C	8H	4F	2N		-353	.0437	125
BIS(DIFLUOROAMINO)DIFLUOROMETH	1C	6F	2N			-698	.0000	126
BIS(DIFLUOROAMINO)METHYLPENTAN	6C	12H	4F	2N		-309	.0000	127
BIS(DINITROFLUOROETHYL)FORMAL	5C	6H	2F	4N	100	-559	.0576	128

BIS(DINITROPROPYL)ACETAL BDNPA	8C	14H	4N	100		-470	.0465	129
BIS(DINITROPROPYL)FORMAL BDNPF	7C	12H	4N	100		-475	.0516	130
BIS(FLUOROXY)DIFLUOROMETHANE	1C	4F	20			-1122	.0000	131
BIS(TRINITROETHYL)NITRAMINE	4C	4H	8N	140		13	[illegible]	132
BIS(DIFLUOROAMINO)BUTANE'2,3	4C	8H	4F	2N		-348	.0438	133
BIS(DIFLUOROAMINO)METHYLPENTAN	6C	12H	4F	2N		-363	.0415	134
BIS(DIFLUOROAMINO)OCTANE'2,2	8C	16H	4F	2N		-347	.0397	135
BIS(DINITRO) FLUOROPROPANE	3C	5H	1F	2N	40	-530	.0000	136
BIS(DINITROPROPYL)ACETAL BDNPA	8C	14H	4N	100		-485	.0491	137
BIS(DINITROPROPYL)FORMAL BDNPF	7C	12H	4N	100		-457	.0511	138
BIS(FLUOROXY)DIFLUOROMETHANE	1C	4F	20			-1159	.0433	139
BIS(METHYLHYDRAZINO)DECABORANE	2C	24H	10B	4N		-470	.0000	140
BORINE AMMONIATE	1B	6H	1N			-1340	.0264	141
BORON (PURE CRYSTALINE)	1B					0	.0845	142
BORON (AMORPHOUS)	1B					37	.0856	143
BORON CARBIDE	4B	1C				-221	.0905	144
BORON NITRIDE	1B	1N				-2430	.0795	145
BORON SLURRY	553H	861B	252C	450	2AL	-425	.0536	146
BORON OXIDE	2B	30				-4339	.0656	147
BORON (TRONA)	67B	30				-359	.0845	148
BROMINE PENTAFLUORIDE	1BR	5F				-627	.0883	149
BROMINE PENTAFLUORIDE	1BR	5F				-586	.0000	150
BROMINE MONOFLUORIDE	1BR	F				-141	.0000	151
BROMINE TRIFLUORIDE	1BR	3F				-530	.1012	152
BROMINE TRIFLUORIDE	1BR	3F				-446	.0000	153
BTNEC	4H	5C	6N	150		-430	.0680	154
BTNEN	4H	4C	8N	140		39	.0704	155
BUTAREZ (PHILLIPS INFO)	519H	347C	80			-21	.0325	156
BUTANE(2,2-BISDIFLUOROAMINO)	4C	8H	4F	2N		-318	.0000	157
BUTANE(2,3-BISDIFLUOROAMINO)	4C	8H	4F	2N		-348	.0000	158
BUTAREZ (PHILLIPS INFO)	519H	347C	80			-21	.0325	159
BUTYL SILANE	12H	4C	1SI			357	.0000	160
BUTYLNITRAMINE (NORMAL)	4C	10H	2N	20		-264	.0365	161
BUTYL RUBBER	8H	4C				-376	.0332	162
CALCIUM BORIDE	519H	347C	80			-21	.0325	163
CALCIUM CARBIDE	2C	1CA				-234	.0801	164
CALCIUM CARBONATE (CACO3)	1C	30	1CA			-2895		165
CALCIUM CHLORIDE	2CL	1CA				-1710	.0775	166
CALCIUM FLUORIDE	2F	1CA				-3722	.1149	167
CALCIUM HYDRIDE	2H	1CA				-1092	.0614	168
CALCIUM NITRATE	1CA	2N	60	-0	-0	-1365	.0652	169
CALCIUM PEROXIDE	1CA	20	-0	-0	-0	-2185	.0000	170
CALCIUM OXIDE (CAO)	10	1CA				-2710		171
CANDELILLA WAX	2C	4H				-453	.0325	172
CANDELILLA WAX	2C	4H				-453	.0325	173
CARBON BLACK	1C					0	.0637	174
CARBON DIOXIDE	1C	20				-2137	.0398	175
CARBON DISULFIDE (WHEW)	1C	2S				276	.0456	176
CARBON MONOXIDE	1C	10				-943	.5721	177
CARBON (GRAPHITE)	1C					0	.0818	178
CARBON TETRACHLORIDE	1CA	4CL				-216		179
CELLULOSE	6C	10H	50			-1417	.0458	180
CELLULOSE ACETATE (2)	149H	109C	740			-1183	.0539	181
CELLULOSE ACETATE (CARBOPOL)	149H	109C	740			-1079	.0448	182
CELLULOSE DINITRATE	6C	8H	2N	90		-7144	.0599	183
CELLULOSE TRINITRATE	6C	7H	3N	110		-524	.0599	184
CELOGEN	2C	4H	20	4N		-1001		185
CERIUM	1CE	-0	-0	-0	-0	0	.2419	186
CERIUM NITRIDE	1CE	1N	-0	-0	-0	-508	.0000	187
CESIUM	1CS	-0	-0	-0	-0	0	.0676	188
CESIUM (PURE CRYSTALINE)	1CS					0	.0676	189
CESIUM AZIDE	1CS	3N				-12	.0000	190
CESIUM CARBONATE	1C	30	2CS			-821	.1521	191
CESIUM HYDRIDE	1CS	1H	-0	-0	-0	217	.1231	192
CESIUM PERCHLORATE	1CS	1CL	40	-0	-0	-447	.1201	193
CESIUM TUNGSTEN FLUORIDE	6F	1CS	1W			-1160	.1770	194

CHLORINE TRIFLUORIDE	1CL	3F					-480	.0652	195
CHLORINE	2CL						-76	.0536	196
CHLORINE HEPTOXIDE	2CL	70					300	.0000	197
CHLORINE MONOFLUORIDE	1CL	1F					-222	.0000	198
CHLORINE PENTAFLUORIDE (GAS)	1CL	5F					-427	.0000	199
CHLORINE PENTAFLUORIDE (CLF5)	1CL	5F					-464	.0642	200
CHLORINE TRIFLUORIDE	1CL	3F					-410	.0000	201
CHROMIUM	1CR	-0	-0	-0	-0		0	.2599	202
CIRCO LIGHT PROCESS OIL	32H	15C					-320	.0250	203
CIRCO LIGHT PROCESS OIL	32H	15C					-320	.0250	204
COPPER CHLORIDE	2CL	2CU					-328	.1270	205
COPPER OXIDE	10	2CU					-278	.2160	206
COPPER CHROMITE	30	1CU	1CR				0	.2150	207
COPPER HYDROXIDE	2H	20	1CU				-1099	.1216	208
COPPER OXIDE (HYDRATED)	2H	20	1CU				-1099	.1216	209
CUPRIC OXIDE	1CU	10					-439		210
COPPER (PURE CRYSTALINE)	1CU						0	.3223	211
CYANAMIDE	1C	2H	2N	-0	-0		219	.0000	212
CYANOGUANYL AZIDE	2C	2H	6N				881	.0000	213
CYANOGEN (GASEOUS)	2C	2N					1414		214
CYCLOHEXYL AZIDE	6C	11H	3N				207	.0356	215
CYCLOPENTYL AZIDE	5C	9H	3N				385	.0353	216
CYCLOTETRAMETHYLENE TETRA HMX	8H	4C	8N	80			61	.0666	217
DECADIBORANE	6H	2B					0	.0079	218
DECABORANE	10B	14H					-129	.0339	219
DEKADIAZENE	10B	22H	4N				-381	.0000	220
DIAMINO DIBORANE	2B	12H	2N				-745	.0000	221
DIAMINOGUANIDINE NITRATE	1C	8H	6N	30			-239	.0000	222
DIAMINOGUANIDINIUM AZIDE(DAZAL	2C	8H	8N				741	.0513	223
DIAMMONIUM DECABORANE	10B	16H	2N				-450	.0000	224
DIAZIDOTRINITRAZAHEPTANE DATH	4C	8H	12N	60			458	.0000	225
DIBORANE	2B	6H					354	.0000	226
DIBUTYL PHTHALATE	22H	16C	40				-733	.0378	227
DIBUTYL PHTHALATE	575C	790H	1440				-754	.0378	228
DIESEL OIL	22H	12C					-476	.0254	229
DIETHYL PHTHALATE	12C	14H	40				-733		230
DIETHYL TRIAMINE	13H	4C	3N				-149	.0344	231
DIETHYLENE GLYCOL DINITRATE	4C	8H	2N	70			-520	.0497	232
DIFLUOROAMINE	2F	1H	1N				-600	.0000	233
DIFLUOROMETHYLENEBISOXYFLUORID	1C	4F	20				-1121	.0433	234
DIBORANE	2B	6H					179	.0158	235
DIETHYL PHTHALATE	14H	12C	40				-832		236
DIETHYL PHTHALATE	14H	12C	40				-832		237
DIBUTYL PHTHALATE	12C	22H	40				-733		238
DICYANDIAMIDE	2C	4H	4N				85	.0505	239
DICYANO-2-BUTYNE-1,4	6C	4H	2N				841	.0415	240
DIHYDRONITRONITRIMINOPYRIDINE	5C	4H	4N	40			143	.0650	241
DI-N-PROPYL ADIPATE	12C	22H	40				-1184		242
DIMETHYL AMMON LITHIUM IODIDE	1LI	1I	4C	13H	1N		-477	.0000	243
DIMETHYL AMMON LITHIUM IODIDE	1LI	1I	6C	19H	1N		-473	.0000	244
DIMETHYL AMMON LITHIUM IODIDE	1LI	1I	10C	31H	1N		-463	.0000	245
DIMETHYLAMINE-BORANE ADDUCT	2C	10H	1B	1N			-516	.0000	246
DINITRO TOLUENE	6H	7C	2N	40			-6200		247
DINITROPHENOXY ETHANOL	98H	104C	26N	750			-271	.0565	248
DINITROPROPYL ACRYLATE	8H	6C	2N	60			-514	.0471	249
DIOCTYL ADIPATE	42H	22C	40				-733	.0332	250
DIOCTYL AZELATE	48H	25C	40				-855		251
DIOCTYL AZELATE	48H	25C	40				-855		252
DITRISDIFLUORCAMINOMETHYLUREA	3C	2H	12F	8N	10		-203	.0679	253
DODECAHYDRODECABORATEDIAMMINE	10B	18H	2N				-564	.0361	254
DULCITOL	6C	14H	60				-1740	.0530	255
DYNAMAR 732/740	970H	549C	11N	1430			-1420	.0376	256
DYNAMAR HX-730	754H	445C	2440				-1200	.0420	257
DYNAMAR HX-743	942H	554C	80N	810			-380	.0360	258
E107 (A MIXTURE)	441H	133C	52N	2320	6AL	49CL	-552	.0604	259
EPOXY 201	24H	16C	40				-661	.0404	260

EPON 828	24H	21C	40			0		261
ERYTHRITCL TETRANITRATE	4C	6H	4N	120		-395	.0000	262
ESTANE	987H	536C	12N	1400		-910	.0379	263
ESTANE 6	55H	302C	1N	100		-940	.0376	264
ETHANETHIOL	2C	6H	1S	-0	-0	-258	.0000	265
ETHANE(1,1-DINITRO)	2C	4H	2N	40		-289	.0000	266
ETHANE(1,1,1-TRINITRO)	2C	3H	3N	60		-166	.0552	267
ETHANE(1,2-BIS DIFLUOROAMINO)L	2C	4H	4F	2N		-356	.0000	268
ETHANE(1,2-BIS DIFLUOROAMINO)G	2C	4H	4F	2N		-310	.0000	269
ETHANE(1,2-DI TETRAZOLYL)	4C	6H	8N			639	.0000	270
ETHANOL	2C	6H	10	-0	-0	-1440	.0000	271
ETHYL CENTRALITE	17C	20H	2N	10		-127		272
ETHYLENE	2C	4H				289	.0205	273
ETHYLENE CARBONATE	3C	4H	30			-1576	.0000	274
ETHYLENE DIHYDRAZINE	12H	2C	4N			346	.0396	275
ETHYLENE DINITRAMINE (EDNA)	2C	6H	4N	40		-158	.0632	276
ETHYLENEBIS(AMINOGUANIDINEAZID	5C	16H	14N			496	.0000	277
FAPETRIN	6C	8H	6F	6N	100	-318	.0000	278
FAPETRIN	6C	8H	6F	6N	100	-268	.0000	279
FERRIC OXIDE (ANHYDROUS)*	30	2FE				-1230	.1818	280
FERRIC OXIDE HEMATITE	2FE	30				-1235	.1848	281
FLOROX (CLF30)	10	3F	1CL			-371	.0666	282
FLUORINE	2F					-82	.0543	283
FLUORINE NITRATE	1F	1N	30			31	.0000	284
FLUORINE (LIQUID)	2F					-76	.0543	285
FLUORO"2,2"DINITROETHANOL"2	2C	3H	1F	2N	50	-741	.0000	286
FLUOROETHANE(1,1-DINITRO-1-)	2C	3H	1F	2N	40	-468	.0000	287
FLUOROTRINITROMETHIDE	1C	1F	3N	60		-221	.0573	288
FLUOROXYTRIFLUOROMETHANE	1C	4F	10			-1769	.0000	289
FORMAMIDE	3H	1C	1N	10		-1370	.0410	290
FREON 116 (ROGERS)	2C	6F				-2195		291
GASOLINE (LIQUID)	46H	21C				-794	.0257	292
GENPOL A-20	75H	555C	3700			-1110		293
GILSINITE	866H	744C	6N	6S		-400	.0364	294
GLUTAMIC ACID	5C	9H	40	1N		-1610	.0555	295
GUANIDINE	5H	1C	3N	-0	-0	-288	.0000	296
GUANADINE CARBONATE	3C	10H	30	6N		-1290		297
GUANIDINE NITRATE	6H	1C	4N	30		-843	.0503	298
GUANIDINIUMNITRAMINOTETRAZLAT	2C	7H	9N	20		141	.0000	299
GUANYLAZIDE NITRATE	1C	4H	6N	30		26	.0000	300
H C BINDER (PAUL)	106H	71C	8N			-102		301
HEPTADYNE	8H	7C				-1127	.0293	302
HEXANE	14H	6C				-464	.0235	303
HEXACYANO"3"HEXENE	12C	6H	6N			862	.0444	304
HEXACYANO"3"HEXYNE	12C	4H	6N			1045	.0437	305
HEXACYANO"3,5"OCTADIYNE	14C	4H	6N			1146	.0466	306
HEXAKIS DIFLUOROAMINO DIPROPYL	8H	12F	6N	10	6C	-315	.0596	307
HEXANE (2,2,5 TRIMETHYL)	20H	9C				-537	.0246	308
HEXANITROETHANE (HNE)	2C	6N	120			95	.0812	309
HMX	4C	8H	8N	80		61	.0686	310
HTPB (SINCLAIR)	103H	73C	10			13	.0332	311
HYCAR	139H	70C	10			-121	.0339	312
HYDRATED AMMONIUM PHOSPHATE	3N	18H	70	1P		-3010		313
HYDROXYETHYL CELLULOSE	35H	22C	140			-1200	.0464	314
HYDROXYL AMMONIUM NITRATE(NBS)	2N	3H	40			-908		315
HYDROXYLAMMONIUMPERCHLORATE	1CL	4H	1N	50		-497	.0767	316
HYDRAZINE NITRATE	5H	3N	30			-531	.0595	317
HYDROXYL AMMONIUM NITRATE(NBS)	2N	3H	40			-908		318
HYDRAZINE	4H	2N				376	.0364	319
HYDRAZINE AZIDE	5H	5N				727	.0470	320
HYDRAZINE CYANOFORMATE	4C	5H	5N			579	.0462	321
HYDRAZINE DIBORANE	2B	10H	2N			-500	.0339	322
HYDRAZINE HYDRATE (N2H4.H20)	6H	2N	10			-2900	.0378	323
HYDRAZINE NITROFORM	5H	1C	5N	60		-95	.0676	324
HYDRAZINE(1,1-METHYLCYANOETHY	4C	9H	3N			339	.0353	325
HYDRAZINE(2)BORANE(8)COMPOUND	8B	28H	4N			-60	.0000	326

HYDRAZINE(3)BORANE(10)COMPOUND	10B	24H	6N			-108	.0000	327
HYDRAZINE(4)BORANE(10)COMPOUND	10B	26H	8N			-92	.0000	328
HYDRAZINE DIPERCHLORATE	6H	2N	8O	2CL		-309	.0797	329
HYDRAZINIUM DIPERCHLORATE	2CL	6H	2N	8O		-296	.0361	330
HYDRAZINIUM NITROFORMATE (HNF)	1C	5H	5N	6O		-94	.0671	331
HYDRAZINIUM PERCHLORATE	1CL	5H	2N	4O		-320	.0700	332
HYDRAZOBISISOBUTYRONITRILE	8C	14H	4N			172	.0000	333
HYDRAZOIC ACID (GASEOUS)	1H	3N				1635		334
HYDRAZOTETRAZOLE"5,5	2C	4H	10N			804	.0010	335
HYDROCARBON POLYMER	2H	1C				-339	.0332	336
HYDROGEN (GASEOUS)	2H					0		337
HYDROGEN AZIDE	1H	3N				1460	.0394	338
HYDROGEN AZIDE	1H	3N				1430	.0000	339
HYDROGEN CYANIDE (GASEOUS)	1H	1C	1N			932	.0248	340
HYDROGEN CYANIDE (LIQUID)	1H	1C	1N			1154	.0325	341
HYDROGEN FLUORIDE	1H	1F				-3581	.0357	342
HYDROGEN FREE RADICAL	1H					52090		343
HYDROGEN PEROXIDE (100 PC)	2H	2O				-1319	.0508	344
HYDROGEN PEROXIDE (50 PC)	850H	572O				-1927	.0430	345
HYDROGEN PEROXIDE (70 PC)	746H	579O				-1684	.0464	346
HYDROGEN PEROXIDE (90 PC)	642H	5[illegible]60				-1439	.0501	347
HYDROGEN PEROXIDE (GASEOUS)	2H	2O				-958	.0000	348
HYDROGEN SULFIDE	2H	1S				-141	.0768	349
HYDROGEN (CRYOGENIC)	2H					-1068	.0026	350
HYDROXYETHYL METHACRYLATE	10H	6C	3O			-1260	.0420	351
HYDROXYL RADICAL	1H	1O	-0	-0	-0	591	.0000	352
HYDROXYLAMINE	3H	1N	1O			-793	.0000	353
HYDROXYETHYL CELLULOSE	35H	22C	14O			-1200	.0464	354
HYDROXYTERMINAT POLYBUTADIENE	103H	73C	1O			13	.0332	355
HYCAT (BENNETT)	36H	29C	2FE			40	.0441	356
HYCAT (BENNETT)	36H	29C	2FE			40	.0441	357
IDP (B. LEE)	38H	19C	2O			-908	.0312	358
IODIC ACID	1H	1I	3O	-0	-0	-324	.1671	359
IODINE	2I	-0	-0	-0	-0	0	.1760	360
IODINE PENTAFLUORIDE	5F	1I				-928	.1140	361
IODINE PENTOXIDE	5O	2I				-127	.1732	362
IODINE TRICHLORIDE	1I	3CL	-0	-0	-0	-90	.1125	363
IODOFORM (CHI3)	1H	1C	3I			-85	.1443	364
IRON OXIDE	3O	2FE				-1230	.1840	365
IRON OXIDE (YELLOW)	2H	4O	2FE			-1490	.1318	366
IRON	1FE					0	.2837	367
ISO OCTANE	16H	8C				-470		368
JP4 (LIQUID TURBOJET FUEL)	17H	9C				-281	.0254	369
JP5 (MONT STEVENS STANDARD)	19H	10C				-387	.0296	370
KRATON	4H	3C				-1073	.0340	371
KRATON STYRENE BUTADIENE	4H	3C				-1073	.0340	372
KRATON (CO-POLYMER)	6H	4C				-100	.0342	373
LAMINAC 4116	555H	558C	171O			-574		374
LEAD ACETYL SALICYLATE	14H	18C	8O	1PB		-857		375
LEAD OXIDE (MINIUM)	4O	3PB				-262	.3286	376
LEAD BETA RECORCYLATE	21H	7C	7O	1PB		0		377
LEAD OXIDE	1PB	1O				-235		378
LEAD IODATE	1PB	2I	6O			-267	.1913	379
LEAD SALICYLATE	10H	14C	6O	1PB		-84	.0337	380
LEAD 2-ETHYL HEXOATE	34H	16C	4O	1PB		0		381
LEAD 2-ETHYL HEXOATE	34H	16C	4O	1PB		0		382
LEAD AZIDE	6N	1PB				397	.0000	383
LEAD IODATE	1PB	2I	6O			-267	.1913	384
LEAD OXIDE (LITHARGE)	1O	1PB				-235	.3440	385
LEAD OXIDE (MASSICOT)	1O	1PB				-235	.2888	386
LEAD DIOXIDE	2O	1PB				-276	.3384	387
LEAD SALICYLATE	10H	14C	6O	1PB		-84	.0337	388
LEAD OXIDE (PLATTNERITE)	2O	1PB				-66	.3384	389
LITHIUM ALUMINUM HEXA HYDRIDE	1AL	6H	3LI			-1417	.0401	390
LITHIUM ALUMINUM PERCHLORATE	3LI	24O	1AL	6CL		-645	.0897	391
LITHIUM ALUMINUM TETRA HYDRIDE	1AL	4H	1LI			-690	.0331	392

LITHIUM AMIDE*	2H	1LI	1N			-1894	.0329	393
LITHIUM AZIDE	1LI	3N				57	.0000	394
LITHIUM BERYLLIUM HYDRIDE	1BE	4H	2LI			-2968	.0000	395
LITHIUM BOROHYDRIDE	1B	4H	1LI			-2131	.0246	396
LITHIUM CARBIDE	2LI	2C	-0	-0	-0	-375	.0596	397
LITHIUM CARBONATE	2LI	1C	30			-3900	.0762	398
LITHIUM DICYANAMIDE	2C	1LI	3N			-120	.0000	399
LITHIUM FLUORIDE	1LI	1F				-5620	.0939	400
LITHIUM HYDRIDE	1H	1LI				-2726	.0296	401
LITHIUM HYDROXIDE	1H	1LI	10			-4868	.0917	402
LITHIUM NITRATE	1LI	1N	30			-1670	.0659	403
LITHIUM NITRIDE	3LI	1N				-1355	.0498	404
LITHIUM PERCHLORATE (LICLO4)	1CL	1LI	40			-854	.0877	405
LITHIUM PERIODATE	1LI	40	1I			-490	.1520	406
LITHIUM (PURE CRYSTALINE)	1LI					0	.0193	407
LP-33	314C	655H	1070	121S		-696	.0458	408
LP-205	416C	846H	850	87S		-720	.0408	409
MAGNESIUM (PURE CRYSTALINE)	1MG					0	.0628	410
MAGNESIUM ALUMINUM HYDRIDE	2AL	8H	1MG			-365	.0378	411
MAGNESIUM BORIDE	2B	1MG				-478	.0970	412
MAGNESIUM CYANAMIDE	1MG	1C	2N	-0	-0	-937	.0000	413
MAGNESIUM FLUORIDE	2F	1MG				-2862	.1063	414
MAGNESIUM HYDRIDE	2H	1MG				-645	.0524	415
MAGNESIUM NITRATE	1MG	2N	60	-0	-0	-1272	.0731	416
MAGNESIUM OXIDE	10	1MG				-3610	.1300	417
MAGNESIUM PERCHLORATE	80	1MG	2CL			-630	.0939	418
MAGNESIUM (NON-REACTIVE)	1U3					0	.0628	419
MAGNESIUM OXIDE	248MG2480					-3567	.1292	420
MAPO (ARC)	18H	9C	10	3N	1P	-266		421
N-BUTYL FERROCENE	18H	14C	1FE			10	.0430	422
MERCURIC FLUORIDE	2F	1HG				-398	.3216	423
MERCURIC OXIDE	10	1HG				-100	.4023	424
MERCUROUS AZIDE	2HG	6N				292	.0000	425
MERCURY (LIQUID)	1HG					0	.4873	426
METHANE	1C	4H				-1271	.0153	427
METHANE*	4H	1C				-1118		428
METHANOL	4H	1C	10			-1780	.0267	429
METHOXYAMINE	1C	5H	1N	10		-276	.0000	430
METHYL ACRYLATE (LIQ.) -HC-	6H	4C	20			-954	.0364	431
METHYL ALCOHOL	4H	1C	10			-1781	.0285	432
METHYL AMMONIA	5H	1C	1N			-216	.0236	433
METHYLNITROACETATE	3C	5H	1N	40		-922	.0000	434
MIXED HYDRAZINE FUEL 3	647H	93C	231N			297	.0323	435
MIXED OXIDES OF NITROGEN	63N	1010				43	.0520	436
MIXED HYDRAZINE FUEL 5	114H	12C	46N	60		149	.0361	437
MIXED HYDRAZINE FUEL 3	647H	93C	231N			297	.0323	438
MON 25"75	175N3250					69	.0498	439
MONOBASIC AMMONIUM PHOSPHATE	1N	6H	1P	40		-3020	.0651	440
MONOBASIC CUPRIC SALICYLATE	14C	10H	70	2CU		-700		441
MONOBASIC CUPRIC RESORCYLATE	14C	10H	90	2CU		-2782		442
MONOBASIC LEAD RESORCYLATE	14C	10H	90	2PB		-1900		443
MONOBASIC LEAD SALICYLAT	14C	10H	90	2PB		-332		444
MONOMETHYL HYDRAZINE (MMH)	6H	1C	2N			276	.0316	445
N P AMINE	7H	6C	1N			-1287	.0329	446
NF4BF4	1B	1N	8F			-1640	.0853	447
NICKEL	1NI					0	.3215	448
NICKEL OXIDE	10	1NI				-773		449
NICKEL CARBIDE	3NI	1C	-0	-0	-0	58	.2872	450
NICKEL CHLORIDE	2CL	1NI				-580	.126[illegible]	451
NITROGEN	2N					-104	.0292	452
NITROGEN TETROXIDE (N2O4) LIQ	2N	40				0	.0517	453
NITROUS OXIDE	2N	10	-0	-0	-0	447	.0714	454
NITROCELLULOSE (12.6PERCENT N)	755H	600C	245N	9900		-617	.0560	455
NITROGLYCERIN	3C	5H	3N	90		-400	.0578	456
NITRATE	5H	3N	30			-932		457
NITRIC ACID (GAS)	1H	1N	30			-509	.0000	458

NITROAMINOGUANIDINE	1C	5H	5N	2O		45	.0000	459
NITROETHANE	2C	5H	1N	2O		-442	.0376	460
NITROGEN PENTOXIDE	2N	5O	-0	-0	-0	-93	.0593	461
NITROGEN TETROXIDE (GASEOUS)	2N	4O				24	.0000	462
NITROGEN TRIFLUORIDE	3F	1N				-416	.0000	463
NITROGEN TRIFLUORIDE	3F	1N				-460	.0562	464
NITROGUANYL AZIDE	1C	2H	6N	2O		548	.0000	465
NITROMETHANE	1C	3H	1N	2O		-443	.0000	466
NITRONITRAMINOPYRIDINIUMCLO4	5C	5H	1CL	4N	8O	7	.0650	467
NITRONIUM ALUMINUM PERCHLORAT	1AL	6CL	3N	30O		-160	.0000	468
NITRONIUM PERCHLORATE	1CL	1N	6O			61	.0794	469
NITROPROPENE POLYMER	3C	5H	1N	2O		-353	.0000	470
NITROSOAMINE(N,N-DIMETHYL)	2C	6H	2N	1O		16	.0036	471
NITROSOL BINDER	143H	105C	40N	164O		-476	.0515	472
NITROSYL FLUORIDE	1F	1N	1O			-324	.0000	473
NITROSYL PERCHLORATE	1CL	1N	5O			-284	.0763	474
NITROSYL TETRAFLUOROCHLORATE	1CL	4F	1N	1O		-489	.1029	475
NITROUREA	1C	3H	3N	3O		-611	.0000	476
NITRYL FLUORIDE	1F	1N	2O			-290	.0000	477
NITRYLTETRAFLUOROCHLORATE	1CL	4F	1N	2O		-305	.0000	478
NITRIC ACID (LIQ)	1H	1N	3O			-658	.0542	479
NITROGUANIDINE	1C	4H	4N	2O		-209	.0000	480
N-AMYL ALCOHOL	5C	12H	1O			-922	+509	481
N-AMYL ALCOHOL	5C	12H	1O			-922	.0509	482
N-PHENYLMORPHOLINE	13H	10C	1N	1O		-123	.0409	483
NORMAL HEPTANE	16H	7C				-449		484
N,N-DINITRO-N-BUTYLAMINE (DNBA	4C	9H	3N	4O		-13	.0433	485
O2/H2 (O/F =10.0058)	889H	594O				0		486
O2/H2 (O/F =10.6058)	889H	594O				0		487
OCTANE	18H	8C				-470		488
OLEIC ACID (VEGETABLE OIL)-HC-	34H	18C	2O			-723	.0323	489
OTTO FUEL 2	999H	430C	2N	503O		-696		490
OXAMID (B. LEE)	4H	2C	2N	2O		-1376	.0602	491
OXYCHLORINE TRIFLUORIDE	1O	3F	1CL			-371	.0686	492
OXYCHLORINE TRIFLUORIDE	1O	3F	1CL			-360	.0669	493
OXYGEN (GAS)	2O					0		494
OXYGEN DIFLUORIDE	2F	1O				-155	.0549	495
OXYGEN DIFLUORIDE	2F	1O				-61	.0000	496
OXYGEN (LIQUID)	2O					-97	.0412	497
OZONE	3O					631	.0523	498
PENTABORANE (GASEOUS)	5B	9H				237	.0231	499
PENTABORANE (LIQUID)	5B	9H				122	.0000	500
PENTAERITHRITOL	5C	12H	4O			-1609	.0523	501
PENTAERYTHRITOL TETRANITRATE	5C	8H	4N	12O		-401	.0640	502
PENTAKIS(HYDRAZINE)DECABORANE	10B	34H	10N			40	.0000	503
PERCHLORIC ACID (ANHYDROUS)	1CL	1H	4O			-110	.0639	504
PERCHLORYL FLUORIDE (CLO3F)	1CL	1F	3O			-50	.0000	505
PERFLUORO METHACRYLATE	6H	8C	2O	8F		-1300	.0650	506
PERFLUOROFORMAMIDINE (PFF)	1C	4F	2N			-290	.0000	507
PERFLUOROGUANIDINE (PFG) (LIQ)	1C	5F	3N			127	.0000	508
PERFLUOROGUANIDINE (PFG) (GAS)	1C	5F	3N			162	.0000	509
PERFLUOROPIPERIDINE	5C	11F	1N			-1729	.0625	510
PERFLUOROPIPERIDINE	5C	11F	1N			-1703	.0000	511
PETRIN	9H	5C	3N	10O		-513	.0557	512
PETRIN	9H	5C	3N	10O		-513	.0557	513
PHENOXY	98H	104C	26N	75O		271	.0565	514
PHENYL AZIDE	6C	5H	3N			694	.0393	515
PHOSPHORUS (RED)	1P					-136	.0794	516
PLASTISOL NITROCELLULOSE	755H	600C	245N	990O		-586	.0599	517
PLEXIGLASS	8H	5C	2O			-906	.0426	518
PNC	755H	600C	245N	990O		-586	.0599	519
POLYMETHYL VINYLTETRAZOLE	6H	4C	4N			470	.0462	520
POLYPROPYLEN GLYCOL	12H	6C	2O			-655		521
POLYETHYLENE	2C	4H				-453	.0325	522
POLYURETHANE BINDER	987H	536C	12N	140O		-910	.0379	523
POLYACRYLAMIDE	3C	5H	1N	1O		-1590	.0000	524

POLYACRYLONITRILE	3H	3C	1N			74	.0398	525
POLYAMINE COMPOSITE	30C	105H	25N			-316	.0342	526
POLYBUTADIENE (SEE BUTAREZ)	6H	4C				55	.0364	527
POLYBUTADIENE ACR A (THIOKOL)	999H	671C	19N	160		-160	.0330	528
POLYTETRAFLUOROETHYLENE	2C	4F				-1952	.0834	529
POLYETHYLENEHYDRAZINE (PEH)	2C	6H	2N			4	.0000	530
POLYPROPYLEN GLYCOL	12H	6C	20			-855		531
POLYBUTADIENE ACRYLIC ACID	104H	70C	40			-84	.0337	532
POTASSIUM PERCHLORATE (KCLO4)	1CL	1K	40			-742	.0910	533
POTASSIUM PERCHLORATE (KCLO4)	1CL	1K	40			-742	.0910	534
POTASSIUM IODATE	30	1K	1I			-568	.1405	535
POTASSIUM SULFATE	40	1S	2K			-1966	.0962	536
POTASSIUM	1K					0	.0500	537
POTASSIUM AMALGAM	1K	1HG	-0	-0	-0	-48	.0000	538
POTASSIUM AZIDE	1K	3N				-5	.0736	539
POTASSIUM CARBONATE	1C	30	2K			-1495	.0877	540
POTASSIUM CHLORIDE	1CL	1K				-1397	.0717	541
POTASSIUM FERRICYNANIDE	3K	1FE	6C	6N	-0	-126	.0684	542
POTASSIUM HYDRIDE	1K	1H	-0	-0	-0	-339	.0516	543
POTASSIUM NITRATE	1N	30	1K			-1167	.0767	544
POTASSIUM IODATE (KIO3)	1K	1I	30			-568	.1405	545
POTASSIUM PEROXIDE	2K	20	-0	-0	-0	-1071	.0000	546
POTASSIUM SULFATE	40	1S	2K			-1966	.0962	547
POTASSIUM SULFIDE	2K	1S	-0	-0	-0	-907	.0652	548
PROPANE	8H	3C				-591		549
PROPYL NITRATE	7C	3C	1N	30		-514	4.298	550
PROPANE(1,1-DINITRO) (LIQUID)	3C	6H	2N	40		-297	.0455	551
PROPANE(1,1-DINITRO) (GASEOUS)	3C	6H	2N	40		-166	.0000	552
PROPANE(1,1,1-TRINITRO)	3C	5H	3N	60		-157	.0000	553
PROPANE(1,1,1,3-TETRANITRO)	3C	4H	4N	80		-172	.0000	554
PROPANE(1,2-BIS DIFLUOROAMINO)	3C	6H	4F	2N		-349	.0000	555
PROPANE(1,2-BIS DIFLUOROAMINO)	3C	6H	4F	2N		-294	.0000	556
PROPANE(1,3-DINITRO)	3C	6H	2N	40		-399	.0469	557
PROPANE(2-NITRO)	3C	7H	1N	20		-491	.0355	558
PROPANE(2,2-DINITRO)	3C	6H	2N	40		-338	.0469	559
PROPYLENE POLY GLYCOL DIACRYL	102H	54C	190			-1000	.0379	560
PROPANE(1-NITRO)	3C	7H	1N	20		-448	.0353	561
P-QUINONEDIOXIME	434C	434H	1450	145N		-700	.0505	562
RDX(HEXAHYDROTRINITROTRIAZINE)	3C	6H	6N	60		66	.0656	563
RED FUMING NITRIC ACID (14NO2)	151H	165N	4710			-654	.0567	564
RED FUMING NITRIC ACID (20NO2)	85H	114N	3140			-544	.0567	565
RED FUMING NITRIC ACID (14NO2)	151H	165N	4710			-654	.0567	566
RP-1	2H	1C				-1340	.0269	567
RESORCINOL	6H	6C	20			-764	.0463	568
RUBIDIUM	1RB	-0	-0	-0	-0	0	.0553	569
SEA WATER	998H	4990	3NA	1MG	5CL	-3792	.0361	570
SILICON DIOXIDE (PURE MOJAVE)	20	1SI				-3418	.0759	571
SILICON TETRACHLORIDE	1SI	4CL	-0	-0	-0	-901	.0535	572
SILICON (PURE CRYSTALINE)	1SI					0	.0874	573
SILVER IODATE	30	1I	1AG			-149	.2010	574
SILVER IODATE	30	1I	1AG			-149	.2010	575
SILVER METAL	1AG					0	.3791	576
SILVER NITRATE	1AG	1N	30	-0	-0	-173	.1571	577
"S-06"	308C	624H	2950			-1145	.0523	578
"S-02"	141C	704H	3520	141N		-1397	.0542	579
SODIUM ALUMINUM AMIDE	1AL	8H	4N	1NA		-1520	.0000	580
SODIUM AZIDE	3N	1NA				60	.0668	581
SODIUM BARBITURATE	3H	4C	2N	30	1NA	-1393	.0793	582
SODIUM BOROHYDRIDE	1B	4H	1NA			-1206	.0390	583
SODIUM CARBONATE	1C	30	2NA			-821	.0914	584
SODIUM CHLORATE	1NA	1CL	30	-0	-0	-805	.0899	585
SODIUM CHLORIDE	1NA	1CL				-1672	.0782	586
SODIUM FLUORIDE	1F	1NA				-3245	.1008	587
SODIUM HYDRIDE	1NA	1H	-0	-0	-0	-571	.0504	588
SODIUM IODATE (AW - DHSKIO3)	NA1	1I	03			-535	.1544	589
SODIUM PERCHLORATE	40	1NA	1CL			-750		590

SODIUM PEROXIDE	2NA	2O	-0	-0	-0	-1546	.1011	591
SODIUM POTASSIUM LIQ ALLOY	3K	1NA	-0	-0	-0	-43	.0000	592
SODIUM THIOCYANATE	1NA	1C	1N	1S	-0	-515	.0000	593
SODIUM (PURE CRYSTALINE)	1NA					0	.0350	594
SPAN 85	30H	15C	1O			-685	.0540	595
STYRENE	8H	8C				80	.0368	596
SUCCINIC ACID	4C	6H	4O			-1900	.0567	597
SULFUR	1S					0	.0747	598
SULFUR DIOXIDE	1S	2O	-0	-0	-0	-1108	.1057	599
SULFUR TRIOXIDE	1S	3O	-0	-0	-0	-1307	.0993	600
SULFUR (MONOCLINIC)	1S	-0	-0	-0	-0	2	.0706	601
SULFURIC ACID	2H	1S	4O	-0	-0	-1977	.0662	602
SULPHUR	1S					0	.0730	603
TETRAHYDRONAPHTHALENE	12H	10C				-13	.0354	604
TETRACYANOCYCLOPROPANE1,1,2,2	7C	2H	4N			1007	.0495	605
TETRACYANOETHYLENE	6C	4H				1174	.0469	606
TETRAETHYLPENTAMINEPERCHLORATE	28H	8C	5N	20O	5CL	-545	.0470	607
TETRAETHYL LEAD	20H	8C	1PB			161	.0599	608
TETRAFLUOROHYDRAZINE (N2F4)	4F	2N				-19	.0000	609
TETRAKIS AMLY ACRYLATE (TAA)	9C	10H	8F	4N	2O	-396	.0530	610
TETRAKIS DIFLUOROAMINOMETHANE	1C	8F	4N			19	.0631	611
TETRAKIS DIFLUOROAMINOMETHANE	1C	8F	4N			12	.0000	612
TETRAKIS(DIFLUOROAMINO) (THF)	4C	4H	8F	4N	1O	-266	.0579	613
TETRAKIS(HYDRAZINE)DECABORANE	10B	30H	8N			-10	.0000	614
TETRAMETHYL LEAD	12H	4C	1PB			202	.0721	615
TETRAMETHYLAMINOTRIBOROHYDRIDE	4C	20H	3B	1N		-293	.0000	616
TETRAMETHYLTRICYCLODECYLENEDIA	14C	26H	2N			-145	.0352	617
TETRANITRODIFLUOROETHANE	2C	2F	4N	8O		-368	.0000	618
TETRANITROMETHANE	1C	4N	8O			45	.0593	619
TETRANITROETHYLENEDIAMINE	2C	4H	6N	8O		195	.0632	620
TETRANITROMETHANE	1C	4N	8O			45	.0592	621
TETRAZOLE	1C	2H	4N			809	.0000	622
TETRAZOLE(2-METHYL-5-AMINO)	2C	5H	5N			502	.0000	623
TETRAZOLE(5-AMINO)	1C	3H	5N			565	.0596	624
TETRAZOLE(5-CYANO)	2C	1H	5N			1010	.0000	625
TETRAZOLE(5-HYDROXY)	1C	2H	4N	1O		-17	.0000	626
TETRAZOLE(5,5-HYDRAZO)	2C	4H	10N			809	.0000	627
THORIUM	1TH	-0	-0	-0	-0	0	.4043	628
TIN (GREY)	1SN					0	.2076	629
TITANIUM DIOXIDE	1TI	2O				-2551		630
TITANIUM	1TI	-0	-0	-0	-0	0	.1624	631
TITANIUM BORIDE	2B	1TI				-1000	.1626	632
TITANIUM DIBORIDE	2B	1TI				-973	.1625	633
TMETN	5C	9H	3N	9O		-415	.0537	634
TMETN	5C	9H	3N	9O		-415	.0537	635
TOLUENE DIRSOCYANATE	6H	9C	2N	2O		-855		636
TOLUENE DIAMINE	13H	7C	2N			-16	.0449	637
TOLUENE DIRSOCYANATE	6H	9C	2N	2O		-855		638
TRIACETIN	14H	9C	6O			-1334	.0419	639
TRIACETIN	14H	9C	6O			-1334	.0419	640
TRIAMINOGUANIDINE	9H	1C	6N			553	.0564	641
TRIAMINOGUANIDINE NITRATE TAGN	1C	9H	7N	3O		-69	.0555	642
TRIAMINOGUANIDINE (TAG)	1C	8H	6N			553	.0563	643
TRIAMINOGUANIDINECYANOFORMATE	5C	9H	9N			603	.0516	644
TRIAMINOGUANIDINEDICYANAMIDE	3C	9H	9N			591	.0505	645
TRIAMINOGUANIDINIUM AZIDE (TAZ)	1C	9H	9N			718	.0520	646
TRIAMINOGUANIDINIUM TRIBOROHYD	1C	17H	3B	6N		329	.0000	647
TRIAMINOGUANIDINIUM NONABOROHYD	1C	23H	9B	6N		131	.0000	648
TRIAMINOGUANIDINIUM DECABOROHYD	1C	26H	10B	8N		120	.0000	649
TRIAMINOMELAMINE	9H	3C	9N			550	.0589	650
TRIAZOETHANOL-2	2C	5H	3N	1O		258	.0415	651
TRICALCIUM PHOSPHATE	8O	3CA	2P			-3156		652
TRICYANO-3-BUTENE-1,1,1	7C	5H	3N			846	.0433	653
TRICYANO-3-BUTYNE-1,1,1	7C	3H	3N			1128	.0433	654
TRICYANOETHANE-1,1,1	5C	3H	3N			807	.0430	655
TRICYANOETHYLENE	5C	1H	3N			1019	.0433	656

TRICYANOTRIAZINE"S	6C	6N				1006	.0502	657
TRICYCLODECYLINEDIAMINE	10C	18H	2N			-173	.0390	656
TRIETHYLAMINE	15H	6C	1N			-667		659
TRIETHYLENEGLYCOLDINITRATE	12H	6C	2N	8O		-645	.0457	660
TRIFLUOROAMINE OXIDE	3F	1N	1O			-413	.0000	661
TRIFLUOROMETHYL HYPOFLUORITE	1C	4F	1O			-1733	.0000	662
TRIMETHYLAMINEBORANE	3C	12H	1B	1N		-468	.0296	663
TRIMETHYLENE ALANE	3C	12H	1AL	1N		-285	.0000	664
TRIMETHYLOLETHANETRINITRATE	9H	5C	3N	9O		-397	.0557	665
TRANS-DIMETHYL-AZOTETRAZOLE	4C	6H	10N			975	.0000	666
TRINITRO"3"HYDROXYBUTANOL	4C	7H	3N	8O		-373	.0000	667
TRINITROETHYL NITRATE (TNEN)	2C	2H	4N	9O		-138	.0596	668
TRINITROHYDROXYBUTYRICACID	4C	5H	3N	9O		-678	.0000	669
TRINITROMETHANE (NITROFORM)	1C	1H	3N	6O		-61	.0576	670
TRISDIFLUOROAMINOFLUOROMETHANE	1C	7F	3N			-281	.0563	671
TRIS(AMMONIA)DECABORANE(14)	10B	23H	3N			-530	.0000	672
TRIS(DIFLUOROAMINO)BUTANE	4C	7H	6F	3N		-273	.0433	673
TRIS(DIFLUOROAMINO)FLUOROMETHA	1C	7F	3N			-249	.0000	674
TRIS(DIFLUOROAMINO)PROPANE	14H	9C	6N	3O	12F	-411	.0556	675
TUNGSTEN (PURE CRYSTALINE)	1W					0	.6969	676
TUNGSTEN OXIDE	1W	3O				-831		677
TURPENTINE	16H	10C				-118	.0296	678
UNSYM-DIFLUOROUREA (UDFU)	1C	2H	2F	2N	1O	-705	.0000	679
UNSYM-DIMETHYLHYDRAZINE (UDMH)	2C	8H	2N			198	.0283	680
URANIUM	1U	-0	-0	-0	-0	0	.6751	681
URANIUM ALUMINUM (ALLOY)	2AL	1U				-76	.2939	682
URANIUM ALUMINUM (ALLOY)	3AL	1U				-105	.2461	683
URANIUM ALUMINUM (ALLOY)	4AL	1U				-129	.2163	684
UREA OXALATE	4C	10H	6O	4N		-1740		685
UREA	1C	4H	1O	2N		-1326	.0462	686
VANADIUM OXIDE	5O	2V				-2488		687
VITONA	10C	7H	13F			-1801	.0650	688
VITEL 207 (LEE)	35H	28C	10O			-729	.2240	689
VITON-TEFLON (1/3 MIXTURE)	22H	100C	176F			-1895	.0730	690
WATER	2H	1O				-3792	.0361	691
YELLOW IRON OXIDE	2H	4O	2FE			0		692
ZIRCONIUM	1ZR					0	.2311	693
ZIRCONIUM BORIDE	2B	1ZR				-654	.2199	694
ZIRCONIUM CARBIDE	1ZR	1C	-0	-0	-0	-436	.2430	695
ZIRCONIUM DIBORIDE	2B	1ZR				-680	.2200	696
ZIRCONIUM HYDRIDE	2H	1ZR				-444	.2024	697
						0		698
SUPPLEMENTARY LIST. CAUTION.						0		699
						0		700
"S-02"	141C	734H	352O	141N		-2397	.0542	701
"S-06"	360C	684H	295O			-1145	.0523	702
ALUMINUM OXIDE	2AL	3O				-4000	.0670	703
AMMONIUM SULFATE	2N	8H	1S	4O		-2149	.0639	704
AMMONIUM PERCHLORATE	340H	340O	85N	85CL		-590	.0704	705
AMMONIATED COPPER NITRATE	1CU	4N	6O	6H	-0	630	.000	706
AMMONIATED COPPER NITRATE	1CU	6N	6O	12H	-0	769	.000	707
AMMONIATED COPPER NITRATE	1CU	8N	6O	18H	-0	822	.000	708
AMMONIATED ALUMINUM IODIDE	1AL	3I	1N	3H	-0	262	.000	709
AMMONIATED ALUMINUM IODIDE	1AL	3I	3N	9H	-0	454	.000	710
AMMONIATED ALUMINUM IODIDE	1AL	3I	5N	15H	-0	592	.000	711
AMMONIATED ALUMINUM IODIDE	1AL	3I	6N	18H	-0	622	.000	712
AMMONIATED ALUMINUM IODIDE	1AL	3I	7N	21H	-0	645	.000	713
AMMONIATED ALUMINUM IODIDE	1AL	3I	9N	27H	-0	676	.000	714
AMMONIATED ALUMINUM IODIDE	1AL	3I	13N	39H	-0	722	.000	715
AMMONIATED ALUMINUM IODIDE	1AL	3I	20N	60H	-0	762	.000	716
AMMONIATED BERYLLIUM IODIDE	1BE	2I	4N	12H	-0	642	.000	717
AMMONIATED BERYLLIUM IODIDE	1BE	2I	6N	18H	-0	692	.000	718
AMMONIATED BERYLLIUM IODIDE	1BE	2I	13N	39H	-0	792	.000	719
AMMONIATED MAGNESIUM IODIDE	1MG	2I	2N	6H	-0	509	.000	720
AMMONIATED CALCIUM IODIDE	1CA	2I	1N	3H	-0	507	.000	721
AMMONIATED CALCIUM IODIDE	1CA	2I	2N	6H	-0	570	.000	722

AMMONIATED CALCIUM IODIDE	1CA	2I	6N	18H	-0	720	.000	723
AMMONIATED CALCIUM IODIDE	1CA	2I	8N	24H	-0	735	.000	724
AMMONIATED LITHIUM IODIDE	1LI	1I	1N	3H	-0	609	.000	725
AMMONIATED LITHIUM IODIDE	1LI	1I	2N	6H	-0	691	.000	726
AMMONIATED LITHIUM IODIDE	1LI	1I	3N	9H	-0	751	.000	727
AMMONIATED LITHIUM IODIDE	1LI	1I	4N	12H	-0	799	.000	728
AMMONIATED LITHIUM IODIDE	1LI	1I	5N	15H	-0	825	.000	729
AMMONIATED LITHIUM IODIDE	2LI	2I	11N	33H	-0	417	.000	730
AMMONIATED LITHIUM IODIDE	1LI	1I	7N	21H	-0	857	.000	731
AMMONIUM CYANIDE	2N	4H	1C	-0	-0	0	.000	732
ARGON	1AR	-0	-0	-0	-0	0	.028	733
BARIUM NITRATE	1BA	2N	6O	-0	-0	907	.117	734
BARIUM PEROXIDE	1BA	2O	-0	-0	-0	689	.179	735
BERYLLIUM NITRIDE	3BE	2N	-0	-0	-0	2404	.090	736
CALCIUM CARBIDE	1CA	2C	-0	-0	-0	234	.080	737
CALCIUM NITRATE	1CA	2N	6O	-0	-0	1365	.085	738
CALCIUM PEROXIDE	1CA	2O	-0	-0	-0	2135	.000	739
CARBON (AMORPHOUS)	1C					917	.0637	740
CARBON MONOXIDE	1C	1O	-0	-0	-0	943	.045	741
DECAHYDRONAPTHALENE	18H	10C				-421	.0319	742
DIBUTYL TIN MALEATE	20H	12C	4O	1SN		-931	.0528	743
DIMETHYL AMMON LITHIUM IODIDE	1LI	1I	4C	13H	1N	477	.000	744
DIMETHYL AMMON LITHIUM IODIDE	1LI	1I	6C	19H	1N	473	.000	745
DIMETHYL AMMON LITHIUM IODIDE	1LI	1I	10C	31H	1N	463	.000	746
ERL-0510	19H	15C	1N	4O		-188	.0444	747
ETHANETHIOL	2C	6H	1S	-0	-0	256	.030	748
HC 434 VICTOR	75H	50C	1O			134		749
HYDROGEN CYANIDE	1H	1C	1N	-0	-0	1154	.032	750
HYDROGEN CYANIDE	1H	1C	1N	-0	-0	952	.024	751
LEAD NITRATE (LEE)	2N	6O	1PB			-324	.1637	752
LITHIUM HYDRIDE	1LI	1H	-0	-0	-0	2719	.028	753
LP-205	416C	646H	85O	87S		-720	.0466	754
LP-33	314C	635H	107O	121S		-696	.0455	755
MAGNESIUM OXIDE	[illegible]					-3567	.1292	756
METHANE	1C	4H	-0	-0	-0	1115	.000	757
MONOBASIC LEAD RESORCYLATE	14C	10H	9O	2PB		-1900		758
NITROUS OXIDE	2N	1O	-0	-0	-0	443	.071	759
O2/H2 (O/F =1.00(52))	[illegible]	[illegible]				0		760
OZONE	3O	-0	-0	-0	-0	708	.077	761
P-QUINONEDIOXIME	454C	454H	145O	145N		-700	.0505	762
POLYMERIZED FORMALDEHYDE	2H	1C	1O			-1345	.0509	763
USE SERIAL 535 FOR KCLO4******						0		764
POTASSIUM NITRATE	1K	1N	3O	-0	-0	1165	.076	765
POTASSIUM AMALGAM	1K	1HG	-0	-0	-0	48	.000	766
SILICONE	6H	2C	1O	1SI		-1820	.0361	767
SODIUM NITRATE	1N	3O	1NA			-1312	.0816	768
SODIUM BOROHYDRIDE	1NA	1B	4H	-0	-0	1155	.038	769
SODIUM HYDRIDE	1NA	1H	-0	-0	-0	571	.050	770
SODIUM NITRATE	1NA	1N	3O	-0	-0	1312	.081	771
TEFLON	1C	2F				-1930	.0794	772
TITANIUM	1TI	-0	-0	-0	-0	0	.162	773
URANIUM	1U	-0	-0	-0	-0	0	.314	774
VITON A	206H	274C	342F			-1890	.0656	775
VITEL (LIEBOLD)	55H	28C	10O			-1720	.0439	776
JP5 (OLD, SEE MONT STEVENS)	16H	9C				-278	.0296	777
INFNA 82.8AC 14NO2 2.5H2O .7HF	4F	126H	185N	536O		-541	.0567	778
SUCROSE (TABLE SUGAR)	22H	12C	11O			-1550	.0574	779
POLYMERIZED FORMALDEHYDE	2H	1C	1O			-1343	.0509	780
ALUMINUM OXIDE	2AL	3O				-4000	.0670	781
ERL-0510	19H	15C	1N	4O		-188	.0444	782
HC 434 VICTOR	75H	50C	1O			134		783
LEAD (PURE CRYSTALINE)	1PB					0	.4096	784
LEAD NITRATE (LEE)	2N	6O	1PB			-324	.1637	785
VITON A	206H	274C	342F			-1890	.0656	786
CARBON BLACK	1C					0	.0637	787
DIBUTYL TIN MALEATE	20H	12C	4O	1SN		-931	.0528	788

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(LEN LEE ORDERED THE CARD THAT USED TO BE HERE DESTROYED.)                  0          789
HTPB (SINCLAIR)                  103H  73C   1O                            13  .0332   790
POLYSULPHIDE  LP2                120C 242H  42O   42S                    -569  .0455   791
CARBON SUBNITRIDE                  4C   2N                               1970  .0350   792
CALCIUM FORMATE                    2H   2C   4O   1CA                   -2469  .0728   793
HELIUM                            1HE                                       0  .0012   794
POLYSULPHIDE  LP2                120C 242H  40O   43S                     569  .0458   795
TETRAFORMALTRISAZINE               4C  12H   6N                           533  .0472   796
 AMMONIUM BICHRATE (N15N2D40I0   15H   2N   4O   130                    -271  .0939   797
CTPB(ARC ICRPG/AIAA PAPER)       579C 984H  22O    5N    1P              -342  .0324   798
LAURYL METHACRYLATE               32H  17C   2O                          -709  .0314   799
OXALIC ACID                        2C   4O   2H                         -2195  .0686   800
OXALIC ACID DIHYDRATE              2C   6O   6H                         -2704  .0597   801
ANTHRACENE                        10H  14C                                152  .0451   802
DECACYLENE                        18H  36C                                117  .0596   803
SILVER IODIDE                     1AG   1I                                -64  .2049   804
SILVER OXIDE                      2AG   1O                                -32  .2501   805
NITROGEN (GASEOUS)                 2N                                       0          806
SYFO                              14H  11C   2N   10O   10F              -441  .0592   807
PCDE                               2H   3C   2N   10    2F               -195  .0549   808
FEFO                               6H   5C   4N   10O   2F               -557  .0575   809
N-BUTANE  (GAS)                   10H   4C                               -517          810
SODIUM HYDROXIDE                  1NA   1O   1H                         -2548  .0769   811
NAPTHALENE                        10C   8H                                164  .0413   812
CARBON TETRAFLOURIDE (GAS)         1C   4F                              -2535          813
 BILL BURDETTE- PAT HALL FUELS                                              0          814
ISOBUTYLBENZENE (USE 1054)        10C  14H                                -12  .0313   815
DECAHYDRONAPTHALENE               18H  10C                               -421  .0319   816
TETRAHYDRONAPTHALENE              12H  10C                                -17  .0354   817
METHYL NAPTHALENE (1-)            10H  11C                                  9  .0370   818
TH-DIMER                          20H  12C                               -198  .0334   819
SHELLDYNE H                      124H 140C                                107  .0399   820
N-BUTYL BENZENE  (BENSON)         10C  14H                               -119  .0313   821
N-BUTYL BENZENE  (LANGE)          10C  14H                               -139  .0313   822
AMSCO 140H SOLVENT                 6C  12H                               -437  .0292   823
SHELLDYNE-BUTYLBENZENE (7-1)     991H 749C                                 64  .0362   824
TETRALIN-DECALIN (70-30)         999H 726C                               -135  .0342   825
METHYLIN-TETRALIN  (70-30)       156H 107C                                  2  .0305   826
DECALIN-TETRALIN (80-20)         999H 596C                               -739          827
 THE FOLLOWING DATA WAS KINDLY PROVIDED BY ED LAPOUTY OF NOS                0          828
 IT IS PREPARED FROM REPEATED HEAT OF COMBUSTION DATA                       0          829
                                                                            0          830
1,1,1-TRINITRO-2-HYDROXYBUTYRI004C 005H 009O 003N                        -684          831
C ACID                                                                      0          832
1,3,5-NITROXY-2-NITROAMINO-DIA004C 007H 005O 005N                        -155          833
ZACYCLOHEXENE                                                               0          834
1,1,1-TRINITRO-2-HYDROXYBUTANO004C 007H 006O 003N                        -373          835
L                                                                           0          836
1,2-BIS(DIFLUOROAMINO)-2-METHYL004C 008H 002N 004F                       -369          837
PROPANE                                                                     0          838
1-DIFLUOROAMINO-2,4,6-TRINITRO006C 002H 006O 004N 002F                     19          839
BENZENE                                                                     0          840
1,1-DIMETHYL HYDRAZINE NITRATE002C 009H 003O 003N                        -470          841
1,2-BIS(DIFLUOROAMINO)BUTANE  004C 008H 002N 004F                        -341          842
1,1,1-TRINTRO-4,4-BIS(DIFLUORO005C 007H 006O 005N 004F                   -197          843
AMINO)PENTANE                                                               0          844
2-METHYL-5-VINYLTETRAZOLE ACRY363C 541H 012O 341N                         357          845
LIC ACID COPOLYMER(15:1)                                                    0          846
2-METHYL-5-METHOXYETHYLTETRAZ353C 745H 057O 283N                         -166          847
OLE                                                                         0          848
3-NITRO-5-HYDROXY-1,2,4-TRIAZO002C 002H 003O 004N                        -238          849
LE                                                                          0          850
2,3-DIFLUOROAMINO-2-METHYLBUTA005C 010H 002N 004F                        -336          851
NE                                                                          0          852
(2,2,2-FLUORODINITROETHYL)ACRY005C 005H 006O 002N 001F                   -669          853
LATE                                                                        0          854
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2,4-DINITROPHENOXY ETHANOL     008C 008H 006O 002N              -419          855
3-DIFLUOROAMINO-2,4,6-TRINITRO007C 004H 006O 004N 002F            -7          856
TOLUENE                                                             0          857
XYLIDINE                       008C 011H 001N                   -144          858
2-FLUORO-2,3-DINITROETHANOL    002C 003H 005O 002N 001F         -741          859
2-HYDROXY-4(2-HYDROXY-3-METHAC020C 020H 006O                    -722          860
RYLYLOXY)-PROPOXYBENZOPHENONE                                       0          861
2,2',4,4',6,6 -HEXANITROAZOBEN012C 004H 012O 008N                135          862
ZENE                                                                0          863
2-METHYL-5-VINYLTETRAZOLE      004C 006H 004N                    566          864
2-METHYL-5-VINYLTETRAZOLE/HYDR377C 550H 035O 311N                252          865
OXY-ETHYL-METHACRYLATE COPOLYM                                      0          866
ER(10:1)                                                            0          867
2,2-DINITRO-2-CHLOROETHANOL    002C 003H 005O 002N 001CL        -348          868
2,3-BUTANEDIOL                 004C 010H 002O                  -1445          869
5-HYDROXYETHYL-1-1-METHYLTETRA004C 008H 001O 004N                  7          870
ZOLE                                                                0          871
5-NITROBARBITANIC ACID         175C 390H 320O 169N             -1625          872
5-AMINOTETRAZOLE NITRATE       001C 004H 003O 006N               130          873
5-AMINOTETRAZOLE PERCHLORATE   001C 004H 004O 005N 001CL         204          874
A COMMERCIAL FLUOROCARBON      249C 139H 002O 360F             -1858          875
A PARAFFINIC OIL               073C 124H                        -367          876
A PHOSPHITED POLYALKYL POLYPHE067C 109H 004O 000N               -368          877
NOL                                                                 0          878
A NAPHTHENIC TYPE OIL          073C 117H                        -167          879
A SUBSTITUTED ACRYLONITRILE    013C 015H 002O 001N              -103          880
ACETYLTRIBUTYL CITRATE         020C 034H 008O                  -1097          881
ACRYLAMIDE                     003C 005H 001O 001N              -753          882
ACRYLONITRILE                  575C 609H 008O 169N               334          883
ADAMANTINE                     010C 016H                        -340          884
BISTETRAZOLE                   002C 002H 008N                   1093  .0576   885
BIS-2,2-METHOXYETHOXY ETHYL ET010C 022H 005O                    -964          886
HER                                                                 0          887
BIS(2-FLUORO-2,2-DINITROETHYL)004C 005H 008O 005N 002F          -439          888
AMINE                                                               0          889
BIS(2-FLUORO-2,2-DINITROETHYL)004C 004H 010O 006N 002F          -361          890
NITRAMINE                                                           0          891
BIS(2-FLUORO-2,2-DINITROETHYL)004C 004H 009O 006N 002F          -321          892
NITROSAMINE                                                         0          893
BIS(2,2,2-TRINITROETHYL)SEBACAT014C 020H 016O 006N              -409          894
BIS(2-FLUORO-2,2-DINITROETHYL)006C 006H 010O 006N 002F          -645          895
OXAMIDE                                                             0          896
BIS(2-FLUORO-2,2-DINITROETHYL)006C 004H 012O 004N 002F          -792          897
OXALATE                                                             0          898
CASTOR DIOL(HYDROXY NO.273-295059C 111H 112H                    -671          899
CARBOXYTERMINATED POLYBUTADIEN073C 105H 001O                     117          900
E                                                                   0          901
CARBOXY TERMINATED POLYISOBUTY070C 135H 001O                    -450          902
LENE                                                                0          903
CARBOXY TERMINATED POLYBUTADIE072C 108H 001O                     160          904
NE                                                                  0          905
CARBOXY TERMINATED POLYBUTADIE691C 928H 001O 005N                -56          906
NE NITRILE                                                          0          907
CARBOXY TERMINATED POLYBUTADIE680C 962H 053N                    -143          908
NE NITRILE                                                          0          909
CARBOXY TERMINATED POLYBUTADIE069C 103H 019O 030N                -29          910
NE NITRILE                                                          0          911
CARBOXY TERMINATED POLYBUTADIE668C 999H 013O 034N                 33          912
NE NITRILE                                                          0          913
CARNAUBA WAX                   067C 127H 004O                   -460          914
CANDELLIA WAX                  069C 122H 003O                   -142          915
CUMENE HYDROPEROXIDE           062C 630H 074O                   -471          916
DELRIN                         334C 604H 033O                  -1373          917
DIHYDROXYGLYOXIME              002C 004H 004O 002N             -1060          918
DIETHYLENEGLYCOL DINITRATE     004C 008H 007O 002N              -580          919
DIETHYLENE GLYCOL MONOBUTYLETH010C 020H 004O                   -1055          920
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ERACETATE                                                              0      921
DIETHYLENE GLYCOL DIMETHYL ETH006C 014H 0030                       -1014      922
ER                                                                     0      923
DIPROPYLENE GLYCOL ESTER OF SE063C 064H 0670                        -893      924
BACIC AND MALIC ACIDS                                                  0      925
DIMETHYLACETAMIDE             004C 009H 0010 001N                   -819      926
DIOXANE                       442C,074H10370                        -935      927
DIETHYLOXALATE                006C 010H 0040                       -1324      928
DIBASIC LEAD PHTHALATE        008C 004H 0060 003PB                  -292      929
DIETHYL PHTHALATE             012C 014H 0040                        -810      930
DI-ISOBUTYL AZELATE           017C 032H 0040                        -925      931
ETHANOLAMINE                  002C 007H 0010 001N                  -1986      932
ETHYLENEDIAMINE DIPERCHLORATE 002C 010H 0080 002N 002CL             -439      933
ETHYL ACRYLATE                005C 008H 0020                        -877      934
ETHYLACRYLATE ACRYLIC ACID    495C 726H 2040                       -1067      935
ETHYL CYCLOHEXANE             008C 016H                             -453      936
GUANIDINIUM-5-NITRAMINOTETRAZO002C 007H 0020 009N                     58      937
LE                                                                     0      938
GUANIDINIUM NITRATE           001C 006H 0030 004N                   -755      939
HEXANETRINITRATE              006C 011H 0090 003N                   -429      940
HYDROXYLAMMONIUM NITRATE      004H 0040 002N                        -843      941
HYDROXYLAMMONIUM PERCHLORATE  004H 0050 001CL                       -496      942
HYDROXY TERMINATED POLYBUTADIE067C.006H 0010 004N                   -116      943
NE NITRILE                                                             0      944
HYDROGENATED HYDROXYTERMINATED071C 120H 002/                        -295      945
/POLYBUTADIENE                                                         0      946
HYDROCARBON OIL               001C 002H                             -756      947
HYDROXY TERMINATED POLYBUTADIE073C 110H 0030                         -3[illegible]      948
NE                                                                     0      949
HYDROXYETHYLMETHACRYLATE      006C 010H 0030                       -1153      950
ISOPROPYLAMMONIUM NITRATE     003C 010H 0030 002N                   -813      951
ISODECYL PELARGONATE          019C 038H 0020                        -714      952
LEAD-4,4-DIACETOMIDO SALICYLAT018C 016H 0060 002N 001PB             -799      953
LOW ACETYL CELLULOSE ACETATE  423C 572H 2570                       -1275      954
METHANOL                      001C 004H 0010                       -1773      955
METHOXY-DI-(BUTOXYDIETHYLENE G052C 111H 0120                       -1229      956
LYCOL)                                                                 0      957
MELAMINE                      003C 006H 006N                        -165      958
MERCAPTO TERMINATED POLYBUTADI069C 941H 0040 001S                     47      959
ENE NITRILE                                                            0      960
MONOMETHYLHYDRAZINE NITRATE   001C 007H 0030 003N                   -565      961
N1,N1,O-TRIS(2-FLUORO-2,2-DINI007C 006H 0140 007N 003F              -568      962
TROETHYL)-CARBAMATE                                                    0      963
NITROSTARCH                   060C 075H 1010 025N                   -613      964
N-FLUORO-N-BUTYLNITRAMINE     004C 009H 0020 002N 001F              -288      965
N-FLUORO-SEC-BUTYLNITRAMINE   004C 009H 0020 002N 001F              -279      966
N-FLUORO-TERT-BUTYLNITRAMINE  004C 009H 0020 002N 001F              -225      967
N-BUTYL ACRYLATE              007C 012H 0020                        -799      968
NONFUNCTIONAL POLYBUTADIENE   004C 006H                               68      969
NONFUNCTIONAL POLYBUTADIENE   004C 006H                               25      970
N,N,N"-TRIFLUOROHEXANEAMIDINE 006C 011H 002N 003F                   -307      971
PETROLATUM(TECHNICAL)         071C 131H                             -325      972
PETROLEUM JELLY               072C 130H                             -161      973
PLASTICIZER(ESTER OF FATTY ACI064C 128H 0060                        -615      974
DS)                                                                    0      975
POLYETHYLENE (PELLETS)        002C 004H                             -478      976
POLYETHYLENE (FILM)           002C 004H                             -491      977
POLYETHYLEN GLYCOL            002C 004H 0010                       -1055      978
POLYMETHYLENE POLYPHENYLISOCYA008C 006H 0010 001N                   -276      979
NATE                                                                   0      980
POLYOXYETHYLENE SORBITAN MONOL050C 103H 0190                       -1132      981
LAURCITE                                                               0      982
POLYPROPYLENE FILM            003C 006H                             -471      983
POLYETHYLENEAMMONIUM NITRATE  327C 027H 1990 131N                   -675      984
POLYVINYLPYRROLIDINE          [illegible] 7[illegible]H 1[illegible]0 00[illegible]N                   -331      985
POLYPROPYLENE GLYCOL          [illegible] 1[illegible]H 0170                       -1[illegible]  [illegible].301  986
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```
POLYTETRAMETHYLENEETHER GLYCOL054C 114H 015O                 -516            987
POLY-1,4-BUTYLENE GLYCOL       054C 111H 015O                 -751            988
POLYGLYCERYL OLEATE            565C 651H 146O                   10            989
POLYBUTENE-6                   072C 141H                      -315            990
POLYBUTADIENE DIOL             073C 110H 005O                   66            991
POLYBUTALIEN /ACRYLONITRILE C0657C 354H 017O 072N              314            992
POLYMER                                                          0            993
POLYBUTADIENE/ACRYLONITRILE C0654C 084H 004O 029N              156            994
POLYMER                                                          0            995
POLYBUTADIENE/ACRYLONITRILE C0604C 081H 008O 066N              132            996
POLYMER                                                          0            997
PYROMELLITIC DIANHYDRIDE       010C 002H 006O                -1143            998
SORBITOL PENTANITRATE          006C 009H 016O 005N            -463            999
TETRAMETHYLAMMONIUM NITRATE    293C 571H 222O 147N            -624           1000
TETRACYANOETHYLENE             006C 004N                      1133           1001
TETRAETHYLAMMONIUM NITRATE     008C 020H 003O 002N            -600           1002
TRINITROFLUOROMETHANE          001C 006O 003N 001F            -311           1003
TRINITROCHLOROMETHANE          001C 006O 003N 001CL            -30           1004
TRINITROBROMOMETHANE           001C 006O 003N 001BR            -14           1005
TRINITROMETHANE                001C 001H 006O 003N            -105           1006
TRIMETHYLAMMONIUM NITRATE      493C 010H 003O 002N            -673           1007
TRIETHYLENE GLYCOL DINITRATE   006C 012H 008O 002N            -654           1008
TRIMETHYLOLPROPANE             006C 014H 003O                -1330           1009
TRIETHYLAMINE                  006C 015H 001N                 -490           1010
TRIETHYL CITRATE               012C 020H 007O                -1291           1011
TRIS(1-(2-ETHYL)-AZIRIDINYL)BE021C 027H 003O 003N             -154           1012
NZENE                                                            0           1013
TRINITROETHYLDINITROXYETHYLNITRA004C 006H 011O 006N            -75           1014
MINE                                                             0           1015
STEAM                            2H   1O                     -3205           1016
FOG                            785N  14H 231O   5AR            -37           1017
PROPYLENE                        3C   6H                       118           1018
NITROGEN GAS                     2N                              0           1019
NIELSEN COMPOUND                12C  26H   4N                 -104           1020
NO2 (GAS)                        1N   2O                       174           1021
IRON PENTACARBONYL              1FE   5C   5O                  267           1022
RP-1 (RFL)                     195H 100C                      -361           1023
CESIUM NITRATE                  1CS   1N   3O                 -625  .1351    1024
TNT                              7C   3N   6O   5H              79  .0597    1025
NOS365                         530C 470H 720O 161N           -1421  .0560    1026
OTTO II                        471C 870H 552O 155N            -696  .0452    1027
NOS 263                        540C 459H 337O 159N           -1570  .0531    1028
OXSOL II                       596H 424O 109N  65CL           -934  .0618    1029
OXSOL I                        370H 410O 100N  70CL          -1361  .0618    1030
BROMINE (GAS)                   2BR                             46           1031
HYDROGEN BROMIDE  (GAS)          1H  1BR                      -108           1032
OTTO II                        274C 526H 308O  94N            -696  .0452    1033
DECABORANE A                    10B  18H   2N                -1198           1034
DECABORANE B                    2CS  10B  10H                 -624           1035
BITETRAZOLE                      2C   8N   2H                  797           1036
MOLYBDENUM TRIOXIDE             1MO   3O                     -1253           1037
BROMOTRIFLUOROMETHANE            1C  1BR   3F                -1301           1038
TNENG                            3C   6O   5H   7N             -63  .0704    1039
ETNEV                            5C  13O   6H   5N            -187  .0675    1040
BENZOTRIFUROXANE (BTF)           6C   6O   6N                  571  .0666    1041
AMMONIUMTRINITROIMIDAZOLE(AT I   3C   6O   4H   6N             -16  .0662    1042
THIOKOL TP-H-3314 (NO FE)      760H 352O 231C 105N   03CL 16S  -735  .0549    1043
AMMONIUM BIFLUORIDE(AF+LIQ HF)   5H   1N   2F                -3189           1044
N2O4 (NTO MISC)                  2N   4O                       -51  .0517    1045
NORMAL HEXYL CARBORANE           8C  24H  10B                 -398  .0379    1046
FC POLYMER     (O,NEILL)         9O  26C   1N  42H           -1275  .0419    1047
F17-47    (SIEG)                13C   5O  16H                -1390  .0444    1048
SYLGARD                         1SI   1O   6H   2C           -1369           1049
WITCO F17-47 (JOS)              13C   5O  16H                -1319  .0430    1050
DIMER ACID/EPCAUL9S NEW BINDER  95C 174H  15O                 -509  .0343    1051
R45 HTPB (UTC)                 901H 654C   6O                    5  .0336    1052
```

DI ISO CYANATE (DDI)	35C	72H	2N	20		-354	.0319	1053
ISOBUTYLBENZENE	10C	14H				-124	.0313	1054
N,N DINITROSOPENTAMETHYLENETET	5C	10H	6N	20		209	.0545	1055
RAMINE						0		1056
HYDRAZINE DIBORANE (JOS)	2B	10H	2N			-502	.0343	1057
HTPB/CURATIVE (JOS)	656C	970H	5N	130		-493	.0329	1058
TRINITROETHYL ORTHOCARBONATE	9C	8H	12N	260		-250	.0664	1059
SHELL EPON 815	21C	24H	40			-327	.0409	1060
ALUMINUM TRIOXIDE TRIHYDRATE	2AL	60	6H			-3434	.0874	1061
LITHIUM PEROXIDE	2LI	20				-3307	.0833	1062
AMMONIUM 5-NITRAMINOTETRAZOLE	1C	7N	5H	20		222	.0538	1063
A TETRAZOLE POLYURETHANE	999H	523C	1230	243N		-392	.0413	1064
R45	661C	999H	1N	90		40	.0325	1065
NGA (CT)	545C	946H	1590			-1366	.0374	1066
ZL 320	606C	909H	22N	930		-579	.0373	1067
IPDI	12C	18H	2N	20		-501	.0384	1068
ERL0510	15C	19H	1N	40		-167	.0435	1069
CASTOR OIL	62C	111H	90			-626	.0346	1070
AN	4H	2N	30			-1085	.0623	1071
ADHG	149C	516H	214N	2930		-1272	.0623	1072
NG	1C	4H	4N	20		-212	.0620	1073
TAGN	1C	9H	7N	30		-84	.0569	1074
GN	1C	6H	4N	30		-758	.0519	1075
GLYOXAL HYDRAZINE POLYMER	2C	2H	2N			278	.0356	1076
DHTT	4C	10H	16N			647	.0572	1077
HEXANITROBENZENE	6C	6N	120			12	.0717	1078
MANGANESE	1MN					0	.2599	1079
PEG4000 (CARBOWAX)	2C	4H	10			-1058	.0435	1080
BITRETRAZOLE	2C	2H	9N			725		1081
CHROMIUM CARBONYL JAX78/5168	1CR	6C	60			-1170		1082
MOLYBDENUM CARBONYL JAX78/5168	1MO	6C	60			-889		1083
TUNGSTEN CARBONYL JAX78/5168	1W	6C	60			-645		1084
SODIUM AZIDE +TEFLON (STOICH)	1C	6N	2F	2NA		-478		1085
CATOCENE	27C	32H	2FE			115	.0414	1086
GE-RTV-615/A+B	2C	6H	1SI	10		-1888	.0372	1087
HTPB (AFAPL VARIANT)	654C	988H	8N	200		123	.0332	1088
CHROMIUM OCTOATE	1CR	24C	45H	60		-506	.0361	1089
F1780	160C	255H	1000			-1297	.0433	1090
HMDI	8C	12H	20	2N		-717	.0375	1091
HC434	669C	999H	1N	130		-16	.0327	1092
MNA	7C	8H	2N	20		-49	.0433	1093
MAR 658	40C	46H	80			-696	.0419	1094
PCP0240	564C	999H	2170			-1393	.0395	1095
PCP0301	564C	999H	2170			-1393	.0396	1096
PAPI	224C	155H	270	27N		-202	.0448	1097
POLYMEG 1000	4C	8H	10			-874	.0355	1098
POLYMEG 2000	4C	8H	10			-874	.0354	1099
POLYSTYRENE	8C	8H				106	.0379	1100
R-18	624C	999H	3740			-1364	.0326	1101
TATB	6C	6N	60	6H		-143	.0698	1102
R45M	667C	999H	50			-30	.0433	1103
STABOXOL P	13C	10H	2N			-41	.0379	1104
TEDGN	6C	12H	80	2N		-645	.0460	1105
THERMAX	1C					0	.0704	1106
LACQUER NITROCELLULOSE	600C	774H	226N	9520		-663	.0599	1107
HYLENE W (HF ESTIMATED)	15C	22H	2N	20		-150	.0366	1108
C5H10N14O8 (NEED)	5C	10H	14N	80		2479		1109
GLYCIDYL AZIDE	3C	7H	10	3N		564	.0470	1110
LEAD STYPHNATE	1PB	6C	3H	3N	90	-205	.1091	1111
CALCIUM CHROMATE	1CA	1CR	40			-2111	.1044	1112
BARIUM CHROMATE	1BA	1CR	40			-1347	.1625	1113

Appendix G

PEP AUXILIARY PROGRAM

In theory, the thermodynamic data for the combustion species could be put onto a magnetic tape and the SEARCH subroutine of the propellant program made to digest this information. In practice, it was decided to "predigest" this information with an auxiliary program, which is called PEPAUX. There are several reasons for this other than the fact that binary rather than a BCD tape may be produced. These will become apparent as the description progresses.

PEPAUX consists of a somewhat small program deck followed by two sets of input cards. The first set contains Holerith information and is somewhat permanent. Since this first may be considered part of the program deck, it will not be described in detail except to note that at present it contains 74 cards and that the first 47, which contain element names, may be permuted in any order. However, the order determines the precedence of the element in the molecular names. Hence, if H precedes C, methane will be denoted H4C; otherwise it will be denoted CH4. As can be suspected from this, PEPAUX generates automatically the Holerith names of all combustion species.

The second and main part of the input to PEPAUX is the thermodynamic data for the combustion species. This contains three card sets for as many species as desired. The first card is a species identification card, and the second two contain the data itself. The number of cards in this group is 3n + 1, where n is the number of species. An extra, blank card is placed at the end to signal the end of the input deck.

The identification card contains the molecular composition of the pertinent species and phase. The composition consists of as many information pairs as there are elements in the species. The information pairs begin in column 48 and repeat the format (A2,I2). The first part is the atomic symbol commonly used by chemists; the second is the number of such atoms in the molecules. For example, AL 1CL 3 designates $AlCl_3$. The phase of the species also appears on this card in column 36. Other information on this card, such as name and molecular weight, is not processed.

The two data cards which follow have a format compatible with the JANNAF thermochemical data in floating point form as follows:

FIRST CARD	L_1(end in 13) L_2(end in 26) L_3(end in 39) L_4(end in 52)
SECOND CARD	L_5(end in 13) L_6(end in 26) L_7(end in 39) L_8(end in 52)

where

$$C_p = l_1 + L_2\Theta + L_3\Theta^2 + L_4\Theta^3 + L_5\Theta^{-2}$$

L_6 is the integration constant for total enthalpy (kcal/mole)

L_7 is the integration constant for entropy (cal/mole/°K)

Θ is T/1000

(L_8 is the heat of formation and is not used.)

More thermodynamic data is permitted to follow the blank card. Another format is used for the second group of thermodynamic data, which is described in both NAVWEPS 7043 and NAVWEPS 7609. It will not be repeated here, especially since the JANAF fits have become generally accepted. Some remarks on PEPAUX operation follow.

PEPAUX not only generates Holerith names for each combustion species but also adds the symbol $ when the species is solid and the symbol * when it is liquid. Plus and minus signs are added for ionic species. However, only the leading six symbols are available on the output tape for the equilibrium program.

PEPAUX reorders the species so that gases come first, and condensed species follow on the output tape. This saves computing time when the equilibrium program utilizes this tape.

PEPAUX automatically deletes and edits. Species which are repeated are deleted and noted in the output. This provides a method of updating the thermo data files. Newer data is simply placed in front. This way, older data in back is deleted. If the input deck becomes too large, the redundant data can easily be removed by studying the previous PEPAUX output.

Logical tape 12 is written by PEPAUX and the plastic ring is removed. It is used by the equilibrium program until an updating effort is required of PEPAUX.

If one is using thermodynamic data supplied by NWC, the following peculiarities should be noted. The symbols U1, U2, U3, U4 and U5 are fictional elements that have the same data (except atomic number internally) as Be, B, Mg, Al, and C. Since only elementary species appear, this allows one to consider problems in which these elements do not burn. If one wants to know what happens if 10% of his aluminum does not burn, he inputs 90% of his aluminum as Al and 10% as U4.

The JANAF data was fit by Howard Shomate at NWC and supplied to Harold Prophet at Dow Chemical for further distribution. Shomate was not always satisfied with the fit and sometimes spliced two fits (over different temperature regimes) together. In these cases three groups of three cards appear for a single gaseous species. The first is the single fit and is ignored by PEPAUX, which picks up the better fit represented by the two regimes on the following six cards.

The PEPAUX program and input follow.

```
-ASG,AX CRUISE*PEPAUX//21734
-USE   12.,CRUISE*PEPAUX
-ASG,T A,F2///256
-USE 28,A
-ASG,T B,F2///256
-USE 29,B
-FOR,IS    PEPAUX,PEPAUX/A
      COMMON /PAUX/ IE(101), HI(101,2), IN(101), HK(50,2), KN(50), JN(7)
C UNIVAC 1108 VERSION, FORTRAN IV
     1,JE(7), OUT(22), SPEC(5), IS(5), PARA(20),REDUND(2,7777), JD, NJD
      INTEGER S
    1 FORMAT (14I3, 12X, I1, 15X, I1)                                       0070
    3 FORMAT (I2, 2A1, I1)                                                  0090
    4 FORMAT (2A1,I1)                                                       0100
    5 FORMAT (A1,I1)                                                        0110
    8 FORMAT (I8, 2A6, I6)
    9 FORMAT (1H 3I5, 2X, A6)                                               0150
  554 FORMAT (7(F3.0,1X,A6), I2/  E12.0,F6.0,E12.0)
   10 FORMAT (15HOREDUNDANCY IN 2A6)
      REWIND 28
      REWIND 29
      DO 11  I = 1,97
   11 READ  (5,3)IE(I), HI(I,1), HI(I,2), IN(I)                             0190
      DO 12  I = 1,22                                                       0200
   12 READ  (5,4)HK(I,1), HK(I,2), KN(I)                                    0210
      DO 13  I = 1,5                                                        0220
   13 READ  (5,5)SPEC(I), IS(I)                                             0230
      CALL BUFFER (1,0,0,0.,0,0,0.)
      HI(98,1) = SPEC(4)
      HI(99,1) = SPEC(5)
      HI(98,2) = HK(I,1)
      HI(99,2) = HK(I,1)
      CALL SHOJAN
      CALL NONJAN
      LIM = JD + NJD
      DO 110  K = 1,2                                                       0730
      REWIND 28
      REWIND 29
      DO 108  I = 1,LIM                                                     0750
      READ (29,8)     KHASE,          REDUND(1,I), REDUND(2,I),S
      READ (29) (JN(L), JE(L), L = 1,7)
  102 READ (28) (PARA(L), L = 1,9)
  103 READ (28) (PARA(L), L = 10,18)
      WRITE (6,6666) KHASE, REDUND(1,I), REDUND(2,I), (JN(L), JE(L),
     1 L = 1,7), (PARA(L), L = 1,18),S
 6666 FORMAT (I5, 2A6, 9X, 14I3/ 9E13.4/9E13.4,I5)
      IF (I .LE. JD) GO TO 107
      IF (K .EQ. 2)  GO TO 107
  104 LII = I-1                                                             0820
      IF (JE(1) .EQ. 55)  GO TO 107
      DO 105  J = 1,LII                                                     0830
      IF (REDUND(1,J) - REDUND(1,I))  105,106,105                           0840
  106 IF (REDUND(2,J) - REDUND(2,I))  105,109,105                           0850
  105 CONTINUE                                                              0860
  107 GO TO (50,55), K                                                      0870
   50 IF (KHASE - 1)  108,51,108                                            0880
   51 CALL BUFFER (2,KHASE,S,REDUND(1,I), JN, JE, PARA)
      GO TO 108                                                             0950
   55 IF (KHASE-1)  108,108,51                                              0960
  109 WRITE (6,10)REDUND(1,I), REDUND(2,I)                                  0970
  108 CONTINUE                                                              0980
  110 CONTINUE                                                              0990
      KHASE = -1
      CALL BUFFER (3,KHASE,S,REDUND(1,I), JN, JE, PARA)
      CALL KINDAT
      END FILE 12
```

```
      REWIND 12
      WRITE (6,6420)
 6420 FORMAT (29H1 PEPAUX WORKED SUCCESSFULLY.)
      CALL EXIT                                                         1040
      END                                                               1050
-FOR,IS   SHOJAN,SHOJAN/A
      SUBROUTINE SHOJAN
C . . . . SUBROUTINE TO DIGEST JANAF DATA AS FITTED BY HOWARD SHOMATE.
      COMMON /PAUX/ IE(101), HI(101,2), IN(101), HK(50,2), KN(50), JN(7)
     1,JE(7), OUT(22), SPEC(5), IS(5), PARA(20),REDUND(2,7777), JD, NJD
      DIMENSION CRAZE(3)
      DATA (CRAZE(I), I = 1,3)/ 1HC, 1HG, 1HL /
      DIMENSION HOL(5), ELM(6,2), NA(6)
      INTEGER S,SA
    1 FORMAT (5A6, 5X, A1, 11X, 6(2A1, I2), 1X, I6)
    2 FORMAT (I8, 12A1, I6)
    3 FORMAT (4(F13.0), F5.0, 3X, F5.0, 8X, I5)
    4 FORMAT (7HOMIX UP  2I9)
      JD = 0
      JN(7) =  0
  101 READ (5,1) (HOL(I),I=1,5), PHASE, ((ELM(I,J),J=1,2),NA(I),I=1,6),S
  102 IFIRST = 0
  103 DO 11  I = 1,18
   11 OUT(I) = SPEC(1)
      IF (NA(1) .EQ. 0)  RETURN
C . . . . IF NO ATOM COUNT, SHOJAN IS FINIISHED.
      JD = JD + 1
      INDEX = 1
      DO 9  I = 1,7
      JN(I) = 0.
    9 JE(I) = 0.
      DO 17  I = 1,99
      DO 16  J = 1,6
C . . . . COMPARE HOLERITH WITH PERIODIC TABLE.
      IF (HI(I,1) .NE. ELM(J,1))  GO TO 16
      K = NA(J)
      IF (I .GE. 98)  GO TO  12
      IF (HI(I,2) .NE. ELM(J,2))  GO TO 16
      OUT(INDEX) = HI(I,1)
      OUT(INDEX+1) = HI(I,2)
      INDEX = INDEX + IN(I)
      OUT(INDEX) = HK(K,1)
      OUT(INDEX+1) = HK(K,2)
      INDEX = INDEX + KN(K)
      JN(J) = K
      JE(J) = IE(I)
      GO TO 17
C . . . . ATTACH CHARGE APPENDAGES.
   12 DO 13  L = 1,K
      OUT(INDEX) = ELM(J,1)
   13 INDEX = INDEX + 1
      JN(J) = K
      JE(J) = 0
      IF (I .EQ. 98) JN(J) = -K
      GO TO 17
   16 CONTINUE
   17 CONTINUE
      IF (JE(1) .NE. 0)  GO TO 18
      OUT(2) = OUT(1)
      OUT(1) = 1HE
C . . . . ATTACH PHASE IDENTIFICATION APPENDAGE.
   18 KHASE = 2
      IF (PHASE .EQ. CRAZE(1))  OUT(INDEX) = SPEC(2)
      IF (PHASE .EQ. CRAZE(2))  KHASE = 1
      IF (PHASE .EQ. CRAZE(3))  OUT(INDEX) = SPEC(3)
      WRITE (29,2) KHASE, (OUT(I), I = 1,12), S
```

```
      WRITE (28) (JN(L), JE(L), L = 1,7)
   87 READ (5,3) A,B,C,D,TL,TU,SA
      IF (S .NE. SA)  WRITE (6,4) S,SA
      READ (5,3) E,F,G,H,TL,TU,SA
      IF (S .NE. SA)  WRITE (6,4) S,SA
      READ (5,1) (HOL(I),I=1,5), PHASE, ((ELM(I,J),J=1,2),NA(I),I=1,6),S
      IF (S .NE. SA)   GO TO 89
      IF (PHASE .NE. CRAZE(2))  GO TO 89
      IF (IFIRST .NE. 0)  GO TO 88
      IFIRST = 1
      GO TO 87
   88 WRITE (28) A,B,C,D,E,F,G,TL,TU
      READ (5,3) A,B,C,D,TL,TU,SA
      IF (S .NE. SA)  WRITE (6,4) S,SA
      READ (5,3) E,F,G,H,TL,TU,SA
      IF (S .NE. SA)  WRITE (6,4) S,SA
      WRITE (28) A,B,C,D,E,F,G,TL,TU
      GO TO 101
   89 WRITE (28) A,B,C,D,E,F,G,TL,TU
      WRITE (28) A,B,C,D,E,F,G,TL,TU
      GO TO 102
      END
-FOR,IS   CONVER,CONVER/A
      SUBROUTINE CONVER (PARA, A,B,C,D,E,F,G,TL,TU)
C . . . . SUBROUTINE TO CONVERT OLD PARAMETRIC FORMS TO NEW PARAMETRIC FORMS.
      DIMENSION PARA(20)
      A = PARA(3)
      B = PARA(4)*1000.
      C = 0.
      D = 0.
      E = PARA(5)/1000000.
      F = PARA(1) + PARA(2) - PARA(3)*3000. - PARA(4)*4500000.
     1    + PARA(5)/3000.
      F = F/1000.
      G = PARA(6) - PARA(3)*ALOG(3000.) - PARA(4)*3000.
     1   + PARA(5)/4500000. + ALOG(1000.)
      TL = PARA(7)
      TU = PARA(8)
      RETURN
      END
-FOR,IS   NONJAN,NONJAN/A
      SUBROUTINE NONJAN
C . . . . THIS SUBROUTINE PROCESSES NON JANAF TYPE DATA ACCORDING TO DOW
C . . . . AND OLD NOTS (NAVWEPS 7043) FORMATS.
      COMMON /PAUX/ IE(101), HI(101,2), IN(101), HK(50,2), KN(50), JN(7)
     1,JE(7), OUT(22), SPEC(5), IS(5), PARA(20),REDUND(2,7777), JD, NJD
      DATA  ELECT/ 6HEEEEEE /
    1 FORMAT (14I3, 12X, I1, 15X, I1)
    2 FORMAT (I8, 12A1, I6)
    6 FORMAT (4E13.0)                                                   0120
    7 FORMAT (6E9.6,2F6.0,I1)                                           0130
      NJD = 0
      DO 99  LIM = 1,7777                                               0240
      DO 98 I = 1,18                                                    0250
   98 OUT(I) = SPEC(1)                                                  0260
      READ  (5,1)(JN(I), JE(I), I = 1,7), LEVEL,KHASE                   0270
      IF (JN(1) .EQ. 0)  GO TO 100
C . . . . IF NO ATOM COUNT,SKIP OUT.
      NJD = NJD + 1
   29 IF (KHASE)  30,31,30                                              0290
   30 READ (5,6) A, B, C, D, E, F, G
      TL = 298.
      TU = 6000.
      JAN = 1                                                           0310
      GO TO 32                                                          0320
   31 READ  (5,7)(PARA(I), I = 1,8),KHASE,(PARA(I),I = 9,16)            0330
```

```
      JAN = 2                                                          0340
   32 INDEX = 1
      DO 17  I = 1,97
      DO 16  J = 1,7                                                   0370
      KK = J
      IF (JN(J))  14,17,14                                             0380
   14 IF (IE(I) - JE(J))  16,15,16                                     0390
   15 OUT(INDEX) = HI(I,1)                                             0400
      OUT(INDEX+1) = HI(I,2)                                           0410
      INDEX = INDEX + IN(I)                                            0420
      K = JN(J)                                                        0430
      OUT(INDEX) =HK(K,1)                                              0440
      OUT(INDEX+1) = HK(K,2)                                           0450
      INDEX = INDEX + KN(K)                                            0460
      GO TO 17                                                         0470
   16 CONTINUE                                                         0480
   17 CONTINUE                                                         0490
      OUT(INDEX) = SPEC(KHASE)                                         0500
      INDEX = INDEX + IS(KHASE)                                        0510
      IF (JE(1) .NE. 0)  GO TO 23
      IF (INDEX .NE. 1)  GO TO 18
      OUT(INDEX) = ELECT
      INDEX = 2
   18 IAB = ABS(JN(1))                                                 0530
      IF (JN(1))  19,23,21                                             0540
   19 DO 20  I = 1,IAB                                                 0550
      OUT(INDEX) = SPEC(4)                                             0560
   20 INDEX = INDEX + IS(4)                                            0570
      GO TO 23                                                         0580
   21 DO 22  I = 1,IAB                                                 0590
      OUT(INDEX) = SPEC(5)                                             0600
   22 INDEX = INDEX + IS(5)                                            0610
   23 IL = MIN0(INDEX-6,6)                                             0620
      IL = 1
      IU = IL + 11                                                     0630
      WRITE (29,2) KHASE, (OUT(I), I = IL,IU), NJD
      WRITE(28) (JN(L), JE(L), L = 1,7)
      IF (JAN .EQ. 2)  CALL CONVER (PARA(1),A,B,C,D,E,F,G,TL,TU)
      WRITE (28) A,B,C,D,E,F,G,TL,TU
      IF (JAN .EQ. 2)  CALL CONVER (PARA(9),A,B,C,D,E,F,G,TL,TU)
      WRITE (28) A,B,C,D,E,F,G,TL,TU
   99 CONTINUE
  100 RETURN
      END
-FOR,IS   KINDAT,KINDAT/A
      SUBROUTINE KINDAT
C . . . . THIS SUBROUTINE READS IN CHEMICAL KINETIC AND COLLISION CROSS
C . . . . SECTION DATA FOR MORE ADVANCED VERSIONS OF THE THERMOCHEMICAL
C . . . . PROGRAM.
      DIMENSION PARA(20)
      REAL JUMP
  554 FORMAT (7(F3.0,1X,A6), I2/  E12.0,F6.0,E12.0)
      DO 209  I = 1,1000
      READ (5,554) (PARA(K), K = 1,14),LBJ,BUMP,JUMP,HUMP
      IF (LBJ .NE. 1)  GO TO 556
      BUMP = -BUMP
  556 WRITE (12) (PARA(K), K = 1,14) , BUMP, HUMP, JUMP
      IF (PARA(1) .EQ. 0.)  GO TO 210
  209 CONTINUE
  210 CONTINUE
      DO 219  I = 1,1000
      READ (5,555)  VA, VB, VC
      WRITE (12) VA, VB, VC
      IF (VA .EQ. 3.) GO TO 220
  219 CONTINUE
  220 CONTINUE
```

```
  555 FORMAT (F4.0, A6, E10.0)
      RETURN
      END
-FOR,IS   BUFFER,BUFFER/A
      SUBROUTINE BUFFER (IW, PHASE, S, REDUND, JN,JE, PARA)
      DIMENSION BIN(20,35), JE(7), JN(7), PARA(18)
      IF (IW.EQ. 1)  GO TO 11
      I=I+1
      BIN(I,1) = PHASE
      GO TO(11,21,51), IW
   11 REWIND 12
      I = 0
      GO TO 99
   21 BIN(I,2) = REDUND
      BIN(I,3) = S
      DO 31  J = 1,7
      K = 3 + 2*(J-1)
      BIN(I,K+1) = JN(J)
   31 BIN(I,K+2) = JE(J)
      DO 41  J = 1,18
   41 BIN(I,J+17) = PARA(J)
      IF (PHASE .LT. 0.)  GO TO 51
      IF (I .LT. 20)  GO TO 99
      I = 0
   51 WRITE (12) ((BIN(J,K), K = 1,35), J = 1,20)
   99 RETURN
      END
-XQT
 3LI2
11NA2
19K 1
37RB2
55CS2
87FR2
 4BE2
12MG2
20CA2
38SR2
56BA2
88RA2
 5B 1
13AL2
21SC2
39Y 1
57LA2
89AC2
95U52
96U12
97U22
98U32
99U42
22TI2
23V 1
24CR2
25MN2
26FE2
27CO2
28NI2
29CU2
30ZN2
31GA2
32GE2
40ZR2
41CB2
42MO2
43TC2
```

```
44RU2
45RH2
46PD2
47AG2
48CD2
49IN2
50SN2
58CE2
59PR2
60ND2
61PM2
62SM2
63EU2
64GD2
65TB2
66DY2
67HO2
68ER2
69TU2
70YB2
71LU2
72HF2
73TA2
74W 1
75RE2
76OS2
77IR2
78PT2
79AU2
80HG2
81TL2
82PB2
90TH2
91PA2
92U 1
93NP2
14SI2
 6C 1
83BI2
51SB2
33AS2
15P 1
 7N 1
 1H 1
84PO2
52TE2
34SE2
16S 1
 8O 1
85AT2
53I 1
35BR2
17CL2
 9F 1
 2HE2
10NE2
18AR2
36KR2
54XE2
  0
2 1
3 1
4 1
5 1
6 1
7 1
```

```
8 1
9 1
102
112
122
132
142
152
162
172
182
192
202
212
222
 0
$1
*1
+1
-1
 ALUMINUM                                 (C)    26.982 AL 1                                         2-A
 .79604324E+1-.74234602E+1 .12013784E+2-.41592804E+1  298 TO 0932    1265      2-B
-.79464640E-1-.24076189E+1 .17672812E+2 .00000000     298 TO 0932    1265      2-C
 ALUMINUM                                 (C)    26.982 U4 1                                         2-D
 .79604320+01-.74234596+01 .12013784+02-.41592802+01  298 TO 0932    1265      2-E
-.79464629-01-.24076188+01 .17672811+02 .00000000     298 TO 0932    1265      2-F
 ALUMINUM, MONATOMIC                (G)    26.982 AL 1                                         4-A
 .48557431+01 .17986383-00-.84569434-01 .12009095-01  298 TO 6000    1265      4-B
 .19636010-01 .76611834+02 .45244449+02 .77999999+02  298 TO 6000    1265      4-C
 ALUMINUM  MONOCHLORIDE            (G)    62.435 AL 1CL 1                                   6-A
 .88697597+01 .17984430-00-.16823909-01 .14357672-02  298 TO 6000     964      6-B
-.57386842-01-.14046012+02 .64827267+02-.11200000+02  298 TO 6000     964      6-C
 ALUMINUM                                 (L)    26.982 AL 1                                         3-D
 .75878742+01 .11669338-03-.29586136-04 .21870895-05 0932 TO 6000    1265      3-B
 .93873461-05-.19028412-00 .17602579+02 .20720000+01 0932 TO 6000    1265      3-C
 ALUMINUM                                 (L)    26.982 U4 1                                         3-D
 .75878742+01 .11669338-03-.29586136-04 .21870895-05 0932 TO 6000    1265      3-E
 .93873461-05-.19028412-00 .17602579+02 .20720000+01 0932 TO 6000    1265      3-F
 ALUMINUM, MONATOMIC                (G)    26.982 U4 1                                         4-A
 .48557431+01 .17986383-00-.84569434-01 .12009095-01  298 TO 6000    1265      4-B
 .19636010-01 .76611834+02 .45244449+02 .77999999+02  298 TO 6000    1265      4-C
 ALUMINUM  CHLOROFLUORIDE          (G)    81.433 AL 1CL 1F  1                               7-A
 .13469642+02 .37285351-00-.10065834+00 .85780894-02  298 TO 6000     964      7-B
-.18165674-00-.12464722+03 .82534085+02-.12000000+03  298 TO 6000     964      7-C
```

Appendix H

LISTING OF PEP PROGRAM

```
      SUBROUTINE ADJUST
COMMENT.   ADJUSTS GRAM ATOM-BALANCE ERRORS BY MODIFYING THE BASIS.
CALLED BY DEFIOJ
     5COMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
     1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), DH(10), RHO(10),
     2ISERI(10), WATE(10), W1(6), W43, IG, NP, VNT(201), W47, NAMF, SER
     0COMMON /IBRIUM/ TL(200,2), TU(200,2), W3(200), VNU(200,12), QA,
     1TAU, H(200), SO(200), Y(200), JC, IR(200,2), DMU(200), VLNK(200),
     2IOJ(12), PA(200,2), RB(200,2), PC(200,2), RD(200,2), RE(200,2),
     3RF(200,2), CH(200,2), JM, W48, CP, FN, C(12,200), SPECIE(200)
      DIMENSION EP(12), X(12)
      DO 1  I = 1,IS
      EP(I) = ALP(I)
      DO 1  J = 1,N
    1 EP(I) = EP(I) - C(I,J)*VNT(J)
      DO 2  K = 1,IS
      X(K) = 0.
      DO 2  I = 1,IS
    2 X(K) = X(K) + A(I,K)*EP(I)
      DO 3  K = 1,IS
      J = IOJ(K)
    3 VNT(J) = VNT(J) + X(K)
   77 FORMAT (1P 12E10.2)
      IF (KR(16) .EQ. 0)  GO TO 99
      WRITE (6,77) (ALP(J), J = 1,IS)
      WRITE (6,77) ( EP(J), J = 1,IS)
      WRITE (6,77) (X(J)  , J = 1,IS)
   99 RETURN
      END
```

```
      SUBROUTINE BOOST(W43,SSI)
COMMENT.   COMPUTES DRAG FREE BOOST VELOCITIES FROM IMPULSE AND DENSITY.
C     IF NOT DESITED, DELETE THE CALL IN SUBROUTINE DESIGN.
      DIMENSION W42(20), W44(20)
      DATA JM/18 /
      DATA(W42(I), I = 1,18)/5.,10.,15.,25.,30.,55.,60.,69.,71.,88.,
     1  100.,150.,175.,200.,300.,1000.,3000.,5000. /
227   FORMAT(/6(F5.0,1H/F6.0)/6(F5.0,1H/F6.0)/6(F6.0,1H/F5.0))
  230 FORMAT(/43H0BOOST VELOCITIES FOR PROPELLANT DENSITY OF F8.5,
     110H  (S.G. OF F8.3, 1H))
      W48 = 1728.*W43
  123 VO = W43/.036128
      VI = SSI*32.174
      DO 127 J = 1, JM
  127 W44(J) = VI*ALOG(1.0+ W48/ W42(J))
  138 WRITE (6,230) W43, VO
      WRITE (6,227)(W42(J), W44(J), J=1,JM)
  139 RETURN
      END
```

```
      SUBROUTINE DEFIOJ
C     COMPUTES SERIAL NUMBER FOR AN OPTIMUM BASIS A LA HN BROWNE JR.
     0COMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
     1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), DH(10), RHO(10),
     2ISERI(10), WATE(10), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
     0COMMON /IBRIUM/ TL(200,2), TU(200,2), W3(200), VNU(200,12), QA,
     1TAU, H(200), SU(200), Y(200), JC, IR(200,2), DMU(200), VLNK(200),
     2IOJ(12), RA(200,2), RB(200,2), RC(200,2), RD(200,2), RE(200,2),
     3RF(200,2), CH(200,2), JM, W48, CP, FN, C(12,200), SPECIE(200)
     4,LL(200)
      CALL SLITET(1,KOOOFX)
       GO TO(7,11),KOOOFX
    7 CALL SLITE (1)
      CALL RANK(IR,W3,N)
      DO 1  I = 1,N
    1 LL(I) = 9
    2 IF = 0
      DO 6  I = 1,IS
    3 IF = IF + 1
      IF (IF-N)  9,9,8
    8 WRITE (6,10)
   10 FORMAT (17H0CANT FIND BASIS   )
      CALL EXIT
    9 DO 4  J = 1,IS
      K = IR(IF,1)
    4 A(J,I) = C(J,K)
    5 CALL LINDEP(I)
      CALL SLITET(2,KOOOFX)
      GO TO (66,3), KOOOFX
   66 LL(K) = 0
    6 IOJ(I) = K
      CALL ADJUST
   11 RETURN
      END
```

```
      SUBROUTINE DESIGN (TE,PR,HE,SYSENT,J,I)
     0COMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
     1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), DH(10), RHO(10),
     2ISERI(10), WATE(10), W1(6), W43, IG, NP, VNT(97), W47, NAME, SER
      COMMON /SCRATC/PLOT(5,100)
     0COMMON /IBRIUM/ TL(200,2), TU(200,2), W3(200), VNU(200,12), QA,
     1TAU, H(200), SU(200), Y(200), JC, IR(200,2), DMU(200), VLNK(200),
     2IOJ(12), RA(200,2), RB(200,2), RC(200,2), RD(200,2), RE(200,2),
     3RF(200,2), CH(200,2), JM, W48, CP, FN, C(12,200), SPECIE(200)
      DIMENSION TEMP(20),PRES(20),HEAT(20),VOLU(20),IPH(20)
      DIMENSION SPI(2),AST(2),PST(2),GAM(2),CF(2),EV(2),CST(2),RISP(2),
     1OEX(2),EL(2),THRT(2),TEX(2)
    1 FORMAT (4E16.6, I9)
      TEMP(I) = TE
      PRES(I) = PR
      HEAT(I) = HE
      VOLU(I) = FN*.08205*TE/PR
      IPH(I) = IPHASE(J)
      NPNTS = I
      IF (I.EQ. 1)  GO TO 99
      SPI(J+1) = 9.3294*SQRT((HEAT(1)-HEAT(2))/W27)
```

```
 10 TEX(J+1) = TEMP(2)
    AS = VOLU(2)/SQRT(HEAT(1)-HEAT(2))
    CONV = 1./1000./SQRT(8372.*W27)
    NSTART = 2
    IF (J .EQ. 0)  GO TO 21
    DO 20  LIM = 1,8
    DO 19  K = NSTART, NPNTS
    IF (NPNTS .EQ. 2)  GO TO 9
    IF (IPH(K-1) .EQ. IPH(K))  GO TO 19
    IF (ABS(TEMP(K)-TEMP(K-1)) .LT. 2.) GO TO 19
  9 TEMP(K+1) = TEMP(K)
    PRES(K+1) = PRES(K)
    HEAT(K+1) = HEAT(K)
    IPH(K+1) = IPH(K)
    VOLU(K+1) = VOLU(K)
    IPH(K) = IPH(K-1)
    NSTART = K+1
    NPNTS = NPNTS + 1
    TUP = TEMP(K-1)
    TLO = TEMP(K+1)
    PUP = PRES(K-1)
    PLO = PRES(K+1)
    HUP = HEAT(K-1)
    HLO=HEAT(K+1)
    DO 15  L = 1,10
    TEMP(K) = .5*(TUP+TLO)
    TE = TEMP(K)
    IF (TE +1. .LT. TEMP(1))  GO TO 151
    TEMP(K) = TLO
    PRES(K) = PLO
    HEAT(K) = HLO
    GO TO 16
151 IF (TE -1.  .GT. TEX(2))  GO TO 152
    TEMP(K) =TUP
    PRES(K) =PUP
    HEAT(K) =HUP
    VOLU(K) = FN*.08205*TEMP(K)/PRES(K)
    GO TO 21
152 TE=TEMP(K)
    CALL TSBAL (TE, PRES(K), HEAT(K), SYSENT,PUP,PLO)
    IVA = IPHASE(J)
    IF (IVA .NE. IPH(K-1))  GO TO 13
    IF (IVA .EQ. IPH(K+1))  GO TO 16
    TUP = TEMP(K)
    PUP = PRES(K)
    HUP = HEAT(K)
    GO TO 15
 13 TLO = TEMP(K)
    PLO = PRES(K)
    HLO = HEAT(K)
    IPH(K) = IVA
 15 CONTINUE
 16 VOLU(K) = FN*.08205*TEMP(K)/PRES(K)
    GO TO 20
 19 CONTINUE
    GO TO 21
 20 CONTINUE
 21 DO 31  L = 2,NPNTS
    CALL ONE D(HEAT(1),TEMP(L-1),PRES(L-1),HEAT(L-1),VOLU(L-1),TEMP(L)
   1,PRES(L), HEAT(L), VOLU(L), PST(J+1), ASTAR,    GT, GC, GV, LL)
    IF (PRES(L) .LT. PST(J+1))  GO TO 53
 31 CONTINUE
 53 IF (PST(J+1) .LT. PRES(L-1))  GO TO 32
    PST(J+1) = PRES(L-1)
    ASTAR = VOLU(L-1)/SQRT(HEAT(1) - HEAT(L-1))
```

```
   32 OEX(J+1) = AS/ASTAR
      GAM(J+1) = GV
      CONV = 1./1000./SQRT(9368.*W27)
      AST(J+1) = ASTAR*CONV
      CONV1 = 9.806/1000./4184./24.218
      CF(J+1)  = CONV1*SPI(J+1)/W1(5)/AST(J+1)
      EV(J+1)  = 32.174*SPI(J+1)
      RISP(J+1) = W43/.03613 *SPI(J+1)
      EL(J+1)  = (W43/.03613)**(.78)    *SPI(J+1)
      AST(J+1) = AST(J+1)*1550./.00220462
      THRT(J+1) = TEMP(L)*(PRES(L)/PST(J+1))**GT
      IF (J .EQ. 0)  GO TO 99
      CONV = CONV/CONV1
      PAST = PST(J+1)
 9875 DO 49  K = 1,100
      IF (KR(3) .NE. 0  .AND.  K .EQ. 2) GOTO9876
      PLOT(1,K) = K
      AREA = ASTAR*PLOT(1,K)
      DO 33 M  = L,NPNTS
      IF (M .GE. NPNTS)  GO TO 34
      IF (AREA .LT. VOLU(M)/SQRT(HEAT(1) -HEAT(M)))  GO TO 34
   33 CALL ONE D(HEAT(1),TEMP(M+1),PRES(M+1),HEAT(M+1),VOLU(M+1),TEMP(M)
     1,PRES(M),HEAT(M),VOLU(M),VA,VB,GT,GC,GV,LL)
   34 L = M
      PUP = PAST
      PLO = PAST/3.
      DO 43  M = 1,28
      PLOT(2,K) = .5*(PUP+PLO)
      IF ((PUP-PLOT(2,K))*(PLO-PLOT(2,K)))  35,44,44
   35 VOL  = VOLU(L)*(PRES(L)/PLOT(2,K))**(1./GV)
      GO TO (36,37), LL
   36 HE = HEAT(L) + GC*(VOL*PLOT(2,K) - PRES(L)*VOLU(L))
      GO TO 38
   37 HE = HEAT(L) + GC*ALOG(PLOT(2,K)/PRES(L))
   38 IF (AREA   VOL/SQRT(HEAT(1)-HE))  39,44,40
   39 PLO = PLOT(2,K)
      GO TO 43
   40 PUP = PLOT(2,K)
   43 CONTINUE
   44 PAST = PLOT(2,K)
      PLOT(3,K) = TEMP(L)*(PRES(L)/PLOT(2,K))**GT
      PLOT(4,K) = 9.3294*SQRT((HEAT(1)-HE)/W27)
      PLOT(5,K) = PLOT(4,K) + PLOT(2,K)*AREA*CONV
   49 CONTINUE
    2 FORMAT (1P 5E18.7)
 9876 WRITE (6,1243)
 1243 FORMAT(/    72H0IMPULSE   IS EX      T*      P*      CF    ISP*   OPT EX
     X D-ISP    A*M.    EX T)
 1245 FORMAT( F7.1,F6.4,F7.0,F7.2,F7.3,F7.1,F7.2,F7.1,F8.5,F7.0)
 1244 FORMAT(/F7.1,F8.4,F7.0,F7.2,F7.3,   7X,F7.2,F7.1,F8.5,F7.0)
      WRITE( 6,1244)SPI(1),GAM(1),THRT(1),PST(1),CF(1),        OEX(1)
     1    , RISP(1), AST(1), TEX(1)
      CST(2) = PLOT(5,1)
      WRITE(6,1245) SPI(2),GAM(2),THRT(2),PST(2),CF(2),CST(2),OEX(2)
     X,RISP(2),AST(2),TEX(2)
   24 FORMAT('0INGRED. DENSITIES ARE'/(9F8.4))
      WRITE(6,24)(RHO(I),I=1,IN)
      IF(KR(3) .GT. 0)GO TO 98
C DELETABLE NON- ASCII OUTPUT OF DATE AND TOFDAY.
      WRITE(6,23)(ISERI(I),I=2,6)
   23 FORMAT('1',5A6)
      CALL BOOST(W43,SPI(2))
   98 CONTINUE
   99 RETURN
      END
```

```
      SUBROUTINE DESNOZ
C    NOZZLE HARDWARE DESIGN ROUTINE.
     0COMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
     1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), DH(10), RHO(10),
     2ISERI(10), WATE(10), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
      COMMON /SCRATC/PLOT(5,100)
      CALL SLITET(3,ISC)
      IF (ISC .EQ. 1)  GO TO 99
   23 FORMAT('1',5A6)
      DO 49 K=1,100
      TVA=PLOT(4,K)+(PLOT(5,K)-PLOT(4,K))*(PLOT(2,K)-1.)/PLOT(2,K)
      IF(K .EQ. 26  .OR.  K .EQ. 66)WRITE(6,23)(ISERI(I),I=2,6)
      IF (K .EQ. 1  .OR.  K .EQ. 26  .OR.  K .EQ. 66)WRITE(6,2000)
2000  FORMAT('0',' EXP.','   EXIT','   EXIT','   EXIT',' OPTIMUM'
     &,' OPTIMUM',' VACUUM',' VACUUM',' SEA LV',' SEA LV'/
     $' RATIO','  PRESS','  PRESS','   TEMP',' IMPULSE',' IMPULSE'
     &,' IMPULS',' IMPULS',' IMPULS',' IMPULS'/
     &10X,'ATM','      SI','       K','      SEC','      SI','    SEC'
     &,'     SI','   SEC','     SI')
      VA=PLOT(2,K)*101.3
      VB=PLOT(4,K)*9.80621
      VC=PLOT(5,K)*9.80621
      VD=TVA*9.90621
49    WRITE(6,7777)PLOT(1,K),PLOT(2,K),VA,PLOT(3,K),PLOT(4,K),VB,
     &PLOT(5,K),VC,TVA,VD
7777  FORMAT(F6.0,F7.3,F7.1,F7.0,F8.1,F8.0,F7.1,F7.0,F7.1,F7.0)
   99 RETURN
      END
```

```
      SUBROUTINE EQUIL(TE,PR,HE,ENTR,IX)
COMMENT.   THIS ROUTINE COMPUTES CHEMICAL EQUILIBRIUM FOR A PRESSURE,
C    TEMPERATURE POINT.   OTHER OUTPUTS ARE ENTHALPY AND ENTROPY.   HEAT
C     (CP) AND MOLES OF GAS ARE AVAILABLE THRU COMMON.
C    THIS ROUTINE IS CALLED BY PEP, HBAL, SBAL, AND TSBAL.
COMMENT    UNITS ARE TE (DEG. K.) PR (ATM.) HE (CAL/SYS WT.) ENTR (CAL/D
C      /SYS. WT.)              SYSTEM WEIGHT IS W27 IN COMMON.
COMMENT.   IX IS 0 FOR FROZEN EVALUATION OF THERMODYNAMIC VARIABLES.
C       IX IS 1 FOR EQULIBRIUM EVALUATIONS (IX = 2 FOR KINETIC IN SOME VER
COMMENT.  IN ADDITION TO PRESSURE TEMPERATURE POINTS THIS ROUTINE MAY BE
C     FREELY FOR VOLUME TEMPERATURE POINTS BY USING THE FOLLOWING MODIFIE
C     CALL SEQUENCE. VNT(NP)=ALOG(.08205*TE/V))   KR(17) = 1     CALL EQU
C     (TE, PR, HE, ENTR, IX)            KR(17) = 0      PR=FN*VNT(NP)
C    V IS THE SYSTEM VOLUME IN LITERS/SYS. WT.
     0COMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
     1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), DH(10), RHO(10),
     2ISERI(10), WATE(10), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
     0COMMON /IBRIUM/ TL(200,2), TU(200,2), W3(200), VNU(200,12), QA,
     1TAU, H(200), SO(200), Y(200), JC, IR(200,2), DMU(200), VLNK(200),
     2IOJ(12), RA(200,2), RB(200,2), RC(200,2), RD(200,2), RE(200,2),
     3RF(200,2), CH(200,2), JM, W48, CP, FN, C(12,200), SPECIE(200)
      COMMON/MOON/TSTEST
      DIMENSION X(12), XM(12)
    8 FORMAT (I5,F10.0, F12.3)
    9 FORMAT (1P 10E13.4)
 1734 CALL GIBBS(TE)
      CALL FIXBAS
 1735 IF (IX - 1)  21,12,12
   12 DO 38  J = 1,IS
      X(J) = 0.
      XM(J) = 0.
      DO 31  I = 1,N
      IF (C(J,I) .EQ. 0.)  GO TO 31
      XM(J) = AMAX1(VNT(I), XM(J))
      X(J) = X(J) + C(J,I)*VNT(I)
```

```
 31 CONTINUE
    IF (ABS(ALP(J) - X(J))/XM(J)  .LT. .00001)  GO TO 38
    CALL SLITE(1)
    GO TO 39
 38 CONTINUE
 39 CALL DEFIOJ
    CALL REACT (TE)
    DO 211  I = 1,N
211 W3(I) = 50.0 -VLNK(I)
    CALL RANK(IR,W3,N)
 11 DO 22  JC = 1,20
    CALL TWITCH(PR,0)
    CALL SLITET(4,KOODFX)
     GO TO(146,17),KOOOFX
146 IF (KR(13)-1)  15,14,15
 14 WRITE (6,8)JC,TE,PR
    WRITE (6,9)(VNT(I), I = 1,N)
 15 DO 23  ICC = 1,3
 25 CALL TWITCH(PR,1)
    CALL SLITET(4,KOUCFX)
     GO TO(23,22),KOUCFX
 23 CONTINUE
 22 CONTINUE
    CALL SLITE (3)
 21 VNT(NP) = ALOG(PR/FN)
 17 CALL THERMO (TE, HE, ENTR)
    VNT(NP) = EXP(VNT(NP))
    TET = TE
    RETURN
    END

    SUBROUTINF FIXBAS
   0COMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
   1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), UH(10), RHO(10),
   2ISERI(10), WATE(10), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
   0COMMON /IBRIUM/ TL(200,2), TU(200,2), W3(200), VNU(200,12), QA,
   1TAU, H(200), SO(200), Y(200), JC, IR(200,2), DMU(200), VLNK(200),
   2IOJ(12), PA(200,2), RB(200,2), RC(200,2), RD(200,2), RE(200,2),
   3RF(200,2), CH(200,2), JM, W48, CP, FN, C(12,200), SPECIE(200)
   4,LL(200)
    IF (IG .EQ. N)  GO TO 99
    IGP = IG+1
    DO 9  J = 1,IS
    II = IOJ(J)
    IF (DMU(II) .LT. .9E+12)  GO TO 9
    DO 8  I = IGP,N
    IQ = 99
    IF (VNU(I,J) .EQ. 0.)  GO TO 8
    IQ = 88
    IF (DMU(I) .GE. .9E+12)  GO TO 8
    DO 7  K = 1,IS
    IF (K .EQ. J)  GO TO 7
    IQ = K
    IF (VNU(I,K) .NE. 0.)  GO TO 8
  7 CONTINUE
    VA = VNT(II)
    VNT(II) = VNT(I)
    VNT(I) = VA
    IOJ(J) = I
    LL(I) = 0
    LL(II) = 9
    GO TO 9
  8 CONTINUE
  9 CONTINUE
 99 RETURN
    END
```

```
      SUBROUTINE GIBBS(TE)
COMMENT.   COMPUTES INDIVIDUAL ENTHALPIES, ENTROPIES AND GIBBS FREE ENERGIES.
     0COMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
     1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), DH(10), RHO(10),
     2ISERI(10), WATE(10), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
     0COMMON /IBRIUM/ TL(200,2), TU(200,2), W3(200), VNU(200,12), GA,
     1TAU, H(200), SD(200), Y(200), JC, IR(200,2), DMU(200), VLNK(200),
     2IOJ(12), RA(200,2), RB(200,2), RC(200,2), RD(200,2), RE(200,2),
     3RF(200,2), CH(200,2), JM, W48, CP, FN, C(12,200), SPECIE(200)
1     FORMAT(3HOT=F6.0,20H  H,S-D,MU-D, 3/LINE)
2     FORMAT(3(1P3E12.4,I3,1H ) )
    3 FORMAT (10HODELETION A6, F10.4)
      THETA=TE/1000.
      DO 18 I=1,N
      TU1=TU(I,1)-10.
      TU2=TU(I,1)+10.
      TEQ=ABS(TU(I,1)-TL(I,2))
      Q=0.
      IF(TE.GE.TL(I,1).AND.TE.LE.TU(I,1)) GO TO 30
      IF(TE.GT.TL(I,2).AND.TE.LE.TU(I,2)) GO TO 31
      IF (TE .LE. 298.16) GO TO 30
      Q=1000000000000.
   31 K=2
      Y2=RA(I,K)+RB(I,K)*THETA+RC(I,K)*THETA**2+RD(I,K)*THETA**3
     1   +RE(I,K)*THETA**(-2)
      H2=(RF(I,K)+RA(I,K)*THETA+.5*RB(I,K)*THETA**2+(1./3.)*RC(I,K)
     1  *THETA**3+.25*RD(I,K)*THETA**4-RE(I,K)*1./THETA)*1000.
      SD2=CH(I,K)+RA(I,K)*ALOG(THETA)+RB(I,K)*THETA+.5*RC(I,K)*
     1   THETA**2+(1./3.)*RD(I,K)*THETA**3-.5*RE(I,K)*THETA**(-2)
      IF(TE.GE.TU1.AND.TE.LE.TU2.AND.TEQ.LE.1.) GO TO 32
      Y(I)=Y2
      H(I)=H2
      SD(I)=SD2
      GO TO 20
   32 K = 1
      Y1=RA(I,K)+RB(I,K)*THETA+RC(I,K)*THETA**2+RD(I,K)*THETA**3
     1   +RE(I,K)*THETA**(-2)
      H1=(RF(I,K)+RA(I,K)*THETA+.5*RB(I,K)*THETA**2+(1./3.)*RC(I,K)
     1  *THETA**3+.25*RD(I,K)*THETA**4-RE(I,K)*1./THETA)*1000.
      SD1=CH(I,K)+RA(I,K)*ALOG(THETA)+RB(I,K)*THETA+.5*RC(I,K)*
     1   THETA**2+(1./3.)*RD(I,K)*THETA**3-.5*RE(I,K)*THETA**(-2)
      GO TO 33
   30 K = 1
      Y1=RA(I,K)+RB(I,K)*THETA+RC(I,K)*THETA**2+RD(I,K)*THETA**3
     1   +RE(I,K)*THETA**(-2)
      H1=(RF(I,K)+RA(I,K)*THETA+.5*RB(I,K)*THETA**2+(1./3.)*RC(I,K)
     1  *THETA**3+.25*RD(I,K)*THETA**4-RE(I,K)*1./THETA)*1000.
      SD1=CH(I,K)+RA(I,K)*ALOG(THETA)+RB(I,K)*THETA+.5*RC(I,K)*
     1   THETA**2+(1./3.)*RD(I,K)*THETA**3-.5*RE(I,K)*THETA**(-2)
      IF(TE.GE.TU1.AND.TE.LE.TU2.AND.TEQ.LE.1.) GO TO 34
      Y(I)=Y1
      H(I)=H1
      SD(I)=SD1
      GO TO 20
   34 Y2=RA(I,K)+RB(I,K)*THETA+RC(I,K)*THETA**2+RD(I,K)*THETA**3
     1   +RE(I,K)*THETA**(-2)
      H2=(RF(I,K)+RA(I,K)*THETA+.5*RB(I,K)*THETA**2+(1./3.)*RC(I,K)
     1  *THETA**3+.25*RD(I,K)*THETA**4-RE(I,K)*1./THETA)*1000.
      SD2=CH(I,K)+RA(I,K)*ALOG(THETA)+RB(I,K)*THETA+.5*RC(I,K)*
     1   THETA**2+(1./3.)*RD(I,K)*THETA**3-.5*RE(I,K)*THETA**(-2)
   33 F2=-(TU(I,1)-10.-TE)/20.
      F1=1.-F2
      Y(I)=F1*Y1+F2*Y2
      H(I)=F1*H1+F2*H2
      SD(I)=F1*SD1+F2*SD2
```

```
   20 IF (Y(I) .GE. 0.)  GO TO 1888
      Q = 10000000000000.
 1888 IF (W1(3) .LT. 0.)  Q = 0.
      IF (TE .LT. 298.16) H(I)=H(I) -(298.16-TE)*Y(I)
      IF (TE .LT. 298.16) SD(I)=SD(I)- Y(I)*ALOG(298.16/TE)
   18  DMU(I) = H(I) - TE*SD(I) + Q
      IF (KR(11) - 1)  21,19,21
   19 WRITE (6,1)TE
      WRITE (6,2)(H(I),SD(I),DMU(I),I, I=1,N)
   21 RETURN
      END
```

```
      SUBROUTINE GUESS(TE,PR)
COMMENT.   THIS ROUTINE COMES UP WITH A CRUDE COMPOSITION GUESS BUT IT S
C    TO GET CALCUATIONS OFF TO A FASTER START.
      COMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
     1FIE(10,6), IE(10,6), ALP(12), W27, N, ELOK(10,5), WH(10), RHO(10),
     2ISERI(10), WATE(20), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
     3,FLOOR
      COMMON /IBRIUM/ TL(200,2), TJ(200,2), W3(200), VNU(200,12), GA,
     1TAU, H(200), SD(200), Y(200), JC, IR(200,2), DMU(200), VLNK(200),
     2IOJ(12), RA(200,2), RB(200,2), RC(200,2), RD(200,2), RE(200,2),
     3RF(200,2), CH(200,2), JM, W46, CP, FN, C(12,200), SPECIE(200)
     4,LL(200)
      FLOOR=W27/10.**(6+KR(5))
   97 DO 89  J = 1,N
      VA = 0.0
      DO 88  I = 1,IS
   88 VA = VA + SQRT(ABS(C(I,J)))
   89 W3(J) = 10.0-VA
      CALL SLITE (1)
      CALL GIBBS (TE)
      DO 14  I = 1,N
   14 VNT(I) = 0.0
      CALL DEFIOJ
  771 CALL REACT(TE)
      DO 1  I = 1,N
    1 VLNK(I) = -VLNK(I)
      CALL RANK(IR,VLNK,N)
      DO 3  I = 1,N
      J = IR(I,1)
      IF (LL(J) .LE. 0)  GO TO 3
      IF (DMU(J) .GE. .9E+12)  GO TO 3
    2 CALL SETUP(Y,XMIN,XMAX,J)
      XMIN = .50*XMAX
    6 VNT(J) = XMIN + VNT(J)
      DO 4  L = 1,IS
      K = IOJ(L)
      IF (K .EQ. 0)  GO TO 4
      VNT(K) = VNT(K) - VNU(J,L)*XMIN
    4 CONTINUE
    3 CONTINUE
    5 CALL SLITE (0)
      CALL SLITE (1)
      DO 7  I = 1,N
    7 W3(I) = VNT(I)
   27 RETURN
      END
```

```
      SUBROUTINE H BAL (TE,PR, ENTR, LL)
COMMENT.   THIS ROUTINE COMPUTES A PRESSURE ENTHALPY POINT.
C  INPUT ENTHALPY IS W1(4) IN COMMON. IT WORKS THE SAME AS FOR EQUIL (WHICH SEE)
C    A VOLUME INPUT INSTEAD OF PRESSURE WORKS THE SAME WAY AS FOR EQUIL ALSO.
     COMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
     1FIE(10,6), IE(10,4), ALP(12), W27, M, BLOK(10,5), GH(10), RHO(10),
     2ISERI(10), WATE(10), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
     COMMON /IBRIUM/ TL(200,2), TU(200,2), W3(200), VAU(200,12), GA,
     1TAU, H(200), S0(200), Y(200), JC, IR(200,2), DMU(200), VLNK(200),
     2IOJ(12), RA(200,2), RB(200,2), RC(200,2), RD(200,2), RE(200,2),
     3RF(200,2), CH(200,2), JM, W48, CP, FN, C(12,200), SPECIE(200)
      COMMON/SCRATC /HN(200,2)
  236 FORMAT (21HCRESULTS NO DAMN GOOD )
      FTU = 6000.0
      FTL=75.
   55 CALL EQUIL (TE,PR,HE,ENTR,LL)
      LIM = 20
      DO 11  I = 1,LIM
      CALL SLITET(7,KOUCFX)
       GO TO(111,200),KOUCFX
  200 IF (HE - W1(4))  201,14,202
  201 FTL = TE
      FLP = VNT(NP)
      HLP = HE
      DO 70  L = 1,N
   70 HN(L,1) = VNT(L)
      GO TO 111
  202 FTU = TE
      FUP = VNT(NP)
      HUP = HE
      DO 71  L = 1,N
   71 HN(L,2) = VNT(L)
  111 K = 1
      CF= AMAX1(1.0,CF)
      CF = AMIN1(16.0, CF)
      DT = (W1(4) - HE)/(CF*CP)
      DT= AMIN1(DT, .5*(FTU-TE))
      DT= AMAX1(DT, .5*(FTL-TE))
      TE = TE + DT
      HOLD = HE
      IF (FTU-FTL .LT. 1.)  GO TO 21
      IF (ABS(LT) .LT. .1)  GO TO 14
      CALL EQUIL (TE,PR,HE,ENTR,LL)
   11 CF = (HE - HOLD)/(CP*DT)
   13 WRITE (6,236)
      WRITE (10,236)
   21 VA = (HUP-W1(4))/(HUP-HLP)
      VB = (W1(4)-HLP)/(HUP-HLP)
      CP = 0.
      DO 22  L = 1,N
      CP = CP + VNT(L)*Y(L)
      IF (LL .NE. 1)  GO TO 14
   22 VNT(L) = VA*HN(L,1) + VB*HN(L,2)
   14 ENTR = ENTR + (W1(4) - HE)/TE
      RETURN
      END
```

```
      FUNCTION IPHASE(L)
COMMENT       THIS ROUTINE DETERMINES WHAT CONDENSED PHASES ARE PRESENT.
     0COMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
     1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), DH(10), RHO(10),
     2ISERI(10), WATE(10), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
     3,FLOOR
      IPHASE = 0
      IF (IG .EQ. N)  GO TO 99
      INC = 1
      IGP = IG+1
      DO 12  I = IGP,N
      IF (VNT(I) .LE. FLOOR)  GO TO 12
      IPHASE = IPHASE + INC
   12 INC = INC + INC
   99 RETURN
      END
```

```
      SUBROUTINE LINDEP (I)
COMMENT. THIS ROUTINE ESTABLISHES LINEAR DEPENDENCE BY THE GRAM SCHMIDT-
C   TION AND THEN INVERTS THE A MATRIX BY THE METHOD OF CONJUGATE GRADIE
     0COMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
     1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), DH(10), RHO(10),
     2ISERI(10), WATE(10), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
      DIMENSION SS(12), D(12,12)
      D(I,I) = 1.
      IF (I .GT. IS)  GO TO 887
      IF (I .EQ. 1)  GO TO 8
      IM = I -1
      DO 7  J = 1,IM
      D(J,I) = 0.
      R = 0.0
      DO 2  K = 1,IS
      IF (A(K,I) .EQ. 0.)  GO TO 2
      IF (A(K,J) .EQ. 0.)  GO TO 2
      R = R + A(K,J)*A(K,I)
    2 CONTINUE
      IF (R .EQ. 0.)  GO TO 7
      Q = R/SS(J)
      VA = 0.
      DO 3  K = 1,IS
      A(K,I) = A(K,I) - Q*A(K,J)
      IF (A(K,I) .EQ. 0.)  GO TO 3
      VA = VA + ABS(A(K,I))
    3 CONTINUE
      IF (VA .LT. .1)  GO TO 6
      DO 17  K = 1,J
   17 D(K,I) = D(K,I) - Q*D(K,J)
    7 CONTINUE
    8 SS(I) = 0.
      DO 4  J = 1,IS
    4 SS(I) = SS(I) + A(J,I)**2
    5 CALL SLITE (2)
      IF (I .LT. IS)  GO TO 6
  887 DO 13  J = 1,IS
      DO 13  K = 1,IS
      VA = 0.
      DO 12  L = J,IS
   12 VA = VA + D(J,L)*A(K,L)/SS(L)
   13 A(K,J) = VA
  871 FORMAT (7F18.6)
    6 RETURN
      END
```

```
      SUBROUTINE ONE D (HSTAG,TZ,PZ,HZ,VZ,TO,PO,HO,VO,PS,AS,GT,GC,GV,LL)
COMMENT    CONTINUITY EQUATION FOR 1 DIMENSIONAL FLOW FOR ADIABATIC (19)
C     OR ISOTHERMAL (20) MODELS.
      COMMON A(12,12),KR(20)
      IF (KR(11) .NE. 0) WRITE (6,1122)PZ,PO
      IF (KR(11) .NE. 0) WRITE (6,1128) HZ,HO
 1128 FORMAT (' HX,HO'2E14.4)
      IF (KR(11) .NE. 0) WRITE (6,1124)TZ,TO
 1124 FORMAT(' TZ,TO'2E14.4)
      IF (KR(11) .NE. 0) WRITE (6,1123)VZ,VO
 1122 FORMAT (' PX,PO'2E14.4)
 1123 FORMAT(' VZ,VO'2E14.4)
      GT = ALOG(TO/TZ)/ALOG(PZ/PO)
      GV = ALOG(PO/PZ)/ALOG(VZ/VO)
      IF (KR(11) .NE. 0) WRITE (6,1125)GV,GT
 1125 FORMAT (' GV,GT'2E14.4)
      LL = 1
      IF (ABS(TZ-TO) .GT. 3.)  GO TO 19
      LL = 2
      GC = (HO-HZ)/ALOG(PO/PZ)
      IF (KR(11) .NE. 0) WRITE (6,1127) GC,HSTAG
 1127 FORMAT (' GC,HSTAG'2E14.4)
      PSTAR = PZ*EXP(-GV/2. + (HSTAG-HZ)/GC)
      HSTAR = HZ + GC*ALOG(PSTAR/PZ)
      IF (KR(11) .NE. 0) WRITE (6,1129)PSTAR,HSTAR
 1129 FORMAT (' PSTAR,HSTAR' 2E14.4)
      VSTAR = VZ*(PZ/PSTAR)**(1./GV)
      GO TO 20
   19 GC = (HO-HZ)/(PO*VC - PZ*VZ)
      PSTAG = PZ*(1. +(HSTAG - HZ)/GC/PZ/VZ)**(GV/(GV-1.))
      PSTAR = PSTAG*(2./(GV+1.))**(GV/(GV-1.))
      VSTAR = VZ*(PZ/PSTAR)**(1./GV)
      HSTAR = HZ + GC*(PSTAR*VSTAR - PZ*VZ)
   20 AS = VSTAR/SQRT(HSTAG-HSTAP)
      PS = PSTAR
      RETURN
      END
```

```
      SUBROUTINE OUT (PR,TE,HE,ENTR,NS)
COMMENT.   COMPOSITION AND STATE VARIABLE OUTPUT ROUTINE.
      0COMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
      1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), DH(10), RHO(10),
      2ISERI(10), WATE(10), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
      3,FLOOR
      0COMMON /IBRIUM/ TL(200,2), TU(200,2), W3(200), VNU(200,12), QA,
      1TAU, H(200), SU(200), Y(200), JC, IR(200,2), DMU(200), VLNK(200),
      2IOJ(12), RA(200,2), RB(200,2), RC(200,2), RD(200,2), RE(200,2),
      3RF(200,2), CH(200,2), JM, W48, CP, FN, C(12,200), SPECIE(200)
      DIMENSION SPOT(4), VOT(4)
  102 FORMAT (/'  T(K)   T(F)   P(ATM)    P(PSI) ENTHALPY  ENTROPY    CP/CV
     X    GAS    RT/V')
  104 FORMAT (2F6.0,F8.2,F9.2,F9.2,F9.2,F8.4,F7.3,F8.3)
   44 FORMAT (4(1X,F9.5,1X,A6))
   45 FORMAT(4(1X,1PE9.2,1X,A6))
   21 FORMAT (1H )
      GAMMA = CP/(CP - 1.9871*FN)
      TF = 1.8*TE - 459.4
      VH = HE/1000.0
      PF = PR*14.70069
      WRITE (6,102)
```

```
 13 WRITE(6,104) TE,TF,PR,PF,VH,ENTR,GAMMA,FN,VNT(NP)
    WRITE (6,21)
    CALL RANK(IR, VNT, N)
    J = 1
    DO 904 II= 1,N
    I = IR(II,1)
    IF (VNT(I) .LE. FLOOR)  GO TO 904
    SPOT(J) = SPECIE(I)
    VOT(J) = VNT(I)
    J = J + 1
    IF (J .LT. 5)  GO TO 904
    IF (VOT(1) .GT. .009995)  WRITE (6,44)(VOT(K),SPOT(K),K=1,4)
    IF(VOT(1) .LE. .009995)  WRITE(6,45)(VOT(K),SPOT(K),K=1,4)
    J = 1
904 CONTINUE
    J = J -1
    IF (J .NE. 0) WRITE (6,45)(VOT(K),SPOT(K),K=1,J)
170 RETURN
    END
```

```
COMMENT.   THIS PROGRAM CONSISTS OF ROUTINES PEP, TSALT, DESNOZ, BOOST, TSBAL,
C     TABLO, TWID, SLTUP, REACT, ADJUST, RANK, OUT,STOICH, EQUIL, PUTIN,
C     DEFIOJ, CNED, IPHASE, THERMO, GIBBS, TWITCH,          HBAL, DESIGN, SEARCH,
C    LINDEP, SBAL, GUESS, TAPEB AND FIXBAS)
COMMENT.   THE MAIN PROGRAM CONTROLS THE INPUT AND OUTPUT AND ESTABLISHES THE
C   PROPELLANT THERMODYNAMIC MODEL IN THE WAY IT CALLS HBAL AND SBAL.
     0COMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
     1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), DH(10), RHO(10),
     2ISERI(10), WATE(10), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
     3,FLOOR
     0COMMON /IBRIUM/ TL(200,2), TU(200,2), W3(200), VNU(200,12), QA,
     1TAU, H(200), SD(200), Y(200), JC, IR(200,2), DMU(200), VLNK(200),
     2IOJ(12), RA(200,2), RB(200,2), RC(200,2), RD(200,2), RE(200,2),
     3RF(200,2), CH(200,2), JM, W48, CP, FN, C(12,200), SPECIE(200)
     4,LL(200)
      COMMON/MOON/TSTEST,TE,IRUN
      CALL SETCLK
      IRUN = 0
      TCH = 3000.
    6 TE= AMAX1(TCH, 500.0)
      TSTEST = 0.
      TE = AMIN1(TE,5000.)
      CALL PUT IN (LE)
C  THE NEXT STATEMENT DELETES CALCULATION WHEN INPUT ERRORS ARE FOUND.
      IF (LE .EQ. 1)  STOP
      PR = W1(5)
      IF (KR(19) .EQ. 1)  GO TO 15
      CALL GUESS (TE,PR)
   15 IF (KR(7) .EQ. 0)  GO TO 14
      TE = W1(6)
      VNT(NP) = ALOG(.08205*W1(6)/W1(5))
      CALL EQUIL (TE, PR, HE, SE, 1)
      PR = FN*VNT(NP)
      SYSENT = SE
      GO TO 114
   14 CALL H BAL (TE, PR, SYSENT, 1)
   12 TCH = TE
      HE = W1(4)
      CHN = FN
```

```
 114 CALL OUT (PR,TE,HE,SYSENT,1)
     IF (KR(1) .EQ. 1)  GO TO 8
     IF (W1(5) .GE. W1(6))  GO TO  125
     WRITE ( 6,3)
   3 FORMAT (/' WHY IS THE EXIT PRESSURE .GE. THE CHAMBER PRESSURE.')
     GO TO 8
 125 CALL DESIGN (TE, PR, HE, SYSENT, 0, 1)
     PR = W1(6)
     CALL S BAL (TE, PR, HE, SYSENT, TCH, 0)
     CALL DESIGN (TE, PR, HE, SYSENT, 0, 2)
  22 TE = .5*(TCH+TE)
  70 CALL S BAL (TE, PR, HE, SYSENT, TCH, 1)
     CALL OUT (PR,TE,HE,SYSENT,2)
     FLOOR=W27*1.E-7
     CALL DESIGN (TE, PR, HE, SYSENT, 1, 2)
     IF (KR(7) .EQ. 0)  CALL DESNOZ
     GO TO 8
     END
```

```
      SUBROUTINE PUT IN (LE)
COMMENT     INPUT ROUTINE CALLED BY MAIN PROGRAM.
CALLS ROUTINES DATE & TOFDAY (TIME OF DAY) WHICH MAY BE DELETED
C ALSO NOTE DELETABLE ROUTINES SETCLK AND LKCLKS THAT MEASURE CPU TIME
     0COMMON A(12,12), KR(20), AHAT(10,12), JAT(12), ASPEC(12), IN, IS,
     1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), DH(10), RHO(10),
     2ISERI(10), WATE(10), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
     3,FLOOR,ITAG(100),WING(10)
      COMMON/MOON/TSTEST,TE,IRUN
      DIMENSION JE(10,6), JIE(10,6),SWING(10)
      DIMENSION ATWT(100)
      DATA (ATWT(I), I = 1,100)/1.008, 4.003, 6.94, 9.013, 10.82, 12.011
     1,14.008, 16., 19., 20.183, 22.991, 24.32, 26.98, 28.09, 30.975,
     2 32.066, 35.457, 39.944, 39.1, 40.08, 44.96, 47.9, 50.95, 52.01,
     4 54.94, 55.85, 58.94, 58.71, 63.54, 65.38, 69.72, 72.6, 74.92,
     5 78.96, 79.916, 83.80, 85.48, 87.63, 88.91, 91.22, 92.91, 95.95,
     6 99., 101.1, 102.91, 106.4, 107.88, 112.41, 114.82, 118.7, 121.76,
     7 127.61, 126.91, 131.3, 132.91, 137.36, 138.92, 140.13, 140.91,
     8 144.27, 147., 150.35, 152., 157.26, 158.93, 162.51, 164.94, 167.2
     97, 168.94, 173.04, 174.99, 178.50, 180.95, 183.86, 186.22, 190.2,
     1 192.2, 195.09, 197., 220.61, 204.39, 207.21, 208.99, 210., 210.,
     2 222., 223., 226., 227., 232., 231., 238., 237., 237.,12.01,9.031,
     310.82,24.32,26.98, 253.  /
    1 FORMAT (19I1, A1, A6, I4, 5X, I5)
    2 FORMAT (5A6, 6(I3, A2), F7.0, F6.0)
222   FORMAT(5A6,6(I3,A2),F5.0,F6.0)
82    FORMAT(1X,5A6,6(I3,A2), F5.0, F6.0)
    3 FORMAT (12F6.6, A6, A2)
      CALL LKCLKS(VB)
      CALL SETCLK
      WRITE(6,8889)VB
8889  FORMAT('0(CPU'F6.2,'SECS.)')
      LE = 0
      IF (IRUN)  19,11,19
   11 WRITE (6,1200)
 1200 FORMAT('11978 VERSION OF PEP.')
7771  WRITE(6,1120)
 1120 FORMAT (/'0PUTIN OPTS, NAME, NO.OF INGRDS.(M), + NO.OF RUNS(N)')
      WRITE (6,1129)
 1129 FORMAT ('01234567890          (NAME)    M           N')
      READ (5,1)(KR(I),I =1,19),ISERI(1),ISERI(2),IN,I
     XRUN
      DO 12  I = 1,12
   12 JAT(I) = 0
      IF (KR(9) .NE. 0)  WRITE (6,1121)
```

```
1121 FORMAT ('0NOW READ IN INGREDIENT SERIAL NUMBERS ENDING UNDER V.'/'
    X     V     V     V     V     V     V     V     V     V')
      IF (KP(9) .NE. 0)  READ (5,1112) (ITAG(I),I=1,IN)
      IF(KP(9) .NE. 0) WRITE(6,1112)(ITAG(I),I=1,IN)
1112 FORMAT (10I5)
      KP=1
      REWIND 11
      READ(11,1110)VA
      DO 13  I = 1,IN
1110 FORMAT (11A6,A5)
1111 FORMAT(' '11A6,A5)
      IF (KP(9) .EQ. 0)  GO TO 1114
      K=ITAG(I)
      IF (KP .LT. K)  GO TO 1117
      REWIND 11
      READ(11,1110)VA
      KP=1
1117 DO 1113 J=KP,K
      IF(J .NE. K)READ(11,2)
      IF(J .NE. K) GO TO 1113
      READ (11,222)(BLOK(I,L),L=1,5),(JIE(I,L),JE(I,L),L=1,6)
     *,DH(I),RHO(I)
1113  CONTINUE
      KP=K+1
      GO TO 1115
1114 READ ( 5,2)(BLOK(I,J),J=1,5),(JIE(I,J),JE(I,J),J=1,6)
     *,DH(I),RHO(I)
1116 FORMAT (10A6,2X,A6,A5)
1115 DO 13 J=1,5
      IE(I,J)=JE(I,J)
  13 FIE(I,J)=JIE(I,J)
      IF (KP(10) .EQ. 0) GO TO 1201
      WRITE(6,1205),IN
1205 FORMAT('0TO CHANGE DH & RHO, TYPE COUNT(1-'I2'), DH &RHO.'/
     &'    V                V              V')
      DO 1204 J=1,IN
      READ(5,1203)I,VA,VB
1203 FORMAT(I5,2F10.0)
      IF(I .EQ. 0)GO TO 1201
      DH(I)=VA
1204 RHO(I)=VB
1201 CONTINUE
      CALL STOICH(LE)
      DO 14  I = 1,IN
      WATE(I) = 0.
      DO 14  J = 1,IS
      K = JAT(J)
  14 WATE(I) = WATE(I) + AMAT(I,J)*ATWT(K)
      CALL SEARCH(LE)
  19 CONTINUE
  16 WRITE (6,1122)
1122 FORMAT ('0READ IN CH. P, EX. P, WT1, WT2, + ETC.'/' (TO READ NEW C
    XONTROL CARD HIT CAR. RET.)')
      WRITE (6,1123)
1123 FORMAT ('       V     V     V     V     V     V     V     V     V')
      READ (5,3) W1(5), W1(6), (WING(I), I = 1,10),ISERI(3), ISERI(4)
      IF (W1(5) .EQ. 0.)  GO TO 7771
      IF (KP(2) .NE. 1)  GO TO 20
      IS = IS -1
  20 IRUN = IRUN - 1
      KR(19) = 1
      IF (WING(1) .EQ. 0.)  GO TO 120
      KR(19) = 0
      DO 21  J = 1,IS
      ALP(J) = 0.
      DO 21  I = 1,IN
```

```
   21 ALP(J) = ALP(J) + AMAT(I,J)*WING(I)/WATE(I)
      W27 = 0.
      W1(4) = 0.
      W43 = 0.
      VA = 1.
      DO 22  I = 1,IN
      SWING(I) = WING(I)
      W1(4) = W1(4) + DH(I)*WING(I)
      W27 = W27 + WING(I)
      IF (RHO(I))  25,25,24
   24 W43 = W43 + WING(I)/RHO(I)
      GO TO 22
   25 VA = 0.
   22 CONTINUE
      W43 = VA/W43  *W27
  120 IF (KR(4) .NE. 1)  GO TO 23
      IF (KR(17) .EQ. 1)  GO TO 23
      W1(5) = W1(5)/14.70069
      IF (KR(7) .EQ. 1)  GO TO 23
      W1(6) = W1(6)/14.70069
      CALL DATE(ISERI(3))
      CALL TOFDAY(ISERI(5))
   23 WRITE (6,16) (ISERI(I), I = 2,6)
   16 FORMAT('1',5A6,6X,'DH   COMPOSITION'/)
      DO 27  I = 1,IN
      DO 135 L=1,6
      IF(JIE(I,L) .EQ. 0) GO TO 136
135   CONTINUE
136   L=L-1
      IDH=DH(I)
   27 WRITE(6,83)(BLOK(I,J),J=1,5),IDH,(JIE(I,J),JE(I,J),J=1,L)
83    FORMAT(2X, 5A6, I7,2X,6(I3,A2))
      WRITE (6,5575)(SWING(II),II=1,IN),W27
 5575 FORMAT('LINGRED.WTS.&TOTAL/ GRAM ATOMS/ CHAMBER/ EXHAUST RESULTS/
     *PERFORMANCE'//(7F10.5))
      WRITE (6,301)(ALP(I),ASPEC(I),I=1,IS)
  301 FORMAT (/5(F10.6,1X,A2,1X))
      IF (KR(2) .NE. 1)  GO TO 28
      IS = IS + 1
   28 IF (LE .NE. 1)  GO TO 29
      IF (IRUN .EQ. 0)  GO TO 29
      DO 30  I = 1,IRUN
   30 READ (5,1)
      WRITE ( 6,33)
      IRUN = 0
   33 FORMAT(/' AT THIS POINT THE PROGRAM WILL ATTEMPT THE NEXT RUN.')
   29 RETURN
      END


      SUBROUTINE RANK(IR,Y,N)
COMMENT.  RANKS VECTOR Y IN DESCENDING ORDER, RANKINGS APPEAR IN IR(I,1).
      DIMENSION X(200), Y(200), IR(200,2)
      DO 1  I = 1,N
      IR(I,2) = IR(I,1)
    1 X(I) = AMAX1(Y(I), .0)
      DO 4  I = 1,N
      S = -1.0
      DO 3  J = 1,N
      IF (S - X(J)) 2,3,3
    2 IR(I,1) = J
      S = X(J)
    3 CONTINUE
      J = IR(I,1)
    4 X(J) = -1.0
      RETURN
      END
```

```
      SUBROUTINE REACT(TE)
COMMENT. THIS ROUTINE COMPUTES THE STOICHIOMETRIC COEFFICIENTS AND LOG EQUILIBRI
C    UM CONSTANTS FOR ALL REACTIONS IN TERMS OF THE CURRENT BASIS.
     0COMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
     1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), DH(10), RHO(10),
     2ISERI(10), WATE(10), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
     0COMMON /IBRIUM/ TL(200,2), TU(200,2), W3(200), VNU(200,12), QA,
     1TAU, H(200), SD(200), Y(200), JC, IR(200,2), DMU(200), VLNK(200),
     2IOJ(12), RA(200,2), RB(200,2), RC(200,2), RD(200,2), RE(200,2),
     3RF(200,2), CH(200,2), JM, W48, CP, FN, C(12,200), SPECIE(200)
      CALL SLITET(1,KOOCFX)
       GO TO(21,31),KOOCFX
   21 DO 11 K = 1,IS
      DO 11 J = 1,N
      VNU(J,K) = 0.0
      DO 1  I = 1,IS
    1 VNU(J,K) = VNU(J,K) + A(I,K)*C(I,J)
      IF (ABS(VNU(J,K)) - .0051)  10,10,11
   10 VNU(J,K) = 0.0
   11 CONTINUE
   31 VA = 1./1.9871/TE
      DO 3  I = 1,N
      VB = 0.0
      DO 2  LS = 1,IS
      IF (VNU(I,LS)) 17,2,17
   17 J = IOJ(LS)
      VB = VB + VNU(I,LS)*DMU(J)
    2 CONTINUE
      VLNK(I) = VA*(DMU(I) - VB)
    3 CONTINUE
      IF (KR(14) -1)  7,4,7
    4 WRITE (6,5)
      WRITE (6,6)(VLNK(I), I = 1,N)
      WRITE (6,8)(IOJ(I), I = 1,IS)
    8 FORMAT (10(5X,I7))
    5 FORMAT (22H0LOGS OF EQUIL CONST,S)
    6 FORMAT (1H 1PE11.4, 9E12.4)
    7 RETURN
      END
```

```
      SUBROUTINE S BAL (TE, PR, HE, SYSENT, TCH, LL)
     0COMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
     1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), DH(10), RHO(10),
     2ISERI(10), WATE(10), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
     0COMMON /IBRIUM/ TL(200,2), TU(200,2), W3(200), VNU(200,12), QA,
     1TAU, H(200), SD(200), Y(200), JC, IR(200,2), DMU(200), VLNK(200),
     2IOJ(12), RA(200,2), RB(200,2), RC(200,2), RD(200,2), RE(200,2),
     3RF(200,2), CH(200,2), JM, W48, CP, FN, C(12,200), SPECIE(200)
      COMMON/SCRATC /MN(200,2)
  236 FORMAT (21H0RESULTS NO DAMN GOOD )
      DIMENSION FAC(2)
      FTU = TCH
      FTL=75.
      LIM = 20
   88 CALL EQUIL(TE,PR,HE,ENTR,LL)
   89 CF = FAC(LL+1)
      DO 15  J = 1,LIM
      CALL SLITET(3,KOOOFX)
       GO TO(4115,210),KOOOFX
  210 IF (ENTR - SYSENT)  211,18,212
  211 FTL = TE
      FLP = VNT(NP)
      SLP = ENTR
      DO 70  L = 1,N
```

```
   70 HN(L,1) = VNT(L)
      GO TO 4115
  212 FTU = TE
      FUP = VNT(NP)
      SUP = ENTR
      DO 71  L = 1,N
   71 HN(L,2) = VNT(L)
 4115 CF= AMAX1(1.0,CF)
      CF = AMIN1(16.0, CF)
      VO = (SYSENT - ENTR)/CP/CF
      DT = TE*VO
      IF (VO)  131,133,133
  131 DT = TE*(EXP(VO) - 1.0)
  133 DT= AMIN1(DT, .5*(FTU-TE))
      DT= AMAX1(DT, .5*(FTL-TE))
  137 TE = TE + DT
      HENT = ENTR
      IF (FTU-FTL .LT. 2.)  GO TO 21
      IF (ARS(SYSENT-ENTR)/SYSENT .LT. .0001)  GO TO 18
      CALL EQUIL (TE,PR,HE,ENTR,LL)
   15 CF= ((ENTR-HENT)/(CP*ALOG(TE/(TE-DT))))
   17 WRITE (6,236)
   21 VA = (SUP-SYSENT)/(SUP-SLP)
      VB = (SYSENT-SLP)/(SUP-SLP)
      CP = 0.
      DO 22  L = 1,N
      CP = CP + VNT(L)*Y(L)
      IF (LL .NE. 1)  GO TO 18
   22 VNT(L) = VA*HN(L,1) + VB*HN(L,2)
   18 HE = HE + TE*(SYSENT — ENTR)
      FAC(LL+1) = CF
      RETURN
      END
```

```
      SUBROUTINE SEARCH(LE)
C . . . . TAPE SEARCH ROUTINE FOR THERMO DATA.
     0COMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
     1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), DH(10), RHO(10),
     2ISERI(10), WATL(10), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
     0COMMON /IBRIUM/ TL(200,2), TU(200,2), W3(200), VNU(200,12), QA,
     1TAU, H(200), S0(200), Y(200), JC, IR(200,2), DMU(200), VLNK(200),
     2IOJ(12), RA(200,2), RB(200,2), RC(200,2), RD(200,2), RE(200,2),
     3RF(200,2), CH(200,2), JM, W48, CP, FN, C(12,200), SPECIE(200)
      INTEGER S
    1 FORMAT (1H A6, I6)
    4 FORMAT (34H0 MARK. NO COMBUSTION SPECIES FOR A6,14H REVISE PEPAUX)
      IF (KR(2) .NE. 1)  GO TO 10
      IS = IS + 1
      JAT(IS) = 0
      ALP(IS) = 0.
   10 NP = 1
      CALL TAPEB (1,0,0,0)
      DO 99  LIM = 1,7777
      DO 9  I = 1,IS
    9 C(I,NP) = 0.
      CALL TAPEB (2,NP, KHASE, S)
      IF (KHASE .LT. 0)  GO TO 100
C . . . . SEE IF SPECIES BELONGS TO ELEMENT GROUP.
      IF (IE(1,1) .EQ. 0)  GO TO 99
   15 DO 18  I = 1,7
      IF (IE(I,1))16,19,16
```

```
   16 DO 17  J = 1,IS
      IF (IE(I,2) .NE. JAT(J))  GO TO 17
      C(J,NP) = IE(I,1)
      GO TO 18
   17 CONTINUE
      GO TO 99
   18 CONTINUE
   19 CONTINUE
   23 NP = NP +1
      IF (KHASE .NE. 1)  GO TO 98
      IG = NP -1
   98 IF (NP .LT. 200)   GO TO 99
      WRITE (6,5)
    5 FORMAT (51HONO. OF COMBUS. SPECIES EXCEEDS PROG. LIMIT OF 200   )
99    CONTINUE
  100 N = NP -1
      REWIND 12
      DO 50  I = 1,N
      W3(I) = 50.
      DO 50  J = 1,IS
   50 W3(I) = W3(I) - SQRT(ABS(C(J,I)))
      DO 51  J = 1,IS
      H(J) = 0.
      DO 51  I = 1,N
   51 H(J) = H(J) + ABS(C(J,I))
      DO 53  J = 1,IS
      IF (H(J))  52,52,53
   52 WRITE ( 6,4) ASPEC(J)
      LE = 1
   53 CONTINUE
      IF (KR(8) .NE. 0) WRITE (6,1124)(SPECIE(I),I=1,N)
 1124 FORMAT ('0COMPLETE SPECIES LIST FOLLOWS'/(1X,11A6))
      RETURN
      END
```

```
      SUBROUTINE SETUP(X,XMIN,XMAX, J)
COMMENT.    THIS ROUTINE DETERMINES THE MAXIMUM AND THE MINIMUM CHANGE
C   ALLOWABLE IN REACTION COORDINATE J BEFORE NEGATIVE CONCENTRATIONS ARISE.
C   IT ALSO SETS UP THE FUGACITY COEFFICIENTS FOR REACTION J IN X(J).
      DIMENSION X(30)
     0COMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
     1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), DH(10), RHO(10),
     21SERI(10), WATE(10), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
     0COMMON /IBRIUM/ TL(200,2), TU(200,2), W3(200), VNU(200,12), QA,
     1TAU, H(200), SG(200), Y(200), JC, IR(200,2), DMU(200), VLNK(200),
     2IOJ(12), RA(200,2), RB(200,2), RC(200,2), RD(200,2), RE(200,2),
     3RF(200,2), CH(200,2), JM, W48, CP, FN, C(12,200), SPECIE(200)
      XMAX = .100000000E+16
      XMIN =-.100000000E+16
      DO 9  I = 1,IS
      X(I) = 0.
      IF (VNU(J,I) .EQ. 0.)  GO TO 9
      K = IOJ(I)
      VQ = VNT(K)
      IF (IG .LT. K)  GO TO 6
    4 X(I) = VNU(J,I)
    6 IF(VNU(J,I))  3,9,7
    7 XMAX= AMIN1(XMAX, VQ/VNU(J,I))
      GO TO 9
    3 XMIN= AMAX1(XMIN, VQ/VNU(J,I))
    9 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE SLITE(J)
      DIMENSION LIT(4)
      IF (J .EQ. 0) GO TO 9
      LIT(J)=1
      GO TO 99
 9    DO 10 I=1,4
 10   LIT(I)=0
      GO TO 99
      ENTRY SLITET(J,K)
      K=2
      IF (LIT(J) .EQ. 0) GO TO 99
      K=1
      LIT(J)=0
 99   RETURN
      END
```

```
      SUBROUTINE STOICH(LE)
COMMENT PROPELLANT STOICHIOMETRY ROUTINE CALLED BY PUTIN.
COMMENT.    ALIASES.  U1= UNBURNED BERYLLIUM, U2 = UNBURNED BORON,
C         U3 = UNBURNED MAGNESIUM, U4 = UNBURNED ALUMINUM,
C     U5 = UNBURNED CARBON,   DON,T USE U6.      THESE INERTS MELT AND
C   EVAPORATE BUT DO NOT REACT.    GAS SPECIES MAY BE ELIMINATED FROM PEPAUX
C      TAPE TO PREVENT EVAPORATION.
     0COMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
     1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), DH(10), RHO(10),
     2 SERI(10), WATE(10), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
     3,FLOOR,ITAG(100),WING(10)
      DIMENSION SYMB(100)
      DIMENSION FE (10,6)
      EQUIVALENCE (FE(1,1), IE(1,1))
      DATA (SYMB(I), I = 1,100)/                                   600HH     HE
     1LI     BE     B      C      N      O      F      NE     NA     MG     AL
     2SI     P      S      CL     AR     K      CA     SC     TI     V      CR
     3MN     FE     CO     NI     CU     ZN     GA     GE     AS     SE     BR
     4KR     RB     SR     Y      ZR     NB     MO     TC     RU     RH     PD
     5AG     CD     IN     SN     SB     TE     I      XE     CS     BA     LA
     6CE     PR     ND     PM     SM     EU     GD     TB     DY     HO     ER
     7TM     YB     LU     HF     TA     W      RE     OS     IR     PT     AU
     8HG     TL     PB     BI     PO     AT     RN     FR     RA     AC     TH
     9PA     U      NP     PU     U5     U1     U2     U3     U4     FM
    1 FORMAT (8H0WHAT,S A6)
    2 FORMAT (/' INGREDIENT CARD 'I2,' GOOFED UP.')
      DO 11  I = 1,100
   11 ITAG(I) = 0
      DO 19  I = 1,IN
      DO 18  J = 1,6
      IF (FIE(I,J))  14,19,12
   12 DO 17  L = 1,100
      IF (FE(I,J) - SYMB(L))  17,13,17
   13 ITAG(L) = 1
      IE(I,J) = L
      GO TO 18
   17 CONTINUE
      WRITE ( 6,1) IE(I,J)
   14 WRITE ( 6,2) I
      LE = 1
   18 CONTINUE
   19 CONTINUE
      IS = 1
      DO 25  I = 1,100
      IF (ITAG(I))  25,25,20
```

```
 20 ASPEC(IS) = SYMB(I)
    JAT(IS) = I
    IS = IS + 1
 25 CONTINUE
    IS = IS - 1
    DO 31  I = 1,IN
    DO 26  J = 1,12
 26 AMAT(I,J) = 0.
    DO 29  K = 1,IS
    DO 28  J = 1,6
    IF (IE(I,J) - JAT(K))  28,27,28
 27 AMAT(I,K) = FIE(I,J)
    GO TO 29
 28 CONTINUE
 29 CONTINUE
 31 CONTINUE
    RETURN
    END
```

```
      SUBROUTINE TABLO(II,JJ,KK)
COMMENT.   WHEN THE BASIS IS NO LONGER OPTIMUM, THIS ROUTINE CHANGES IT BY
C     THE TABLEAU METHOD OF LINEAR PROGRAMMING.
     CCOMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
     1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), DH(10), RHO(10),
     2ISERI(10), WATE(10), W1(6), W43, IS, NP, VNT(201), W47, NAME, SER
     9COMMON /IBRIUM/ TL(200,2), TU(200,2), W3(200), VNU(200,12), QA,
     1TAU, H(200), SU(200), Y(200), JC, IR(200,2), DMU(200), VLNK(200),
     2IOJ(12), RA(200,2), RB(200,2), RC(200,2), RD(200,2), RE(200,2),
     3RF(200,2), CH(200,2), JM, W48, CP, FN, C(12,200), SPECIE(200)
     4,LL(200)
      COMMON/MOON/TSTEST,TE
  104 DO 19  L = 1,N
      IF (LL(L) .LT. 0)  GO TO 19
      IF (L .EQ. JJ)  GO TO 19
      IF (ABS(VNU(L,KK)) .LT. .0001)  GO TO 19
      VA = -VNU(L,KK)/VNU(JJ,KK)
      DO 15  M = 1,IS
   15 VNU(L,M) = VNU(L,M) + VA*VNU(JJ,M)
      VNU(L,KK) = -VA
      DO 16  M = 1,IS
      IF (ABS(VNU(L,M)) .GT. .00001)  GO TO 16
      VNU(L,M) = 0.
   16 CONTINUE
   19 CONTINUE
      DO 20  M = 1,IS
   20 VNU(JJ,M) = 0.
      VNU(JJ,KK) = 1.
      IOJ(KK) = JJ
      LL(JJ) = 0
      LL(II) = 9
      CALL REACT(TE)
      IF (KR(15) .NE. 1)  GO TO 99
      WRITE (6,999)II,JJ,KK,SPECIE(II),SPECIE(JJ)
  999 FORMAT (3I5, 3X, A6, ' REPLACED BY ', A6)
   99 RETURN
      END
```

```
       SUBROUTINE TAPEB (IW, L, PHASE, S)
COMMENT.   THIS ROUTINE BUFFERS THE INPUT FROM THE LIBRARY TAPE.  THIS SPEEDS
C   INPUT ON THE UNIVAC BUT MAY SLOW IT ON A GOOD MACHINE.
      0COMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
      1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), DH(10), RHO(10),
      2ISERI(10), WATE(10), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
      0COMMON /IBRIUM/ TL(200,2), TU(200,2), W3(200), VNU(200,12), QA,
      1TAU, H(200), SD(200), Y(200), JC, IR(200,2), DMU(200), VLNK(200),
      2IOJ(12), RA(200,2), RB(200,2), RC(200,2), RD(200,2), RE(200,2),
      3RF(200,2), CH(200,2), JM, W48, CP, FN, C(12,200), SPECIE(200)
       DIMENSION BIN(20,35)
       GO TO (11,21), IW
   11 REWIND 12
       I = 20
       GO TO 99
   21 I = I + 1
       IF (I .LT. 21)  GO TO 31
       I = 1
       READ (12) ((BIN(J,K),K = 1,35),J=1,20)
   31 PHASE = BIN(I,1)
       SPECIE(L) = BIN(I,2)
       S = BIN(I,3)
       DO 41  J = 1,7
       K = 3 + 2*(J-1)
       IE(J,1)  = BIN(I,K+1)
   41 IE(J,2)  = BIN(I,K+2)
       RA(L,1)  = BIN(I,18)
       RB(L,1)  = BIN(I,19)
       RC(L,1)  = BIN(I,20)
       RD(L,1)  = BIN(I,21)
       RE(L,1)  = BIN(I,22)
       RF(L,1)  = BIN(I,23)
       CH(L,1)  = BIN(I,24)
       TL(L,1)  = BIN(I,25)
       TU(L,1)  = BIN(I,26)
       RA(L,2)  = BIN(I,27)
       RB(L,2)  = BIN(I,28)
       RC(L,2)  = BIN(I,29)
       RD(L,2)  = BIN(I,30)
       RE(L,2)  = BIN(I,31)
       RF(L,2)  = BIN(I,32)
       CH(L,2)  = BIN(I,33)
       TL(L,2)  = BIN(I,34)
       TU(L,2)  = BIN(I,35)
   99 RETURN
       END
```

```
       SUBROUTINE THERMO(TE,HF,ENTR)
COMMENT.   COMPUTES SYSTEM ENTHALPY, ENTROPY AND HEAT CAPACITY
      0COMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
      1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), DH(10), RHO(10),
      2ISERI(10), WATE(10), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
      0COMMON /IBRIUM/ TL(200,2), TU(200,2), W3(200), VNU(200,12), QA,
      1TAU, H(200), SD(200), Y(200), JC, IR(200,2), DMU(200), VLNK(200),
      2IOJ(12), RA(200,2), RB(200,2), RC(200,2), RD(200,2), RE(200,2),
      3RF(200,2), CH(200,2), JM, W48, CP, FN, C(12,200), SPECIE(200)
       VH = 0.0
       VS = 0.0
       CP = 0.0
       DO 11  I = 1,N
       CP = CP + VNT(I)*Y(I)
       VH = VH + VNT(I)*H(I)
```

```
   11 VS = VS  + VNT(I)*SD(I)
      FN = 0.0
      VSM  = 0.0
      DO 12  I = 1,IG
      IF(VNT(I) .LE. 0.)GO TO 12
      FN = FN  + VNT(I)
      VSM= VSM+ VNT(I)*ALOG(VNT(I))
12    CONTINUE
      VSM  = 1.9871*(VSM + FN*VNT(NP))
      HE  = VH
      ENTR = VS - VSM
      RETURN
      END
```

```
      SUBROUTINE TSALT(TE,PR,HE,ENTR,PUPI,PLOI)
COMMENT.      THIS SUBROUTINE COMPUTES COMPOSITION, PRESSURE AND ENTHALPY
C     GIVEN TEMPERATURE AND ENTROPY.  IT IS CALLED BY TSBAL.
      COMMON  A (12,12),KR(20)
      COMMON/MOON/TSTEST
      TSTEST = -217.1934
      PLO  = PLOI
      PUP  = PUPI
      PR=(PUP +PLO )/2.
      DO 22  JI = 1,20
      CALL EQUIL(TE,PR,HE,SE,1)
      IF (KR(13) .NE. 0) WRITE(6,9)JI,TE,SE,PUP,PLO
    9 FORMAT (' TSBAL'I5,F8.1,3F12.3)
      IF (SE .GT. ENTR) PLO=PR
      IF (SE .LT. ENTR) PUP=PR
      PR=(PUP +PLO )/2.
  166 IF ((PUP-PLO)/PLO .LT. .00008)    GO  TO 23
   22 CONTINUE
      WRITE (6,1)
    1 FORMAT (' TSALT STOP')
      CALL SLITE (3)
   23 TSTEST = 0.
      RETURN
      END
```

```
      SUBROUTINE TSBAL(TE,PR,HE,ENTR,PUPI,PLOI)
COMMENT.      THIS SUBROUTINE COMPUTES COMPOSITION, PRESSURE AND ENTHALPY
C     GIVEN TEMPERATURE AND ENTROPY.   IT IS CALLED BY TSBAL.
     0COMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
     1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), DH(10), RHO(10),
     2ISERI(10), WATE(10), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
     0COMMON /IBRIUM/ TL(200,2), TU(200,2), W3(200), VNU(200,12), QA,
     1TAU, H(200), SD(200), Y(200), JC, IR(200,2), DMU(200), VLNK(200),
     2IOJ(12), PA(200,2), PB(200,2), RC(200,2), RD(200,2), PE(200,2),
     3RF(200,2), CH(200,2), JM, W48, CP, FN, C(12,200), SPECIE(200)
      DIMENSION X(12), XM(12)
    6 FORMAT (I5,F10.0, F12.3)
    9 FORMAT (1P 10E13.4)
      KR(18)=1
      PR=.5*(PUPI +PLOI)
 1734 CALL GIBBS(TE)
      CALL FIXBAS
   12 DO 38  J = 1,IS
      X(J) = 0.
      XM(J) = 0.
      DO 31  I = 1,N
      IF (C(J,I) .EQ. 0.)  GO TO 31
```

```
      XM(J) = AMAX1(VNT(I), XM(J))
      X(J) = X(J) + C(J,I)*VNT(I)
   31 CONTINUE
      IF (ABS(ALP(J) - X(J))/XM(J) .LT. .00001)  GO TO 36
      CALL SLITE(1)
      GO TO 39
   38 CONTINUE
   39 CALL DEFIOJ
      CALL REACT (TE)
      DO 211  I = 1,N
  211 W3(I) = 50.0 -VLNK(I)
      CALL RANK(IR,W3,N)
   11 DO 22  JC = 1,20
      PR=AMAX1(PLOI,PR)
      PR=AMIN1(PUPI,PR)
      CALL TWITCH(PR,0)
      CALL THERMO (TE,HE,STRY)
      VX=1.
      IF (JC .GT. 5) VX=2.
      IF (JC .GT. 10) VX=4.
      PR=PR*EXP(-(ENTR-STRY)/(FN*VX)/1.9871)
      CALL SLITET(4,KOCOFX)
       GO TO(146,17),KOCOFX
  146 IF (KR(13)-1)  15,14,15
   14 WRITE (6,8)JC,TE,PR
      WRITE (6,9)(VNT(I), I = 1,N)
   15 DO 23  ICC = 1,3
   25 CALL TWITCH(PR,1)
      CALL THERMO (TE,HE,STRY)
      PR=PR*EXP(-(ENTR-STRY)/(FN*VX)/1.9871)
      CALL SLITET(4,KOCOFX)
       GO TO(23,22),KOCOFX
   23 CONTINUE
   22 CONTINUE
      KR(18)=0
   18 CALL TSALT(TE,PR,HE,ENTR,PUPI,PLOI)
   17 VNT(NP)  = EXP(VNT(NP))
      RETURN
      END
```

```
       FUNCTION TWID (X)
COMMENT.   COMPUTES THE EQUILIBRIUM FUNCTION.
      0COMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPLC(12), IN, IS,
      1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), DH(10), RHO(10),
      2ISERI(10), WATE(10), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
      0COMMON /IBRIUM/ TL(200,2), TU(200,2), W3(200), VNU(200,12), QA,
      1TAU, H(200), SO(200), Y(200), JC, IR(200,2), DMU(200), VLNK(200),
      2IOJ(12), RA(200,2), RB(200,2), RC(200,2), RD(200,2), RE(200,2),
      3RF(200,2), CH(200,2), JM, W48, CP, FN, C(12,200), SPECIE(200)
       DIMENSION X(30)
       VA = 0.0
       TWID = 0.0
       DO 1  I = 1,IS
       IF (X(I) .EQ. 0.)  GO TO 1
    11 VA = VA + X(I)
       K = IOJ(I)
       IF (VNT(K) .LE. 0.) GO TO 1
   111 TWID= TWID+ X(I)*ALOG(VNT(K))
     1 CONTINUE
       TWID = TWID + VA*VNT(NP)
       RETURN
       END
```

```
      SUBROUTINE TWITCH(PR,JQ)
COMMENT.   THIS IS THE ROUTINE WHICH CONVERGES ON CHEMICAL COMPOSITION.
CALLED BY EQUIL.
      COMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
     1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), UH(10), RHO(10),
     2ISERI(10), WATE(10), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
     3,FLOOR
      COMMON /IBRIUM/ TL(200,2), TU(200,2), W3(200), VNU(200,12), GA,
     1TAU, H(200), SL(200), Y(200), JC, IP(200,2), DMU(200), VLNK(200),
     2IOJ(12), PA(200,2), RB(200,2), RC(200,2), RD(200,2), RE(200,2),
     3RF(200,2), CH(200,2), JM, W48, CP, FN, C(12,200), SPECIE(200)
     4,LL(200)
      DIMENSION X(30)
      IC = 0
      VQQ = JC -1
      VQQ = .5 - VQQ/20.
      VQQ = AMAX1(.05, VQQ)
      VC = 0.0
      IF  (KR(17) - 1)   401,402,401
  401 DO 200  I = 1,IG
  200 VC = VC + VNT(I)
      VNT(NP) = ALOG(PR/VC)
  402 DO 99  J = 1,N
      IF (LL(J) .LE. 0)  GO TO 99
      IF (JQ .NE. 0  .AND.  LL(J) .NE. 9)  GO TO 99
      KICK = 0
      VG = VQQ
    7 CALL SETUP (X, XMIN, XMAX, J)
      IF (VNT(J) .GT. 0.)  GO TO 22
      DX = - 1.001*VNT(J) + FLOOR
      GO TO 97
   22 CONTINUE
      VA = VLNK(J) - TWTU (X)
      VB = 0.0
      LL(J) = 1
      IF (J.LE.IG)  GO TO 4
COMMENT       MAJOR SPECIES TOLERANCE
    3 IF (ABS(VA).LT. 0.00008)  GO TO 99
   31 IF ( (VNT(J).GT. W27*1.E-7) .OR. (VA.LT. 0.) )  GO TO 6
      IF (VNT(J) .EQ. FLOOR)  GO TO 99
      DX = -VNT(J) + FLOOR
      GO TO 97
    4 IF (VNT(J) .EQ.0.)  GO TO 44
      IF(VA+VNT(NP) .LT. +5.)GO TO 66
      V = EXP(-VA -VNT(NP))
      XMMM = AMIN1(-XMIN, XMAX)
      IF (VNT(J)/XMMM .LT. .01) XMAX=.011*XMMM
      IF ((V+VNT(J))/XMMM .GT. .01)  GO TO 66
      GO TO 45
   44 V = FLOOR
      GO TO 5
   45 V= AMAX1(V,FLOOR)
    5 VTEQ = ABS(1. - VNT(J)/V)
COMMENT MINOR SPECIES TOLERANCE
      IF (VTEQ .LT. .0008)  GO TO 99
   55 DX = V - VNT(J)
      LL(J) = 6
      VNT(J) = V
      GO TO 82
   66 VA= VA+ ALOG(VNT(J)) + VNT(NP)
      IF (ABS(VA) - .00008)  99,99,67
   67 VB = 1.0/VNT(J)
    6 DO  69  I = 1,IS
      IF (X(I))  68,69,68
   68 K = IOJ(I)
      VB = VB + X(I)*X(I)/VNT(K)
```

```
 69 CONTINUE
    VF=0.
    IF (KR(16) .EQ. 0)  GO TO 801
    M=0
    IF (J .LE. IG) M=+1
    VS=SD(J)
    DO 800  I=1,IS
    K=IOJ(I)
    IF (K .LE. IG)  M=M -VNU(J,I)
800 VS=VS-VNU(J,I)*SD(K)
    VF=AMAX1(0., M/FN/1.9871 *VS)
    IF(VF .GT. .5*VB)  VFF=1.5
    IF (VF .GT. VB) VFF=3.
    IF (VF .GT. 1.5*VB) VFF=5.
    VF=VFF*VF
    IF (KR(12) .NE. 0) WRITE (6,802) J,M,VF,VB,PR,VA
802 FORMAT (2I6, 1P 5E17.8)
801 IF (VB.NE. 0.)  GO TO 72
 70 VB = .0000001
    VQ = .999999
 72 DX =-VA/(VB+VF)
    DX= AMAX1(DX, -VQ*VNT(J))
    LL(J) = 9
 97 DX= AMAX1(DX, VQ*XMIN)
    DX= AMIN1(DX, VQ*XMAX)
    IF (ABS(DX) .LT. .0001*VNT(J))  GO TO 81
3465 FORMAT (I5,1P 13E10.2)
 80 CALL SLITE (5)
    IC = 1
 81 VNT(J) = VNT(J) + DX
 82 VC = .90*VNT(J)
    DO 98  I = 1,IS
    IF (VNU(J,I).EQ. 0.)  GO TO 98
975 K = IOJ(I)
    VNT(K) = VNT(K) - VNU(J,I)*DX
    IF (VNT(K) .GE. VC) GO TO 98
    IF(KICK .EQ. 1  .AND.  VNT(K) .GT. VD) GO TO 98
    VD=VNT(K)
    KICK = 1
    JJ = J
    II = K
    KK = I
 98 CONTINUE
    IF (KICK .NE. 1)  GO TO 99
    CALL TABLO(II,JJ,KK)
 99 CONTINUE
100 IF (KR(15).NE.1)  GO TO 107
999 WRITE (6,88)(LL(JJ), JJ = 1,N)
 88 FORMAT (1H080I1)
107 CONTINUE
    RETURN
    END
```

Appendix I

LISTING OF THE XEP SUBROUTINES

The following listing shows routines which modify the PEP program to evaluate gaseous detonation processes. Only those routines not common to PEP appear. XEP is run the same way as PEP except:

1. Option 9, the input of ingredients by serial numbers is not allowed.
2. Ingredient densities must be inputted as grams/liter instead of lbs/in^3.
3. The first pressure in the weight ratio card is a *guess* for the detonation pressure. It must exceed the second pressure which is the pressure to which the detonation products are expanded.
4. A plot is generated by this program. The plot is only a convergence check and may be deleted.

```
      SUBROUTINE HUEO(PR,HE,V,PONE,TONE,HR,VONE,SONE,HONE)
     0COMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
     1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), DH(10), RHO(10),
     2ISERI(10), WATE(10), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
     0COMMON /IPRIUM/ TL(200,2), TU(200,2), W3(200), WNU(200,12), CA,
     1TAU, H(200), SU(200), Y(200), JC, IR(200,2), DMU(200), VLNK(200),
     2IOJ(12), RA(200,2), RB(200,2), RC(200,2), RD(200,2), RE(200,2),
     3RF(200,2), CH(200,2), JM, W48, CP, FN, C(12,200), SPECIE(200)
     4,LL(200)
      TUPP=6000.0
      TLOW=298.16
      KR(17) = 1
      VNT(NP) = ELOG(1.9871*TONE/VONE)
      CALL EQUIL(TONE,PONE,HONE,SONE,1)
      PONE = FN*VNT(NP)
      Z=HE-HONE-(VONE+V)*(PR-PONE)/2.0
      ZP = Z
      DO 8 J = 1,23
      CF= AMAX1(1.0,CF)
      CF = AMIN1(16.0, CF)
      CV = CP - 1.9871*FN
      DELTAT = +Z/CV/CF
      DELTAT=AMIN1(DELTAT,.5*(TUPP-TONE))
      DELTAT=AMAX1(DELTAT,.5*(TLOW-TONE))
      TONE = TONE+DELTAT
      IF(ABS(DELTAT)-.001)10,88,88
   88 VNT(NP) = ELOG(1.9871*TONE/VONE)
    4 CALL EQUIL(TONE,PONE,HONE,SONE,1)
      PONE = FN*VNT(NP)
      Z=HE-HONE-(VONE+V)*(PR-PONE)/2.0
      CF = ((ZP-Z)/(CV*DELTAT))
      ZP = Z
      CALL SLITET(3,KOOFFX)
       GO TO(70,74),KOOFFX
   74 IF(Z)72,10,71
   71 TLOW=TONE
      GO TO 70
   72 TUPP=TONE
   70 CONTINUE
    8 CONTINUE
   10 HONE = HONE + Z
      SONE = SONE + Z/TONE
      KR(17) = 0
      IF (V .EQ. VONE)  GO TO 903
      HR=((VONE/V)**2*HE-HONE)/((VONE/V)**2-1.0)
  903 RETURN
      END
```

```
      SUBROUTINE PUT IN (LE)
     0COMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
     1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), DH(10), RHO(10),
     2ISERI(10), WATE(10), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
      COMMON/ICINFO/AAAA(6)
      COMMON ITAG(100), WING(10)
      DIMENSION ATWT(100), SWING(10), VOUT(10)
      DATA IRUN/0 /
      DATA (ATWT(I), I = 1,100)/1.008, 4.003, 6.94, 9.013, 10.82, 12.011
     1,14.008, 16., 19., 20.183, 22.991, 24.32, 26.98, 28.09, 30.975,
     2 32.066, 35.457, 39.944, 39.1, 40.08, 44.96, 47.9, 50.95, 52.01,
     4 54.94, 55.85, 58.94, 58.71, 63.54, 65.38, 69.72, 72.6, 74.92,
     5 78.96, 79.916, 83.80, 85.48, 87.63, 88.91, 91.22, 92.91, 95.95,
     6 99., 101.1, 102.91, 106.4, 107.88, 112.41, 114.82, 118.7, 121.76,
     7 127.61, 126.91, 131.3, 132.91, 137.36, 138.92, 140.13, 140.91,
     8 144.27, 147., 150.35, 152., 157.26, 158.93, 162.51, 164.94, 167.2
     97, 168.94, 173.04, 174.99, 178.50, 180.95, 183.86, 186.22, 190.2,
     1 192.2, 195.09, 197., 200.61, 204.39, 207.21, 208.99, 210., 210.,
     2 222., 223., 226., 227., 232., 231., 238., 237., 242., 243., 247.,
     3 249., 251., 254., 253.  /
    1 FORMAT (19I1, A1, A6, I4, I5, I5)
    2 FORMAT (5A6, 6(F3.3, A2), F7.0, F6.0, I7)
    3 FORMAT (12F6.6, A6, A2)
    4 FORMAT (/1H 34X, 12A5)
    5 FORMAT (12H+INGREDIENTS 70X, 29H    WEIGHT   CAL./G.  DENSITY)
    6 FORMAT (12F10.6)
    7 FORMAT (1H )
    8 FORMAT (1H 5A6,1X, 12F5.3, F9.3, F10.0, F9.4)
    9 FORMAT (43H0GRAM ATOM AMOUNTS FOR PROPELLANT WEIGHT OF F9.3)
   10 FORMAT (1H0 12(4H    (A2,4H)    ))
      LE = 0
      IF (IPUN)  19,11,19
   11 READ (5,1) (KR(I), I = 1,19),ISERI(1), ISERI(2), IN, IT, IRUN
      DO 12  I = 1,12
   12 JAT(I) = 0
      DO 13  I = 1,IN
   13 READ (5,2) (BLOK(I,J), J= 1,5), (FIE(I,J), IE(I,J), J = 1,6),
     1 DH(I), RHO(I)
      CALL STOICH(LE)
      DO 14  I = 1,IN
      WATE(I) = 0.
      DO 14  J = 1,IS
      K = JAT(J)
   14 WATE(I) = WATE(I) + AMAT(I,J)*ATWT(K)
      CALL SEARCH(LE)
      REWIND 16
C     THE NEXT 8 CARDS CONTROL THE SC 4020 OUTPUT ON PSEUDO UNIT 16
   19 CALL CAMRAV(1)
      CALL FRAMEV
      CALL CAMRAV(2)
      CALL FRAMEV
      INC = 1019/(30 + IN + (N+3)/4)
      CALL SCOUTV(1,INC)
      CALL LOCSTV(33,1009,4)
      CALL MAXFRM(5000)
      IF (KR(6) .NE. 1)  GO TO 18
      READ (5,17)
      WRITE (16,17)
   17 FORMAT (80H
     1                                                                  )
   18 READ (5,3) W1(5), W1(6), (WING(I), I = 1,10),ISERI(3), ISERI(4)
      WRITE (6,16) (ISERI(I), I = 2,4)
   16 FORMAT (1H1 3A6)
```

```
      IF (KR(2) .NE. 1)  GO TO 20
      IS = IS -1
   20 IRUN = IRUN - 1
      KR(19) = 1
      IF (WING(1) .EQ. 0.)  GO TO 120
      KR(19) = 0
      DO 21  J = 1,IS
      ALP(J) = 0.
      DO 21  I = 1,IN
   21 ALP(J) = ALP(J) + AMAT(I,J)*WING(I)/WATE(I)
      W27 = 0.
      W1(4) = 0.
      W43 = 0.
      VA = 1.
      DO 22  I = 1,IN
      SWING(I) = WING(I)
      W1(4) = W1(4) + DH(I)*WING(I)
      W27 = W27 + WING(I)
      IF (RHO(1))  25,25,24
   24 W43 = W43 + WING(I)/RHO(I)
      GO TO 22
   25 VA = 0.
   22 CONTINUE
      W43 = VA/W43  *W27
  120 IF (KR(4) .NE. 1)  GO TO 23
      IF (KR(17) .EQ. 1)  GO TO 23
      W1(5) = W1(5)/14.70069
      IF (KR(7) .EQ. 1)  GO TO 23
      W1(6) = W1(6)/14.70069
   23 WRITE (16,4) (ASPEC(I), I = 1,IS)
      WRITE ( 6,4) (ASPEC(I), I = 1,IS)
      WRITE (16,5)
      WRITE ( 6,7)
      WRITE (16,7)
      DO 27  I = 1,IN
      IF (KR(5) .NE. 0)  GO TO 27
      WRITE ( 6,8)(BLOK(I,J), J = 1,5), (AMAT(I,J), J = 1,12),SWING(I),
     1DH(I), RHO(I)
   27 WRITE (16,8)(BLOK(I,J), J = 1,5), (AMAT(I,J), J = 1,12),SWING(I),
     1DH(I), RHO(I)
   36 FORMAT (20HCXEP VOLUME RATIOS = 10F10.5)
      SU = 0.
      DO 34  I = 1,IN
   34 SU = SU + WING(I)/RHO(I)
      DO 35  I = 1,IN
   35 VOUT(I) = WING(I)/RHO(I)/SU
      WRITE (16,36) (VOUT(I), I = 1,IN)
      WRITE ( 6,9) W27
      WRITE (16,9) W27
      WRITE ( 6,10) (ASPEC(I), I = 1,IS)
      WRITE (16,10) (ASPEC(I), I = 1,IS)
      WRITE ( 6,6) (ALP(I), I = 1,IS)
      WRITE (16,6) (ALP(I), I = 1,IS)
      IF (KR(2) .NE. 1)  GO TO 28
      IS = IS + 1
   28 IF (LC .NE. 1)  GO TO 29
      IF (IRUN .EQ. 0)  GO TO 29
      DO 30  I = 1,IRUN
   30 READ (5,1)
      WRITE ( 6,33)
      IRUN = 0
   33 FORMAT (52HOMAYBE THIS TIMID MONITOR WILL TRY THE NEXT SYSTEM.   )
   29 RETURN
      END
```

```
       SUBROUTINE PVPLOT
      0COMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
      1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), DH(10), RHO(10),
      2ISERI(10), WATE(10), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
      0COMMON /IBRIUM/ TL(200,2), TU(200,2), W3(200), VNU(200,12), QA,
      1TAU, H(200), S0(200), Y(200), JC, IR(200,2), DMU(200), VLNK(200),
      2IOJ(12), RA(200,2), RB(200,2), RC(200,2), RD(200,2), PE(200,2),
      3RF(200,2), CH(200,2), JM, W48, CP, FN, C(12,200), SPECIE(200)
      4,LL(200)
       COMMON/EXPLO/ VL(20), PL(20), VEL(20), HT(20), TET(20), NE
       CALL GRIDIV (1, .2, 1., 0., 6000., .01, 100., 10,10,10,10,2,4)
       DO 19  I = 1,NE
       IX1 = IX2
       IP1 = IP2
       IS1 = IS2
       IV1 = IV2
       IC1 = IC2
       IX2 = NXV(VL(I))
       PL(I) = PL(I)*100.
       HT(I) = HT(I)/10.
       IP2 = NYV(AMIN1(PL(I), 6000.))
       IS2 = NYV(AMIN1(HT(I), 6000.))
       IV2 = NYV(AMIN1(VEL(I),6000.))
       IC2 = NYV(AMIN1(TET(I), 6000.))
       IF (I.EQ.1)  GO TO 19
       CALL LINEV(IX1,IP1,IX2,IP2)
       CALL LINEV(IX1,IS1,IX2,IS2)
       CALL LINEV(IX1,IC1,IX2,IC2)
       IF (I .EQ. NE)  GO TO 19
       CALL LINEV(IX1,IV1,IX2,IV2)
    19 CONTINUE
       CALL APLOTV(30, VL,   PL, 9,9,1, 1HP, NLAST)
       CALL APLOTV(30, VL,  TET, 9,9,1, 1HT, NLAST)
       CALL APLOTV(30, VL,  VEL, 9,9,1, 1HV, NLAST)
       CALL APLOTV(30, VL,   HT, 9,9,1, 1HH, NLAST)
       CALL PRINTV(33, 33HVOLUME RATIO ALONG HUGONIOT CURVE, 416,6 )
       CALL APRNTV (0,-16, 61, 61H*PRESSURE X100    *TEMPERATURE    *VELO
      1CITY     *ENTHALPY /10  ,4, 592)
       RETURN
       END
```

```
CMAIN PROGRAM
      0COMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
      1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), DH(10), RHO(10),
      2ISERI(10), WATE(10), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
      0COMMON /IBRIUM/ TL(200,2), TU(200,2), W3(200), VNU(200,12), QA,
      1TAU, H(200), S0(200), Y(200), JC, IR(200,2), DMU(200), VLNK(200),
      2IOJ(12), RA(200,2), RB(200,2), RC(200,2), RD(200,2), RE(200,2),
      3RF(200,2), CH(200,2), JM, W48, CP, FN, C(12,200), SPECIE(200)
      4,LL(200)
       COMMON/EXPLO/ VL(20), PL(20), VEL(20), HT(20), TET(20), NE
       COMMON/MUON/TSTEST,TE
   770FORMAT(19H0INITIAL DENSITY = ,F12.6,6X,19HINITIAL PRESSURE = F12.6
      1/23H0DETONATION PRESSURE = ,F12.5,6X,22HDETONATION VELOCITY = ,F12
      2.5)
   660FORMAT(19H0HEAT OF REACTION =,F11.2,13X,19HPARTICLE VELOCITY =,F12
      1.2)
   330FORMAT(36H0IMPULSE FROM ISENTROPIC EXPANSION= ,F14.5)
  8888 CONTINUE
     8 CALL PUT IN (LE)
       PIN = W1(6)
       HIN = W1(4)
       VIN = 1.9871*W27/W43/.08205
```

```
      TE=3000.0
      CALL GUESS(TE,PIN)
      CALL CJDET (VMIN)
      CALL HUGO(PIN,HIN,VIN,PZERO,TE,HRZERO,VMIN,SZERO,HZERO)
      TCH=TE
      HE = HIN
  803 VWAVE=SQRT(8372.0*(HRZERO-HE)/W27)
  905 LS = 1
      CALL OUT (PZERO, TE, HZERO, SZERO, LS)
      PR = PIN
  906 WRITE(16,77)W43,PR,PZERO,VWAVE
      WRITE( 6,77)W43,PR,PZERO,VWAVE
  907 SOUNDV=SQRT(8372.0*(HRZERO-HZERO)/W27)
      PARTV=VWAVE-SOUNDV
      SYSENT=SZERO
      CALL S PAL (TE, PR, HE, SYSENT, TCH, 1)
      OHE=HE
      CALL EQUIL(298.16,PR,HE,ENTR,0)
      DHREAC = (HZERO - HE)/1000.
      WRITE(16,66)DHREAC,PARTV
      WRITE( 6,66)DHREAC,PARTV
      FSI = 9.3294*SQRT((HZERO - OHE)/W27)
      WRITE(16,33)FSI
      WRITE( 6,33)FSI
 1010 CONTINUE
      CALL PVPLOT
      GO TO 8889
      END




      SUBROUTINE CJDET (VMIN)
     0COMMON A(12,12), KR(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
     1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), DH(10), RHO(10),
     2ISERI(10), WATE(10), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
     0COMMON /IBRIUM/ TL(200,2), TU(200,2), W3(200), VNU(200,12), QA,
     1TAU, H(200), S0(200), Y(200), JC, IP(200,2), DMU(200), VLNK(200),
     2IOJ(12), RA(20[illegible]), RB(200,2), RC(200,2), RD(200,2), RE(200,2),
     3RF(200,2), C[illegible],2), JM, W48, CP, FN, C(12,200), SPECIE(200)
     4,LL(200)
      COMMON/EXPLO/ VL(20), PL(20), VEL(20), HT(20), TET(20), NE
      COMMON/MCON/TSTEST,TONE
      PIN = W1(6)
      HIN = W1(4)
      VIN = 1.9871*W27/W47/.08205
      VONE = VIN
      CALL HUGO (PIN, HIN, VIN, PONE, TONE, HRONE, VONE, SONE, HONE)
      VL(2) = 1.
      PL(2) = PONE
      VEL(2) = +1000000000000.
      HT(2) = HONE-HIN
      TET(2) = TONE
      VONE = .55*VIN
      CALL HUGO (PIN, HIN, VIN, PONE, TONE, HRONE, VONE, SONE, HONE)
      VL(1) = .55
      PL(1) = PONE
      VEL(1) = SQRT(8372.*(HRONE-HIN)/W27)
      HT(1) = HONE-HIN
      TET(1) = TONE
      NE = 2
      DL = .25
      IM = 1
      DO 19  K = 1,9
      NEM = NE-1
```

```
      DO 12   I = IM,NE
      IL = NE + 2 + IM - I
      VL(IL) = VL(IL-2)
      PL(IL) = PL(IL-2)
      TET(IL) = TET(IL-2)
      VEL(IL) = VEL(IL-2)
   12 HT(IL) = HT(IL-2)
      VL(IM+1) = VL(IM)
      PL(IM+1) = PL(IM)
      TET(IM+1) = TET(IM)
      HT(IM+1) = HT(IM)
      VEL(IM+1) = VEL(IM)
      VL(IM+2) = VL(IM+1) + DL
      VL(IM) = VL(IM+1) - DL
      IL = IM +2
      DO 15  J = IM,IL,2
      VONE = VL(J)*VIN
      CALL HUGO (PIN, HIN, VIN, PONE, TONE, HRONE, VONE, SONE, HONE)
      PL(J) = PONE
      VEL(J) = SQRT(6372.*(HRONE-HIN)/W27)
      TET(J) = TONE
   15 HT(J) = HONE - HIN
      A1 = VEL(IM+1)
      A2 = (VEL(IM+2)-VEL(IM))/2./DL
      A3 = (VEL(IM) + VEL(IM+2) - 2.*VEL(IM+1))/2./DL/DL
      VMINP = VMIN
      VMIN = VL(IM+1) - A2/2./A3
      DELP = DEL
      DEL = ABS(VMIN-VMINP)
      DO 17  I = 1,2
      IF (VEL(IM) .LT. VEL(IM+1))  GO TO 18
   17 IM = IM +1
   18 NE = NE + 2
   19 DL = DL/2.
      VMIN = VMIN*VIN
      RETURN
      END
```

Appendix J

SUBROUTINE VERSION OF PEP

By exchanging the main program and input routine with the subroutines below, one obtains a version of the program that may be made a satellite of another main program. This has been done for the final reduction program for airbreathing propulsion tests.[15]

```
      SUBROUTINE PFP3
     0COMMON A(12,12), KK(20), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
     1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), UH(10), RHO(10),
     2ISERI(10), WATL(10), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
     0COMMON /IBRIUM/ TL(200,2), TU(200,2), W3(200), VNU(200,12), QA,
     1TAU, H(200), SO(200), Y(200), JC, IP(200,2), DMU(200), VLNK(200),
     2IOJ(12), RA(200,2), RB(200,2), RC(200,2), RD(200,2), RE(200,2),
     3RF(200,2), CH(200,2), JM, W48, CP, FN, C(12,200), SPECIE(200)
     4,LL(200)
      COMMON/MOON/TSTEST,TE,IRUN
      COMMON/RESULT/SP1(2),AST(2),GAM(2),CF(2),EV(2),RISP(2),OEX(2),
     XTHRT(2),TEX(2),TCOMB,ENTH(2),ENTRO(2),GASM(2),RTV(2)
      TCH = 3467.
      TE= AMAX1(TCH, 500.0)
      TSTEST = 0.
      TE = AMIN1(TE,5000.)
      PR=W1(5)
   15 IF (KP(7) .EQ. 0)  GO TO 14
      TE = W1(6)
      VNT(NP) = ELOG(.0F205*W1(6)/W1(5))
      CALL EQUIL (TE, PF, HE, SE, 1)
      PR = FN*VNT(NP)
      SYSENT = SE
      GO TO 8
   14 CALL H BAL (TE, PR, SYSENT, 1)
   12 TCH = TE
      TCOMB=TCH
      ENTH(1)=W1(4)
      ENTRO(1)=SYSENT
      GASM(1)=FN
      RTV(1)=VNT(NP)
      GAM(1)=CP/(CP-FN*1.9871)
      GASM(2)=0.
      IGP=IG+1
      DO 1  I=IGP,N
    1 GASM(2)=GASM(2)+VNT(I)
    8 RETURN
      END
```

---

[15] Naval Weapons Center. *The Final Reduction Program for Airbreathing Propulsion Tests at T-Range, Theory and Usage*, by L. R. Cruise. China Lake, Calif., NWC, January 1978. (NWC TM 3364, publication UNCLASSIFIED.)

```
      SUBROUTINE  PUTINS(ISER,WTS)
      DIMENSION ISER(10), WTS(10)
     0COMMON A(12,12), PR(10), AMAT(10,12), JAT(12), ASPEC(12), IN, IS,
     1FIE(10,6), IE(10,6), ALP(12), W27, N, BLOK(10,5), DH(10), RHO(10),
     2ISERI(10), WATE(10), W1(6), W43, IG, NP, VNT(201), W47, NAME, SER
      COMMON ITAG(100), WING(10)
      COMMON/ILINFO/AAAA(6)
      DIMENSION ATWT(100), SWING(10)
      COMMON/MOON/TSTEST,TE,IRUN
      DATA (ATWT(I), I = 1,100)/1.008, 4.003, 6.94, 9.013, 10.82, 12.011
     1,14.008, 16., 19., 20.183, 22.991, 24.32, 26.98, 28.09, 30.975,
     2 32.066, 35.457, 39.944, 39.1, 40.08, 44.96, 47.9, 50.95, 52.01,
     4 54.94, 55.85, 58.94, 58.71, 63.54, 65.38, 69.72, 72.6, 74.92,
     5 78.96, 79.916, 83.80, 85.48, 87.63, 88.91, 91.72, 92.91, 95.95,
     6 99., 101.1, 102.91, 106.4, 107.88, 112.41, 114.82, 118.7, 121.76,
     7 127.61, 126.91, 131.3, 132.91, 137.36, 138.92, 140.13, 140.91,
     8 144.27, 147., 150.35, 152., 157.26, 158.93, 162.51, 164.94, 167.2
     97, 169.94, 173.04, 174.99, 178.50, 180.95, 183.86, 186.22, 190.2,
     1 192.2, 195.09, 197., 200.61, 204.39, 207.21, 208.99, 210., 210.,
     2 222., 223., 226., 227., 232., 231., 238., 237., 237.,12.01,9.031,
     310.82,24.32,26.98, 253.  /
      LE = 0
      IF (IRUN .NE. 0)  GO TO 19
   11 DO 12  I = 1,12
   12 JAT(I) = 0
      KP=1
      REWIND 11
      READ(11,1110)VA
      DO 13  I = 1,IN
      K=ISER(I)
      IF (KP .LT. K)  GO TO 1117
      REWIND 11
      READ(11,1110)VA
      KP=1
 1117 DO 1113 J=KP,K
 1113 READ (11,1110)(VNT(L),L=1,12)
 1110 FORMAT (11A6,A5)
      KP=K+1
 1115 CONTINUE
   13 DECODE(2,VNT)(BLOK(I,J),J=1,5),(FIE(I,J),IE(I,J),J=1,6),
     1 DH(I), RHO(I)
```

```
   2 FORMAT (5A6, 6(F3.3, A2), F5.0, F6.0, I7)
     CALL STOICH(LE)
     DO 14  I = 1,IN
     WATE(I) = 0.
     DO 14  J = 1,IS
     K = JAT(J)
  14 WATE(I) = WATE(I) + AMAT(I,J)*ATWT(K)
     CALL SEARCH(LE)
  16 IF (KR(2) .NE. 1)  GO TO 19
     IS = IS -1
  19 DO 1199 I=1,IN
1199 WING(I)=WTS(I)
  20 KR(19) = 0
     DO 21  J = 1,IS
     ALP(J) = 0.
     DO 21  I = 1,IN
  21 ALP(J) = ALP(J) + AMAT(I,J)*WING(I)/WATE(I)
     W27 = 0.
     W1(4) = 0.
     W43 = 0.
     VA = 1.
     DO 22  I = 1,IN
     SWING(I) = WING(I)
     W1(4) = W1(4) + DH(I)*WING(I)
     W27 = W27 + WING(I)
     IF (RHO(I))  25,25,24
  24 W43 = W43 + WING(I)/RHO(I)
     GO TO 22
  25 VA = 0.
  22 CONTINUE
     W43 = VA/W43  *W27
 120 IF (KR(4) .NE. 1)  GO TO 23
     IF (KR(17) .EQ. 1)  GO TO 23
     W1(5) = W1(5)/14.70069
     IF (KR(7) .EQ. 1)  GO TO 23
     W1(6) = W1(6)/14.70069
  23 DO 27  I = 1,IN
  27 IF (KR(2) .NE. 1)  GO TO 28
     IS = IS + 1
  28 CALL GUESS(2500.,50.)
  29 RETURN
     END
```

NOMENCLATURE

Note: Symbols are listed in the order of their appearance in text.

S	Number of chemical elements
N	Number of molecular species ($N \geq S$)
C	Molecular composition matrix
c_{ik}	Elements of composition matrix
$i(j)\ 1 \leq j \leq S$	A given choice of basis species
$b_{jk} = c_{i(j),k}$	Composition matrix of basis species
$n_{i(j)}$	Molar amounts
B	Optimized basis matrix
b_{jk}	Element of basis matrix
ν	Matrix of reaction coefficients
K_i	Equilibrium constant for ith reaction
g_i	Gibbs free energy for ith species
R	Gas constant (1.9871 cal/K-mole = 0.08205 ℓ-atm/K-mole)
T	Temperature
$\Delta\xi$	Small difference in reaction coordinate
n_i	Molar amounts
n_i'	New composition after adjustment of n_i
$\gamma_{i(j)}$	Phase parameter $\left\{ \begin{array}{l} 1 \text{ for gas} \\ 0 \text{ for condensed} \end{array} \right\}$ for ith species
A	$P/\sum_{i=1}^{N} = RT/V$
P	Pressure
Q_i	Guess for equilibrium constant
$f(T)$	$H(T) - H_0$ or $S(T) - S_0$ in enthalpy or entropy balance procedure
$H(T)$	Enthalpy at temperature T
H_0	Reference enthalpy
$S(T)$	Entropy at temperature T
S_0	Reference entropy
C_p	Specific heat at constant pressure
K	Degrees Kelvin
H_1, V_1, T_1, S_1, P_1	Chamber state variables
H_2, V_2, T_2, S_2, P_2	Exit plane state variables

V_1,V_2	Volume
I_{sp}	Specific impulse
g_{MKS}	Acceleration of gravity in SI units
J	Mechanical equivalent of heat
m	Mass
γ	C_p/C_v = ratio of specific heats
L	Conversion factor
γ_c	A parameter that equals γ only for a perfect gas
γ_v	Isentropic exponent (PV^{γ_v} = constant). A parameter that equals γ only for a perfect gas
$\dot{m}$	Mass flow
k	10^3 liters/m^3
ρ	Density
v	Velocity
A	Duct cross-sectional area
P^*,A^*	Nozzle throat values
C_f	Throat coefficient
C^*	Characteristic velocity
g_{FPS}	Acceleration of gravity in common units
ΔU	Ideal boost velocity
g	Acceleration due to gravity
ρ^*	Switch density

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    AIR-03P2 (1)
    AIR-03212 (2)
    AIR-320 (1)
    AIR-320C, W. Volz (1)
    AIR-330 (1)
    AIR-340B (1)
    AIR-503 (1)
    AIR-503E (1)
    AIR-510B (1)
    AIR-5108 (1)
    AIR-5109 (1)
    AIR-5203 (1)
    AIR-52032C (1)
    AIR-5312 (1)
    AIR-53232 (1)
    AIR-5332 (1)
    AIR-5351 (1)
    AIR-5366 (1)
5 Chief of Naval Material
5 Chief of Naval Material
    MAT-030 (1)
    MAT-030B (1)
    MAT-032 (1)
    NSP-27 (1)
    NSP-2731 (1)
5 Naval Sea Systems Command
    SEA-03 (1)
    SEA-031 (1)
    SEA-033 (1)
    SEA-04H (1)
    SEA-6531 (1)
3 Marine Corps Development and Education Command, Quantico (Marine Corps Landing Force Development Center)
1 Air Test and Evaluation Squadron 5
1 Fleet Analysis Center, Seal Beach (Library)
1 Naval Air Development Center, Warminster (Code 3014)
1 Naval Ammunition Depot, Hawthorne (Code 05, Robert Dempsey)
1 Naval Explosive Ordnance Disposal Facility, Indian Head
1 Naval Intelligence Support Center (OOXA, Cdr. Jack Darnell)
6 Naval Ocean Systems Center, San Diego
    Code 133 (1)
    Code 6133, R. Hagan (1)
    Code 6341
        Caraher (1)
        Rathson (1)
        Shadduck (1)
        Sorenson (1)
1 Naval Ordnance Station, Indian Head (Code FS, A. T. Camp)
1 Naval Postgraduate School, Monterey (Prof. Netzer)
1 Naval Ship Research and Development Center, Bethesda (Code 166, John F. Talbot)
5 Naval Surface Weapons Center, Dahlgren Laboratory, Dahlgren
    Code CG-33 (1)
    Code DG (1)
    Code DG-50 (1)
    Code CR-22, E. Baroody (2)
2 Naval Surface Weapons Center, White Oak
    Code 312, W. C. Ragsdale (1)
    WR-12, H. Heller (1)
1 Naval Intelligence Support Center Liaison Officer (LNN)
1 Army Materiel Readiness Command, Rock Island (DRSAR-LEM)
1 Army Missile Research and Development Command, Redstone Arsenal (AMSMI-RK, Dr. R. G. Rhoades)
4 Army Armament Research and Development Center (SMD, Concepts Branch)
1 Army Ballistics Research Laboratories, Aberdeen Proving Ground (DRDAR-TSB-S (STINSO))

2 Air Force Systems Command, Andrews Air Force Base
    DLFP (1)
    SDW (1)
1 Air Force Aero-Propulsion Laboratory, Wright-Patterson Air Force Base (RJA)
8 Air Force Armament Laboratory, Eglin Air Force Base
    DLD (1)
    DLDE (1)
    DLJW (1)
    DLMI, Aden (1)
    DLO (1)
    DLODL (1)
    DLQ (1)
    DLR (1)
1 Air Force Rocket Propulsion Laboratory, Edwards Air Force Base (MKCC)
1 Air Force Rocket Propulsion Laboratory, Edwards Air Force Base (MKP)
1 Foreign Technology Division, Wright-Patterson Air Force Base (Code PDXA, James Woodard)
5 Wright-Patterson Air Force Base
    AFAPL
        RJA (1)
        RJT (1)
    STINSO (1)
    XRDP (1)
    XRHP (1)
1 Defense Advanced Research Projects Agency, Arlington
12 Defense Documentation Center
1 Department of Defense Explosives Safety Board, Alexandria (6-A-145)
1 Lewis Research Center (NASA), Cleveland
1 Aluminum Corporation of America, Alcoa Center, PA (W. E. Wahnsiedler)
1 Applied Physics Laboratory, JHU, Laurel, MD (W. B. Shippen)
1 Atlantic Research Corporation, Gainesville, VA (Phillip H. Graham)
1 Beech Aircraft Corporation, Wichita, KS
1 Convair Division of General Dynamics, San Diego, CA
1 Ford Motor Company, Dearborn, MI (C. J. Litz, Jr.)
1 Grumman Aerospace Corporation, Bethpage, NY
1 Holex, Inc., Hollister, CA (Howard Dilts)
1 Honeywell Corporate Research Center, Bloomington, MN
1 Hughes Aircraft Company, Culver City, CA
1 Hughes Aircraft Company, Missiles Systems Division, Canoga Park, CA
1 MBA Associates, San Ramon, CA (Glen Hopkins)
1 McDonnell Douglas Corporation, St. Louis, MO (J. L. Bledsoe, Dept. E241)
1 Marquardt Corporation, Van Nuys, CA
1 Martin-Marietta Corporation, Orlando, FL
1 Montana Energy and MHD Research and Development Institute, Inc., Butte, MT
1 North American Rockwell Corporation, Columbus, OH (R. C. Wykes)
1 Olin Corporation, Energy Systems Division, Marion, IL (I. L. Markovitch)
1 Ryan Aeronautical Company, San Diego, CA
1 The Boeing Company, Seattle, WA
1 United Aircraft Corporation, East Hartford, CT (Research Laboratories, R. L. O'Brien)
1 United Technologies, Chemical Systems Division, Sunnyvale, CA (T. D. Meyers)
85 Chemical Propulsion Mailing List No. 271 dated October 1975, including categories 1, 2, 3, 4, 5

Attachment O

ARMY RESEARCH LABORATORY

COMBIC, Combined Obscuration Model for Battlefield Induced Contaminants:

Volume 1—Technical Documentation and Users Guide

Alan Wetmore and Scarlett D. Ayres

ARL-TR-1831-1

August 2000

ARMY RESEARCH LABORATORY

COMBIC, Combined Obscuration Model for Battlefield Induced Contaminants:

Volume 2—Appendices

Alan Wetmore and Scarlett D. Ayres

ARL-TR-1831-2 August 2000

Approved for public release; distribution unlimited.

Attachment P

Combined Obscuration Model for Battlefield Induced Contaminants (COMBIC92) Model Documentation

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May 17, 1997

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1. Introduction

There is a need to quantify the effects of obscurants on transmission of the visible through infrared wavelengths for the realistic battlefield in order to determine the effectiveness of electrical optical (EO) sensors. The Combined Obscuration Model for Battlefield Induced Contaminants (COMBIC) was developed by the U.S. Army Research Laboratory Battlefield Environment Directorate (ARL-BED) formerly known as the Atmospheric Sciences Laboratory (ASL) to meet this goal. The COMBIC computer simulation predicts spatial and temporal variation in transmission produced by various munitions and vehicles. COMBIC models the effects of reduction in electromagnetic energy (visible through infrared (IR) wavelengths) by combining the munition characteristics with meteorological information of an idealized real world. It produces transmission histories at any of seven wavelength bands for a potentially unlimited number of sources and lines of sight (LOS). COMBIC was designed to be computationally fast without losing accuracy for wargame modeling applications. This was a very major concern in the early development of the model and had a big influence on the approach. Several wargaming models use the COMBIC model to play smoke in the battlefield.

Computations are performed in two phases. First, a cloud history file is preprocessed "off-line" for one or more obscurant source types selected from a menu or defined through user inputs. Except for wind direction, all meteorological influences are included in these "Phase I" calculations of transport, rise, and diffusion of the obscurant clouds. Additional effects of the atmosphere on aerosol properties are also included. Four dimensional clouds (space and time) are compressed to tables of two-dimensional subcloud profiles (about 370 values per subcloud based upon downwind distance from source and time). The total cloud for each user-selected source that goes into the history file can contain up to five subclouds. Data stored for each of 60 non-equally spaced downwind distances for each subcloud are: cloud centroid height for average heat production; cloud dimensions (gaussian sigmas) and tilt (puffs); and time required to reach each downwind distance. Total obscurant produced up to a given time is stored every second.

In separate, "Phase II" calculations, COMBIC builds a user-defined scenario of smoke and dust sources. By table lookup and scaling of Phase I histories, cloud concentrations at any given time are computed. Path-integrated concentration is determined for each observer-target pair (LOS), and transmittance are computed at each of seven wavelength bands for (in principle) any scenario which is defined by multiple sources and active LOS. Phase II emphasizes computation speed. Efficient techniques are used to determine the path-integrated cloud concentrations over each LOS. A filtering process ignores clouds which do not contribute to the integral. Bookkeeping functions add target-observer pairs, as specified, add new sources to the scenario, and remove dissipated clouds. Phase II also uses scaling laws to model moving sources which have different speeds and directions but which share a common cloud history produced by Phase I.

1.1 Format of the COMBIC Model Document

following chapters give model methodologies, terminology, error messages, descriptions, evaluations, coding, and usage guidance for the COMBIC model. Chapter 2 provides a brief overview of the theory behind the COMBIC model. Chapter 3 gives error diagnostic messages and a summary of the evaluation effort for the model. Chapter 4 documents use of the code, input and output records as well as modifications to the code the user might want to make. Chapter 5 provides several examples and subroutine descriptions. Appendix A and B provide extensive technical documentation and derivations. Appendix C provides a listing of the default parameters that go into modeling the munitions. Appendix D is a simple flowchart that can aid the user in determining Pasquill stability given only windspeed, cloud cover and time of day.

Section 2.3 is a guide to the terminology, definitions of variables, and geometry conventions used in the model and documentation. It is particularly useful to new users who are unfamiliar with the meaning of the model input parameters.

Chapter 4 contains information useful to the user and to the programmer who must interface, modify, or implement the code. The section provides reference tables of the COMBIC input parameters.

Section 5.2 provides complete examples. These can be used to gain a sense of the types of output and as a means to determine if the user's code is running properly. Other sections in this chapter contain subroutine descriptions and the programming techniques used for "bookkeeping" of clouds and observer-target pairs. Guidance is given to modify the code to process excessively large number of clouds or large number of LOS.

Appendix A.1 and A.2 develop the mathematical framework on which the compact cloud history tables are based. The derivation of the efficient path integration methods used in Phase II is given there.

Appendix A.3 through A.5 contain the models used to determine the cloud expansion with time (diffusion), the vertical rise (buoyancy and momentum), and the meteorological model. The meteorological model determines microscale parameters and the windspeed profile with height. These sections contain derivations and/or empirical representations which are also probably not of great interest to the casual user.

Sections B.1 and B.2 of appendix B contain the aerosol properties models and the munition characteristics that initialize cloud descriptions. Built-in models which translate user inputs into micro-physical parameters used in the cloud models are also documented in these sections.

1.2 Availability of COMBIC

COMBIC92 is part of EOSAEL92. EOSAEL92 is available to U.S. Department of Defense, specified allied organizations, and their authorized contractors at no cost. DoD agencies needing COMBIC92 should send a letter of request, signed by a branch chief or division director, to ARL. Contractors should have their DoD contract monitor send the letter of request. Allied organizations must request COMBIC92 through their national representative.

Please include, within security restrictions, your intended use(s). Also, indicate what type of nine-track tape your computer can read. We can make "ASCII" tapes and UNIX "tar" format tapes in either 1600 or 6250 bpi. We can't supply

COMBIC92 or any part of EOSAEL92 on other media. Documentation for the modules is included.

We encourage suggestions and the reporting of errors. Users can contact Ms. Scarlett Ayres or Dr. Robert Sutherland (505-678-4520; Autovon 258-4520) for source characteristics. Users can also contact Ms. Scarlett Ayres (505-678-4350; Autovon 258-4350) for applications and code usage concerning technical aspects of the model, and Dr. Alan Wetmore (505-678-5563; Autovon 258-5563) for EOSAEL applications, distribution, and documentation.

Check on Phine numbers

1.2.1 Mailing Address

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2. Background

2.1 Model Capabilities

Significant amounts of airborne dust, smoke, and debris add to the battlefield environment. Resulting reduction in transmission of electromagnetic energy at visual, near-, mid-, and far-infrared wavelengths affects performance of many electro-optical systems. Freshly produced high explosive (HE) dust momentarily reduces millimeter wave (MMW) transmission. COMBIC predicts spatial and time variation in transmission through dust raised by HE and vehicular motion; screening smoke from white phosphorus (WP), red phosphorus (RP), WP wicks and wedges, and plasticized WP (PWP); hexachloroethane (HC) smoke; smoke plumes from diesel-oil fires; fog oil or SGF2 (Standard Grade Fuel Number 2.), vaporized diesel fuel (DF), polyethylene glycol (PEG200) and IR screener disseminated from generators.

The barrage option produces simplified, continuous, and extended sources in place of individual rounds. Moving sources, producing a continuous obscurant cloud (vehicular dust, moving smoke generators, and even moving barrage sources) can be specified with different speeds and directions. The model provides a menu of various obscurants and allows the user to define the basic properties of sources not stored in the code menus.

Execution speed, modeled cloud detail, and prediction accuracy are all competing design criteria in obscuration codes. COMBIC seeks a reasonable balance between these factors. COMBIC was an outgrowth of earlier EOSAEL models [D. W. Hoock and Clayton, 1984; Duncan, 1982], but it has a greater emphasis on reducing computation time for large scenarios. This led to a separation of calculations into two parts or "phases." The first phase concentrates on accuracy and details of the physical processes acting on single obscurant clouds. The second phase is designed to be fast and to make efficient use of results from the first phase to simulate large obscuration scenarios.

COMBIC was designed in part around the natural decrease in detail or resolution with distance from a source. For example, the most rapid spatial and time changes in cloud concentration and cloud rise occur nearest the source. At large downwind distances, changes take place more slowly and over larger spatial scales. This has been taken into account in defining the grid over which cloud properties are computed and stored. As a further example, the user is given some control over execution and resolution tradeoffs. The barrage option groups multiple sources impacting over a period of time in some limited area, and computation time is reduced. But this simplification is at the expense of the detail which can be had by specifying individual source locations and times.

Obscurant clouds are modeled in COMBIC as combinations of subclouds having concentrations described by Gaussian instantaneous puffs and continuous plumes. Subclouds move downwind, expand, and perhaps rise due to buoyancy. Figure 2.1 show an example of a typical smoke cloud modeled as a combination of a plume and a puff. Wind shear, temperature gradients, relative humidity, surface roughness and wind speed and direction can all have an effect on how the cloud rises and expands downwind. Optical properties are defined in terms of extinction per unit mass concentration for the material in each subcloud. Thus, transmittance includes the combined effect of extinction along the observer-target path for every subcloud along that path. Output includes the predicted transmittance at each of the seven EOSAEL wavelength regions and the Concentration Length (CL, the integral of the concentration over the path length through the cloud) for each specified observer-target pair at each specified output time. The user can also manipulate the inputs to produce optical depth and concentrations.

COMBIC is usually executed in two phases through separate submodules. The driver routine is the branch point at which these execution paths split. It is thus relatively easy to separate COMBIC into completely independent "Phase I" and "Phase II" modules if needed.

Phase I uses meteorological input data and obscurant source characteristics selected from a menu or input by the user. A history file is produced which describes the evolution of the obscurant cloud for the source types and specified meteorology selected. These tabulated values are all relative to the source location and are independent of wind direction or scenario-specified source location and detonation time. The generated history file is defined as direct access, (that is, record-addressable) to reduce access time to the tables. This change is compatible with FORTRAN 77. Because, both Phase I and Phase II are run on the user's system, the precise internal format of direct access files on the user's system is irrelevant to COMBIC. Phase I contains the bulk of code usually associated with the physical processes modeled in obscuration codes.

In principle, Phase II produces transmittance histories for scenarios containing any number of target-observer pairs and any number and combination of obscurant sources from among the types precomputed in the Phase I output file.

The Phase II code has four major functions.

- First, storage arrays are loaded with the locations of active observer-target pairs and obscurant sources specified by the user. Storage can optionally be reused as observer-target pairs become inactive and as clouds dissipate.
- A second function is interpolation and scaling of the Phase I cloud histories. Scaling allows the Phase I history to serve for a limited range of source strengths different from the single value specified in Phase I inputs. For example, a history computed in Phase I for six 155-mm WP rounds detonated at the same point and time can be used in Phase II calculations for cases of 2 to 12 rounds. A single "one case fits all" Phase I calculation is not possible due to variation in buoyant rise from the heat produced by groups of closely spaced smoke or HE munitions.
- The third function of Phase II is to update cloud dimensions with time and to apply simple tests to determine which clouds contribute to a given observer–target line of sight (LOS).
- The final function is to compute the path–integrated concentration and transmittance along the LOS. Phase II accepts arbitrary scenario times since all calculations requiring iteration by small time increments are performed in Phase I.

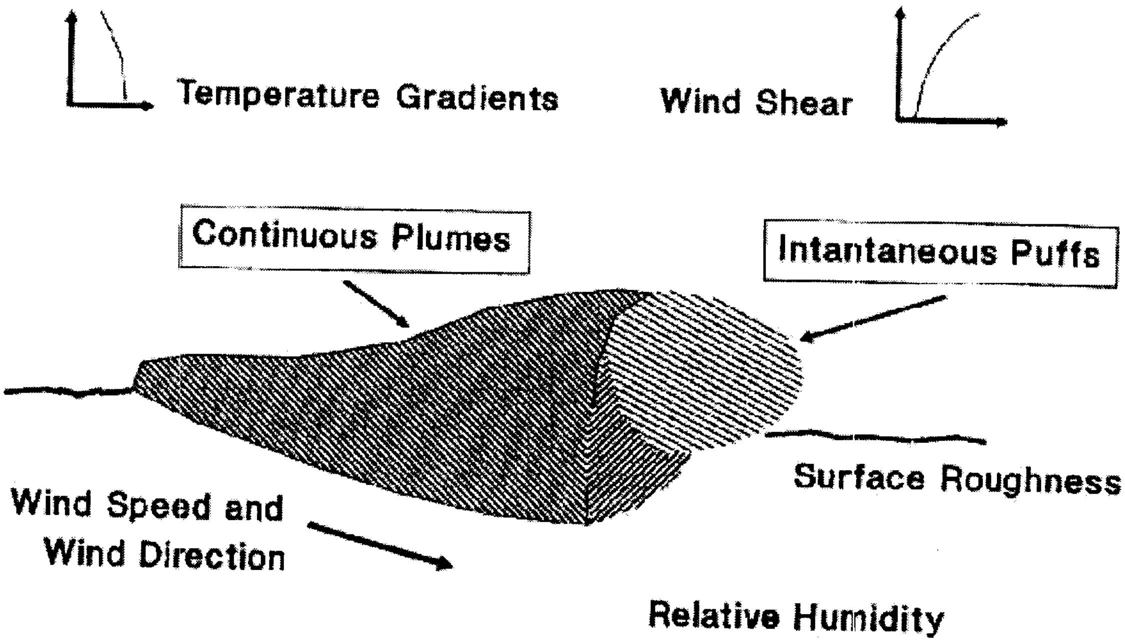


Figure 2.1: Typical smoke cloud and some of the items which effect it.

2.2 Model Changes and Extensions

Users of the previous EOSAEL 87 version of COMBIC, will note a few changes in this latest revision. Extensions to the obscurant sources in COMBIC for EOSAEL 87 include the addition of extinction coefficients for graphite. Several new munitions have been added like the M76 IR grenade, L8A1 and L8A3 grenades and CBU88 munition. The characteristics of these munitions are stored in the model menus. The COMBIC model also now has the capability of modeling the dust produced by muzzle blasts. Anyone, who has seen large artillery fired knows that in the process of firing, dust is lofted into the atmosphere. Questions arose in 1990, if the dust produced by muzzle blasts can effect transmission of electro-magnetic energy. ARL-BED was requested by the user community to include muzzle blasts as a source of obscuration. One of the examples included in this report shows muzzle blast.

Smoldering is also included in the input records used to define a munition. Smoldering results when the smoke munition produces a comparatively small amount of smoke for a large amount of time. Smoldering is controlled by COMBIC with the record SMOU which allows for obscurant burn rate modification for smoldering munitions. The records specifies when smoldering occurs and how fast the smoke production decays. This change was included in EOSAEL87, however, it was not included in the EOSAEL87 documentation.

A subroutine was added to COMBIC87 Phase II to generate printer plots of transmittance or optical depth for what amounts to bundles of parallel LOS surrounding an input observer-target pair. This output option is very useful for displaying the cloud shape and dimensions in a graphic form and for examining screen coverage and concentration patterns. Paths producing transmittance or optical depth within user-assigned bands are given corresponding symbols which defines a grey scale and are printed. Thus, a form of contour printout is generated. Many users have requested modifications to these printer plots. Some of the modifications are included in COMBIC92. They are:

- COMBIC87 would always label the axis so the origin was at the center. This often did not reflect the battlefield the user had created. Now the user has the option of defining the axis numbering.
- The grey scale in COMBIC87 was always evenly spaced. Often, the user wanted to see a very fine grey scale where the cloud was very dense and a coarse grey scale where the cloud was very thin. COMBIC92 allows the user the option of adjusting the grey scale to suit their purposes. This option is valid only when the grey scale is transmission.
- In COMBIC87, all the LOS that made the printer-plot were parallel to each other. Thus, the printer plot was an orthrographic representation of the smoke. However, it is more realistic to include a perspective view of the smoke. In COMBIC92, the user can request the perspective view, in which case, all LOS originate at the observer.

The modeling of diffusion in the planetary boundary layer is now approached using a distance-related Lagrangian weighted function instead of a power law based upon the downwind distance for distances greater than that traveled by the cloud after 30 s. For lesser distances, the usual power law methodology is used. The new dispersion lengths formula described in section A.3 results in higher but narrower puffs and plumes with higher concentration along the center. Also, a Pasquill category G is added to the Pasquill categories A-F. G represents a highly stable atmosphere with wind.

The most significant change occurs in the methodology used to compute the CL integral of LOS-cloud pairs through plumes. The Romberg method of integration is used to increase the speed of the COMBIC runs. As many as ten thousand LOS-cloud pairs in a scenario are not unusual. To determine the reduction in transmission requires the computation of CL, the integral over the optical path of the mass concentration. Mathematical/computer models are available which describe CL quite accurately, but with many LOS-cloud pairs, the computation time can be prohibitive. COMBIC was designed to give the user a balance between speed and accuracy. This revision of COMBIC, is designed to further increase the speed of computation of CL for plumes of aerosol concentration over electro-optical paths which have nonnegligible downwind components. This revision provides the user with the option of specifying three values: the percentage of error which can be tolerated, a low threshold value, and a high threshold value beyond which further computation of CL is unnecessary for the user's application. Each of these values is used by COMBIC to monitor the integration process for determining the point at which computation of CL can be terminated. Choice of these parameters for optimum speed and desired accuracy will require experimentation by the user.

2.3 Terminology, Definitions, and Conventions

This section is included to help those unfamiliar with obscuration models to become familiar with the terminology and to provide a sense of what the model can do and cannot do. The section does not assume any deep background in physics or mathematics, although a few basic mathematical formulas are given which show the way that the physical quantities interact. It answers many of the questions most often asked by new users of the COMBIC model. Further guidance on usage is given in chapters 4 and 5.

The purpose of COMBIC is to provide representative values of transmittance. Transmission is the process of moving an electromagnetic signal or electromagnetic energy between two points, in this case, through an aerosol-laden atmosphere. Transmittance is the quantity which defines the fraction of the original energy which is left in the beam after passing along the optical path. The optical path is often referred to as a "line of sight" or LOS. This is used purely as a geometric term meaning a straight line between some initial point (the observer) and a final point (the target). The term LOS is also used in some combat models, however, to represent a path with a clear view unobstructed by terrain. COMBIC does not determine if terrain intercepts an optical path. This is left to other models. In addition, the term LOS does not imply that someone looking from one end of the line to the other will necessarily be able to "see" something at the other end. That is, of course, the purpose of computing transmittance by the model. COMBIC includes only the transmission reductions by obscurant aerosols. Natural gases, haze, rain, etc. must be included from other EOSAEL modules.

Energy is removed from a propagating beam through scattering of the energy out of the LOS and by absorption of energy along the LOS. The combination of both processes is called extinction. COMBIC uses a "mass extinction coefficient" which is a single number which describes the extinction encountered in traversing 1 m of an aerosol cloud which has a concentration of 1 g/m^3. The mass extinction coefficient is wavelength dependent and is different for each type of aerosol. Transmittance is determined by the "Beer-Lambert" law:

$$T = e^{-\alpha CL} \tag{2.1}$$

where T is the transmittance, α is the mass extinction coefficient, in units of m^2/g, and "CL" is the combined product, or more properly, the integral, of the aerosol concentration C (g/m^3) over the optical path length L (m). "CL" or the "CL product" are terms often encountered in the study of obscuration and in test reports of the measured ability of an aerosol to reduce transmission . CL is in units of g/m^2. The product αCL is itself dimensionless and is called the "optical depth," or "optical thickness" of the path through the aerosol. T is a fraction between 0 and 1 and has no physical units. Thus, a transmittance T of 0.35 means that 35 percent of the original energy will remain after passing along that particular optical path.

The purpose of COMBIC is to find the CL value appropriate to a particular region and age of the aerosol cloud, to multiply by the corresponding extinction coefficient and then to obtain the transmittance using equation 2.1. If a path passes through a series of different types of aerosol clouds, the transmittance of each is found and then transmittances are multiplied to obtain the net transmittance for the group. Equivalently, the optical thickness through each cloud can be determined. These are added together, and the exponential in equation 2.1 can be used to evaluate the same net transmittance. COMBIC performs these actions so the output quantity is the combined transmittance through all clouds present on the path.

It should be noted transmittance is the same along both directions of the path. It does not matter in terms of the calculation which end of the path is designated as the observer or the target. Transmittance does not include any stray light which might be scattered by the aerosol into the field of view or any additional electromagnetic energy which might be emitted by the aerosol itself.

2.3.1 Aerosols and Particulates

These terms are used interchangeably in COMBIC, although the former more properly refers to all types of small particles suspended in a gaseous medium and the latter to dry particles. Aerosols and particulates are airborne materials with varying composition and sizes. Concentrations of battlefield aerosols usually contain particles from tenths of a micrometer up to hundreds of micrometers in diameter. Battlefield aerosols tend to be larger than background haze particles of the atmosphere, and their size distributions have important effects on extinction at wavelengths comparable to these sizes.

2.3.2 Barrage

In COMBIC, the user is given an option to define a barrage. The barrage replaces the effect of many munitions detonating over some well defined area for a period of time. The result is a continuous cloud which replaces the individual clouds that would be computed if each source had been individually specified. This approximation now includes the specification of a cross-wind dimension and an along-wind dimension for the impact area, a rate of the number of munitions per second impacting in the area, and the total time duration in seconds over which the rounds impact.

2.3.3 Buoyancy Radius R_o

A hot thermal region is produced by HE detonation and by bulk WP. This "fireball" region is modeled as a spheroid of warm aerosol and gases that rises in cooler ambient air. The initial buoyancy radius is the starting radius for this region. It is generally smaller than the obscurant dissemination radius. The buoyancy radius is, by default, determined from an initial fireball temperature and the total thermal energy available for buoyancy. It may be input optionally by the user.

2.3.4 Burn Rate Profile $M(t)$

This term refers to an equation that describes the history of the rate at which obscurant mass is produced from a source as a function of time (g/s). The cumulative burn rate profile is the equation or data curve that quantifies the fraction of the total source mass that has been released up to a given time (dimensionless). COMBIC rescales the cumulative burn rate profile internally to match the total mass produced. Thus, it accepts the profile in any system of units.

2.3.5 Burn Duration T_b

The total time (in seconds) over which a source produces obscurant is called the burn duration. In COMBIC, this term is also applied to the total length of time any source produces obscurant including dust produced from a vehicle.

2.3.6 Convective, Neutral and Lapse Conditions

These terms refer to an unstable, a buoyantly neutral, and a stable atmosphere, respectively. For further details see the Pasquill category.

2.3.7 Carbon Fraction C_f

The ratio of the mass of free carbon produced from a source to the mass of other obscurants in which the free carbon is mixed is called the carbon fraction. With respect to high explosives, however, the definition is the ratio of the weight of free carbon produced to the original explosive weight (as in pounds carbon per pound of equivalent TNT). Values of 0.1 to 0.3 are typical of HE.

2.3.8 Casing Dimensions

The length of an HE munition casing and its diameter at its widest point (m) are called the casing dimensions. The casing dimensions indirectly determine the fractions of energy that generate dust and produce heat.

2.3.9 Concentration Length

CL is sometimes called a columnar mass density, is a quantitative measure of how much smoke is present along the LOS in g/m^2 The simplest way to think of the CL is to conceptualize a square frame one meter long on each side. Looking at the target through the frame, walk the frame from the observer towards the target. This forms an imaginary column 1 m x 1m x (distance to the target). The total smoke mass is present inside this column is the CL.

2.3.10 Depth of Burst *DOB* and Dip Angle

The depth of burst and munition inclination angle, or dip angle, at burst are used for HE dust only. The depth (m) is positive below the surface and negative above the surface. The depth is measured to the center of mass of the munition or charge. Fuzing, casing dimensions, and dip angle also determine the depth of burst. Given no other information, 10° to 20° dip angle for artillery and 80° for short range mortars are reasonable.

2.3.11 Efficiency *E*

Efficiency is defined differently among modelers and among developers of obscurants. Except for HE dust, efficiency is the ratio of obscurant mass released to the original fill weight of the source. Thus, if 10 lb of a chemical mixture burns to produce 4 lb of actual obscurant, the efficiency is 40 percent. Efficiency does not include the mass of water that the aerosol may absorb from the air during its growth process. That is included in the yield factor. Thus,

$$M_a = c_o Y_f (E/100) W \tag{2.2}$$

where M_a is the total mass of airborne obscurant, c_o converts weight to grams, Y_f is the yield factor (dimensionless), E is the efficiency (percent) and W is the fill weight. The efficiency may include, however, additional factors such as a part of the original fill weight left in the munition, buried in mud or snow, or deposited on the ground. For the HE dust model, the efficiency input parameter represents the fraction of explosive energy that goes into heat for the buoyant rise of the cloud. This is also called the hydro-yield fraction of the HE munition. It is usually input as zero and left for calculations by internal models.

2.3.12 Equivalent TNT Yield or Equivalent Pounds TNT *W*

This term means the weight of TNT that has the same energy as the explosive actually used. COMBIC uses the equivalent TNT in modeling the crater volume from which dust is produced. It takes the place of an obscurant Fill-Weight for HE dust.

2.3.13 Fill Weight *W*

Fill weight is the weight (lb) of smoke material inside a smoke munition. In the COMBIC inputs, however, the fill weight for HE dust is the equivalent TNT yield, expressed in pounds, of the explosive. Fog oil and diesel fuel fill weights are in gallons for the convenience of the user. For a user-specified IR screener produced from the generator, the fill weight is in pounds, and the production rate is determined internally from fill weight and burn duration inputs. The fill weight of generator-produced obscurants divided by the burn duration gives the emission rate or the amount of material produced per second by the generator. This rate is constant for generator-produced obscurants.

2.3.14 Fireball Temperature T_o

The spherical heated region of HE and bulk WP munitions is sometimes called the "fireball." The initial fireball temperature may optionally be specified by the user. Otherwise, the fireball temperature is determined in the code from the initial buoyancy radius and the total thermal energy available for buoyancy, or is assigned an initial value.

2.3.15 HE dust

When a high-explosive munition detonates just above, at or below the ground surface, a quantity of soil is lofted into the air from the resultant crater. A region of rising, circulating air flow is triggered by the shock wave and the buoyant rise of the heated air. Part of the lofted soil is entrained into the rising flow fields and forms the main dust cloud. Part of the lofted soil is thrown to the side and is not entrained. Furthermore, the shock wave will scour some additional dust from the ground surface. The dust particles range in size from tenths of millionths of a meter to about one centimeter in diameter. The propagation effects along the LOS are extremely sensitive both to the total dust mass encountered and to the size distribution of the dust particles. Lighter particles, in general, rise, expand, transport and diffuse at the fastest rates, while the heavier particles lag behind and fall out. COMBIC divides the size distribution of the dust particles among three "modes": a small particle mode, a large particles mode and a ballistic or very large particle mode. The very large particle mode accounts for the ballistic soil and large agglomerates that remain airborne for only a few seconds. The resultant dust cloud produced by HE munitions is modeled as a combination of five subclouds, a buoyant fireball of small mode particles, a surface cloud of small mode particles, a connecting stem of small mode particles, a stem of large particles that have 0.92m/s fallout, and an initial ballistic cloud of large particles that rapidly return to earth. The primary obscurant that has the most significant effect on MMW transmission for the usual obscurant concentrations on the battlefield is HE produced dust, specifically the very large particle mode. That effect is short-lived. To better model the time-dependence of MMW obscuration by HE dust, the very large particle mode was introduced along with an appropriate ballistic formation of the dust cloud and a modeled, rapid fallout of particle sizes larger than a few tenths of a millimeter.

2.3.16 Hydro-yield Fraction E

For HE-generated dust, the hydro-yield fraction takes the place of an efficiency input. The hydro-yield fraction is the fraction of available energy from the explosion that goes into the form of heat and causes a fireball region to rise buoyantly into the air. This quantity is normally computed by an internal model in COMBIC but may optionally be input by the user. It is the thermal efficiency of the explosive.

2.3.17 Smoke Type

Table B.1 and B.2 contain many default munition parameters used to internally characterize the obscurants. These defaults can be overridden by the user. Table B.1 contain the fill weight, efficiency, obscurant and source types. Table B.2 contain the extinction coefficients for all non-hygroscopic smoke.

WP smoke is a dense white smoke generated when phosphorus burns spontaneously in air. WP is a mixture of phosphoric acids and is highly hygroscopic. More information about WP is contained in section 2.3.21. Bulk WP typically ignites into a hot thermal region that carries much of the initial smoke upward, producing an effect called pillaring. The remaining pieces scatter on the ground. Being physically separated, the fragments produce smoke which is not as buoyant as the initial smoke. PWP and felt-impregnated WP retard the initial rate at which smoke is produced, and thus the pillaring effect is reduced. RP is less spontaneous in igniting and thus produces a more gradual burn and a longer smoke production period than bulk WP. WP smoke is most often delivered by munitions. It is effective in the visual and near-IR wavelength regions and is less effective in the 3 μm to 5 μm and 8 μm to 12 μm mid- and far-IR regions, but still sufficient to defeat thermal systems if used is sufficient quantity.

HC smoke mix produces a (mostly) white zinc-chloride smoke from the chemical reaction of zinc oxide, hexachloroethane and aluminum. In the reaction, the aluminum removes chlorine from the hexachloroethane and then reacts with the zinc oxide. The aluminum content thus alters the burn rate of HC smoke. For example, if the burn duration is 147 s with a 5.5 percent aluminum content, then the burn duration is only 55 s for a 9 percent aluminum content. The amount of aluminum in a given mix is estimated internally from the burn duration. HC smoke is hygroscopic and not particularly buoyant, although heats of combustion of 300 to 940 cal/g have been reported [Cichowicz, 1983]. HC is most often released from burning smoke pots or delivered by a munition, for example, the 105-mm cartridge or 155-mm projectile. HC is effective in the visual and near IR wavelength regions but is relatively ineffective in the 3 μm to 5 μm and 8 μm to 12 μm regions except in high concentrations or over long paths. HC is much less effective in the thermal band than WP.

SGF-2 and DF are oil smokes that are produced by generators. The oil is not burned but rather is vaporized and condenses rapidly upon ejection from a generator. These smokes are non-hygroscopic and, to use the terms employed in COMBIC, have a yield factor of one. COMBIC also assumes, by default, that they are slightly buoyant. Oil smoke produced by most smoke generators may be ejected at some relatively high velocity, typically 120 to 150 m/s, mixed with a large volume of air. This speed rapidly decreases, however, as ambient air mixes with the smoke. Oil smokes are very effective in the visual and effective at near-IR wavelengths. They are ineffective in the 3 μm to 5 μm and 8 μm to 12 μm wavelength regions except, perhaps, at extremely high concentrations or over very long path lengths. COMBIC also includes the cold regions mixture of fog oil and kerosene defined by obscurant type 15 (Note: the cold region flag does not have to be set for use of this mixture). Although the oil smokes are almost always disseminated by generator, fog oil pots are in the US inventory as well. Diesel fuel/oil/rubber fire smoke may also reduce MMW transmission significantly for sufficiently long LOS.

2.3.18 Pasquill Stability Category P_c

Atmospheric conditions are characterized in part by stability. A stable (or inversion) condition may occur at night. In this situation, the ground becomes cooler than the air above it, and air temperature increases with height. Thus, the tendency of warm clouds to rise is reduced, and turbulence is somewhat more intermittent. Obscurant clouds remain closer to the ground with less upward diffusion. A neutral stability condition can exist early in the morning before the ground has the opportunity to become much warmer than the air above it, under cloudy conditions or in high winds. The atmosphere in this state has a slightly decreasing temperature with height of about 1C per 100 m. Obscurant clouds have a greater tendency to rise and diffuse upward than under stable conditions. Finally, an unstable, or convective, stability condition is present when the ground gives off heat to the air, air temperature decreases at a rate greater than 1C per 100 m, and windspeed is low to moderate. In these conditions, the atmosphere is turbulent. Convective cells promote the rise and vertical diffusion of obscurants. The Pasquill stability category is a scheme designating atmospheric stability. Pasquill categories A through C denote unstable conditions, D is neutral and E through G are stable. COMBIC provides an optional routine to compute the Pasquill stability category for the user in terms of windspeed, cloud cover, and time of day.

2.3.19 Number of Submunitions N_s

COMBIC uses the term submunition to designate parts of a munition that act separately to produce the obscurant cloud. The amount of explosive in HE munitions is divided among the submunitions. This affects slightly the total of the crater volumes produced and thus the dust produced. For both smoke and HE dust submunitions are considered to be thermally independent of each other. This produces less buoyancy and causes independent obscurant clouds to rise more slowly. In COMBIC, for munitions containing submunitions, the fill weight is that of the entire munition. It is not the weight of a single submunition.

2.3.20 Wind Direction

COMBIC uses the meteorological definition of wind direction, the azimuth from which the wind is blowing. Azimuth is the usual compass angle measured in degrees clockwise from north.

2.3.21 Yield Factor Y_f

Some obscurants are hygroscopic. They draw liquid water from the water vapor in the air and grow to some equilibrium size. This growth is very rapid. The result and not the process itself is, therefore, modeled in COMBIC. Growth greatly increases the mass of smoke in the air and thus increases extinction. The coefficient for extinction per unit mass takes into account the change in droplet refractive index as the particles grow and are diluted by absorbed water. The yield factor is the ratio between the final mass of the smoke and the original mass before water was absorbed from the air. The yield factor increases with increasing relative humidity. As with efficiency, modelers choose different definitions for the yield factor. In COMBIC, for example, the yield factor for phosphorus smoke is larger than one at zero humidity because the burning of phosphorus to phosphoric acids includes water in the chemical reaction. The combined effects of efficiency and yield factor convert original fill weight of material in the munition into the mass of obscurant that is present in the cloud. For users providing a full set of inputs, it is only important that the result from equation 2.2 equals the mass actually appearing in the smoke cloud. The fill weight, efficiency and yield factor can otherwise be defined arbitrarily by the user if all three are input.

2.3.22 Coordinate System Conventions

The COMBIC code and EOSAEL use certain conventions for coordinate systems. The systems are rectangular cartesian, X, Y and Z, all expressed in meters. The COMBIC user is allowed to input a coordinate origin x_o, y_o, z_o.

The Z coordinate points upward, perpendicular to a flat earth. The z_o origin is added to every observer and target Z coordinate as they are input. The default for z_o is 0. The EOSAEL code contains a dummy terrain-access routine that returns 0 for all terrain heights. Thus, these default values define the ground surface to have a Z coordinate of 0, and all observer and target Z coordinates are the same as their heights above this surface.

The usefulness of z_o can be seen in the following example. Suppose the user puts in a terrain array referenced to sea level. The user can then set z_o to zero and input all target and observer Z coordinates with respect to sea level. But, suppose the observer and target Z positions are reported with respect to a surveyed benchmark at a field test. The user can then input z_o as the height above sea level of that benchmark and then input all target and observer Z coordinates referenced to the benchmark.

All sources (for example, smoke munitions) are input by the user in terms of their burst height above the local terrain. COMBIC determines the height of the terrain at that point (default 0 in the code supplied with EOSAEL) and adds it to the input height to obtain the Z coordinate. Thus, all computations internal to COMBIC occur in a Z frame of reference determined by the terrain data base reference, if any.

The X and Y axes lie parallel to the surface of a flat earth. The X axis direction is specified by user input as an arbitrary compass direction in degrees clockwise from north. Thus, if the X axis points east (90), the Y axis points north. This is the default in COMBIC and in the EOSAEL library. The coordinate origins x_o and y_o can also be specified by the user. All positions of targets, observers, and obscurant sources immediately have x_o and y_o added to their input values before being stored internally in COMBIC. This allows the code to shift the input system to a terrain data base convention if desired. Default values for x_o and y_o are zero.

The COMBIC model internally rotates the user's coordinate system about the Z axis and coordinate origin (x_o, y_o) to one in which the new X axis lies along direction toward which the wind is blowing, and the Y axis lies cross-wind. This is done as each new observer, target, and source are input and is very common in obscuration models. All distances in X coordinates are then distances downwind, while all Y distances are cross-wind. Documentation in later sections uses this notational convention of downwind x, cross-wind y, and upward z variables.

A third internal coordinate system is used in evaluating the plumes produced by moving sources. The aerosol still moves with the wind, of course, but the motion of the source effectively makes the plume appear to lie along the vector difference between the wind velocity and the moving source velocity. COMBIC, therefore, rotates these plumes into this "effective plume frame" in which the plume appears to be extended along the effective X axis.

2.4 Model Limitations

COMBIC uses a simple atmospheric boundary layer model. In COMBIC, the wind field direction and vertical windspeed profile are uniform every where in the scenario. COMBIC does not model complex wind fields that changes direction as well as speed in all three dimensions. In the real world, wind fields and diffusion rates are determined by the effects of complex terrain and surface properties. COMBIC is still a "flat terrain" model. It allows only for a uniform boundary layer wind field that is assumed to apply over the entire geographic region. To include the effects of complex terrain and wind field would significantly increase the run time. The user must be cautioned that COMBIC represents an idealized world of smooth terrain and a relatively simple wind field. COMBIC does, however, allow the user to attach a terrain data array. Clouds then follow the vertical changes in terrain height, moving up or down as required, but without changing the basic windspeed and wind direction input by the user. Thus, for example, a cloud flows over and not around a hill. A dummy terrain routine that can access terrain arrays is provided in the code as a guide to those who wish to include this crude level of approximation to terrain effects.

Smoke is stochastic. Natural atmospheric turbulence will modify the smoke cloud in a random fashion. This produces thick and thin screening spots which are most evident near smoke sources. COMBIC, however, is a deterministic model. COMBIC's output is meant to show the average effects of a random process. Variations in the atmosphere make the smoke less effective if the target can be acquired through momentarily thin spots in the cloud.

Vehicular dust and moving smoke sources like generators are included in COMBIC. However, COMBIC can not model accelerations and changes in direction by moving sources. All moving sources, are modeled as moving in a straight line at a constant velocity. Changes in direction by moving sources can be simulated by COMBIC by effectively stopping the vehicle and starting it again moving towards a new direction.

COMBIC models extinction and not path radiance. However, there are existing EOSAEL models which do model the complex notion of path radiance. Extinction is composed of scattering of light out of the LOS and absorbtion of light along the LOS. Transmittance is directly related to extinction by Beer's law. One usually attempts to directly relate transmission to electro-optical system performance and smoke effectiveness by considering only the directly transmitted signal. Now most system performance people know electro-optical systems respond not only to directly transmitted signal but also to contrast, which ususally requires one to account for path radiance or brightness. The contribution to path radiance may be due either to scattering of ambient radiation (sun, moon, sky) into the LOS path or emission along the path, or both. Transmittance is still the key component in these more complex models, however. Transmittance is primarily important because it quantifies when a received signal will be below some operational threshold of an EO device. But transmittance is not the only quantity which determines the energy that is detected. Just as extinction removes energy along a path, multiple scattering can return some of that energy. Equation 2.1 includes the results of single scattering out of the path and absorption along the path. Once the energy is scattered from the path, it is gone. Some probability exists, however, that a fraction of the energy scatters more than once. Some of this energy, not itself absorbed by the aerosol, may return close to the optical path and scatter again in approximately the original direction of the beam. COMBIC does not compute this multiple scattering contribution to the energy received by finite area collection optics. Other models in the EOSAEL library address this complex problem. Large optical depths, a significant scattering component in the extinction, and a large field of view at the detector are generally conditions in which the received energy at the detector may have a significant multiple scattering component. For additional information, see the ASCAT module of EOSAEL. Path radiance can be of overriding importance. For example, the apparent disappearance of stars during the daytime and the effect of high beams in a fog. To truly consider the effects of smoke on the ability to "see", the effect of radiance along the LOS must be considered. These "path radiance" contributions are the subject of models like BED's ACT II. ACT II examines the effects of emissive sources and of single scattering of the ambient radiation into the LOS (Sutherland et al., 1982).

Furthermore, COMBIC does not include target acquisition routines or the transmittance contribution from adverse weather and/or natural atmospheric gases. Though COMBIC properly takes into account that smoke blown behind the target does not contribute to obscuring the target. However, a real world effect which COMBIC does not model is that smoke behind a target often enhances its signature. This is both through a silhouette effect of the target on the smoke background and a related tendency for smoke to suppress the confusing detail of image clutter behind the target. COMBIC also does not address the process of high energy laser propagation through aerosol clouds in which the aerosol along the path may be modified by the laser. These processes are the subjects of separate models in the EOSAEL library. The results from COMBIC in the form of cloud concentrations, cloud dimensions, and transmittance may be useful as inputs to these models. The total transmittance can be determined by the following equations.

$$T_{tot} = T_{gas} T_{natural} T_{COMBIC}, \tag{2.3}$$

$$T_{tot} = T_{LOWTRN} T_{XSCALE} T_{COMBIC} \tag{2.4}$$

or for Lasers.

$$T_{tot} = T_{LZTRAN} T_{XSCALE} T_{COMBIC} \tag{2.5}$$

LOWTRN is an EOSAEL module that calculates atmospheric transmittance and radiance for different model atmospheres. XSCALE is another EOSAEL module that determines the transmittance through naturally occurring aerosols (haze and fog), rain and snow for both individual wavelengths and broadband averages. The EOSAEL module LZTRAN calculates molecular absorption coefficeints and transmittances for 97 specific laser frequencies ranging from the visible to the far infrared. The user may specify one of six model atmospheres or input his own atmosphere. To determine the total transmittance, the user must run all three modules. Though for clear weather, the transmittance computed by COMBIC often dominates.

3. Caveats

3.1 Grade of Software

COMBIC is a developmental model. Several evaluations have been made, but it is constantly being upgraded and refined. It is not applicable for all scenarios, but can handle most well behaved situations.

3.2 Model Failure

COMBIC has limited diagnostics to provide the user with some way of knowing of model failure. In most circumstances, the model will try to complete a job. If input parameters are unreasonable, then reasonable values will be substituted and a warning message will usually be printed in the output file. This section lists the errors and warnings COMBIC might produce for the typical user. It also lists the most likely cause for the errors and suggestions on how to correct them. In the following, any number composed of nines is representative of a number that COMBIC will print. The value varies with the user input and the type of error. Any words in italics are notes on what will be printed. These messages are printed in the Phase I and Phase II output files. This section does not list the usual diagnostic messages for open errors of a file since the correction for these errors are usually obvious.

Although EOSAEL models are generally portable between different types of computers, the user should be aware of two potential machine-dependent problem areas. First, some computers equate completely blank input fields with "0.". Others, however, require each numeric input field explicitly contain some number with a decimal point. It is, therefore, possible that the user will need to input "0."s in every unused field of the 7 numeric values read in from the standard input format discussed above. Second, some computers interpret blanks as zeros in the exponential field (following the letter "E") of numbers input in exponential notation. This may require the user to right-justify inputs in the 10-column field if exponential notation is used. As an example, 1.2E-2 may be the intended input. But, if not right justified on some machines, the input will be interpreted as 1.2E-20.

If COMBIC issues an error message about a particular input record, the user should first check to determine if each input number has a decimal, that it falls inside its 10-column input field, and that there are no "nonprinting" special characters (CNTRL or ESC sequences) on the record. These comprise almost 100 percent of the usual input problems.

```
*** FIRST COMBIC CARD NOT PHAS
```

Actually, unless the user has a stand-alone model, the first two records of the input file are EOSAEL records, read by the EOEXEC driver. The third record is the first record which the COMBIC module reads, and it must be a PHAS record.

```
*** FILE RECORD UNIT#, 99999 OPENED FOR FILE filename
BUT THE UNIT NUMBER WAS NOT ON THE PHAS RECORD
```

This warning occurs if the user inputs a FILE record with no matching unit number of the PHAS record. As a result, COMBIC can open the file but it cannot utilize the file. The user should check to see if the unit number is entered correctly on the PHAS and FILE records.

```
***** PHASE PARAMETER OUT OF RANGE COMBIC ABORTED *****
```

The first parameter PHASE on the PHAS record specifies whether Phase I or Phase II calculations are to be performed. This parameter must be either 1. or 2. Any other value will cause this error.

```
*** ERROR, CHECK SUBCLOUD RECORD ORDER AND NUMBER OF SUBCLOUDS TO BE
GENERATED.
NUMBER OF SUBCLOUDS SPECIFIED = 99.9
BUT ATTEMPTED SUBRECORD COUNTS:
SUBA=99, SUBB=99, SUBC=99
```

A user defined cloud is specified by first defining the number of subclouds which makes up the cloud. This is specified by the NSUB parameter of the CLOU record. Usually a SUBA, SUBB and SUBC follow the CLOU record for each of the NSUB subclouds. A GO record usually signals COMBIC that the input records for this munition has been completed. The above error occurs when there are a greater number of SUBA, SUBB and SUBC clouds than are specified by the NSUB parameter. To correct this problem, the user is advised to input at most a maximum of one SUBA, SUBB and SUBC record for each subcloud. Note: the user does not have to define these records for each subcloud, but at the most, only one of each can be input.

```
*** ERROR # 999 IN READING HISTORY FILE
:
ERROR. REQUESTED SOURCE NUMBER 9999 NOT IN HISTORY FILE
DATA ON OBSCURANT TYPE 9999 NOT PREPROCESSED
```

This error occurs in Phase II. In Phase I, the user chooses the obscurants which will be used in Phase II. The first obscurant in the inputs has a source number of one in the history file and is accessed in Phase II by referring to the source number. The second obscurant in the input for Phase I is referred to as source number two and the third is referred to as source number three, etc. This error states that the Phase II inputs have requested a source number which is not in the history file. To correct this problem the user should check to see if the source number is correct (STYPV on the VEH1 record or STYP on the SLOC record) in the Phase II inputs or check to see if the Phase I input deck has the correct number of obscurants.

```
*** ERROR - INVALID SMOKE TYPES SPECIFIED
** ERROR IN SMASS, SMOKE TYPE 99 UNDEFINED.
** THIS SOURCE PRODUCES NO OBSCURANT. *** NO HISTORY GENERATED
0**** CARD SEQUENCE RESET DUE TO ERROR IN PREVIOUS MODULE (IERR=1)
```

These errors are produced when the user requests a smoke type (STYP on the MUNT record) not defined in the menus. The obscurant type is used for the selection of extinction coefficients and for assigning default model characteristics if information is not otherwise provided by menu values or user inputs. The obscurant type ranges from 0–30. The first 23 are are listed in the default tables and the last 7 are user-defined by inputs. This error will cause COMBIC to exit prematurely. To fix this error correct the STYP parameter of the MUNT record.

```
*** ERROR - NO SMENU, NO STYP, NO SUB(-) RECORDS
** THIS SOURCE PRODUCES NO OBSCURANT. *** NO HISTORY GENERATED
0**** CARD SEQUENCE RESET DUE TO ERROR IN PREVIOUS MODULE (IERR=1)
```

The user has the option of creating a new menu using the SUBA, SUBB and SUBC input records. Setting SMENU = 0 on the MUNT record signals the model the user is designing a new munition. Setting STYP$\geq$ 24. on the MUNT record signals the model that the user is designing a new obscurant. When these are set the MUNT record must be followed by the CLOU record and at least the SUBA record for each subcloud.

```
NO MORE ROOM, ADDITIONAL OBSCURANTS NOT ALLOWED
```

COMBIC has a limit in the maximum number of active clouds and subclouds which can be processed at one time. By default NPMACT = 100 is the maximum number of active clouds and NMPCLD = 300 is the maximum number of subclouds. Clouds have anywhere from 1 to 5 subcloud components. For example HE is composed of 5 subclouds. So at most only 60 active HE rounds can be processed at one time ($5 * 60 = 300$). The user needs to review section 4.5 on how to modify the COMBIC model for large number of obscurants if NPMACT or NMPCLD are exceeded. COMBIC has been modified in the past to compute the obscuration from more than 5000 HE rounds.

```
NO ROOM FOR NEW MOVING OBSCURANT SOURCE AT 999.9, 999.9 of type 999
```

COMBIC has a default limit in the maximum number of active clouds and subclouds which can be processed at one time. NPMACT = 100 is the maximum number of active clouds and NMPCLD = 300 is the maximum number of subclouds. Clouds have anywhere from 1 to 5 subcloud components. This error occurred because the user requested a new moving obscurant and exceeded the amount of sources allowed by COMBIC.

```
NO ROOM FOR LOS, OBSN, 999., TARN, 999.
```

Currently, there is a default limit to the maximum number of LOS which can be processed. This error is printed when the number of active LOS exceed 50. Refer to section 4.5 if the user has a large number of LOS to process. This section explains how to modify COMBIC to accept and process more than 50 LOS. This restriction does not apply to "printer plot" lines of sight.

```
*** INVALID INPUT RECORD TO COMBIC PHASE 1:
```

an input record will be printed here

```
*** CARD SEQUENCE RESET DUE TO ERROR IN PREVIOUS MODULE (IERR=1)
```

COMBIC reads each record in the input file and identifies it by the first four letters. COMBIC produces this error when it does not recognize the first 4 letters of the input record. Note COMBIC will not produce this error message if it reads Phase II input records when executing PHASE I. It simply ignores these. Only one error is allowed per input deck before the model ends prematurely. To correct this error, the user should check the spelling of the input record listed above.

```
*** COMBIC IGNORES MET INPUTS AFTER FIRST GO RECORD)
```

Meteorological conditions need to be input before the first GO record. The meteorological records are MET1, MET2, and PASQ. To correct this warning, the user is advised to move the meteorological records above the GO records. Refer to section 4.2.2 for information on the meteorological records.

```
*** ERROR, CLOU RECORD CAN CONTAIN 1.  TO 5.  ONLY.
INPUT WAS .0
*** CARD SEQUENCE RESET DUE TO ERROR IN PREVIOUS MODULE (IERR=1)
```

The user custom designs a new cloud by first specifying how many subcloud defines the new cloud using the NSUB parameter on the `CLOU` record. NSUB must be either 1., 2., 3., 4., or 5. COMBIC outputs the above error message and prints the NSUB parameter for any other number. To correct this error, the user should correct the NSUB parameter on the `CLOU` record.

```
*** INVALID INPUT RECORD TO COMBIC PHASE 2:
```

an input record will be printed here

```
0**** CARD SEQUENCE RESET DUE TO ERROR IN PREVIOUS MODULE (IERR=1)
```

COMBIC reads each record in the input file and identifies it by the first four letters. COMBIC produces this error when it does not recognize the first 4 letters of the input record. Note COMBIC will not produce this error message if it reads Phase I input records when executing PHASE II. It simply ignores these. Only one error is allowed per input deck before the model ends prematurely. To correct this error, the user should check the spelling of the input record listed above.

```
********************************************************************
EOF IN INPUT CONTROL FILE 5 - PROGRAM TERMINATED
**********************************************************************
STOP DATA SET MISSING STOP OR END STATEMENT
```

Chances are the `DONE` record is missing at the end of the inputs.

```
AXES AND ORIGIN ALREADY USED IN LOADING SOURCES AND/OR LINES OF SIGHT.
IGNORING:
```

(ORIG record printed here.)

```
WIND DIRECTION ALREADY USED IN LOADING SOURCES AND/OR LINES OF SIGHT.
IGNORING:
```

(ORIG record printed here.)

The `ORIG` record defines the axes, origin and the wind direction for the battlefield scenario. This record must input before the `SLOC`, `VEH1` and `VEH2` records. If COMBIC reads any of these three records, then this error message will be printed. Note if there is multiple `ORIG` records before the source or vehicle location records, then the last one will be the one used by COMBIC. If there is no `ORIG` record, then default parameters will be used.

```
999.9 NO ACTIVE LOS
```

The LIST record determines the times that the transmittance or CL will be output. The parameters from this record specifies a start time, an end time and the time increment between lines of output. Furthermore, for each observer, the user specifies the time the observer becomes active and the time the observer can be removed from the active list by the parameters on the OLOC record. If there is no active observer at a time specified by the LIST record to output transmittance, then COMBIC lists the time and states there is no active LOS. This warning does not affect the results in any way and can be ignored by the user if so desired.

```
*** WARNING - NO MUNT RECORD OR BAD SMENU, STYPE.
PROCESSING A DEFAULT CLOUD TYPE
```

This warning occurs when no MUNT record has been used in Phase I or the parameters SMENU and STYPE are badly defined for the MUNT record. Check to see if the Phase I input file contains a MUNT record and the parameters are defined correctly. The model will proceed with the calculations even without a MUNT record but will use a default munition.

```
*** STEM DOES NOT CONNECT PROCESSED SUBCLOUDS
0**** CARD SEQUENCE RESET DUE TO ERROR IN PREVIOUS MODULE (IERR=1)
```

This error occurs when the user is defining a cloud using the SUBA, SUBB and SUBC records. On the SUBA record, the RISMOD defines if the subcloud is buoyant (RISMOD=1), nonbuoyant (RISMOD = 2) or if the cloud is a stem (two-digit number "ij" from 12 to 45 indicating that the subcloud is an instantaneously canted stem, spanning subclouds i and j). If RISMOD is entered as a number greater than 45 or if no "ith" or "jth" subclouds exist, then this error will be printed. Check subcloud structure and RISMOD parameter. If there is no "ith" or "jth" subcloud for the stem to span, then this error will be printed.

```
*** WARNING, AT LEAST ONE SUBCLOUD DOES NOT HAVE A
PLUME OR RISE MODEL VALUE
```

This error occurs when the user is defining a cloud using the SUBA, SUBB and SUBC records. If STYP on the MUNT record is between 24–30, then the user must specify munition characteristics such as the PLUME and RISMOD parameter on the SUBA record. PLUME must be either 1. or 2. and RISMOD is either 1., 2., or a number "ij" from 12 to 45. Check to see if these numbers are entered correctly for each subcloud.

```
*** NO ROOM LEFT IN THE EXTINCTION COEFFICIENT ARRAY
24.  - 30.  (USER DEFINED) FOR EFFECTIVE BARRAGE COEFFICIENT
```

This error only occurs with the barrage option. It states there is no room to make a new obscurant type with the combined extinction coefficients.

```
*** WARNING, INPUTS OF SUBCLOUD FRACTIONS, TOTALONLY: 9.9999.  THIS MAY
BE INTENTIONAL
```

The user has the option of designing a cloud not modeled by the tables. The user specifies how many subclouds define the new smoke cloud using the CLOU record. The fraction of total obscurant mass to be placed in each subcloud is specified by the FRACT parameter on the SUBA record. If FRACT= 1 then 100 percent of the cloud's obscurant mass is placed in the subcloud. Usually $0 \leq$ FRACT ≤ 1. The total summation of the FRACT parameter for each subcloud should equal 1.0. If it totals less than one, the model prints this message. This may be intentional by the user. The user should check to see if the fraction of obscurant mass is input correctly for each subcloud.

```
*** WARNING, INPUT SUBCLOUD FRACTION(S) TOTAL, 9999.99 THEY SHOULD
TOTAL ONE. RESCALING TO ONE.
```

The user has the option of designing a cloud not modeled by the tables. The user specifies how many subclouds define the new smoke cloud using the CLOU record. The fraction of total obscurant mass to be placed in each subcloud is specified by the FRACT parameter on the SUBA record. If FRACT= 1 then 100 percent of the cloud's obscurant mass is placed in the subcloud. Usually $0 \leq$ FRACT ≤ 1. The total summation of the FRACT parameter for each subcloud should total 1.0. If it totals more than one, the model rescales to one and prints this message. The user should check to see if the fraction of obscurant mass in input correctly for each subcloud and the summation totals 1 or 100. Note even if the user inputs FRACT as percent, the model will adjust and use the correct values.

```
ITERATION IN SUBROUTINE VOLAC HAS FAILED TO CONVERGE
```

This warning occurs only for HE dust and only for cased munitions. The COMBIC model computes the equivalent yield of bare charge, that, at the same depth of burst as the cased munition produces the same yield coupled to the ground as the cased munition. It uses an iterative technique to determine this equivalent yield, iterating a maximum of twenty times. This warning hardly ever occurs. If it does occur the user can try increasing the number of iterations in the source code and recompiling COMBIC.

3.3 Verification

Since COMBIC is a theoretical model, its accuracy needs to be established by comparison with experimental data. Also, for this model to be used effectively, the users need to know the accuracy with which COMBIC reflects the battlefield atmosphere. The successes as well as the shortcomings of modeling with COMBIC must be established. The analysis and war-gaming community needs the information in using COMBIC to estimate the impact of obscurants on EO sensor performance. This impact affects the training and doctrine community and ultimately the soldier in the field who needs the knowledge of sensor performance to effectively employ the increasing inventory of EO systems.

Since the release of EOSAEL and its subsequent revisions and additions, significant amounts of time and resources have been devoted to model (module) "validation". If anything has been learned from all these validations efforts is that the models cannot be validated. Webster defines the following:

validate To declare or make legally valid. 2. To mark with an indication of official sanction.

valid Correctly inferred or deduced from a premise.

For COMBIC to be valid, the predictions must be field tested for all possible meteorological conditions, environmental parameters, lines of sights, munitions and munition placements. The cost of providing test data for validation purposes of COMBIC would most likely exceed the Atmospheric Sciences Laboratory operating budget, therefore defeating one of the advantages of computer simulation by COMBIC. Though validating COMBIC is out of the question, it can be *evaluated.*

evaluate To determine or fix the value of. 2. To examine carefully: appraise.

3.3.1 Evaluation History

The model has been qualitatively evaluated for HC, RP, IR screener, PWP, WP, and HE munitions, and the results were presented at previous EOSAEL conferences, Smoke symposiums and technical reports. Independent contractors [F.A. Lawrence and Wood, 1984] evaluated the COMBIC82 model for 155mm HE, 105mm HE and the 4.2inch HE. They also performed sensitivity studies by varying the meteorological conditions to see if the agreement between model and data improved.

Since COMBIC model is an amalgam which includes established theory along with empirical and semi-empirical results to model the battlefield environment, sections of the model can be evaluated. It is also necessary to analyze sensitivity of the model to various parameters and to know the conditions that some of the COMBIC algorithms could create significant problems. *Comparisons of Data with COMBIC Model Assumptions*, and *Statistical Evaluation of* *the* COMBIC *Model* [Hoock, 1986; Ayres *et al.*, 1988], evaluate various assumptions and internal models. Areas addressed are: multiple scattering; extinction coefficients; humidity effects; broad-band detectors; obscurant release rates; and cloud transport and diffusion. Refer to following reports for more details.

- Ayres, .S.D., M. Munoz, D.W. Hoock and E. Spitzanagel, 1991: "Statistical Evaluation of the COMBIC Model, Technical report of the U.S. Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM (in press).
- Spitznagel, E. L., and S. D. Ayres, [1988], " A Methodology for the Evaluation of COMBIC", in *Proceedings of the Ninth Annual EOSAEL/TWI Conference*, U.S. Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM (in press).
- Ayres, S. D., and L. Baca, [1987], "Changes in the Burn Rate Coefficients of COMBIC," in *Proceedings of the Eighth Annual EOSAEL/TWI Conference*, U.S. Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM, 54-62.
- Hoock, D. W., [1986], "Comparisons of Data with COMBIC Model Assumptions," In *Proceedings of the Sixth Annual EOSAEL Conference*, Atmospheric Sciences Laboratory, White Sands Missile Range, NM.
- Ayres, S. D., [1986], "COMBIC Validation-Part II," in *Proceedings of the Sixth Annual EOSAEL/TWI Conference*, U.S. Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM, 269-288.
- Ayres, S. D., [1985], "COMBIC Validation," in *Proceedings of the Sixth Annual EOSAEL/TWI Conference*, U.S. Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM, 269-288.
- F.A. Lawrence, Daniel R. Fuller, Tamra L. Kite and Terri L. Wood, [1984]: 'Validation of Electro-Optical Systems Atmospheric Effects Models: COMBIC" DAAD07-82-c-0009, Physical Sciences Laboratory, Las Cruces NM.

3.3.2 Methodology

Ideally, output from the COMBIC model should match experimentally obtained obscuration data, such as that from the "Smoke Weeks." However, perfect matches do not occur, for several possible reasons:

- Source characteristics are not completely known and thus development of the obscurant cloud is not modeled accurately
- Meteorological conditions vary temporally and spatially during the course of the experiment (for example, wind direction and wind speed).
- Measurement error exists in the data.

We have developed statistics which can be calculated automatically for a large number of trials, to determine how well model and data fit together [Spitznagel and Ayres, 1988]. A small family of three statistics measures goodness of fit overall. Other statistics identify particular ways which poor fit occurs. From these latter, one can often identify the major reason for lack of fit.

Measure One M_1: Average Distance from Ideal Line.

A numerical value indicative of the amount of scatter about a central point is called a measure of dispersion. The measure of dispersion which denotes the average distance from an ideal line is called *measure one.* In this case, the ideal line is $COMBIC_i = DATA_i$ or $y = x$. To analyze the agreement between COMBIC and data, we measure distances perpendicular to that line. The distance from any single point (x_i, y_i) to the line $y = x$ is given by $|x_i - y_i| / \sqrt{2}$. If we average over all x-y pairs, we have a measure of deviation, $\bar{D}$, from the ideal:

$$\bar{D} = \frac{1}{n\sqrt{2}} \sum_{i=1}^{n} |x_i - y_i| \, . \tag{3.1}$$

Because most people think of the number 1 as a perfect value of a measure of association and of -1 as the worst possible value, we define the following transform of $\bar{D}$, which we call "Measure One":

$$M1 = 1 - \sqrt{8}\bar{D}. \tag{3.2}$$

This has been adjusted so that the largest possible value is 1 and the smallest possible value is -1. A value of 0 corresponds to one definition of no association.

Variants of Measure One

Measure One serves well in most trials, but it can be "fooled" in two ways. We have developed two variants of Measure One to signal when this occurs and to provide "corrections" to the original measure.

First, the wind might carry smoke away from a particular LOS, resulting in good visibility most or all of the time. In this case, COMBIC and the field data will agree simply because there is no smoke to be detected. Or there could be some reduction in transmission that is poorly modeled, followed by a long period of good visibility. When this happens we need to know so we are not misled by an overly optimistic value of $M1$. A solution is to censor Measure One in the following way: Whenever COMBIC predicts greater than 90 percent transmission and greater than 90 percent transmission is measured, discard the data pair. The 90 percent criterion was determined by experiment. It is not particularly critical; any value in the range 85 percent to 95 percent works well. We will call the resulting variant $M1_a$.

Measure One can also be misleading by using it to compare the fit of COMBIC at different wavelengths. Most obscurants are more effective in blocking short wavelengths than they are in blocking long ones. If, for example, transmission of visible light drops nearly to zero, transmission of mid IR might drop only to 75 percent. This difference alone will lead to a difference in the values of $M1$ for visible and IR. If the transmittance is high for both data and COMBIC due to small extinction factors, $M1$ is high since there is little degradation caused by the small extinction for longer wavelengths. However, high extinction leads to more degradation, increasing the difference between model and data. The difference can be adjusted out by rescaling each set of predicted and actual data values to about full range. The scale factor is computed from the trial data by taking the difference between the 5th and 95th percentiles. (Use of percentiles rather than minimum and maximum values eliminates possible outliers.) Then $\bar{D}$ is scaled by dividing by this difference, and the new measure, $M1_b$, is calculated from the scaled $\bar{D}$.

Bias

COMBIC allows windspeed and wind direction to be input at the beginning of its run, but not to be changed during the run. A change in speed or direction during the trial can cause the cloud mass to move across the LOS either more slowly or more rapidly than COMBIC predicts. It also changes the amount of smoke across the LOS path length. To check for this, we compute the mean signed difference $[= \frac{1}{n}\sum_{i=1}^{n}(COMBIC_i - DATA_i)]$ between COMBIC and the trial data. This measure is also sensitive to the cloud being more dense or less dense than predicted, and to the length of time the trial runs after transmission returns to 100 percent. No attempt is made to separate these different contributors, because they can easily be distinguished graphically once a run with a large bias has been identified. The range of possible values for bias is ±1, but a bias of ±0.2 is already large enough to be important. A negative bias means COMBIC is too low (overpredicts); a positive bias means COMBIC is too high (underpredicts).

Time Shift (Lag or Lead)

A change in windspeed or wind direction could also cause the cloud mass to move across the LOS sooner or later than COMBIC predicts. To check for this, we compute $M1$ a total of 80 additional times, 40 with COMBIC leading by 1, 2, 3, etc., s, and another 40 with COMBIC lagging. The largest value of $M1$ and the lead or lag that produced it are then printed. Not infrequently, the lag or lead turns out to be the maximum 40 s, but the corresponding change in $M1$ is small. The appropriate way to read this pair of statistics is to compare "best M1" with $M1$. If the change is substantial, then the shift that produced it is meaningful.

The primary measurement of how well COMBIC fits the data is $M1$, a scaled measure of average absolute deviation between the predicted transmission values and the observed values. The assignment of a qualitative meaning to the numerical quantity $M1$ is subjectively based upon visual comparison of hundreds of plots. The values of $M1$ have the following meaning:

.80	-	1.00	Excellent
.55	-	.79	Good
.40	-	.54	Fair
.20	-	.39	Poor
.00	-	.19	Bad
	<	0.00	Very Bad

3.4 Statistical Results

This section briefly presents the quantitive results from the statistical evaluation of the COMBIC model. In that evaluation, model results (predictions) were compared with observations made in field tests. For a more complete analysis as well as the results for individual munitions see *Statistical Evaluation of the* COMBIC *Model* , [Ayres *et al.*, 1988].

3.4.1 Hexachloroethane Munitions

M116 155–mm HC

Table 3.1 show the statistics for the M116 155–mm HC. The fit of COMBIC to the data is in the fair-to-good range, though the worst statistics are believed to be mostly due to an incorrect start time for some of the trials rather than problems with the model. This causes COMBIC to appear to "lead" the measured transmission by an average of about 15 s, and time-shifting reclassifies the fit as a "good" fit ($M1$ =.74). The fit for far IR looks good based on Measure 1, but Measure 1b indicates that the good fit is due partially to the data having little deviation from 100 percent transmission. However, the low value of $M1_b$ can also indicate the time shift. COMBIC tends to predict that the cloud passes more quickly than it actually does (visible light having positive bias), and it also intends to slightly overestimate the concentration length within the modeled cloud (mid IR having negative bias). These two causes lead to the range in biases seen here.

M84 105–mm HC

Table 3.2 show the statistics for the M84 105–mm HC. The fit for COMBIC is good to excellent ($M1$ .62 to .92). Similar to the M116, the two opposing sources of biases combine to produce the range in bias from -.08 visible to .04 near IR for the M84 105–mm HC.

Based upon two trials, the COMBIC models M84 105–mm HC successfully. However, more trials are needed to obtain a clearer view of possible areas of improvement for COMBIC to model M84 105–mm HC. The disparity in biases between the two trial makes it difficult to determine areas of improvement.

Statistics for M116 155–mm Hexachloroethane

Wavelength	$M-1$	$M1_a$	$M1_b$	Bias	Best $M1$	Shift	Bias At Shift
0.4μm-0.7μm(11)	.40	.30	.29	.16	.59	-27.(10)	.12
0.7μm-1.2μm(12)	.35	.18	.15	.07	.49	-20.(10)	-.05
1.06μm(12)	.35	.18	.15	.08	.50	-18.(10)	-.06
3.48μm (24)	.61	.49	.44	-.06	.66	-11.(12)	-.06
8.0μm-12.μm(11)	.64	.50	.37	.09	.66	-5.(2)	.09
10.6μm(6)	.77	.65	.46	-.04	.79	-11.(1)	-.03
Combined(76)	.51	.38	.32	.02	.74	-15.	.03

Table 3.1: Statistics for the M116 155–mm HC show the agreement between COMBIC and data

Statistics for M84 105–mm Hexachloroethane

Wavelength	$M1$	$M1_a$	$M1_b$	Bias	Best $M1$	Shift	Bias At Shift
0.4μm-0.7μm(4)	.64	.59	.58	-.05	.73	11.	.01
0.7μm-1.2μm(2)	.62	.52	.50	-.13	.73	15.	-.08
1.06μm(2)	.65	.55	.52	-.10	.75	18.	-.06
3.48μm(6)	.81	.76	.75	-.04	.83	11.	-.04
8.0μm-12.μm(1)	.91	.87	.86	.04	.91	0.	.04
10.6μm(1)	.93	.90	.89	.04	.93	0.	.04
Combined(16)	.74	.68	.66	-.05	.79	11.	-.03

Table 3.2: Statistics for the M84 105–mm HC show the agreement between COMBIC and data

3.4.2 Red Phosphorus Munitions

XM819 81-mm RP

Tables 3.3 reflect a recent change in the COMBIC model for RP, to allow for longer smoldering time [Ayres and Baca, 1987]. Using this statistical methodology to compare the improved model to the older version, indicates that the newer version of COMBIC fits better for both wavelengths, across all measures.

L8A1 and L8A3 Grenades

Best $M1$ of table 3.4 demonstrates that most of the disagreement for these trials are caused by discrepancies in the start time. This time lead and/or lag could all cause the range statistics seen in these trials for $M1_a$ and $M1_b$. Agreement between data and the COMBIC model is good, though the negative bias indicates the model overpredicts the CL.

XM819 RP subset($n = 52$)

Wavelength	$M1$	$M1_a$	$M1_b$	Bias	Best $M1$	Shift
0.4-0.7μm	.57	.51	.41	.034	.61	-40(1)
3.48μm	.81	.69	.43	.008	.83	.
Combined	.69	.60	.42	.021	.72	-40(1)

Table 3.3: Statistics for the XM819 RP for a partial subset show the agreement between COMBIC and data

Statistics for L8A1 and L8A3 grenades

Wavelength	$M1$	$M1_a$	$M1_b$	Bias	Best $M1$	Shift	Bias At Shift
0.4μm-0.7μm(16)	.31	.28	.27	.06	.68	-17.	.04
0.7μm-1.2μm(13)	.23	.21	.11	-.27	.65	83.	-.13
1.06μm(13)	.28	.25	.16	-.23	.69	73.	-.10
3.48μm(19)	.67	.63	.58	-.02	.87	49.	.00
8.0μm-12.μm(8)	.49	.48	.46	-.14	.80	119.	-.04
10.6μm(3)	.90	.87	.83	.02	.91	10.	.02
Combined(72)	.43	.40	.35	-.10	.75	51.	-.04

Table 3.4: Statistics for the L8A1 and L8A3 Grenades show the agreement between COMBIC and data

5 inch Zuni

Table 3.5 show the statistics for the M84 105-mm HC. The fit for PWP ZUNI ranged from bad to good. The difference between $M1_b$ and $M1$ indicates noise is present, that is amplified when the data is scaled. Note that $M1$ and Best $M1$ increase with increasing wavelength, and the bias decreases with increasing wavelength. Smoldering is believed to be responsible for the poor agreement.

The higher the extinction value for the wavelength, the poorer the fit because of the presence of smoldering and the greater the bias. For longer wavelengths, there is not enough smoke due to smoldering to significantly degrade the transmission. Therefore, the agreement between model and data is higher and the resultant bias is lower. More trials are needed for further comparisons.

In summary, the range in biases indicates that COMBIC predicts a smoke cloud that is too dense and passes too quickly when compared with the trial's smoke cloud. If future trials show the above relationship, then it is suggested that the burn function be modified to allow for a more gradual burn of the M54 ZUNI munition. Modifying the burn function should alleviate the problems noted above.

Statistics for 5 inch PWP Zuni

Wavelength	$M1$	$M1_a$	$M1_b$	Bias	Best $M1$	Shift	Bias At Shift
$0.4\mu m$-$0.7\mu m$(2)	.35	.34	.33	.11	.35	-20.	.09
$0.7\mu m$-$1.2\mu m$(5)	.41	.32	.18	-.14	.43	23.	-.12
$1.06\mu m$(5)	.44	.35	.22	-.13	.45	15.	-.11
$3.48\mu m$(4)	.73	.64	.62	-.03	.74	2.	-.03
$8.0\mu m$-$12.\mu m$(4)	.67	.53	.43	-.10	.69	30.	-.07
Combined(20)	.53	.44	.35	-.08	.54	14.	-.07

Table 3.5: Statistics for the 5 inch PWP Zuni show the agreement between COMBIC and data

3.4.3 Infrared Munitions

Table 3.6 show the statistics for the M76 IR grenade. A data set of one hardly make for good statistics. However, several items can be noted from this one trial. Note the near identical values of the statistics across the spectrum. This is due to the identical extinction coefficients for all wavelengths. The sharp decrease of $M1_a$ over $M1$ appears odd, but the M76 IR grenades have a very sharp decrease and increase in transmission, that is successfully modeled by COMBIC. The large negative shift causes the COMBIC data to be almost completely out of phase with the measure values, that is, when COMBIC transmission is high the measure data is low and vice versa. Eliminating the data of COMBIC and measured trial data that exceed 90 percent level transmission eliminates the only portion of the two curves that agree, causing the low $M1_a$. Note $M1 = .41$ improves to .71 when COMBIC is shifted 26 s to the right causing the bias at shift to be minuscule. As mentioned before for HC M116, this bias is believed to be due to an incorrect start time and not problems with the model. This one trial suggests that the agreement between model and data is very good.

3.4.4 White Phosphorus Munitions

M328 WP

Table 3.7 show the statistics for the M328 WP. Agreement between model and measured data is nearly excellent based upon $M1$. However, the measure $M1_a$ indicates that $M1$ is inflated by the long period of high visibility at the end of the trials, especially for the near-IR wavelengths. The negative bias indicates that COMBIC overestimates the amount of time the LOS is obscured and slightly underestimates the transmission, with the most severe bias occurring at the near-IR bands. Based upon one trial comparison, we concluded that COMBIC

Statistics for M76 IR Grenades

Wavelength	$M1$	$M1_a$	$M1_b$	Bias	Best $M1$	Shift	Bias At Shift
$0.4\mu m$-$0.7\mu m(1)$	.40	.04	-.06	.09	.70	-27.	.01
$0.7\mu m$-$1.2\mu m(1)$	.41	.13	-.03	.09	.69	-27.	.02
$1.06\mu m(1)$	.41	.13	-.03	.09	.69	-27.	.02
$3.48\mu m(4)$	.43	.18	.02	.06	.75	-22.	.00
$8.0\mu m$-$12.\mu m(1)$	.39	.05	-.07	.09	.71	-28.	.01
$10.6\mu m(1)$	.40	-.04	-.10	.08	.72	-26.	.01
Combined(9)	.42	.11	-.02	.08	.73	-25.	.01

Table 3.6: Statistics for the M76 IR Grenades show the agreement between COMBIC and data

is a good model for describing M328 WP smoke clouds, however, more data are needed.

M110 155–mm WP

The range in $M1$ in table 3.8 are from fair to excellent. However, $M1_a$ and $M1_b$ is substantially lower than $M1$ for the near IR regions. We believe the agreement is good partly because of the inflation of $M1$ at a higher transmission level for these wavelengths.

M825 155–mm WP

The values of $M1$ in table 3.9 range from good to excellent (.61 to .80). No time shift of any significance was noted. $M1_a$ is less than $M1$, denoting the fact that $M1$ was inflated due to high transmission. $M1_b$ is much lower than $M1$ since scaling amplifies the noise. However, on the whole, the agreement between model and measured data is good.

Statistics for M328 WP

Wavelength	$M1$	$M1_a$	$M1_b$	Bias	Best $M1$	Shift	Bias At Shift
$0.4\mu m$-$0.7\mu m(2)$	.81	.65	.62	-.08	.82	0.	-.08
$0.7\mu m$-$1.2\mu m(1)$	.72	.41	.37	-.14	.72	14.	-.04
$1.06\mu m(1)$	.76	.50	.46	-.12	.76	0.	-.12
$3.48\mu m(3)$	.76	.63	.60	-.11	.85	3.	-.06
$8.0\mu m$-$12.\mu m(1)$	.80	.68	.66	-.09	.81	-2.	-.09
$10.6\mu m(1)$	.80	.69	.66	-.09	.81	-2.	-.09
Combined(9)	.78	.61	.58	-.10	.81	2.	-.08

Table 3.7: Statistics for the M328 WP show the agreement between COMBIC and data

M54 Zuni PWP

The fit for PWP ZUNI ranged from bad to good in table 3.10. The difference between $M1_b$ and $M1$ indicates noise is present, that is amplified when the data is scaled. Note that $M1$ and Best $M1$ increase with increasing wavelength,

Statistics for M110 155–mm WP

Wavelength	$M1$	$M1_a$	$M1_b$	Bias	Best $M1$	Shift	Bias At Shift
0.4μm-0.7μm(4)	.74	.74	.74	.09	.76	-18.	.08
0.7μm-1.2μm(10)	.52	.44	.35	.22	.54	-6.	.21
1.06μm(10)	.52	.44	.35	.23	.54	-8.	.22
3.48μm(4)	.78	.78	.74	.02	.81	-2.	.02
8.0μm-12.μm(2)	.84	.83	.80	.02	.86	6.	.03
10.6μm(2)	.84	.83	.80	.02	.86	6.	.03
Combined(32)	.62	.57	.50	.16	.64	-6.	.15

Table 3.8: Statistics for the M110 155–mm WP show the agreement between COMBIC and data

Statistics for M825 155–mm WP

Wavelength	$M1$	$M1_a$	$M1_b$	Bias	Best $M1$	Shift	Bias At Shift
0.4μm-0.7μm(6)	.80	.80	.80	.03	.82	-9.	.03
0.7μm-1.2μm(32)	.63	.58	.55	-.07	.66	5.	-.06
1.06μm(32)	.65	.60	.57	-.05	.67	3.	-.05
3.48μm(20)	.61	.59	.58	.08	.62	-7.	.07
8.0μm-12.μm(8)	.64	.62	.61	-.03	.65	-1.	-.03
10.6μm(7)	.73	.72	.71	-.08	.74	-1.	-.08
Combined(105)	.65	.61	.59	-.03	.67	0.	-.03

Table 3.9: Statistics for the M825 155–mm WP show the agreement between COMBIC and data

and the bias decreases with increasing wavelength. Smoldering is believed to be responsible for the poor agreement. The higher the extinction value for the wavelength, the poorer the fit because of the presence of smoldering and the greater the bias. For longer wavelengths, there is not enough smoke due to smoldering to significantly degrade the transmission. Therefore, the agreement between model and data is higher and the resultant bias is lower. More trials are needed for further comparisons.

Statistics for M54 PWP Zuni

Wavelength	$M1$	$M1_a$	$M1_b$	Bias	Best $M1$	Shift	Bias At Shift
$0.4\mu m$-$0.7\mu m$(8)	-.02	-.04	-.05	.45	.06	-24.	.45
$0.7\mu m$-$1.2\mu m$(14)	.35	.27	.23	.17	.41	-17.	.16
$1.06\mu m$(19)	.43	.35	.30	.14	.48	-15.	.13
$3.48\mu m$(20)	.62	.58	.54	.15	.66	-26.	.14
$8.0\mu m$-$12.\mu m$(15)	.65	.60	.56	.12	.68	-80.	.11
Combined(76)	.46	.40	.37	.18	.51	-22.	.17

Table 3.10: Statistics for the M54 PWP Zuni show the agreement between COMBIC and data

3.4.5 Fog oil

Generators

$M1$ indicates the agreement between COMBIC and data is poor (table 3.11). However, Best $M1$ indicates the disagreement is partly due to time shift of an average 35 s. In fact, individual statistics show many trials have a time shift of 200 s. The fog oil trials did not yield results as clearly as for the trials employing other smoke types. The difficulty was caused by the properties of the smoke itself. The short wavelengths were attenuated very strongly; whereas, the long wavelengths were often hardly attenuated at all. Noise would often swamp any signal for the long wavelengths leading to very poor values for $M1_a$ and $M1_b$. As a whole, COMBIC overpredicts the density of the smoke at all wavelengths (negative biases). The visible wavelength data indicate the bias is not high; however, this is due to the data "bottoming out." The ability of COMBIC to model fog oil can was effected by the production of the wet fog oil instead of dry fog oil during several trials. Wet fog oil would affect the extinction and the deposition rate of fog oil.

3.4.6 All Munitions

Table 3.12 gives the statistics for each obscurant type and for the model as a whole. Though more trials are needed for all munitions except XM819 RP, some conclusions can be drawn. The fit for HC, WP, RP, and IR is good (using Best M1). COMBIC can be used with confidence in modeling these types of smokes. The fit for PWP and fog oil is fair, though again more trials are needed (especially for the PWP smokes of which there are only 8 trials for evaluation purposes). Also, more trials are needed to determine if smoldering can improve the modeling capability for PWP Zuni and M110 WP. Table 3.12 indicates the model, based upon the combined statistics for PWP, IR, WP, fog oil, and HC, adequately modeled obscurants on the battlefield for the wavelengths tested.

Statistics for Fog Oil Generators

Wavelength	$M1$	$M1_a$	$M1_b$	Bias	Best $M1$	Shift	Bias At Shift
$0.4\mu m$-$0.7\mu m$(45)	.34	.29	.27	-.08	.60	-53.	-.08
$0.7\mu m$-$1.2\mu m$(1)	.18	.03	.02	-.41	.25	35.	-.37
$1.06\mu m$(45)	.29	.22	.20	-.12	.53	-33.	-.12
$3.48\mu m$(18)	.25	.15	.07	-.21	.32	-19.	-.18
$8.0\mu m$-$12.\mu m$(4)	.21	-.01	-.13	-.27	.26	40.	-.33
Combined(113)	.30	.23	.19	.13	.51	-35.	-.13

Table 3.11: Statistics for the Fog Oil Smoke show the agreement between COMBIC and data

(Statistics for Each Obscurant Type)

	$M1$	Bias	Best $M1$	Shift	Bias At Shift
HC (99)	.57	.02	.65	-8.	.01
RP (141)	.58	-.06	.61	6.	-.05
WP (146)	.65	.01	.67	-1.	.01
PWP(76)	.46	.18	.51	-22.	.17
IR (9)	.42	.08	.73	-25.	.01
FOG OIL(113)	.30	-.13	.51	-35.	-.13
Combined(531)	.50	-.01	.59	-11.	.01

Table 3.12: Statistics for smoke type

4. Operations Guide

4.1 Introduction

COMBIC executes in two phases. Either phase or both phases can be executed in a single computer run. Phase I generates a cloud history for one or more obscurant sources that (1) can be selected by the user from a menu, (2) can be completely defined by user inputs, or (3) can be determined by inputs between the two extremes. Cloud histories are output to a direct-access (record-addressable) mass storage file. In Phase II calculations, the user inputs a scenario of one or more obscurant sources and one or more target-observer pairs. The Phase I cloud history file is used to obtain cloud positions, dimensions, and concentrations. Output from Phase II is the transmittance history at the EOSAEL wavelengths for each target-observer pair for all obscurant clouds in the scenario.

Both Phase I and Phase II generate conventional listings of up to 132 characters per line. At the user's option, Phase II can also generate supplementary listings of the contributions of individual subclouds to obscuration and can produce a printed contour representation of clouds with time. These listings are directed to separate print files or unit numbers.

The primary purpose of Phase I is to compute separate cloud histories for given types of battlefield obscurants under one set of meteorological conditions. Each cloud history is computed in relation to an arbitrary source position and thus is independent of any specific scenario. Phase II calculations are for scenarios that potentially contain many obscurant sources at user-defined locations and starting times. Phase II also performs bookkeeping of user-defined observer-target pairs. Memory locations for sources and for observer-target pairs are reused as they become available. Phase II computes the transmittance at one or more wavelengths and bands between the target–observer pairs as a function of time.

The following sections define inputs to Phase I and Phase II. Code structure is given in subsequent sections. The two "phases" can be easily separated into two distinct programs if necessary. Input formats are structured so that records applicable to Phase II calculations are ignored by Phase I and vice versa, allowing the user to input a single file (or card deck) with inputs for both phases.

Except for NAME and FILE records, all inputs to COMBIC follow a standard format. An example is provided in Table 4.1. Values are provided by the user on a series of 80-column records. Each record has a 4-letter identifier in columns 1-4. Columns 5-10 are ignored. Up to 7 numeric values are placed on each record in 10-column fields, that is, one value in columns 11-20, one in columns 21-30, etc. Each numeric value is FORTRAN type REAL and therefore must contain a decimal point. The FORTRAN input format is (A4,6X,7F10.4). The advantage to making all the numeric inputs REAL is that they can be placed anywhere within their ten-column input field with blanks on either or both ends of the numeric value.

The input value may have any number of digits preceding or following the decimal point within the 10 column limit for the entire number. Very small or very large numbers can be expressed in terms of exponential notation. For example, 1.234E-6 can be used to designate the number 0.000001234. The integer following the letter "E" tells the number of places to move the decimal point (either left negative or right positive) to obtain the usual decimal notation.

If COMBIC issues an error message about a particular input record, the user should first check to determine if each input number has a decimal, that it falls inside its 10-column input field, and that there are no "nonprinting" special characters (CNTRL or ESC sequences) on the record. These comprise almost 100 percent of the usual input problems.

4.2 Phase I Input

4.2.1 General Features

Input may also be taken from EOSAEL common blocks for default input/output (I/O) file numbers, coordinate system definition and for (optional) climatology inputs in place of meteorological observations. Relative humidity, windspeed, wind direction, Pasquill category, air temperature, and air pressure are provided by the EOSAEL CLIMAT model under the latter option.

User-specified inputs to COMBIC in Phase I calculations include: control records that separate the calculations of cloud histories for the specified obscurant sources, environmental records that include primarily meteorological inputs, munition or source definition records, an optional record that modifies the source to form an effective barrage source, an optional record to modify or input additional extinction coefficients, an optional record to allow comments to be placed into the input file for documentation purposes, and optional records that define the subcloud stucture of the obscurant cloud to allow the user to input more general obscurant sources. The record identifiers for Phase I inputs are:

Control:	PHAS, FILE, GO, DONE
Environment:	MET1, MET2, PSQ1, PSQ2, TERA
Source:	MUNT, BURN, DUST, VEHC
Barrage:	BARG
Extinction:	EXTC
Comments:	NAME
Subclouds:	CLOU, SUBA, SUBB, SUBC

Hereafter, the set of input records is called the "input file." This file is often created and edited as a mass storage file. But it can also be a physical deck of input cards or a series of lines typed into a terminal one after the other as well.

The input file to COMBIC must begin with a PHAS record and end with a DONE record. Additional records before the PHAS and after the DONE are required if the routine is executed as part of the larger EOSAEL library. The reader is referred to the EOSAEL library general documentation for those inputs.

COMBIC Phase I output cloud histories would change if meteorological inputs are changed. COMBIC is, therefore, designed to use only one set of meteorological conditions per computer run, unless additional PHAS records are input to reinitialize the program. An exception to the meteorological restriction is wind direction. Wind direction is read into Phase I but is not used. It is simply passed to Phase II through the history file. Thus, Phase I need not be rerun if a change in wind direction is all that is required. Phase II allows the user to input a new wind direction if desired.

Environmental records (MET1, MET2, PSQ1, PSQ2 and/or TERA) should be input soon after the PHAS input record and preceding the first GO or DONE record. Their order is not important except PSQ2 must follow PSQ1. Appendix D is a simple flowchart that can aid the user in determining pasquill stability for the MET1 record given only windspeed, cloud cover and time of day.

More than one obscurant type can be specified in Phase I. The history file produced grows in size as each additional source is specified. Different source inputs are separated by GO records. The GO record tells COMBIC that all desired input records have been read in for a given source and that now a cloud history should be generated for that source. Following a GO record, the source inputs are reinitialized. The next source can now be defined, followed by another GO record. Once a GO is input, the environmental inputs cannot be redefined, and environmental records result in warning messages. A DONE record is a special type of GO record that tells COMBIC to compute the final cloud history and then stop or return to the EOSAEL executive library routine.

The remaining control record is the FILE input record. If used, FILE records should be placed immediately following the PHAS record. The FILE record does not follow the standard input format. It allows the user to link a named mass storage file to a "unit number." The unit numbers are specified on the PHAS record or default to those in EOSAEL common block IOUNIT. The FILE record contains the unit number in columns 11-20 (again a real number with a decimal point) and a file name of up to 16 characters beginning in column 21. COMBIC will then open that file for I/O.

Sources are defined on MUNT, BURN, DUST and/or VEHC records. Most users wishing only to use the menu-provided sources, with perhaps some modification of characteristics, will find these records sufficient. They may occur in any order before the GO or DONE record. The MUNT record, in particular, allows the user to specify the menu number for the source and a scaling factor XN for the number of such munitions (or sources) to be considered as lumped together to produce a single cloud.

The scale factor, again specified (or modified) in Phase II inputs, is provided in Phase I so that the proper amount of heat produced by the cloud (thermal buoyancy) can be accounted for. The user can specify a different scaling XN of up to a factor of about 3-4 (or one-third to one- fourth) in Phase II for hot clouds such as WP. For nonthermal sources, such as fog oil, or for warm thermal sources, such as HC, the range of different scaling in Phase II can be increased. For users needing a wide range of WP source strengths in Phase II, it is suggested that more than one history be generated in Phase I to cover the reasonable ranges expected.

This can be confusing to new users. For example, suppose Phase I is for $XN = 8$ rounds of 155-mm WP. In Phase II an input source factor of $XN = 1$ will place 1 round in the scenario, an $XN = 8$ places 8 rounds in the scenario at the coordinates input, and an $XN = 24$ places 24 rounds at that point. The model in each case scales the amount of WP smoke appropriately, and the cloud height computed in Phase I is also scaled in relation to the height of the cloud determined for 8 rounds in Phase I. For the case of 24 rounds, the instantaneous puff generated by the WP burst will rise $(24/8)^{\cdot 25} = 1.32$ or 32 percent higher. But, windspeed varies logarithmically with height. Thus, if the Phase II input number of rounds is sufficiently different from the number computed for in Phase I, the effects of higher winds at greater heights will not be appropriately taken into account.

The submunition parameter on the MUNT record allows the user to decouple the thermal buoyancy of parts of the source. It should be used in conjunction with XN when the amount of obscurant produced by many munitions is large, but the munitions can be assumed to be thermally uncoupled or independent. The fill weight inputs on the MUNT record are for one source.

The user will generally input zeros for the fill weight, yield factor, and efficiency if a menu source is selected. COMBIC interprets zeros for most inputs where zero is not otherwise meaningful to imply that an internal default or model is to be used to produce a value.

The BURN record allows the burn duration (or the obscurant production duration) to be specified for a source and a profile of the production to be input. Again, if the record is not present, COMBIC assigns menu or default values.

The VEHC and DUST records are needed for vehicular and high-explosive dust sources. They can be placed before or after the MUNT input. The VEHC record can also be used to specify a speed and direction for a moving smoke source (or a moving barrage). If input, the VEHC speed and direction is passed to Phase II where it can be modified by other inputs or can be assumed as input in Phase I.

The BARG record may be placed ahead of or after the MUNT record. If not present, then the source is assumed to act as an individual source. If the BARG record appears, then an approximate equivalent obscurant cloud is produced that combines the effect of several sources spread over an area and igniting or initially producing obscurant over a period of time. The basic source is still defined on the inputs of MUNT, BURN, and so forth. The BARG record forms a single source cloud with the amount of obscurant determined by the number of rounds per second and the barrage duration.

The "round" used in Phase I for calculating cloud mass and buoyancy is determined by XN and the other MUNT parameters. Thus, if the barrage is for 0.1 rounds per second, the duration is 100 s and the XN value is 5 for 155-mm WP, then 50 rounds impact the barrage area over the 100 s period. The cloud history is thus for these 50 rounds. In Phase II if the source strength is $XN = 1$, then the barrage placed in the scenario is for only 10 rounds, that is, 0.1 round per 100 s, and the amount of smoke and the thermal rise are computed correspondingly. Again, the reason for inputting a value other than $XN = 1$ in Phase I is to insure that the correct cloud rise and wind effects are generated for a barrage of this size.

The EXTC record allows the user to alter extinction coefficients and to define new values if desired for different obscurants or different wavelength regions. The values resulting from Phase I are passed to Phase II in the history file. Phase II inputs also allow the user to modify values during the Phase II run as well. In Phase I, it should be placed in the same area of the input file as the meteorological conditions.

The NAME record may appear anywhere in the input file to provide comments or documentation. Comments should not appear on the NAME record itself but on a record immediately after the NAME record. The comments may be of any form and are ignored by COMBIC but may be echoed to the output listing along with other inputs through a flag input on the PHAS record.

Input parameters for each of the Phase I records are given below. The order of the input parameters corresponds to the order of the numeric fields that are input in columns 11-20, 21-30, 31-40, and so forth.

4.2.2 Phase I Input Records

Control Records

Environmental Records

Table 4.1: All cards except NAME, DONE, GO, FILE have this format.

4-Letter Record ID Beginning in Col 1

Data Values (With Decimal), Up to 7 per Record

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
CARD                 1.0       1.0       1.0       1.0       1.0       1.0       1.0
```

10 Columns reserved for each data value

Table 4.2: The `WAVL` Card. This is one of the cards that may be used to specify wavelength, wavenumber, or frequency. Choose one from among `WAVL`, `WAVNUM`, or `FREQ`.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
WAVL           WAVE1     WAVE2     MULDV
```

NAME	UNITS	TYPICALLY	Description
WAVE1	μm	1.06	Wavelength used for the calculation. Alternatively either frequency or wavenumber may be specified by using a FREQ or WVNUM card instead of this WAVL card. If WAVE2 is not specified then this is the single wavelength used; if WAVE2 is specified then the modules will attempt to do their calculation for a range of wavelengths. There is no default; this information must specified.
WAVE2	μm	0.	Wavelength used for the calculation. This is the other end of a wavelength interval started by WAVE1. If WAVE2 is not specified then the modules will attempt to do their calculation for a single wavelength WAVE1. The default is to perform the calculations for a single wavelength.
MULDV		1	Number of equal intervals to divide WAVE1 – WAVE2 into.

Table 4.3: The PHAS Card. PHAS *must* be the first record after calling COMBIC.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
PHAS          PHASE     IUNIT     OUNIT     UNITC     UNITF     ORDRS      ECHO
PHAS             1.        5.        6.       12.        9.        0.        0.
```

NAME	UNITS	TYPICALLY	Description
PHASE		1. or 2.	Select Phase I or Phase II. A second PHAS card reinitializes COMBIC to the phase specified. There is no default. It must be specified.
IUNIT		1. to 30.	The standard input unit for COMBIC commands. (IOIN in common /IOUNIT/)
OUNIT		1. to 30.	The standard output unit for COMBIC listings. (IOOUT in common /IOUNIT/)
UNITC		1. to 30.	Secondary output unit, not used in Phase I. Used for the printer-plot option. (NPLOTU in common /IOLNIT/)
UNITF		1. to 30.	History file output unit, direct-access storage. (NDIRTU in common /IOUNIT/)
ORDRS		0. or 1.	Flag, not used in Phase I. If ORDRS equals 1, then inputs in Phase II are scanned, and calculations are performed up to the last time input on a source or observer record. This allow the calculation to progress in an interactive fashion if ORDRS equals 1, otherwise if ORDRS equals 0 then it is batch mode.
ECHO		0. or 1.	If ECHO equals 1, all inputs will be echoed to the print file.

Table 4.4: The GO and DONE Cards. GO initiates calculation of a CLOUD HISTORY for one source type then returns control to the input record file for further inputs. Previous meteorological data remains effective, but all source inputs are reinitialized. (No parameters). DONE is similar to the GO input record, except control exits COMBIC after the CLOUD HISTORY is computed and stored in the HISTORY file. (No parameters)

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
GO               0.        0.        0.        0.        0.        0.        0.
DONE             0.        0.        0.        0.        0.        0.        0.
```

Table 4.5: The FILE Card. Optional–Connect Named File to Input/Output.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
FILE          UNITNO     FNAME
```

NAME	UNITS	TYPICALLY	Description
UNITNO		1. to 30.	Any unit # input on PHAS record.
FNAME		(chars)	File Name, Up To 16 characters, beginning in column 21. Only COMBIC input record with character input field.

Table 4.6: The NAME Card. Optional record to allow user to place non-executable comments in the input record file. The comment record must immediately follow the name record. The text on the comment card will be ignored as input except to be echoed to the print file if ECHO is 1. The NAME card itself should have blank or 0. fields and no text. This card may appear anywhere after the PHAS card. It effectively comments out the next card in the input file.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
NAME           0.        0.        0.        0.        0.        0.        0.
 (Comment record goes here.)
```

Table 4.7: The MET1 Card. Meteorological conditions for Phase I calculations. If the ICLMAT = 1 option is used in the EOSAEL library executive routine, then all values are passed to COMBIC through the climatology common block /CLYMAT/.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
MET1          RELHUM        UW      PCAT      AIRT     PRESR    WINDIR     COLDR
MET1             50.        6.        4.       21.     1013.      270.        0.
```

NAME	UNITS	TYPICALLY	Description
RELHUM	Percent	0. to 100.	Relative humidity.
UW	m/s	.2 to 30.	Windspeed at height ZREF. Default for ZREF is 10 m. 1m/s = 2.24 mi/hr.
PCAT		1. to 7.	Pasquill stability category. (Fractions allowed). Standard values are 0.6 = A, 1.6 = B, 2.6 = C, 3.6 = D, 4.6 = E, 5.6 = F, 6.6= G. Unstable A, B, C (0.2–3.0), Neutral D (3.1–4.0), Stable E, F (4.1–7.0). If PCAT is input as 0., a PSQ1 and PSQ2 card will compute a category.
AIRT	deg C	-40. to 45.	Air temperature at height ZREF.(Calculation is insensitive to the reference height and any value 2-16m is appropriate.)
PRESR	mb	up to 1020.	Air pressure at height ZREF above ground level. (Standard at sea level is 1013.) Calculation is insensitive within 10's of mbar and thus to the reference height. If air density ρ is known, then PRESR is $\text{PRESR} = 2.883 \times 10^{-3}\rho(\text{AIRT}+273.2)$ where ρ is is g/m^3.
WINDIR	deg wrt N	0. to 360.	Wind direction. Not used in Phase I.
COLDR		0. or 1.	Cold regions flag. If 1. then WP and HC yield factors are computed from the cold regions model. Not related to winterized fog oil.

Table 4.8: The MET2 Card. Optional meteorological parameters. This card is not usually used except to change the reference height or to set a known inversion height. Other parameters are used only in sensitivity studies or boundary layer model effects.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
MET2            ZREF      ZINV     SBARM      SBAR     USTAR     SHFLX
MET2             10.        0.        0.        0.        0.        0.        0.
```

NAME	UNITS	TYPICALLY	Description
ZREF	m	1. to 20.	The reference height for input wind speed, temperature and pressure.
ZINV	m	30. to 1000.	Height of the limiting inversion. If 0., the internal model is used.
SBARM		0. or 1.	Flag. If 1., then the average static stability parameter model is used for buoyant rise. Defaults to the model for decreasing stability parameter with height.
SBAR	(s^{-2})	varies	Option user-specified average static stability parameters when SBARM is 1. If SBAR is input as 0. and SBARM is 1., the internal model averages from 10 to 50m.
USTAR	m/s	.001 to 2.	Optional surface friction velocity to overide the internal model value. If 0., the internal model is used.
SHFLX	$watt/m^2$	varies	Optional sensible heat flux to override the internal model value. If 0., internal model is used.

Table 4.9: The PSQ1 Card. Optional for determining and overriding the PCAT on the MET1 card. Must be used conjunction with PSQ2 record. No defaults.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
PSQ1            SLAT     SLONG    SZHOUR    SJDATE        CCOV
```

NAME	UNITS	TYPICALLY	Description
SLAT	degrees	0. to 90.	Site latitude (degrees, positive northward).
SLONG	degrees	+180. to -180.	Site longitude (degrees, positive eastward)
SZHOUR	hrs and decimal	0. to 24.0	Time of day in hours and fractions of hours, local time (no daylight savings). Input is converted internally to Greenwich mean time (GMT) using the code GMT = TOD + IFIX ((SLONG + 7.5)/15.)
SJDATE	days	0. to 365.	Julian date.

Table 4.10: The PSQ2 Card. Optional Pasquill category calculation. Must be used right after PSQ1.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
CCEIL          GCOND     RLGTH
```

NAME	UNITS	TYPICALLY	Description
CCEIL	m	100. to 9999.	Height above Ground of Lowest cloud layer.
GCOND		1. to 3.	Ground condition: 1 = Bare ground, 2 = snow patchy, < 6', 3 = snow > 6' deep.
RLGTH	m	.00001 to 10.	Land use category/roughness length Bare desert, playas = 0.0003 Tundra = 0.004 Snow-covered farmland = 0.002 Prairie, 0.2-0.4 m grass = 0.03 Airfields = 0.03 Farmland = 0.06 Agricultural areas, Asia = 0.08 Farmland, hedgerows = 0.10 Brush, scrub growth = 0.16 Trees, hedgerows, few buildings = 0.20 Tall crops, scattered obstacles = 0.25 Dense brush = 0.25 Citrus orchards = 0.35 Level wooded countryside = 0.40 Cup-over forest areas = 0.40 Subtropical savannah = 0.40 Barren hills, low mountains = 0.75 Forested plateau, rain forest = 1.0 Forested, rolling terrain = 2.0 Fir forest = 3.0 Smooth mud Flats = 0.00001 Blacktop or concrete = 0.00002 Dry lake bed = 0.00003 Normal sea = 0.001 Closely mown grass = 0.001 Short grass = 0.0014 Grass (5 - 6 cm) = 0.0075 Alfalfa = 0.0272 Long grass = 0.03 Grass (60 - 70 cm) = 0.114 Wheat = 0.22 Forest clearings, cutover areas = .32-.48 Corn (220 cm) = 0.74 Coniferous forest = 1.10

Table 4.11: The TERA Card. Optional soil and surface parameters. This card allows the user to modify the environmental parameters that affect cloud diffusion (ZNOT) or obscurant production.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
TERA            ZNOT      SILT       SOD      SNOW
TERA             0.1       50.        0.        0.        0.        0.        0.
```

NAME	UNITS	TYPICALLY	Description
ZNOT	m	.001 to 5.	Surface Roughness. Used in Wind and Diffusion Model. Typically 10 percent of highest vegetation elements.
SILT	percent	0. to 100.	Surface soil silt content. Used in vehicle dust model. Silt particles are < 74 μm Diameter.
SOD	m	0. to 2.	Depth of Sod Cover. Used in HE dust model.
SNOW		0. or 1.	Snow cover (1 if yes). Reduces RP smoke munition burning by 80 percent.

Source Records

Barrage Record

Subcloud Records

Table 4.12: The MUNT Card. Munition definitions and menus.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
MUNT              XN        FW     SMENU      STYP       EFF        YF      SUBM
MUNT              1.        0.       12.        0.        0.        0.        1.
```

NAME	UNITS	TYPICALLY	Description
XN		.1 to 100	The number of munitions or sources grouped at the same point and initiated at the same time. This parameter scales-up obscurant mass and heat production. It can be a non integer.
FW	lbs or gal.	.01 to 1000.	Fill weight. For high-explosives, FW is the weight of the charge in pounds equivalent–TNT. For fogoil, diesel fuel, PEG200 and Diesel fuel/oil/rubber fires, the fill weight is in gallons. For all other obscurants, including vehicular dust, FW is in pounds. Normally the FW is zero for vehicular dust to use the internal model. Otherwise if input as zero, defaults are used.
SMENU		0. to 33.	Selects a source from the built-in menu: 0. = User specified by inputs. 1. = 155-mm HC M1 canister. 2. = 155-mm HC M2 canister. 3. = 105-mm HC canister. 4. = 155-mm HC M116B1 canister.* 5. = 155-mm HC M84A1 projectile.* 6. = Smoke pot, HC M5.* 7. = Smoke pot, HC M4A2.* 8. = 60-mm WP M302A1 cartridge.* 9. = 81-mm WP M375A2 cartridge.* 10. = 4.2-in WP M328A1 cartridge.* 11. = 2.75-in WP M156 rocket.* 12. = 155-mm WP M110E2 projectile.* 13. = 105-mm WP M60A2 cartridge* 14. = 4.2-in PWP M328A1. 15. = 5-in PWP Zuni MK4. 16. = 2.75-in WP wedge. 17. = 2.75-in WP M259 rocket.*

Table 4.12: The **MUNT** Card. Munition definitions and menus.

NAME	UNITS	TYPICALLY	Description
			18. = 3-in WP wick. 19. = 6-in WP Wick. 20. = 155-mm WP M825 projectile.* 21. = 81-mm RP wedge. 22. = 81-mm RP XM819 cartridge.* 23. = Generator, ABC M3A3.* 24. = Generator, VEESS.* 25. = Smoke Pot, Fog Oil M7A1.* 26. = 155-mm HE (dust). 27. = 105-mm HE (dust). 28. = 4.2-in HE (dust). 29. = 10-lb C4 (dust). 30. = Diesel fuel/oil/rubber fire. 31. = Muzzle Blast. 32. = M76 IR grenade. 33. = L8A1/L8A3 RP grenade. *. = Inventory munitions.
STYP		0. to 30.	Obscurant type for the selection of extinction coefficients and for assigning default model characteristics if information is not otherwise provided by menu values or user inputs. 0. = Assigned by the internal menu. 1. = Bulk white phosphorus (WP) munition. 2. = WP wedges, wicks and Plasticized WP (PWP) munitions. 3. = Hexachloroethane(HC) smoke. 4. = Fog oil (SGF2) generator or smoke pot. 5. = Red Phosphorus (RP) munition. 6. = IR screener, generator disseminated. 7. = IR screener, munition. 8. = Diesel fuel (DF) produced by generator. 9. = Dust, vehicular. 10. = Dust, High Explosive (HE), small particle, persistent mode. 11. = Dust, (HE), large particle mode. 12. = Carbon, HE debris product.

NAME	UNITS	TYPICALLY	Description
			13. = Dust/soil, HE, very large, ballistic soil aggregates. 14. = Fire smoke from diesel, oil, and rubber mix. 15. = Kerosene/fog oil cold region mix. 16. = Polyethylene glycol (PEG 200) mix for alcohohols. 17. = Anthracene (Not use in SMENU). 18. = Chlorosulfonic acid (FS, not used in SMENU). 19. = Titanium tetrachloride (FM, not used in SMENU). 20. = IR(M76). 21. = O.A Brass. 22. = GRAPH 7525. 23. = Kaolin. 24.–30. = User defined by inputs.
EFF	%	1. to 100.	Production efficiency. For smoke, the percent of actual aerosol weight produced from the fill weight. For HE dust, the percent of the yield appearing as heat. Defaults to modeled values when input is zero. Ignored for vehicular dust. Total Mass $= CX_nW_f\left(\frac{E_f}{100}\right)Y_f$ C is a conversion constant.
YF		0. to 20.	Yield factor. For smokes (dimensionless), the ratio of the total airborne mass of obscurant absorbed water to the total mass or obscurant alone. For HE explosions, the crater volume scaling factor $S_a(m^3/TNT^{1.111})$. If 0., internal models are used.
SUBM		varies	Number of submunitions per munition that make up the source and produce independently buoyant portions of the total obscurant cloud. Specifies thermal independence.

Table 4.13: The BURN Card. Obscurant burn rate profile for continuous sources.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
BURN            TBURN     BRAT1     BRAT2     BRAT3     BRAT4     BRAT5     BRAT6
```

NAME	UNITS	TYPICALLY	Description
TBURN	s	1. to 900.	Burn Duration. The length of time that the source releases obscurant. If input as zero, the menu defaults is used.
BRAT1		varies	Coefficient of constant term.
BRAT2		varies	Coefficient of linear term.
BRAT3		varies	Coefficient of quadratic term.
BRAT4		varies	Coefficient of cubic term.
BRAT5		varies	Coefficient of added exponential term.
BRAT6	(s^{-1})	varies	Coefficient of exponential.

The burn rate profile has the form:

$$\dot{M}(t) = \frac{1}{T_b}\left[B_1 + B_2\left(\frac{t}{T_b}\right) + B_3\left(\frac{t}{T_b}\right)^2 + B_4\left(\frac{t}{T_b}\right)^3 + B_5B_6\exp\left(-B_6t\right)\right]$$

and can be multiplied by any constant value since the model normalizes 1 to total mass produced. T_b is burn duration TBURN. In terms of the cumulative mass M(t) produced up until time t, the coefficients describe:

$$M(t) = B_1\left(\frac{t}{T_b}\right) + \frac{1}{2}B_2\left(\frac{t}{T_b}\right)^2 + \frac{1}{3}B_3\left(\frac{t}{T_b}\right)^3 + \frac{1}{4}B_4\left(\frac{t}{T_b}\right)^4 + B_5\left(1 - \exp\left(-B_6t\right)\right)$$

Table 4.14: The SMLD Card. Obscurant burn rate modification for smoldering munitions.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
SMLD            TSMLD     CSMLD
```

NAME	UNITS	TYPICALLY	Description
TSMLD	s	1. to 500.	Time smoldering begins. Must be less than TBURN.
CSMLD	(s^{-1})	varies	Exponential coefficient for all times. It defines how fast the smoldering decays. The larger the coefficient, the faster the mass production.

The burn function for smoldering munitions is:

$$\dot{M}_{new}(T) = \dot{M}_{old}(T) \qquad T < TSMLD$$

$$\dot{M}_{new}(T) = \dot{M}_{old}(TSMLD) * \exp - \left(\frac{CSMLD}{(TBURN-TSMLD)} * (T - TSMLD)\right) \qquad T > TSMLD$$

Table 4.15: The EXTC Card. Optional user-defined extinction coefficients. All values *must* be specified if EXTC is used.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
EXTC           CLTYP      R(2)      R(3)      R(4)      R(5)      R(6)      R(7)
```

NAME	UNITS	TYPICALLY	Description
CLTYP		1. to 30.	Obscurant number STYP from MUNT record definition. User inputs replace the extinction coefficients
R(2)	m^2/g	0. to 20.	0.4 – 0.7 μm waveband.
R(3)	m^2/g	0. to 20.	0.7 – 1.2 μm waveband.
R(4)	m^2/g	0. to 20.	1.06 μm waveband.
R(5)	m^2/g	0. to 20.	3.0 – 5.0 μm waveband.
R(6)	m^2/g	0. to 20.	8.0 – 12.0 μm waveband.
R(7)	m^2/g	0. to 20.	10.6 μm waveband.

Table 4.16: The VEHC Card. Vehicle inputs (primarily for dust but also for any moving source. If the total dust is input as a fill weight (lbs) on the MUNT card, the internal vehicular dust model will not be used. The dust production rate is then determined from TBURN. The Phase II scaling will then assume dust production per unit time varies as vehicle speed squared, as in the internal mode. In either case VEHC must be input. VEHC can also be input with any other obscurant to designate it as moving. This passes speed and direction to Phase II. It is more common, however, to use the VEH1 and VEH2 cards in Phase II to place obscurant sources other than vehicular dust into motion.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
VEHC          VSPEED    VWIDTH    VWEIGH    VEHTYP    VEHDIR
VEHC              5.        3.       60.        1.       90.        0.        0.
```

NAME	UNITS	TYPICALLY	Description
VSPEED	m/s	0. to 35.	Moving source speed. This can be altered in Phase II.
VWIDTH	m	0. to 4.	Vehicle width for internal dust model only.
VWEIGH	tons	0. to 70.	Vehicle weight for internal dust model only.
VEHTYP		0. or 1.	Vehicle type (0=Wheeled, 1= Tracked) for internal dust model only.
VEHDIR	deg	0. to 360.	Moving source direction. This can be altered in Phase II.

Table 4.17: The DUST Card. This card is input for the HE dust model only. DOB, DELIV, CASEL, CASED and CYDEG are ignored if YF (equal to S_{ac} for HE dust) is nonzero on the MUNT card.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
DUST            SOIL       DOB     DELIV     CASEL     CASED     CYDEG
DUST             4.5      -.06        3.     .6096     .1778       10.        0.
```

NAME	UNITS	TYPICALLY	Description
SOIL		1. to 6.	Soil type (can be noninteger). 1. = rock 2. = dry cohesive soil 3. = dry sandy soil 4. = dry-to-moist sand 5. = wet sand, moist cohesive soils 6. = wet cohesive soil
DOB	m	-5. to 5.	Depth (or height if negative) of center of mass of munition at burst.
DELIV		1. to 3.	Delivery type. 1. = uncased static 2. = cased static 3. = cased live fire
CASEL	m	.1 to 2.	Length of casing.
CASED	m	.01 to 1.	Diameter of casing.
CYDEG	deg	0. to 90.	Dip angle of munition from the horizontal at burst.

Table 4.18: The BARG Card. This card modifies the munition source to be treated as multiple rounds ignited or exploded crosswind width YBARW meters and uniformly distributed in time over T=TBARG s. No barrage is assumed if the BARG card is absent. Note that the BARG card generates an approximate representation of obscurant production resulting in a gain in computation speed at the expense of the detail.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
BARG           RATEB     TBARG     XBARL     YBARL
```

NAME	UNITS	TYPICALLY	Description
RATEB	rnds/s	0. to 10.	Production rate in the user-defined area. The "round" is defined as XN munitions of source strength FW on the MUNT card. If the round produces a continuous cloud, the burn profile and burn duration of one round, TBURN, is folded into the barrage production.
TBARG	s	0. to 900.	The barrage duration.
XBARL	m	0. to 500.	The alongwind length of the impact region.
YBARL	m	0. to 500.	The crosswind width of the impact region.

Table 4.19: The CLOU Card. Optional card that specifies if the user will define the full set of subcloud definitions, effectively generating a new model within the code for this source. The CLOU card must be immediately followed by SUB–cards for each subcloud set.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
CLOU            NSUB
```

NAME	UNITS	TYPICALLY	Description
NSUB		1. to 4.	Specifies number of subclouds (up to 5) that will define the modeled cloud.

Table 4.20: The SUBA Card. Optional primary subcloud definition. It is recommended that this card be input for each of the NSUB subclouds. If absent, then a default structure is assumed based on the the menu selection SMENU or, if no menu selection, by the obscurant type STYP designated on the MUNT card. COMBIC will assign non–specified values.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
SUBA           SUBNO     FRACT     DCARB     PLUME    RISMOD      SEXT    BALMOD
```

NAME	UNITS	TYPICALLY	Description
SUBNO		1. to 5.	Subcloud designation.
FRACT		0. to 1.	Fraction of total obscurant mass to be placed in this subcloud.
DCARB		0. to 10.	Relative amount of free carbon. Specifically, its the amount of carbon divided by the the amount of obscurant.
PLUME		1. or 2.	Flag. If 1., the subcloud is an instantaneous puff produced in the initial burst. If 2., the subcloud is continuous with a production rate assigned by the BURN card or by default.
RISMOD		1. to 45.	Flag. If 1., then the subcloud is buoyant and rise will be computed by the buoyancy model. If 2., then the subcloud is non-buoyant and no thermal rise is computed, although initial cloud velocity may cause the cloud to rise as a non-thermal "jet." If RISMOD is a two–digit number, "ij" from 12 to 45, then the subcloud is an instantaneously canted stem, spanning subclouds i and j.
SEXT		0. to 30.	Selects the extinciton coefficient from the same list defined under STYP on the MUNT card defined above.
BALMOD		0. or 1.	Flag. If 0., then the subcloud is not ballistic. If 1., then its formation follows the ballistic cloud model. Presently, the ballistic model applies only to soil expelled from HE detonations.

Table 4.21: The SUBB Card. Optional defines subcloud initial obscurant radii and buoyancy characteristics. It should follow the SUBA card for the corresponding subcloud. All parameters on the SUBB card other than the initial upward velocity WUP default to model or menu values if input as 0. or if the card is absent.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
SUBB           ROBSX     ROBSY     ROBSZ      RBUO    TCLOUD      QOBS       WUP
```

NAME	UNITS	TYPICALLY	Description
ROBSX	m	.1 to 50.	Initial cloud radius downwind.
ROBSY	m	.1 to 50.	Initial cloud radius crosswind.
ROBSZ	m	.1 to 50.	Initial cloud radius vertical.
RBUO	m	.01 to 10.	Buoyancy radius.
TCLOUD	°K	270. to 9999.	The initial mean cloud temperature. Note that the buoyancy radius and mean temperature imply a value for the total heat available for buoyancy and are thus not independent.
QOBS	cal/g obsc	0. to 2000.	Thermal production coefficient (see section B.1.4 and equations B.17 through B.19
WUP	m/s	0. to 100.	Initial upward velocity of the subcloud.

Table 4.22: The SUBC Card. Optional. Defines subcloud intial conditions. This card should also follow the corresponding SUBA card for the subcloud. Only the EVAPF card defaults to internal stored or modeled values if it input as 0.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
SUBC          ZBURST     VFALL     EVAPF     EVAPD     REFCO      RMOM      VHOR
```

NAME	UNITS	TYPICALLY	Description
ZBURST	m	0. to 50.	Initial height of the subcloud above local terrain.
VFALL	m/s	0. to 10.	The effective fall velocity (positive downward) of the cloud)
EVAPF		0. to 1.	The limiting fraction f_d of the cloud mass after a long time period.
EVAPD	$(s)^{-1}$	0. to 10.	The parameter δ. Used in the following mass equation for the time dependent evaporation or deposition: $M(t) = M\left[f_d + (1 - f_d)\exp -\delta t\right]$
REFCO		0. to 1.	The ground "reflection coefficient" for the subcloud. REFCO defines the fraction of the cloud mass that is "reflected" off the ground back up into the airborne region of the cloud.
RMOM	m	0. to 10.	Momentum radius. This parameter can be input for cases where the buoyancy radius as determined in the model is small and/or the initial upward velocity is large. The momentum radius sets a lower limit on the cloud radius used in the rise calculations.
VHOR	m/s	0. to 100.	Initial horizontal velocity (positive downwind, negative upwind.)

The above records define the full set possible for Phase I calculations. In general, not all record types will be used to produce cloud histories for the obscurant. In particular, most users will never use the subcloud records except to input predetermined values for obscurant sources not in the code.

4.3 Phase II Input

4.3.1 General Features

Phase II sets up a scenario of multiple obscurant sources from those precomputed in the Phase I history file. This is done by input of either a SLOC record or, for moving sources, by a pair of VEH1 and VEH2 records. Multiple LOS are assigned by user inputs of pairs of "targets" on TLOC records and "observers" on OLOC records. The resulting transmittance between each pair is output at user-defined times specified on a LIST record.

Each time the transmittance is to be computed. COMBIC must determine which clouds intercept the LOS. To facilitate the rejection of non-intersecting clouds, COMBIC stores their position at specified times. The time step for updating cloud positions for rejection purposes can optionally be specified on a TIME record.

COMBIC84 can also generate "pictures" of the clouds in the scenario by use of VIEW, GREY, and, TPOS input records. These records form pictures two ways. The first method, as illustrated in Figure 4.1, creates a bundle of parallel LOS surrounding one of the specified target-observer pairs. All the LOS originate on a plane and end on a plane parallel to the first plane. It provides an orthographic representation of the obscurant cloud. The second method , as illustrated in Figure 4.2, creates a bundle of LOS surrounding one of the specified target-observer pairs. However, all the LOS originate with the specified observer. The LOS end normally on a plane. This provides a perspective representation of the obscurant cloud. For example, your eye gives you a perspective representation of the the visual world. These two types of viewing the battlefield can yield different values on the obscuration levels (see Orthographic vs. Perspective LOS, Randolph and Ayres, [1990]. Characters are assigned to represent different ranges of transmittance or optical depth for each LOS. These input records provide a crude but useful picture of transmittance or optical depth of the clouds. This is discussed more below.

With the inclusion of some of the records already defined in Phase I inputs, the Phase II input card set is:

As in Phase I, the PHAS and DONE records are the first and last records read by COMBIC (the EOSAEL driver program requires two records at the beginning and end of the input files, however, these are not read by COMBIC). Any Phase I records are simply ignored if they are present in the same input stream as Phase II records. The FILE record serves the same purpose as in Phase I.

The scenario records, ORIG, LIST and TIME set up the axis convention for input coordinates and the computation time steps. The default axis convention used is from the EOSAEL library, that is, the x-axis points eastward, the y-axis points northward, and the z-axis points upward. The ORIG record allows the x-axis to be defined along an arbitrary compass direction. The y-axis is then automatically 90 less than the x-axis heading. The wind direction can also be changed from the Phase I input by use of the ORIG record. If input, the ORIG record should be be placed at the beginning of the noncontrol records. This

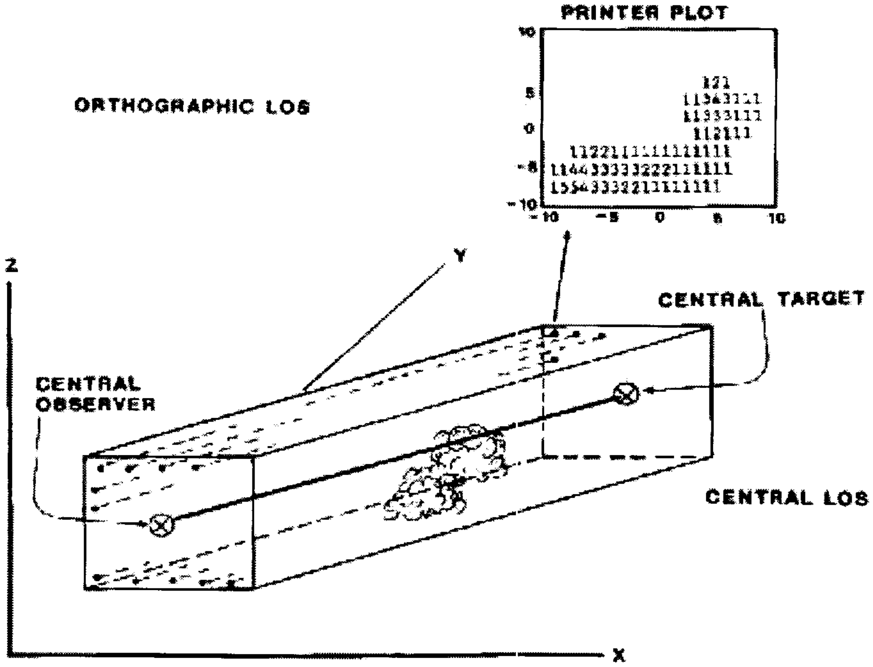


Figure 4.1: Orthographic LOS.

insures that the coordinate system convention defined by the wind direction and x-axis is set before source and observer-target locations are input. If the common geometry option from EOSAEL (IGEOSW=1) is invoked then XORG, YORG, ZORG and XORDIR are forced to be 0., 0., 0., and 90. If the common climatology option from EOSAEL EXEC has been invoked (ICLMAT=1), then WNDDIR is overridden by the CLIMAT module.

The LIST record defines the times that the output is to be generated. The usual output option is to print only the total transmittance for the entire set of clouds intersecting the LOS. A second output option lists the contributions of individual clouds.

The TIME record is optional. If the TIME record is absent, then cloud positions are updated just prior to each output time. In some situations, when transmittance is output over relatively small time steps, the clouds do not move very far at each step. Since the cloud position update is primarily for cloud rejection purposes, it is sometimes desirable to have the cloud update time step longer than the transmittance output time step. There is never any reason for the update time step to be smaller than the output time step.

The TIME record also sets the criteria that a cloud is determined to be so thin that it can be removed from further consideration in the scenario. This is done through the CLEND parameter. When the maximum possible integrated concentration (the "CL") falls below CLEND, the cloud is removed. At the opposite extreme, the cloud may be so dense that there is no need to continue particular integration steps along a LOS, that is, the transmittance has already been found to be effectively zero. The CLIM parameter sets the upper limit on the computed CL so that the path integration can be stopped and the resulting minimum transmission is printed out. CLACC sets the percentage of error that

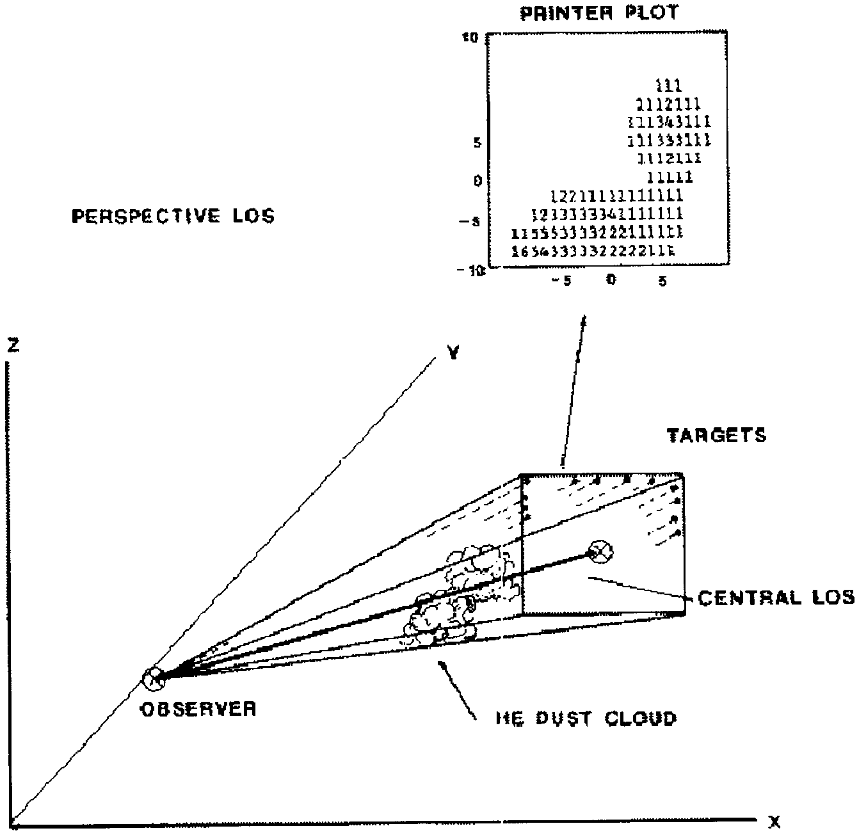


Figure 4.2: Perspective LOS.

can be tolerated in the Romberg method of integration.

Defaults are conservative, with CLIM, CLEND and CLACC set to 100., 0.01 g/m^2 and 10 percent respectively. The TIME and LIST records should be set at least once before sources, targets and observers are entered in the scenario.

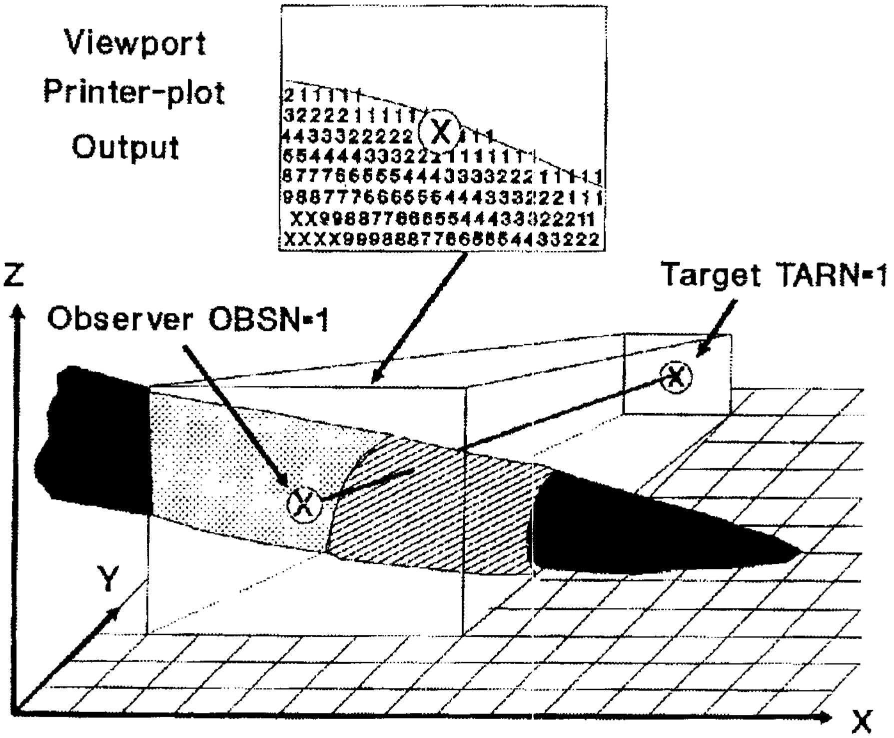
Whether or not record order is important depends on the user's choice of execution mode. The default method reads in all input records and stores the data in arrays for reference as needed during calculations. The calculation is then made all at once when a GO or DONE record is input. Through the ORDRS flag on the PHAS record, however, the user may specify that the calculation is to be "event ordered." In event ordered processing, COMBIC does computations and produces output as the sources and observers are entered. The distinction is simple, but important. If ORDRS=0., then all observer positions, target positions and source positions are read in at once and calculations begin only following a GO or DONE record. Input times (and thus input records) can be in any order. In the second option, ORDRS=1., however, obscurant source and target/observer pair records are read in and the "start time" (STIM, STIMV or STIMO) is checked against a future cloud update time. Record input is suspended and transmission calculations are then performed up to that update time only. Input then resumes until the next cloud update time. The only advantage to this option is that it allows COMBIC to more efficiently re-use storage released by deleted clouds and lines of sight. It also is closer to the interactive calls for smoke and dust encountered in gaming simulations.

Though input records are mostly order-independent, note however, it is wise to enter the ORIG record before any sources or target/observer coordinates are read in. The ORIG record sets up the coordinate system including origin and direction of the coordinate axes. Once set, the origin cannot be reset during that run.

The source location and time are entered on a SLOC record or on VEH1 and VEH2 records. The former record adds a new source at a fixed location or initiates a moving source that was already specified in Phase I as having a certain speed and direction. The VEH1 and VEH2 records allow any source to be defined as moving. Speed and direction are then entered on those records. If event ordered processing is specified on the PHAS record, then calculations are performed up to but not including the time specified for the new source to begin. In the process, older clouds may have been removed from the scenario, thus allowing the storage used for their locations to be released for use by the new source. The SLOC and VEH1 records allow the user to define the time that the cloud can be removed from the scenario. The default is 1800 s after the source stops emitting obscurant.

Similarly, the coordinates and the time interval over which an observer views the scenario are input on an OLOC record. In event-ordered processing, the calculations progress up to but not including the time that the new observer will be initiated. In the process, other observers may have reached the time limits of their observation. The computer storage used to define their coordinates and observation directions is thus released for use by the new observer.

In event ordered processing, the user must, of course, insure that the source records and observer-target pairing records are input in a time-ordered sequence. A GO record under this option completes the calculations up to the limit input on the LIST record. Time ordering is not the chosen default in COMBIC because the EOSAEL library attempts to stress order-independent, input records as much as possible within models.



```
211111
32222111111
4433322222 X 111
6544443332221111111
8777666655444333322211111
9887777666656444333222111
XX9988776665544433322211
XXXX9998888776666544333222
```

Figure 4.3: Horizontal LOS. The central LOS is defined by X. Note that it is well above ground level and at such a height that the window ends at ground level.

Extinction coefficients may be altered through an EXTC record similar to that defined in Phase I inputs and comments may be included through NAME records.

The VIEW, GREY, and TPOS input records define a "window" on the scenario. The resulting output is placed on a separate output unit or print file specified on the PHAS and (optionally) FILE records. The VIEW record defines one observer-target line of sight as the center of the window. (Users will learn from experience that this LOS must be well above the surface, if a horizontal window through the clouds is desired. See Figure 4.3).

The width and height of the window in meters are also defined on the VIEW record. The corresponding number of characters across the printed page, up to 100 generally, and the lines down the printed page, which have no set limit, are also input. These lines thus define the number of meters per character on the resultant listing. If the user defines a resolution of X m/char in both the horizontal and vertical direction of the printer-plot, the cloud will appear to be elongated. This is quite natural since a character's height is longer than a character's width. Most line printers usually have 10 char/inch in the horizontal direction and 8 lines/inch in the vertical direction. An example is a printer plot that represents a viewport 500 m by 500 m. We would like the resolution to be *100 m/inch* in both the horizontal and vertical resolution. To do this we compute in equation 4.1 and equation 4.2 CLOSD and VLOSD of the VIEW record. These parameters define the number of horizontal and vertical characters used to span the printer plot.

$$CLOSD = \frac{10char/inch}{100m/inch} 500m = 50char \tag{4.1}$$

$$VLOSD = \frac{8lines/inch}{100m/inch} 500m = 40char \tag{4.2}$$

These define a resolution of 100 m/inch in the vertical and horizontal direction or 10.0 m/char in the horizontal direction and 12.5 m/line in the vertical direction.

COMBIC internally generates LOS surrounding the central target-observer line of sight for each character position to be printed on the page and computes the transmittance or optical depth for that position. A new "picture" is generated at each time step specified on the LIST record. As mentioned before the LOS can all be parallel to the specified central LOS, or can be "fan shaped", originating at the observer. The range of each path through the cloud equals that of the specified observer-target pair for the orthographic viewpoint. This is not true for the perspective viewpoint. The smallest of the path lengths for the perspectives LOS is the central viewpoint. All other LOS end equally spaced on a plane perpendicular to the central LOS For slant path or downward views, the program limits the range to the intersection of the LOS with the ground for both viewing methods. COMBIC treats only flat terrain.

The GREY and TPOS record defines the scale to be used to display the results. The user inputs a maximum and a minimum transmittance or optical depth and the number of divisions between the minimum and maximum that are to be assigned different characters on the listing. COMBIC92 allows the user the option of having the grey scale levels be equally spaced or varying with the density of the cloud. Most users like this new option which allows closely spaced grey scale levels during the most interesting part of the cloud–where it is most dense. Then the grey scale level's separations for the thin parts of the cloud are quite large. This new option allows the user to use a minimum number of grey scales to illustrate the obscurant. The user also selects a wavelength band for the desired output.

The usefulness of optical depth as an output quantity can be seen from the following example. Suppose one is really interested in finding the concentration of HC smoke at 2.5 m above the surface. This can be produced by first specifying that the observer is at 3 m looking down on a target directly below at 2 m above the ground. The window is then a "slab" one meter thick lying between 3 and 2 m above the ground over the region defined by the length and width of the window. Next, suppose the EXTC record is used to set the extinction coefficient for one of the wavelengths of HC smoke to be exactly 1 m^2/g. It is easy to see that the resulting value displayed for the optical depth at that wavelength is then equal in magnitude to the concentration of HC in units of g/m^3. It is important, of course, that the path was defined to be 1 m in length in the example so that the units would be correct. A 2-m path would require an extinction coefficient of 0.5 to produce a value numerically equivalent to the concentration in g/m^3, and so forth.

TPOS also lets the user manipulate the "axis" of the printer plot. In the previous version of COMBIC, the axis were always labeled so that the origin was at the center specified by the OLOC--TLOC pair used as the central LOS. This labeling might or might not correspond to the actual layout for the scenario. The new option is defined by the parameters HLOSP and VLOSP from the TPOS record. These parameters define the center of the printer-plot.

The specific parameters for Phase II input records are given below.

4.3.2 Phase II Input Records

Control Records

The PHAS, GO, DONE and FILE records are identical in definition to those in section 4.2.2. The UNITC secondary output file is used in Phase II for output pictures of the clouds as defined by the presence of a VIEW and GREY record.

In PHAS II, under the event ordered option, the insertion of a GO record completes calculations up to the last time on the LIST record. The DONE record should, therefore, be used if COMBIC calculations are to halt at that point.

The EOSAEL library has a common geometry option (IGEOSW=1) for specifying one obscurant source and one target-observer pair. If the common geometry option is set in effect by the user, then the first source assigned to the Phase II scenario will be the first history source. Its coordinates are designated in the EOSAEL executive routine as the "PTS(10-12)" input on the GEO-OBSC record. The first observer is designated as "PTS(7-9)" input on the GEO-SEEK record. The first target is designated as the "PTS(1-3)" input on the GEO-TARG record. The returned values to the EOSAEL executive routine are the last transmittance determined of the target-observer pair at wavelength WAVE1.

Comment Records

Scenario Records

Control: PHAS, FILE, GO, DONE
Scenario: ORIG, LIST, TIME
Source: SLOC, VEH1, VEH2
Line of Sight: OLOC, TLOC
Extinction: EXTC
Comments: NAME
Display: VIEW, GREY TPOS

Table 4.23: The `WAVL` Card. This is one of the cards which may be used to specify wavelength, wavenumber, or frequency. Choose one from among `WAVL`, `WAVNUM`, or `FREQ`. The card is identical to the `WAVL` card in Phase I.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
 WAVL          WAVE1     WAVE2     MULDV
```

NAME	UNITS	TYPICALLY	Description
WAVE1	μm		Wavelength used for the calculation. Alternatively either frequency or wavenumber may be specified by using a FREQ or WVNUM card instead of this WAVL card. If WAVE2 is not specified then this is the single wavelength used; if WAVE2 is specified then the modules will attempt to do their calculation for a range of wavelengths. There is no default; this information must specified.
WAVE2	μm		Wavelength used for the calculation. This is the other end of a wavelength interval started by WAVE1. If WAVE2 is not specified then the modules will attempt to do their calculation for a single wavelength WAVE1. The default is to perform the calculations for a single wavelength.
MULDV			Number of equal intervals to divide WAVE1 – WAVE2 into. The default is one.

Table 4.24: The PHAS Card. PHAS *must* be the first record after calling COMBIC. The first parameter must be 2.0 for Phase II inputs.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
PHAS               PHASE     IUNIT     OUNIT     UNITC     UNITF     ORDRS      ECHO
PHAS                  0.        5.        6.       12.        9.        0.        0.
```

NAME	UNITS	TYPICALLY	Description
PHASE		1. or 2.	Select Phase I or Phase II. A second PHAS card reinitializes COMBIC to the phase specified. There is no default. It must be specified.
IUNIT		1. to 30.	The standard input unit for COMBIC commands. (IOIN in common /IOUNIT/)
OUNIT		1. to 30.	The standard output unit for COMBIC listings. (IOOUT in common /IOUNIT/)
UNITC		1. to 30.	Secondary output unit, not used in Phase I. Used for the printer-plot option. (NPLOTU in common /IOUNIT/)
UNITF		1. to 30.	History file output unit, direct-access storage. (NDIRTU in common /IOUNIT/)
ORDRS		0. or 1.	Flag, not used in Phase I. If 1, then inputs in Phase II are scanned, and calculations are performed up to the last time input on a source or observer record. This allow the calculation to progress is an interactive fashion if = 1, otherwise if = 0 then it is batch mode.
ECHO		0. or 1.	If 1, all inputs will be echoed to the print file.

Table 4.25: The GO and DONE Cards. GO initiates calculation of a CLOUD HISTORY for one source type then returns control to the input record file for further inputs. Previous meteorological data remains effective, but all source inputs are reinitialized. (No parameters). DONE is similar to the GO input record, except control exits COMBIC after the CLOUD HISTORY is computed and stored in the HISTORY file. (No values)

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
 GO                   0.        0.        0.        0.        0.        0.        0.
 DONE                 0.        0.        0.        0.        0.        0.        0.
```

Table 4.26: The FILE Card. Optional — Connect Named File to Input/Output.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
 FILE          UNITNO    FNAME
```

NAME	UNITS	TYPICALLY	Description
UNITNO		1. or 30.	Any unit # input on PHAS record.
FNAME		(chars)	File Name, Up To 16 characters, beginning in column 21. Only COMBIC input record with character input field.

Table 4.27: The NAME Card. Optional record to allow user to place non-executable comments in the input record file. The comment record must immediately follow the name record. The text on the comment card will be ignored as input except to be echoed to the print file if ECHO is 1. The NAME card itself should have blank or 0. fields and no text. This card may appear anywhere after the PHAS card. It effectively comments out the next card in the input file.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
 NAME              0.        0.        0.        0.        0.        0.        0.
 (Comment record goes here)
```

Table 4.28: The ORIG Card.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
ORIG                XORG      YORG      ZORG    XORDIR     WNDIR      ORIG
ORIG                  0.        0.        0.       90.      270.        0.        0.
```

NAME	UNITS	TYPICALLY	Description
XORG	m	0.	Arbitrary X-origin added to all user input. Generally not used.
YORG	m	0.	Arbitrary Y-origin.
ZORG	m	0.	Arbitrary Z-origin.
XORDIR	deg wrt N	0. to 360.	Compass heading of user X-axis. EOSAEL default East (90°).
WNDIR	deg wrt N	0. to 360.	Wind direction. Compass heading which the wind blows. Can differ from Phase I direction. If the ORIG card is used then specify WNDIR. Defaults to the climatology wind direction if the EOSAEL common climatology option is in effect.
ORIG	s	0.	Arbitrary time origin. All input times have ORIG added before they are stored. Useful only when output is to be compared to data with some different time origin.

Table 4.29: The LIST Card. This record determines the times that the transmittance will be listed.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
LIST            PRNT    TBEGIN      TEND      TDEL
LIST              1.        0.      120.        5.        0.        0.        0.
```

NAME	UNITS	TYPICALLY	Description
PRNT		0. to 3.	Flag. Print option 0.–2.: 0 = Suppress all output except ECHO, errors and VIEW/GREY pictures, if any. 1 = Print transmittance for all LOS that intersect at least one cloud. 2 = Also print pathlength and contributing histories for each contributing subcloud. 3 = Add a second output file(UNITC) to dump cloud positions and sizes with time.
TBEGIN	s	0. to 7200.	Time to begin printout.
TEND	s	0. to 7200.	Time to end printout.
TDEL	s	0.1 to 10.	Time increment for printout.

Table 4.30: The TIME Card. This card controls the times that the cloud positions are updated for cloud rejection calculations and the cloud removal criteria.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
TIME           BEGIN      ENDT      DELT      CLIM     CLEND     CLACC
TIME          TBEGIN      TEND      TDEL      100.       .01       10.        0.
```

NAME	UNITS	TYPICALLY	Description
BEGIN	s	0.	Time when updates begin.
ENDT	s	1. to 7200.	Time when updates end.
DELT	s	.1 to 10.	Time increment for cloud update.
CLIM	g/m^2	1. to 1000.	Minimum CL (g/m^2) that the calculation can be cut short since the cloud is so dense.
CLEND	g/m^2	.001 to .1	CL (g/m^2) cloud removal limit. When the maximum possible CL will always be less than CLEND, the cloud is removed from the active list.
CLACC	percent	0.00 to 100.	CLACC is the percentage of error that can be tolerated in the Romberg method of integration. Each succeeding step is compared with the previous step to check if the desired accuracy is reached.

Line of Sight Records

Source Records

Extinction Records

Display Records

Table 4.31: The OLOC Card. Assigns the observer's position and viewing times.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
OLOC            OBSN      XOBS      YOBS      ZOBS     STIMO     ETIMO
OLOC              1.       70.    -2000.        3.        0.   100000.        0.
```

NAME	UNITS	TYPICALLY	Description
OBSN		1. to 35.	Assign designator OBSN to identify this observer (whole number)
XOBS	m	varies	X coordinate of observer.
YOBS	m	varies	Y coordinate of observer.
ZOBS	m	varies	Z coordinate of observer. It is usually the height above surface.
STIMO	s	0. to 7200.	Time observer becomes active.
ETIMO	s	0. to 7200.	Time observer is no longer active.
Note: an additional OLOC with the same OBSN entered before time ETIMO will update the observer location or time			

Table 4.32: The TLOC Card. Assigns coordinates and viewing times to a target.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
TLOC            OBSN      XTAR      YTAR      ZTAR      TARN
TLOC              1.       70.     2000.        3.        1.        0.        0.
```

NAME	UNITS	TYPICALLY	Description
OBSN		1. to 35.	Assign the target to observer OBSN of an OLOC card. More than one target can be assigned to an observer.
XTAR	m	varies	X coordinate of target.
YTAR	m	varies	Y coordinate of target.
ZTAR	m	varies	Z coordinate of target. Usually height above ground level.
TARN		1. to 35.	User-assigned target number. Useful on printouts if more than one target assigned to an observer.

Table 4.33: The SLOC Card. This record defines or initiates a new source into the scenario. The source is stationary if defined with an SLOC card unless it was already defined to be moving in the Phase I calculation. Its speed and direction are then the same as in Phase I inputs.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
SLOC                STYP        SN      STIM      ETIM        XM        YM        ZM
SLOC                  1.        0.        0.     3600.        0.        0.        0.
```

NAME	UNITS	TYPICALLY	Description
STYP		1. to 35.	Selects the STYP'th source cloud in the Phase I history file. Phase I and Phase II provide listings of the characteristics of the sources by this number.
XN		varies	Like Phase I MUNT card, number of munitions or other sources set off at (XM, YM, ZM). If 0., the XN of Phase I is used. Otherwise, COMBIC rescales to this Phase II XN. (Example, if Phase I computed a history for XN = 4. smoke pots, then in Phase II XN is still defined with XN = 4. for 4 smoke pots, XN = 1. for 1 smoke pot, and so forth.
STIM	s	0. to 7200.	Starting time for this source.
ETIM	s	0. to 7200.	Time after which cloud can be removed as ineffective. Default if 0. is STIM + 3600.
XM	varies	varies	X coordinate of the source.
YM	varies	varies	Y coordinate of the source.
ZM	varies	varies	Z coordinate of the source. (Height above ground).

Table 4.34: The VEH1 Card. Designates any continuous obscurant cloud as a moving source.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
VEH1                STYP        XN     STIMV     ETIMV     ETIMC
VEH1                  1.        0.        0.     3600.        0.        0.        0.
```

NAME	UNITS	TYPICALLY	Description
STYPV		1. to 35.	Selects the STYP'th source cloud in the Phase I history file. Phase I and Phase II provide listings of the characteristics of the sources by this number.
XNV		varies	Like Phase I MUNT card, number of munitions or other sources started at (XSTAR, YSTAR, ZSTAR). If 0., the XN of Phase I is used. Otherwise, COMBIC rescales to this Phase II XN.
STIMV	s	0. to 7200.	Starting time for this source.
ETIMV	s	0. to 7200.	Time to stop source production. Can be any time between STIMV and STIMV + TBURN. (Phase I duration).
ETIMC	s	0. to 7200.	Time after which cloud can be removed as ineffective. Default if 0. is STIMV + 3600.

Table 4.35: The VEH2 Card. Must be input after VEH1 if VEH1 values are to be effective.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
VEH2           XSTAR     YSTAR     ZSTAR      VDIR   VSPEED
VEH2              0.        0.        0.        0.        0.        0.        0.
```

NAME	UNITS	TYPICALLY	Description
XSTAR	m	varies	Starting X coordinate.
YSTAR	m	varies	Starting Y coordinate.
ZSTAR	m	varies	Starting Z coordinate.
VDIR	deg wrt N	0. to 360.	Compass heading toward which source moves
VSPEED	m/s	0. to 35.	Source speed. 1m/s = 2.237 mi/h.

Table 4.36: The EXTC Card. Optional user-defined extinction coefficients. All values *must* be specified if EXTC is used. If the event–ordered execution mode is not in effect, however only the latest extinction coefficients in effect at the point the GO or DONE card is encountered are used.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
EXTC                     CLTYP      R(2)      R(3)      R(4)      R(5)      R(6)      R(7)
```

NAME	UNITS	TYPICALLY	Description
CLTYP		1. to 30.	Obscurant number STYP from MUNT. If 0., reset all to Phase I values. If values for CLTYP changed, then -CLTYP resets Phase I for that CLTYP only. Otherwise, user inputs replace current values for type CLTYP: 1. = Bulk white phosphorus (WP) munition. 2. = WP wedges, wicks and Plasticized WP (PWP) munitions. 3. = Hexachloroethane(HC) smoke. 4. = Fog oil (SGF2) generator or smoke pot. 5. = Red Phosphorus (RP) munition. 6. = IR screener, generator disseminated. 7. = IR screener, munition. 8. = Diesel fuel (DF) produced by generator. 9. = Dust, vehicular. 10. = Dust, High Explosive (HE), small particle persistent mode. 11. = Dust, (HE), large particle mode. 12. = Carbon, HE debris product. 13. = Dust/soil, HE, very large, ballistic soil aggregates. 14. = Fire smoke from diesel, oil, and rubber mix. 15. = Kerosene/fog oil cold region mix. 16. = Polyethylene glycol (PEG 200) mix for alchohols. 17. = Anthracene (Not use in menu). 18. = Chlorosulfonic acid (FS, not used in menu). 19. = Titanium tetrachloride (FM, not used in menu). 20. = IR(M76). 21. = Brass. 22. = GRAPH 7525. 23. = Kaolin. 24.–30. = User defined by inputs.
R(2)	m^2/g	0. to 20.	extinction coefficient for the 0.4 – 0.7 μm waveband.
R(3)	m^2/g	0. to 20.	extinction coefficient for the 0.7 – 1.2 μm waveband.
R(4)	m^2/g	0. to 20.	extinction coefficient for the 1.06 μm waveband.
R(5)	m^2/g	0. to 20.	extinction coefficient for the 3.0 – 5.0 μm waveband.
R(6)	m^2/g	0. or 20.	extinction coefficient for the 8.0 – 12.0 μm waveband.
R(7)	m^2/g	0. or 20.	extinction coefficient for the 10.6 μm waveband.

Table 4.37: The VIEW Card. Defines a single viewport or window for a printer-plot of the cloud(s). Output is directed to UNITC on the PHAS and FILE cards.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
VIEW              OB        TR     CLOSW     VLOSW     CLOSD     VLOSD      RTAT
```

NAME	UNITS	TYPICALLY	Description
OB		0. to 100.	Identifies a LOS Observer (OBSN on OLOC card) for one end of the viewport.
TR		0. to 100.	Identifies a LOS Observer (OBSN on TLOC card). The viewport is a rectangle centered on the LOS from OB to TR. The LOS ranges from OB to TR or to ground level, whichever point is closer.
CLOSW	m	1. to 1000.	Horizontal width of viewport.
VLOSW	m	1. to 1000.	Vertical extent of viewport.
CLOSD	m	1. to 100.	Number of horizontal pixels. It is the number of horizontal characters to span CLOSW. (The routine attempts to fit the horizontal dimensions across the computer page if CLOSD is less than 101 characters.)
VLOSD	m	1. to 65.	Number of vertical pixels. It is the number of vertical characters to span VLOSW.
RTAT	deg	0. to 360.	Used only to delinate the ambiguity of term "horizontal" for up- or down-looking LOS. RTAT is the angle in degrees of the horizontal viewing axis wrt north. For downwind to the right, set RTAT to wind direction + 180°. For east, toward the right hand side of the page, set RTAT to 90°

Table 4.38: The GREY Card. Set up the grey scale, assigning a alpha-numeric character to an obscuration level.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
GREY           DIVIS     SMINV     SMAXV     CLOPT     ALOPT     WAVEL      RVEL
```

NAME	UNITS	TYPICALLY	Description
DIVIS		1. to 35.	Number of grey scale intervals between SMINV and SMAXV. For example, to obtain the usual transmission scales at .05, .10, .15, .20.,. . ., .95 with the standard symbol * for transmission less than .05 and blank characters for transmission above .95, set DIVIS = $\frac{.95-.05}{.05}$ = 18. The largest value for DIVIS is currently 35.
SMINV		0. to 100.	The minimum value shown on the scale. Transmission values less than SMINV are printed as "*", and optical depths less than SMINV are printed as "blank".
SMAXV		0. to 100.	The maximum value shown on the scale. Transmission values greater than SMAXV and print as "blank" and optical depths greater than SMAXV print as "*".
CLOPT		0. or 1.	0. = Transmittance, 1= Optical Depth (To output CL in g/m^2 set the extinction to 1.0 and CLOPT=1.)
ALOPT		1. to 2.	If 2. alternate output characters with blanks in the grey-levels. Otherwise use a printing character for every scale division.
WAVEL		1. to 6.	Select wavelength band. 1. = 0.4 – 0.7 μm waveband. 2. = 0.7 – 1.2 μm waveband. 3. = 1.06 μm waveband. 4. = 3.0 – 5.0 μm waveband. 5. = 8.0 – 12.0 μm waveband. 6. = 10.6 μm waveband.
RVEL	m/s	0. to 100.	Optional, speed for target to move away (positive) or toward (negative) the observer along LOS.

Table 4.39: The TPOS Card. Modify grey scale density, revise printer-plot axis labeling and change from orthographic viewpoint.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
TPOS           HLOSP     VLOSP     PERSP     NEWGR
TPOS             0.0       0.0       0.0       0.0
```

NAME	UNITS	TYPICALLY	Description
HLOSP		varies	Parameter which defines the centers of horizontal axis for the printer plot. The labeling of the horizontal axis of the printer plot is then labeled from HLOSP-.5CLOSW to HLOSP+.5CLOSW. CLOSW is a VIEW parameter that defines the horizontal extent of the printer plot's viewport.
VLOSP		varies	Parameter which defines the centers of vertical axis for the printer plot. The labeling of the vertical axis of the printer plot is then labeled from VLOSP-.5*VLOSW to VLOSP+.5*VLOSW that defines the vertical extent of the printer plot's viewport.
PERSP		0. or 1.	If PERSP = 1, then the perspective viewpoint is chosen for the printer-plot option and all LOS originate at the observer. If PERSP = 0, then the orthographic viewpoint is chosen and LOS for the printer plot option are of equal length and parallel to a LOS defined by a OLOC–TLOC.
NEWGR		0. or 1.	If NEWGR = 0. then grey scale interval is equally spaced, if NEWGR 1. then there is logarithmic grey scale separation. The new grey scale is more closely spaced for the densest part of the cloud where most researches are interested. Valid only for transmission (CLOPT = 0. on GREY record.

If NEWGR=1., then each grey scale value for transmission is a multiplicative factor times the previous grey scale value. The factor is determined from SMINV, SMAXV and DIVIS from the GREY record and is defined by the following equation:

$$MULT = \left(\frac{SMINV}{SMAXV}\right)^{\frac{1}{DIVIS-1}}$$

Ex. SMINV=.05, SMAXV=.95, and DIVIS = 5, then $MULT = (.95/.05)^{1/4}$ or 2.088

This yields a grey scale at .05, .104, .218, .455 and .950.

4.4 Tips and Tricks for using COMBIC

4.4.1 Making Vehicles "Change" Direction

One of the limitations of the model is that vehicles cannot accelerate, decelerate or change direction. However, the user can arrange the vehicle records so that the vehicle stops and another starts at the exact same place and time heading in a new direction. A typical example is shown below.

In this example, the vehicle starts moving at 0 s and continues for 100 s (column 4 and 5 of VEH1) in an easterly direction at 2 m/s (VEH2).

Starting coordinates are the origin (VEH2). This places the vehicle at (200,0,0) after 100 s. Since the goal is to have the vehicle change directions after 100 s, these numbers are used as the starting coordinates and start time for the second set of vehicle records. In the second set, the vehicle travels from 100 s to 150s in an southerly direction at 2 m/s. This places the vehicle at (200,-100,0) after 50 s. The third set of vehicle records keeps the vehicle going in the same direction but at a speed of 3 m/s – simulating an acceleration.

4.4.2 Phase II Viewport Tips

Viewing Concentration Length

The CLOPT flag on the GREY record determines output type: CLOPT = 0. display transmittance, CLOPT = 1. display optical depth. It is easily seen from Beer's law that to output CL (g/m^2), set the extinction coefficient to be 1 m^2/g on the EXTC record (see table 4.36) and choose CLOPT = 1. (Optical Depth).

Viewing Concentration

The CLOPT flag on the GREY record determines output type: 0. = display transmittance, 1. = display optical depth. It is easily seen from Beer's law that to output concentration (C) (g/m^2), set the extinction coefficient to be 1 m^2/g on the EXTC record, set the LOS to be 1 m in length using the OLOC and TLOC records, and choose CLOPT = 1. (Optical Depth). Figure 4.4

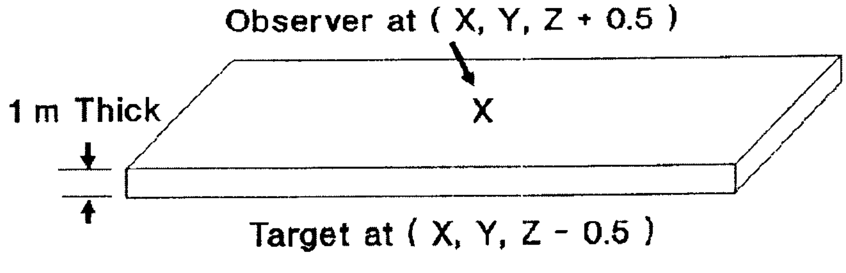


Figure 4.4: Phase II Viewport Tip. The viewport can be used to find the concentration (g/m^3) at a level of z meters above the surface.

Viewing At An Angle

Frequently, slant paths are requested where the observer views from some altitude towards an object on the ground. In this case it is important that the user specifies the target to be below ground to insure all lines of sight reach ground level (see figure 4.5. Otherwise, many of the LOS that form the viewport might not reach ground level. The following equations can be used if the user wishes to determine the coordinates of a new target so that all the LOS end at ground level.

$$\begin{aligned}\Delta R &= 0.5VLOSW * \cot\theta \\ XTAR_{new} &= XOBS + (R + \Delta R) * \alpha \\ YTAR_{new} &= YOBS + (R + \Delta R) * \beta \\ ZTAR_{new} &= ZOBS + (R + \Delta R) * \gamma\end{aligned} \tag{4.3}$$

VLOSW is defined as the vertical width of the viewport in meters. The directional cosines, α, β, and γ and the range R is determined from the observer location and the non-corrected target location using equation A.9 and equation A.10. The above equations define a new target position at a range $R + \Delta R$ from the observer along the directional cosine defined by the old LOS.

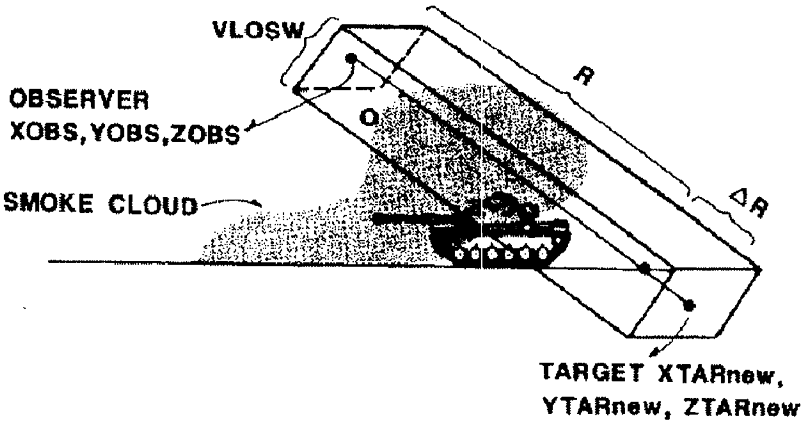


Figure 4.5: Choose the target end of the viewport below ground to insure all lines of sight reach ground level.

4.5 User Modifications to the Code

The above records represent the set of Phase II inputs. The user can simulate fairly sophisticated obscuration scenarios with the input parameters defined in Phase I and Phase II. There are invariably some changes that the user would like to make, however. In EOSAEL82, the problem was that the number of obscurant types that could be played was limited by available memory. Since EOSAEL84 , the histories are now placed on a record-addressable disc file. Thus, their size is no longer a major problem. Only one cloud type is read into memory at a time. All calculations for clouds of that type are performed before moving on to another cloud type. However, the Phase II code must still record the coordinates and times associated with active LOS and active source clouds. The user may wish to alter the limit on the number of active values.

The LOS are stored in common block /SIGHT/. To change the maximum number of LOS, change the variable MXLOS and the second array index in array variables IPOIN and POSI in the code.

Continuous clouds, puffs, and moving sources all share dynamic storage in the same arrays. Each type of source has a different definition within the array structure, however. Their definitions are as follows:

- IACT(1-3,NPMACT) = pointers to active subclouds.
- IVACT(NPMACT) = pointers to active moving vehicle clouds
- IHIS(1-2,NPMACT) = data on the history file associated with clouds.
- CMUN(1-5,NPMACT) = scaling and time duration information on active sources.
- LCLD(1-4,NPMCLD) = pointers to active subclouds and subcloud types.
- CLD(1-8,NPMCLD) = data on current positions of active subclouds.
- LTERA(1-2,NPMCLD)= terrain height at positions of active suclouds.
- LINDX(1-2,NPMCLD)= history file indices last accessed for each subcloud.

The values of MPMACT (maximum number of active clouds) and NPMCLD (maximum number of active subclouds) can be altered and the corresponding dimensions of arrays in common block /ACTIVE/ can be changed. The user should remember that there may be many more subclouds than there are total clouds. COMBIC will issue a warning when cloud arrays have been filled.

4.6 Output Format

Whenever possible the "standard" output was limited to 80 columns. The exceptions are the printer-plot option and the PRNT=2 option (see table 4.29). This allows successful viewing on a display terminal and printing on "all" printers. The following is an outline of the phase I and phase II output. Appropriate references are also included.

4.6.1 Phase I Output Format

1. METEOROLOGICAL CONDITIONS
    (a) Reference Height (m); table 4.8
    (b) Wind Speed (m/s); table 4.7

   (c) Temperature (°C); table 4.7
   (d) Surface Roughness (m); table 4.11
   (e) Wind Direction (degrees east of north); table 4.7
   (f) Inversion Height (m); table 4.8, equation A.175
   (g) Pasquill Category; table 4.7
   (h) Relative Humidity (percent); table 4.7

2. BOUNDARY LAYER PARAMETERS
   (a) Friction Velocity (m/sec); table 4.8, equations A.151, A.159, A.157, A.158, A.151
   (b) Pasquill Class; equation A.148
   (c) Air Density (g/m^3)
   (d) Monin-Obukhov Length (m^{-1}); equations A.154, A.155
   (e) Kazanski-Monin; section A.5
   (f) Mean static *Sbar* [10-50m] (sec^{-2}); table 4.8
   (g) Sensible Heat Flux ($watt/m^{-2}$); table 4.8, equation A.161
   (h) Cold Region Flag; table 4.7
   (i) Surface Buoyancy Flux (m^2/s^3); table 4.8, equation A.162
   (j) *Sbar* Model Flag; table 4.8

3. DIFFUSION COEFFICIENTS;
   (a) A Coefficient; section A.3
   (b) B Coefficient; section A.3
   (c) C Coefficient; section A.3
   (d) D Coefficient; section A.3

4. SURFACE CONDITIONS;
   (a) Snow Cover Flag; table 4.11
   (b) Silt Content (percent); table 4.11
   (c) Sod Depth (m); table 4.11

5. VERTICAL PROFILE MODEL (*the following parameters are vs height*)
   (a) Windspeed; equation A.159
   (b) Atmospheric Temperature (constant SBAR model); equations A.171, A.172
   (c) Atmospheric Temperature (variable SBAR model) equation A.170
   (d) S, Static Stability Parameter; equation A.167
   (e) *Sbar*; equation A.169
   (f) Eddy Dissipation Rate; equation A.184

6. MASS EXTINCTION COEFFICIENTS ($M^2/GRAM$);
   (a) Obscurant Code; table 4.15, section B.1.2

    - (b) Extinction .4-.7-μm; table 4.15, section B.1.2
    - (c) Extinction .7-1.2-μm; table 4.15, section B.1.2
    - (d) Extinction 1.06-μm; table 4.15, section B.1.2
    - (e) Extinction 3.-5. μm; table 4.15, section B.1.2
    - (f) Extinction 8.-12. μm; table 4.15, section B.1.2
    - (g) Extinction 10.6 μm; table 4.15, section B.1.2
    - (h) Extinction 94 ghz; table 4.15, section B.1.2

7. CLOUD HISTORY *repeated for each cloud*
    - (a) Munition Characteristics; table 4.8
        - i. XN No. of Sources; tables 4.12, B.1
        - ii. Fill Weight; tables 4.12, B.1
        - iii. Menu Selection Type; tables 4.12, B.1
        - iv. Obscurant Type; tables 4.12, B.1
        - v. Efficiency; tables 4.12, B.1
        - vi. Yield Factor; table 4.12, section B.1.1
        - vii. Number of Submunitions; tables 4.12, B.1
        - viii. Burn Duration; tables 4.13, B.7, sectionB.1.5
        - ix. Burn Coefficients $B_1, ...B_2$; table 4.13, B.7, sectionB.1.5
        - x. Smoldering Time; table 4.14, sectionB.1.5
        - xi. Smoldering Coefficient; table 4.14, sectionB.1.5
    - (b) Subcloud Structure *repeated for each subcloud*
        - i. subcloud characteristics
            - A. Mass Fraction; table 4.20
            - B. Debris Carbon; table 4.20
            - C. Flag: Plume or Puff; table 4.20
            - D. Flag: Cloud Rise Model; table 4.20
            - E. Extinction Coefficient Code; table 4.20
            - F. Flag: Ballistic Subcloud; table 4.20
            - G. Downwind Initial Obscurant Radii; table 4.21
            - H. Crosswind Initial Obscurant Radii; table 4.21
            - I. Vertical Initial Obscurant Radii; table 4.21
            - J. Buoyancy Radius; table 4.21
            - K. Initial Cloud Temperature; table 4.21
            - L. Thermal Production Coefficient; table 4.21
            - M. Height of Burst; table 4.22
            - N. Fall Velocity; table 4.22

        O. Evaporation/Deposition Terms; table 4.22
        P. Reflection Coefficient; table 4.22
        Q. Momentum Radius; table 4.22
        R. Horizontal Velocity; table 4.22
        S. Upward Velocity; table 4.21
        T. Mass Production Profile; table 4.8
    ii. subcloud trajectory (vs. height)
        A. time to reach downwind distance; table 4.8
        B. centroid height; table 4.8
        C. gaussian cloud standard deviations σ_x;
        D. gaussian cloud standard deviations σ_y; table 4.8
        E. gaussian cloud standard deviations σ_z; table 4.8
        F. peak cloud temperature; table 4.8
        G. mean cloud temperature; table 4.8
        H. air temperature; table 4.8
        I. air density; table 4.8
        J. centroid vertical velocity; table 4.8
        K. centroid horizontal velocity; table 4.8
        L. effective buoyancy radius; table 4.8

4.6.2 Phase II Output Format

The Phase II output file contains the data most users are interested in. The output lists the transmittance and CL g/m^2 for each LOS that potentially pass through one or more clouds in the scenario. and for each time determined from the `LIST` input. The observer and target numbers from the `OLOC` and `TLOC` records are also printed on each line listing transmittance. Though each line listing transmission also lists CL, this number is not meaningful when the clouds are of different types of obscurants, however, since a small CL from one type of obscurant can be very obscuring while a large CL from another may be much less effective as an obscurant.

The PRNT option 2 on the `LIST` record will display the CL contributions from each individual cloud intersecting the LOS. This option also prints the large particle CL which is simply the contribution from the large component of battlefield dust.

1. METEOROLOGICAL CONDITIONS
    (a) Reference Height (m); table 4.8
    (b) Wind Speed (m/s); table 4.7
    (c) Temperature (Deg C) table 4.7
    (d) Surface Roughness (m); table 4.11
    (e) Wind Direction (degrees east of north); table 4.7

   - (f) Inversion Height (m); table 4.8, equation A.175
   - (g) Pasquill Category; table 4.7
   - (h) Relative Humidity (percent); table 4.7

2. MASS EXTINCTION COEFFICIENTS (M**2/GRAM);
   - (a) Obscurant Code; table 4.36, section B.1.2
   - (b) Extinction .4-.7-μm; table 4.36, section B.1.2
   - (c) Extinction .7-1.2-μm; table 4.36, section B.1.2
   - (d) Extinction 1.06-μm; table 4.36, section B.1.2
   - (e) Extinction 3.-5. μm; table 4.36, section B.1.2
   - (f) Extinction 8.-12. μm; table 4.36, section B.1.2
   - (g) Extinction 10.6 μm; table 4.36, section B.1.2
   - (h) Extinction 94 ghz; table 4.36, section B.1.2
3. MUNITION CHARACTERISTICS *repeated for each munition*; table 4.8
   - (a) Source No.; tables 4.12, B.1
   - (b) Number of Subclouds; tables 4.12, B.1
   - (c) XN No.of Sources; tables 4.12, B.1
   - (d) Fill Weight; tables 4.12, B.1
   - (e) Menu Selection Type; tables 4.12, B.1
   - (f) Obscurant Type; tables 4.12, B.1
   - (g) Efficiency; tables 4.12, B.1
   - (h) Yield Factor; tables 4.12, section B.1.1
   - (i) Number of Submunitions; tables 4.12, B.1
   - (j) Vehicle Speed and Direction; tables 4.13, B.7, sectionB.1.5
   - (k) Barrage Parameters; table 4.13, B.7, sectionB.1.5
4. ALTERED MASS EXTINCTION COEFFICIENTS *repeated for each new* EXTC *record*; table B.1.2
5. SOURCE LOCATION AND DIRECTION *repeated for each source*; table 4.33
6. OBSERVER AND TARGET LOCATION *repeated for each LOS*; table 4.31, 4.32
7. LOS START AND END TIME *repeated for each LOS*; table 4.31
8. OBSCURATION DATA *repeated for each time specified by the* LIST *record and for each LOS*
   - (a) Concentration Length
   - (b) Transmission .4-.7 μm
   - (c) Transmission .7-1.2 μm
   - (d) Transmission 1.06 μm

   (e) Transmission 3.-5. μm
   (f) Transmission 8.-12. μm
   (g) Transmission 10.6 μm
   (h) Transmission 94 ghz

9. SUBCLOUD CONTRIBUTIONS (*printed only if PRNT = 2 on the* LIST *record*)
   (a) Integrated Path Concentration (g/m^2) for the Subcloud
   (b) Path Length Through the Subcloud
   (c) Coordinates of Gaussian centroid (m) of the Subcloud
   (d) Sigmas of the Gaussian Subcloud (m)
   (e) Total Mass (g) Contained in the Subcloud

Table 4.40: The following is an example of how to use the VEH1 Card and the VEH2 Card to simulate a vehicle changing direciton.

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
VEH1           1.000     1.000     0.000   100.000  3600.000        0.        0.
VEH2           0.000     0.000     0.000    90.000     2.000        0.        0.
VEH1           1.000     1.000   100.000   150.000  3600.000        0.        0.
VEH2         200.000     0.000     0.000   180.000     2.000        0.        0.
VEH1           1.000     1.000   150.000   200.000  3600.000        0.        0.
VEH2         200.000  -100.000     0.000   180.000     3.000        0.        0.
```

5. Sample Runs

5.1 Overview

This section lists the input and output from COMBIC for the following examples. COMBIC executes in two parts: Phase I and Phase II. Either phase or both phases can be executed in a single computer run. Phase I generates a cloud history for one or more obscurant sources that the user defines. The cloud histories are then stored in a direct-access (record-addressable) mass storage file. The cloud history files are non-ascii and therefore cannot be printed. In Phase II calculations, the user inputs a scenario of one or more obscurant sources and one or more target-observer pairs. The Phase I cloud history file is used to obtain cloud positions, dimensions, and concentrations. Output from Phase II takes several forms. If the PRNT option of the LIST record is one or two, COMBIC will print a transmittance history at seven different wavelengths for each target-observer pair for the times determined by the user inputs on the LIST record. If PRNT=2, the transmittance and contribution of individual subclouds to the transmittance is printed. If the user includes a VIEW and GREY record, then a printed contour representation of clouds with time (printer plot) will be formed and located in the file specified by a FILE record with a nonzero UNITC on the PHAS.

The times at which the transmittance and printer plot are output are determined from the LIST input. The observer and target numbers from the OLOC and TLOC records are also shown for each line in the transmittance history. A line of transmittance history is printed for each LOS that can potentially pass through one or more clouds in the scenario. The total CL in g/m^2 is given for all the clouds lying on the LOS. This number is not meaningful when the clouds are of different types of obscurants, however, since a small CL from one type of obscurant can be very obscuring while a large CL from another may be much less effective as an obscurant.

Both Phase I and Phase II generate conventional listings of up to 132 characters per line. However, every attempt has been made to limit the listings to 80 characters. The exceptions are PRNT=2 on the LIST record and the printer plot option.

5.2 Sample Inputs/Outputs

5.2.1 Example 1: Simple HC scenario

```
WAVL      1.06
COMBIC
PHAS            1.0       5.0       6.0       0.0       9.0       0.0       0.0
FILE          9.0  h.history
NAME            0.
  SAMPLE ONLY
MET1           50.0      2.20       3.      27.50     962.5    202.40      0.00
MUNT            0.0       0.0       1.0       0.0       0.0       0.0       0.0
DONE            0.0
END
```

```
STOP
```

The above inputs exhibit the most basic COMBIC Phase I run. Note the first and last two input records are input records for the EOEXEC driver. The COMBIC records begin with PHAS and end with DONE. This set of input records opens unit nine to be the history file, unit five to be the standard input unit and unit six to be the standard output unit. The direct access history file will be stored in "h.history". This is a non-ascii file and should not be printed. The NAME record indicates that the record directly following it, "SAMPLE ONLY" is just a comment record and is not to be processed. MET1 contains the meteorological data. COMBIC will use default values if no meteorological data is input. This sample contains only one obscurant. SMENU=1 selects the 155-mm HC M1 canister. Note, unless the user desires to modify the munition default characteristics, then the user does not have to input any other information on the MUNT record. The COMBIC model will use defaults from internal tables to specify the rest of the parameters for the 155mm HC canister. The DONE record signals COMBIC that there are no more Phase I records. The following shows the resultant output.

```
******************************************************************************
  WARNING - THIS LIBRARY CONTAINS TECHNICAL DATA WHOSE EXPORT IS RESTRICTED
  BY THE ARMS EXPORT CONTROL ACT (TITLE 22, U.S.C., SEC 2751 ET SEQ.) OR
  EXECUTIVE ORDER 12470.  VIOLATION OF THESE EXPORT LAWS ARE SUBJECT TO
                 SEVERE CRIMINAL PENALTIES.
******************************************************************************
1
                     ********************************
                     *                              *
                     *    ELECTRO-OPTICAL SYSTEMS   *
                     *                              *
                     *  ATMOSPHERIC EFFECTS LIBRARY *
                     *                              *
                     *    NOT FOR OPERATIONAL USE   *
                     *                              *
                     * EOSAEL87 REV 2.1   02/23/90  *
                     *                              *
                     ********************************
WAVL      1.06
 NOTE: THAT THE ABOVE CARD WAS MODIFIED FOR CONSISTENCY TO:
WAVL        .1060E+01 .1060E+01 .0000E+00
                                       BEGINNING            ENDING
            WAVENUMBER (CM**-1)        9433.963             9433.963
            WAVELENGTH (MICROMETERS)      1.060                1.060
            FREQUENCY (GHZ)          283018.875           283018.875
         **** EOSAEL WARNING ****
 VISIBILITY AND EXTINCTION = 0.0, VISIBILITY CHANGED TO 10.0 KM
                                  VISIBILITY
                                   10.00 KM
1
                     ********************************
                     *                              *
                     *         C O M B I C          *
                     *                              *
                     *COMBINED OBSCURATION MODEL FOR*
                     * BATTLEFIELD-INDUCED AEROSOLS *
                     *   NOT FOR OPERATIONAL USE    *
                     *                              *
                     * EOSAEL92 REV 1.0   12/12/90  *
                     *                              *
                     ********************************
1
                                ****************
                                *              *
                                *    COMBIC    *
                                *    PHASE 1   *
                                *              *
                                ****************
 COMBIC WARNING: FILE(                                  h.history       )
  WILL BE OVER WRITTEN
 COMBIC CLOUD HISTORY ON UNIT  9  OPENED TO: h.history
1
                           METEOROLOGICAL CONDITIONS
  REFERENCE HEIGHT    10.00  METERS    WIND SPEED          2.20  METERS/SEC
  SURFACE ROUGHNESS  .10000  METERS    WIND DIRECTION     202.4  DEG WRT NORTH
  INVERSION HEIGHT    824.   METERS    TEMPERATURE        27.49  DEG CELCIUS
  PRESSURE            963.   MB        RELATIVE HUMIDITY   50.0  %
```

```
 PASQUILL CATEGORY      3
                             BOUNDARY LAYER PARAMETERS
 FRICTION VELOCITY       .214 M/SEC      PASQUILL CLASS            2.60
 KAZANSKI-MONIN        -.3254            OMEGA                     .853
 COLD REGION FLAG        0               SBAR MODEL FLAG            0
 AIR DENSITY           1110.4 G/M**3     1/MONIN-OBUKHOV LENGTH  -.02386 M**-1
 SENSIBLE HEAT FLUX     20.2 WATT/M**2 SURFACE BUOYANCY FLUX     .0006  M**2/S**3
 MEAN STATIC SBAR (10-50M)  -.000165  SEC**-2
                                  DIFFUSION COEFFICIENTS
 A COEFFICIENT         B COEFFICIENT         C COEFFICIENT        D COEFFICIENT
      .216                  .900                  .220                  .802
                                    SURFACE CONDITIONS
 SNOW COVER FLAG    0    SILT CONTENT 50.0 %    SOD DEPTH   .000 METERS
1                                VERTICAL  PROFILE  MODEL
                            ATMOSPHERIC TEMPERATURE      S, STATIC        EDDY
 HEIGHT  WINDSPEED  CONSTANT SBAR   VARIABLE S      STABILITY      DISSIPATION
  (M)      (M/S)    MODEL (DEG K)  MODEL (DEG K)    PARAMETER    RATE (M**2/S**3)
 ------  ---------  -------------  -------------   ----------    ----------------
    1.0     1.19       300.78         301.05        -.00586841       .02165
    2.0     1.52       300.77         300.91        -.00261031       .00996
    3.0     1.71       300.75         300.83        -.00158293       .00627
    4.0     1.84       300.74         300.78        -.00109635       .00452
    5.0     1.93       300.72         300.74        -.00081889       .00353
    6.0     2.00       300.71         300.71        -.00064244       .00289
    7.0     2.06       300.69         300.68        -.00052179       .00246
    8.0     2.12       300.68         300.65        -.00043491       .00215
    9.0     2.16       300.66         300.63        -.00036983       .00191
   10.0     2.20       300.65         300.61        -.00031958       .00173
   15.0     2.34       300.58         300.52        -.00018065       .00123
   20.0     2.44       300.50         300.45        -.00011971       .00102
   25.0     2.51       300.43         300.38        -.00008673       .00090
   30.0     2.56       300.35         300.32        -.00006654       .00082
   35.0     2.60       300.28         300.26        -.00005313       .00078
   40.0     2.64       300.20         300.21        -.00004368       .00074
   45.0     2.67       300.13         300.15        -.00003674       .00072
   50.0     2.70       300.06         300.10        -.00003146       .00070
   55.0     2.72       299.98         300.04        -.00002734       .00068
   60.0     2.74       299.91         299.99        -.00002404       .00067
   65.0     2.76       299.83         299.94        -.00002136       .00066
   70.0     2.78       299.76         299.89        -.00001914       .00065
   75.0     2.80       299.68         299.83        -.00001728       .00065
   80.0     2.81       299.61         299.78        -.00001570       .00064
   85.0     2.83       299.54         299.73        -.00001435       .00034
   90.0     2.84       299.46         299.68        -.00001318       .00034
   95.0     2.85       299.39         299.63        -.00001217       .00034
  100.0     2.86       299.31         299.58        -.00001127       .00033
  125.0     2.91       298.94         299.33        -.00000809       .00032
  150.0     2.95       298.57         299.08        -.00000617       .00032
  175.0     2.98       298.20         298.83        -.00000490       .00031
  200.0     3.00       297.83         298.58        -.00000401       .00031
  225.0     3.02       297.46         298.33        -.00000337       .00030
  250.0     3.04       297.09         298.08        -.00000288       .00030
  275.0     3.06       296.72         297.84        -.00000249       .00030
  300.0     3.07       296.35         297.59        -.00000219       .00030
  325.0     3.09       295.98         297.34        -.00000194       .00030
  350.0     3.10       295.61         297.10        -.00000174       .00030
  375.0     3.11       295.24         296.85        -.00000157       .00030
  400.0     3.12       294.87         296.60        -.00000142       .00030
```

```
   450.0    3.14     294.13       296.11      -.00000119     .00030
   500.0    3.15     293.40       295.62      -.00000102     .00030
   550.0    3.17     292.66       295.13      -.00000088     .00030
   600.0    3.18     291.92       294.64      -.00000078     .00030
   650.0    3.19     291.19       294.15      -.00000069     .00030
   700.0    3.20     290.45       293.65      -.00000062     .00030
   750.0    3.21     289.72       293.16      -.00000056     .00029
   800.0    3.22     288.98       292.67      -.00000050     .00029
   850.0    3.22     288.25       292.18      -.00000046     .00029
   900.0    3.23     287.52       291.69      -.00000042     .00029
   950.0    3.24     286.79       291.20      -.00000039     .00029
  1000.0    3.24     286.06       290.71      -.00000036     .00029
1
                        MASS EXTINCTION COEFFICIENTS (M**2/GRAM)
 OBSCURANT                          WAVELENGTH (MICROMETERS)
   CODE       .4-.7    .7-1.2    1.06     3.-5.    8.-12.    10.6     94 GHZ
 ---------   ------    ------   ------   ------    ------   ------    ------
     1       4.0790    1.7699   1.3742    .2939     .3756    .3800     .0010
     2       4.0790    1.7699   1.3742    .2939     .3756    .3800     .0010
     3       3.6618    2.6693   2.2810    .1897     .0280    .0377     .0010
     4       6.8510    4.5920   3.4970    .2450     .0200    .0180     .0010
     5       4.0790    1.7699   1.3742    .2939     .3756    .3800     .0010
     6       1.8600    1.6300   1.4000   1.7900    1.6800   1.6800     .0010
     7       1.8600    1.6300   1.4000   1.7900    1.6800   1.6800     .0010
     8       5.6500    4.0800   3.2500    .2450     .0230    .0270     .0010
     9        .3200     .3000    .2900    .2700     .2500    .2500     .0010
    10        .3200     .2900    .2600    .2700     .2600    .2400     .0010
    11        .0350     .0360    .0370    .0350     .0380    .0360     .0010
    12       1.5000    1.4600   1.4200    .7500     .3200    .3000     .0010
    13        .0010     .0010    .0010    .0010     .0010    .0010     .0004
    14       6.1000    3.7500   2.9400   1.3500    1.0100   1.0000     .0020
    15       6.8510    4.5920   1.4300    .0540     .0200    .0180     .0010
    16       5.3700    2.9000   2.1000    .0900     .0900    .0700     .0010
    17       6.2000    3.5000   2.5000    .2300     .0500    .0480     .0010
    18       3.3300    2.7500   2.6600    .2600     .3200    .2300     .0010
    19       1.3000    1.7400   1.7000    .0800     .1600    .3800     .0010
    20       2.0000    2.0000   2.0000   1.6000    2.0000    .0000     .0000
    21       2.0000    2.0000   1.0000    .1000     .4000    .0000     .0000
    22        .0000     .0000    .0000    .0000     .0000    .0000     .0000
    23        .0000     .0000    .0000    .0000     .0000    .0000     .0000
    24        .0000     .0000    .0000    .0000     .0000    .0000     .0000
    25        .0000     .0000    .0000    .0000     .0000    .0000     .0000
    26        .0000     .0000    .0000    .0000     .0000    .0000     .0000
    27        .0000     .0000    .0000    .0000     .0000    .0000     .0000
    28        .0000     .0000    .0000    .0000     .0000    .0000     .0000
    29        .0000     .0000    .0000    .0000     .0000    .0000     .0000
    30        .0000     .0000    .0000    .0000     .0000    .0000     .0000
1
                    CLOUD HISTORY, FILE NAME = COMHIS
 HISTORY FILE SOURCE #  1 CONTAINS 1 SUBCLOUDS, TOTAL    3242.71 GRAMS OBSCURANT
    XN     FILL WEIGHT    MENU     OBSCURANT
  NO. OF    (LB, GAL   SELECTION    TYPE     EFFICIENCY    YIELD   NUMBER  OF
  SOURCES  OR LB TNT)    TYPE       CODE     (PERCENT)    FACTOR  SUBMUNITIONS
  -------  ----------  ---------  ---------  ----------   ------  ------------
   1.00      5.400        1.         3.         70.0       1.891      1.00
   BURN
 DURATION                             BURN RATE COEFFICIENTS
   (SEC)        B1          B2          B3          B4          B5          B6
```

```
 --------  ---------  ---------  ---------  ---------  ---------  ---------
  100.00     .5370      .4760     4.7790    -5.4720      .0000      .0000
 SMOULDERING   SMOULDERING
    TIME       COEFFICIENT
   (SEC)          CSMLD
 -----------   -----------
     .00          .0000
1
           PROCESSING SUBCLOUD  1
          SUBCLOUD # 1        HISTORY FILE SOURCE #  1
                    DEBRIS       PLUME    CLOUD RISE MODEL    EXTINCTION   BALLISTIC
     MASS           CARBON      (1=PUFF,   (1=RISE, 2= NO     COEFFICIENT   SUBCLOUD
   FRACTION       (G/G OBSC)   2=PLUME)   RISE, >2=STEM)        CODE       (1=Y, 0=N)
   --------       ----------   --------   --------------     -----------  ----------
   1.000000          .000         2.            1.                3.          0.
                                               INITIAL        THERMAL      UPWARD
  INITIAL OBSCURANT RADII (M)  BUOYANCY         CLOUD        PRODUCTION    VELOCITY
  DOWNWIND CROSSWIND VERTICAL  RADIUS(M)   TEMP(DEG K)   COEF (CAL/G)      (M/S)
  -------- --------- --------  ---------   -----------   ------------   --------
     3.10      3.10     3.70       2.29       306.01        1083.63          .74
              FALL    EVAPORATION/DEPOSITION          MOMENTUM  HORIZONTAL
  HEIGHT OF   VELOCITY      FD           DELTA    REFL.   RADIUS     VELOCITY
  BURST (M)    (M/S)   (LONG-TERM)    (S**-1)    COEF.     (M)        (M/S)
  ---------   --------  -----------   -------    -----  --------   ----------
      .0        .000    1.000000       .00000    .5500     .00         .67
              MASS PRODUCTION PROFILE
     TIME T       MASS PRODUCED       MASS STILL       MDOT
     AFTER        UP UNTIL TIME       AIRBORNE BY
  IGNITION (SEC)     T ( G )          TIME T ( G )
  --------------  -------------     ------------
      1.000            17.5              17.5          17.5880
      2.000            35.2              35.2          17.6902
      3.000            53.1              53.1          17.9040
      4.000            71.2              71.2          18.1461
      5.000            89.6              89.6          18.4154
      6.000           108.3             108.3          18.7110
      7.000           127.3             127.3          19.0317
      8.000           146.7             146.7          19.3765
      9.000           166.4             166.4          19.7443
     10.000           186.6             186.6          20.1340
     11.000           207.1             207.1          20.5446
     12.000           228.1             228.1          20.9751
     13.000           249.5             249.5          21.4242
     14.000           271.4             271.4          21.8911
     15.000           293.8             293.8          22.3746
     16.000           316.6             316.6          22.8736
     17.000           340.0             340.0          23.3872
     18.000           363.9             363.9          23.9141
     19.000           388.4             388.4          24.4535
     20.000           413.4             413.4          25.0041
     21.000           438.9             438.9          25.5649
     22.000           465.1             465.1          26.1350
     23.000           491.8             491.8          26.7131
     24.000           519.1             519.1          27.2983
     25.000           547.0             547.0          27.8894
     26.000           575.4             575.4          28.4855
     27.000           604.5             604.5          29.0854
     28.000           634.2             634.2          29.6880
```

29.000	664.5	664.5	30.2924
30.000	695.4	695.4	30.8975
31.000	726.9	726.9	31.5021
32.000	759.0	759.0	32.1053
33.000	791.7	791.7	32.7059
34.000	825.0	825.0	33.3029
35.000	858.9	858.9	33.8953
36.000	893.4	893.4	34.4818
37.000	928.5	928.5	35.0616
38.000	964.1	964.1	35.6335
39.000	1000.3	1000.3	36.1966
40.000	1037.1	1037.1	36.7496
41.000	1074.4	1074.4	37.2915
42.000	1112.2	1112.2	37.8213
43.000	1150.5	1150.5	38.3379
44.000	1189.4	1189.4	38.8403
45.000	1228.7	1228.7	39.3274
46.000	1268.5	1268.5	39.7981
47.000	1308.8	1308.8	40.2513
48.000	1349.5	1349.5	40.6861
49.000	1390.6	1390.6	41.1012
50.000	1432.1	1432.1	41.4956
51.000	1473.9	1473.9	41.8684
52.000	1516.2	1516.2	42.2184
53.000	1558.7	1558.7	42.5447
54.000	1601.6	1601.6	42.8460
55.000	1644.7	1644.7	43.1213
56.000	1688.1	1688.1	43.3695
57.000	1731.7	1731.7	43.5897
58.000	1775.5	1775.5	43.7807
59.000	1819.4	1819.4	43.9416
60.000	1863.5	1863.5	44.0712
61.000	1907.7	1907.7	44.1684
62.000	1951.9	1951.9	44.2321
63.000	1996.2	1996.2	44.2613
64.000	2040.5	2040.5	44.2550
65.000	2084.7	2084.7	44.2122
66.000	2128.8	2128.8	44.1316
67.000	2172.9	2172.9	44.0124
68.000	2216.7	2216.7	43.8532
69.000	2260.4	2260.4	43.6532
70.000	2303.8	2303.8	43.4114
71.000	2347.0	2347.0	43.1265
72.000	2389.8	2389.8	42.7975
73.000	2432.2	2432.2	42.4233
74.000	2474.2	2474.2	42.0030
75.000	2515.8	2515.8	41.5354
76.000	2556.8	2556.8	41.0197
77.000	2597.3	2597.3	40.4543
78.000	2637.2	2637.2	39.8389
79.000	2676.3	2676.3	39.1716
80.000	2714.8	2714.8	38.4517
81.000	2752.5	2752.5	37.6781
82.000	2789.4	2789.4	36.8499
83.000	2825.4	2825.4	35.9661
84.000	2860.4	2860.4	35.0253
85.000	2894.4	2894.4	34.0268
86.000	2927.4	2927.4	32.9690
87.000	2959.3	2959.3	31.8513

```
   88.000          2990.0            2990.0            30.6725
   89.000          3019.5            3019.5            29.4315
   90.000          3047.6            3047.6            28.1274
   91.000          3074.4            3074.4            26.7589
   92.000          3099.7            3099.7            25.3252
   93.000          3123.6            3123.6            23.8248
   94.000          3145.9            3145.9            22.2571
   95.000          3166.5            3166.5            20.6208
   96.000          3185.4            3185.4            18.9150
   97.000          3202.6            3202.6            17.1383
   98.000          3217.9            3217.9            15.2900
   99.000          3231.3            3231.3            13.0912
  100.000          3242.7            3242.7             7.6571
                                                  SUBCLOUD TRAJECTORY
                                                     PEAK     MEAN                          CENTROID OR CM        EFFECTIVE
DOWNWIND             CENTROID      GAUSSIAN CLOUD    CLOUD    CLOUD      AIR      AIR         VELOCITY      CM     BUOYANCY
DISTANCE    TIME     HEIGHT    STD. DEVIATIONS (M)   TEMP.    TEMP.     TEMP.   DENSITY    VERT.   HOR.  HEIGHT    RADIUS
  (M)       (SEC)      (M)    SIGMAX  SIGMAY  SIGMAZ (DEG K)  (DEG K)  (DEG K) (G/M**3)    (M/S)  (M/S)   (M)       (M)
--------  -------  -------  ------  ------  ------  -------  -------  -------  --------   -----  -----  -----   -------
    1.00     1.20      .78    1.44    1.59    2.22   309.88   304.44   300.92   1110.46     .57    .99    2.1    2.567
    2.84     2.80     1.56    1.44    1.87    2.60   306.76   303.20   300.87   1110.56     .43   1.27    2.8    2.911
    5.24     4.56     2.24    1.44    2.29    2.87   305.06   302.51   300.83   1110.61     .35   1.44    3.3    3.268
    8.09     6.45     2.87    1.44    2.84    3.13   304.02   302.08   300.81   1110.64     .31   1.56    3.9    3.628
   11.33     8.47     3.47    1.44    3.50    3.41   303.32   301.79   300.78   1110.65     .29   1.64    4.5    3.988
   14.92    10.61     4.06    1.44    4.26    3.71   302.83   301.58   300.76   1110.66     .27   1.71    5.0    4.350
   18.82    12.85     4.63    1.44    5.08    4.05   302.46   301.42   300.74   1110.66     .25   1.77    5.7    4.713
   23.02    15.18     5.20    1.44    5.98    4.41   302.18   301.30   300.72   1110.65     .24   1.82    6.4    5.077
   27.50    17.61     5.76    1.44    6.93    4.80   301.95   301.20   300.70   1110.64     .23   1.87    6.8    5.442
   32.24    20.08     5.99    1.44    7.70    5.20   301.32   300.93   300.70   1110.63     .09   1.94    7.2    5.596
   37.22    22.60     5.99    1.44    8.35    5.59   301.01   300.81   300.70   1110.63     .10   1.98    7.5    5.596
   42.44    25.19     5.99    1.44    9.03    6.00   300.85   300.75   300.69   1110.62     .10   2.01    7.7    5.596
   47.89    27.86     5.99    1.44    9.72    6.42   300.77   300.72   300.68   1110.61     .11   2.04    8.0    5.596
   53.78    30.72     5.99    1.44   10.47    6.87   300.72   300.70   300.68   1110.60     .11   2.06    8.3    5.596
   60.39    33.89     5.99    1.44   11.30    7.37   300.69   300.68   300.67   1110.58     .11   2.08    8.7    5.596
   67.82    37.42     5.99    1.44   12.22    7.91   300.68   300.67   300.66   1110.57     .11   2.10    9.0    5.596
   76.17    41.36     5.99    1.44   13.25    8.51   300.67   300.66   300.65   1110.55     .11   2.12    9.5    5.596
   85.54    45.74     5.99    1.44   14.40    9.17   300.65   300.65   300.64   1110.53     .11   2.14   10.0    5.596
   96.06    50.62     5.99    1.44   15.68    9.90   300.64   300.64   300.63   1110.51     .11   2.16   10.5    5.596
  107.88    56.05     5.99    1.44   17.10   10.71   300.63   300.63   300.62   1110.48     .11   2.18   11.1    5.596
  121.15    62.10     5.99    1.44   18.67   11.60   300.62   300.62   300.61   1110.44     .11   2.19   11.8    5.596
  136.06    68.84     5.99    1.44   20.43   12.57   300.61   300.61   300.60   1110.40     .11   2.21   12.5    5.596
  152.80    76.33     5.99    1.44   22.38   13.65   300.60   300.60   300.59   1110.36     .11   2.23   13.4    5.596
  171.60    84.67     5.99    1.44   24.55   14.83   300.58   300.58   300.57   1110.30     .11   2.25   14.3    5.596
  192.71    93.94     5.99    1.44   26.96   16.13   300.57   300.57   300.56   1110.24     .11   2.28   15.3    5.596
  216.42   104.26     5.99    1.44   29.64   17.56   300.56   300.56   300.54   1110.17     .11   2.30   16.4    5.596
  243.04   115.73     5.99    1.44   32.62   19.13   300.54   300.54   300.52   1110.10     .11   2.32   17.7    5.596
  272.94   128.49     5.99    1.44   35.92   20.86   300.52   300.52   300.51   1110.01     .11   2.34   19.0    5.596
  306.52   142.68     5.99    1.44   39.60   22.76   300.50   300.50   300.49   1109.91     .11   2.37   20.5    5.596
  344.23   158.46     5.99    1.44   43.68   24.85   300.49   300.49   300.47   1109.79     .10   2.39   22.2    5.596
  386.58   176.00     5.99    1.44   48.22   27.14   300.46   300.46   300.44   1109.67     .10   2.41   24.0    5.596
  434.14   195.52     5.99    1.44   53.25   29.67   300.44   300.44   300.42   1109.53     .10   2.44   26.0    5.596
  487.55   217.22     5.99    1.44   58.85   32.44   300.42   300.42   300.39   1109.37     .10   2.46   28.2    5.596
  547.53   241.35     5.99    1.44   65.06   35.48   300.39   300.39   300.37   1109.19     .10   2.49   30.6    5.596
  614.89   268.20     5.99    1.44   71.96   38.82   300.37   300.37   300.34   1108.99     .10   2.51   33.3    5.596
  690.54   298.06     5.99    1.44   79.62   42.49   300.34   300.34   300.31   1108.77     .10   2.53   36.2    5.596
  775.49   331.29     5.99    1.44   88.13   46.53   300.31   300.31   300.27   1108.53     .10   2.56   39.4    5.596
  870.90   368.26     5.99    1.44   97.58   50.95   300.27   300.27   300.24   1108.26     .10   2.58   42.9    5.596
  978.04   409.41     5.99    1.44  108.07   55.82   300.23   300.23   300.20   1107.96     .09   2.60   46.8    5.596
 1098.37   455.20     5.99    1.44  119.72   61.15   300.20   300.20   300.16   1107.63     .09   2.63   51.0    5.596
```

```
  1233.50   506.19    5.99   1.44  132.65   67.01   300.15   300.15   300.11  1107.26    .09   2.65   55.7   5.596
  1385.25   562.96    5.99   1.44  147.01   73.45   300.11   300.11   300.06  1106.86    .09   2.67   60.8   5.596
  1555.67   626.19    5.99   1.44  162.95   80.51   300.06   300.06   300.00  1106.41    .09   2.70   66.5   5.596
  1747.06   696.61    5.99   1.44  180.65   88.27   300.00   300.00   299.95  1105.92    .09   2.72   72.7   5.596
  1962.00   775.07    5.99   1.44  200.30   96.79   299.94   299.94   299.88  1105.38    .09   2.74   79.4   5.596
  2203.37   862.49    5.99   1.44  222.12  106.13   299.88   299.88   299.81  1104.79    .09   2.76   86.9   5.596
  2474.45   959.92    5.99   1.44  246.34  116.39   299.80   299.80   299.73  1104.13    .08   2.78   95.1   5.596
  2778.87  1068.53    5.99   1.44  273.23  127.66   299.73   299.73   299.65  1103.41    .08   2.80  104.1   5.596
  3120.74  1189.61    5.99   1.44  303.09  140.02   299.64   299.64   299.56  1102.62    .08   2.82  113.9   5.596
  3504.68  1324.62    5.99   1.44  336.23  153.59   299.55   299.55   299.46  1101.74    .08   2.84  124.8   5.596
  3935.85  1475.20    5.99   1.44  373.02  168.49   299.45   299.45   299.35  1100.78    .08   2.86  136.6   5.596
  4420.06  1643.17    5.99   1.44  413.86  184.84   299.34   299.34   299.23  1099.73    .08   2.88  149.7   5.596
  4963.84  1830.56    5.99   1.44  459.20  202.79   299.22   299.22   299.10  1098.57    .08   2.90  164.0   5.596
  5574.53  2039.66    5.99   1.44  509.54  222.49   299.09   299.09   298.96  1097.30    .08   2.92  179.7   5.596
  6260.34  2273.03    5.99   1.44  565.41  244.11   298.94   298.94   298.80  1095.91    .07   2.94  197.0   5.596
  7030.53  2533.52    5.99   1.44  627.44  267.84   298.79   298.79   298.63  1094.37    .07   2.96  215.9   5.596
  7895.47  2824.33    5.99   1.44  696.30  293.89   298.61   298.61   298.44  1092.69    .07   2.97  236.7   5.596
  8866.82  3149.04    5.99   1.44  772.75  322.48   298.42   298.42   298.23  1090.85    .07   2.99  259.5   5.596
  9957.67  3511.65    5.99   1.44  857.61  353.87   298.22   298.22   298.01  1088.82    .07   3.01  284.5   5.596
 11182.73  3916.66    5.99   1.44  951.81  388.31   297.99   297.99   297.76  1086.60    .07   3.02  312.0   5.596
                TOTAL TRANMITANCE FOR ALL SOURCES IS:  .0000E+00
                               END EOSAEL RUN
STOP 000
```

The above output contains an extensive listing of important PHASE I parameters. Included in the listing is the following:

1. Meteorological conditions
2. Boundary Layer Parameters
3. Vertical Profile with Height
4. Diffusion coefficients
5. Surface Conditions
6. Mass extinction coefficients
7. Munition characteristics
8. Mass production profile for each plume
9. Subcloud trajectory parameters

Refer to section 4.6 for a more complete listing of the variables contained in the output files as well as for references. Appendix B contains tables listing the parameters for the munition as well as the individual subclouds. The above input records are for the 155mm HC canister. The output states that this is history file source # 1 and contains 1 subcloud. COMBIC PHASE I output prints out the default values for the `MUNT` record. If there was any changes by the user, then the changes would show here. The default values for the `BURN` record and the `SMOU` record are listed next. These were not listed in the above inputs, so the default parameters associated with SMENU=1 on the `MUNT` record are printed. The COMBIC model then prints out the subcloud characteristics for each subcloud of the cloud. In this case, the 155mm HC canister is composed of only one subcloud. The parameters printed here are the parameters associated with the `SUBA`, `SUBB` and `SUBC` records if the user was to input them manually. By only specifying SMENU=1, the user accessed over 40 parameters used to define the 155mm HC canister! The remaining information describes the mass production profile and the the trajectory associated with this subcloud. If there was further subclouds, then the characteristics and trajectory information would follow.

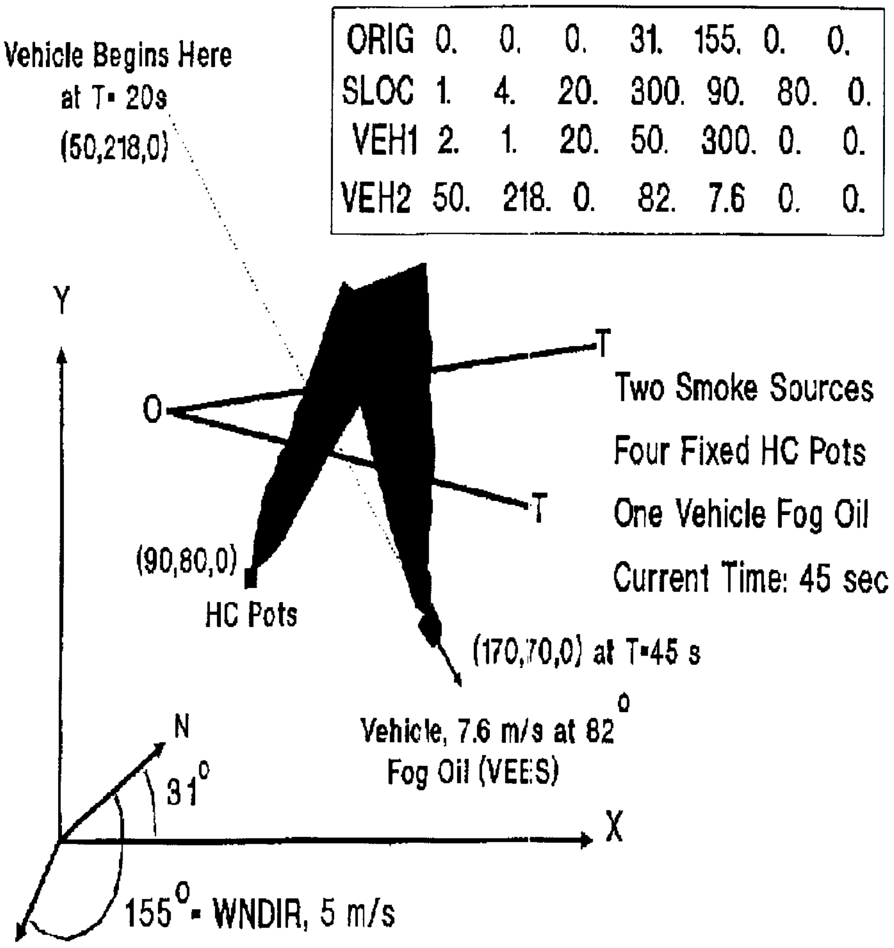
5.2.2 Example 2: Vehicle dust and HC scenario

```
WAVL      1.06
COMBIC
PHAS             1.0       5.0       6.0       0.0       9.0       0.0      0.0
FILE            9.0  h.vehc-hc
NAME             0.
  SAMPLE INPUT SHOWING VEHICULAR DUST AND HC
MET1            90.0      5.00       3.       27.50     962.5    202.40     0.00
MUNT             0.0       0.0       1.0       0.0       0.0       0.0      0.0
GO
MUNT             0.0       0.0       0.0       9.0       0.0       0.0      0.0
VEHC             4.0       3.0      60.0       1.0      90.0
DONE             0.0
END
CONTINUE
WAVL      1.06
COMBIC
PHAS             2.0       5.0       6.0       0.0       9.0       0.0      0.0
FILE            9.0  h.vehc-hc
NAME             0.
  SAMPLE INPUT SHOWING VEHICULAR DUST AND HC
ORIG             0.0       0.0       0.0      31.0     155.0
LIST             1.0       0.0     120.0       5.0
NAME             0.
123456789 123456789 123456789 123456789 123456789 123456789 123456789 123456789
NAME
         Four munition at {90., 80., 0.,) starting at T=20.
SLOC             1.0       4.0      20.0     300.0      90.0      80.0     0.0
NAME
         One vehicle {50., 218., 0.,) starting at T=20.
NAME
         Traveling 7.6m/s at 82 degrees wrt North
VEH1             2.0       1.0      20.0      50.0     300.0
VEH2            50.0     218.0       0.0      82.0       7.6
OLOC             1.0      50.0     130.0       3.0      20.0     100.0
TLOC             1.0     250.0     150.0      15.0       1.0
TLOC             1.0     220.0     100.0       3.0       2.0
DONE             0.0
END
STOP
```

This example illustrates the usage of the VEHC record for vehicular dust and the geometry of the battlefield scenario. Two obscurants are used for this scenario—

155mm HC canister and vehicular dust from a 60-ton tracked vehicle. The vehicle direction and speed on the VEHC record can be changed (like this example) in the PHASE II inputs. The 155mm HC canister are loaded in the history file "h.vehc-hc" as source number one and vehicular dust is loaded as source number two. In this example, there are two LOS with both LOS originating at one observer. OBSN=1 on the TLOC record indicates that both targets are paired with the observer. The TARN parameter is used for assigning more than one target to an observer (as in this case). Figure 5.1 illustrates the source and LOS placement and direction of the resultant clouds. Note that the cloud direction for vehicular dust is the vector sum of the vehicle direction and the wind direction. Below is the output.

Notice that COMBIC prints out the warning NO ACTIVE LOS in the transmittance history. The LIST record determines the times that the transmittance or CL will be output. The parameters from this record specifies a start time, an end time and the time increment between lines of output. Furthermore, for each observer, the user specifies from the STIMO and ETIMO parameters on the OLOC record, the time the observer becomes active and the time the observer can be removed from the active list. If there is no active observer at a time specified by the LIST record to output transmittance, then COMBIC lists the time and states there is no active LOS. This warning does not affect the results in any way and can be ignored by the user if so desired.



ORIG	0.	0.	0.	31.	155.	0.	0.
SLOC	1.	4.	20.	300.	90.	80.	0.
VEH1	2.	1.	20.	50.	300.	0.	0.
VEH2	50.	218.	0.	82.	7.6	0.	0.

Figure 5.1: Source placement and direction of clouds for example 2.

```
*****************************************************************************
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1
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                      *                             *
                      *  ATMOSPHERIC EFFECTS LIBRARY *
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                      *                             *
                      * EOSAEL87 REV 2.1   02/23/90 *
                      *                             *
                      *******************************
WAVL       1.06
 NOTE: THAT THE ABOVE CARD WAS MODIFIED FOR CONSISTENCY TO:
WAVL        .1060E+01 .1060E+01 .0000E+00
                                          BEGINNING           ENDING
             WAVENUMBER (CM**-1)         9433.963            9433.963
             WAVELENGTH (MICROMETERS)       1.060               1.060
             FREQUENCY (GHZ)           283018.875          283018.875
          **** EOSAEL WARNING ****
 VISIBILITY AND EXTINCTION = 0.0, VISIBILITY CHANGED TO 10.0 KM
                                     VISIBILITY
                                      10.00 KM
1
                      *******************************
                      *                             *
                      *          C O M B I C        *
                      *                             *
                      *COMBINED OBSCURATION MODEL FOR*
                      * BATTLEFIELD-INDUCED AEROSOLS *
                      *   NOT FOR OPERATIONAL USE    *
                      *                             *
                      * EOSAEL92 REV 1.0   12/12/90 *
                      *                             *
                      *******************************
1
                                 ****************
                                 *              *
                                 *    COMBIC    *
                                 *    PHASE 1   *
                                 *              *
                                 ****************
 COMBIC WARNING: FILE(                                        h.vehc-hc        )
  WILL BE OVER WRITTEN
 COMBIC CLOUD HISTORY ON UNIT  9  OPENED TO: h.vehc-hc
1
                        METEOROLOGICAL CONDITIONS
  REFERENCE HEIGHT    10.00  METERS   WIND SPEED          5.00  METERS/SEC
  SURFACE ROUGHNESS  .10000  METERS   WIND DIRECTION     202.4  DEG WRT NORTH
  INVERSION HEIGHT    1783.  METERS   TEMPERATURE        27.49  DEG CELCIUS
  PRESSURE             963.  MB       RELATIVE HUMIDITY   90.0  %
  PASQUILL CATEGORY     3
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                     BOUNDARY LAYER PARAMETERS
 FRICTION VELOCITY     .464 M/SEC     PASQUILL CLASS          2.60
 KAZANSKI-MONIN      -.3254           OMEGA                    .853
 COLD REGION FLAG      0              SBAR MODEL FLAG           0
 AIR DENSITY         1110.4 G/M**3    1/MONIN-OBUKHOV LENGTH  -.01102 M**-1
 SENSIBLE HEAT FLUX    94.7 WATT/M**2 SURFACE BUOYANCY FLUX    .0027  M**2/S**3
 MEAN STATIC SBAR (10-50M)  -.000357  SEC**-2
                          DIFFUSION COEFFICIENTS
 A COEFFICIENT        B COEFFICIENT        C COEFFICIENT        D COEFFICIENT
      .216                 .900                 .220                 .802
                            SURFACE CONDITIONS
 SNOW COVER FLAG    0    SILT CONTENT 50.0 %    SOD DEPTH   .000 METERS
1                          VERTICAL  PROFILE  MODEL
                     ATMOSPHERIC TEMPERATURE      S, STATIC        EDDY
 HEIGHT  WINDSPEED  CONSTANT SBAR   VARIABLE S   STABILITY    DISSIPATION
  (M)      (M/S)    MODEL (DEG K)  MODEL (DEG K)  PARAMETER  RATE (M**2/S**3)
 ------  ---------  -------------  -------------  ----------  ----------------
    1.0     2.62       300.84         301.53     -.01371238       .23342
    2.0     3.38       300.82         301.21     -.00641614       .11068
    3.0     3.82       300.80         301.03     -.00403414       .07061
    4.0     4.11       300.77         300.91     -.00287111       .05104
    5.0     4.34       300.75         300.82     -.00219048       .03959
    6.0     4.52       300.73         300.75     -.00174800       .03215
    7.0     4.67       300.71         300.69     -.00143973       .02696
    8.0     4.79       300.69         300.64     -.00121410       .02317
    9.0     4.90       300.67         300.60     -.00104273       .02029
   10.0     5.00       300.65         300.56     -.00090875       .01803
   15.0     5.36       300.55         300.39     -.00052900       .01164
   20.0     5.59       300.44         300.27     -.00035665       .00874
   25.0     5.77       300.34         300.18     -.00026134       .00714
   30.0     5.91       300.23         300.09     -.00020211       .00614
   35.0     6.02       300.13         300.01     -.00016235       .00548
   40.0     6.11       300.03         299.94     -.00013412       .00500
   45.0     6.20       299.92         299.87     -.00011323       .00465
   50.0     6.27       299.82         299.81     -.00009725       .00438
   55.0     6.33       299.72         299.75     -.00008471       .00417
   60.0     6.39       299.61         299.68     -.00007466       .00400
   65.0     6.44       299.51         299.62     -.00006645       .00386
   70.0     6.48       299.41         299.57     -.00005964       .00375
   75.0     6.52       299.30         299.51     -.00005392       .00365
   80.0     6.56       299.20         299.45     -.00004906       .00357
   85.0     6.60       299.09         299.39     -.00004489       .00350
   90.0     6.63       298.99         299.34     -.00004127       .00344
   95.0     6.66       298.89         299.28     -.00003812       .00339
  100.0     6.69       298.78         299.23     -.00003535       .00334
  125.0     6.82       298.27         298.96     -.00002544       .00317
  150.0     6.91       297.75         298.70     -.00001943       .00307
  175.0     6.99       297.23         298.44     -.00001546       .00300
  200.0     7.05       296.72         298.18     -.00001268       .00159
  225.0     7.11       296.20         297.93     -.00001064       .00155
  250.0     7.16       295.69         297.68     -.00000910       .00153
  275.0     7.20       295.17         297.43     -.00000790       .00151
  300.0     7.24       294.66         297.17     -.00000694       .00149
  325.0     7.27       294.15         296.92     -.00000616       .00148
  350.0     7.31       293.63         296.67     -.00000551       .00147
  375.0     7.33       293.12         296.43     -.00000497       .00146
  400.0     7.36       292.61         296.18     -.00000452       .00145
  450.0     7.41       291.59         295.68     -.00000379       .00144
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   500.0     7.45       290.57          295.19      -.00000324      .00143
   550.0     7.48       289.55          294.69      -.00000281      .00142
   600.0     7.52       288.53          294.20      -.00000246      .00141
   650.0     7.55       287.52          293.70      -.00000219      .00141
   700.0     7.57       286.50          293.21      -.00000196      .00141
   750.0     7.60       285.49          292.72      -.00000177      .00140
   800.0     7.62       284.48          292.22      -.00000160      .00140
   850.0     7.64       283.47          291.73      -.00000146      .00140
   900.0     7.66       282.47          291.24      -.00000134      .00139
   950.0     7.68       281.46          290.75      -.00000124      .00139
  1000.0     7.69       280.46          290.26      -.00000115      .00139
1
                          MASS EXTINCTION COEFFICIENTS (M**2/GRAM)
  OBSCURANT                         WAVELENGTH (MICROMETERS)
    CODE        .4-.7     .7-1.2     1.06      3.-5.     8.-12.     10.6      94 GHZ
  ---------    ------     ------    ------    ------     ------    ------     ------
       1       3.2280     2.3638    2.1094     .4127      .3043     .2792      .0010
       2       3.2280     2.3638    2.1094     .4127      .3043     .2792      .0010
       3       2.1520     2.1368    2.0302     .2668      .0601     .0750      .0010
       4       6.8510     4.5920    3.4970     .2450      .0200     .0180      .0010
       5       3.2280     2.3638    2.1094     .4127      .3043     .2792      .0010
       6       1.8600     1.6300    1.4000    1.7900     1.6800    1.6800      .0010
       7       1.8600     1.6300    1.4000    1.7900     1.6800    1.6800      .0010
       8       5.6500     4.0800    3.2500     .2450      .0230     .0270      .0010
       9        .3200      .3000     .2900     .2700      .2500     .2500      .0010
      10        .3200      .2900     .2600     .2700      .2600     .2400      .0010
      11        .0350      .0360     .0370     .0350      .0380     .0360      .0010
      12       1.5000     1.4600    1.4200     .7500      .3200     .3000      .0010
      13        .0010      .0010     .0010     .0010      .0010     .0010      .0004
      14       6.1000     3.7500    2.9400    1.3500     1.0100    1.0000      .0020
      15       6.8510     4.5920    1.4300     .0540      .0200     .0180      .0010
      16       5.3700     2.9000    2.1000     .0900      .0900     .0700      .0010
      17       6.2000     3.5000    2.5000     .2300      .0500     .0480      .0010
      18       3.3300     2.7500    2.6600     .2600      .3200     .2300      .0010
      19       1.3000     1.7400    1.7000     .0800      .1600     .3800      .0010
      20       2.0000     2.0000    2.0000    1.6000     2.0000     .0000      .0000
      21       2.0000     2.0000    1.0000     .1000      .4000     .0000      .0000
      22        .0000      .0000     .0000     .0000      .0000     .0000      .0000
      23        .0000      .0000     .0000     .0000      .0000     .0000      .0000
      24        .0000      .0000     .0000     .0000      .0000     .0000      .0000
      25        .0000      .0000     .0000     .0000      .0000     .0000      .0000
      26        .0000      .0000     .0000     .0000      .0000     .0000      .0000
      27        .0000      .0000     .0000     .0000      .0000     .0000      .0000
      28        .0000      .0000     .0000     .0000      .0000     .0000      .0000
      29        .0000      .0000     .0000     .0000      .0000     .0000      .0000
      30        .0000      .0000     .0000     .0000      .0000     .0000      .0000
1
                     CLOUD HISTORY, FILE NAME = COMHIS
 HISTORY FILE SOURCE #  1 CONTAINS 1 SUBCLOUDS, TOTAL     9815.65 GRAMS OBSCURANT
     XN      FILL WEIGHT   MENU      OBSCURANT
   NO. OF    (LB, GAL    SELECTION     TYPE      EFFICIENCY    YIELD    NUMBER  OF
  SOURCES    OR LB TNT)     TYPE       CODE       (PERCENT)    FACTOR   SUBMUNITIONS
  -------   ----------  ----------  ---------   ----------    ------   ------------
    1.00       5.400         1.         3.          70.0        5.725       1.00
   BURN
 DURATION                              BURN RATE COEFFICIENTS
   (SEC)        B1          B2          B3          B4          B5          B6
 --------   ---------   ---------   ---------   ---------   ---------   ---------
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  100.00       .5370       .4760      4.7790     -5.4720       .0000       .0000
 SMOULDERING  SMOULDERING
    TIME      COEFFICIENT
   (SEC)         CSMLD
 -----------  -----------
      .00         .0000
1
          PROCESSING SUBCLOUD  1
         SUBCLOUD # 1        HISTORY FILE SOURCE #  1
                 DEBRIS      PLUME    CLOUD RISE MODEL    EXTINCTION   BALLISTIC
    MASS         CARBON     (1=PUFF,   (1=RISE, 2= NO     COEFFICIENT   SUBCLOUD
  FRACTION    (G/G CBSC)   2=PLUME)    RISE, >2=STEM)        CODE      (1=Y, 0=N)
  --------    ----------   --------    --------------     -----------  ----------
  1.000000        .000        2.            1.                 3.          0.
                                         INITIAL        THERMAL       UPWARD
 INITIAL OBSCURANT RADII (M)  BUOYANCY     CLOUD        PRODUCTION     VELOCITY
 DOWNWIND CROSSWIND VERTICAL  RADIUS(M)  TEMP(DEG K)   COEF (CAL/G)     (M/S)
 -------- --------- --------  ---------  -----------   ------------   --------
    3.10      3.10      3.70      2.29       308.38       3307.09        1.64
                 FALL    EVAPORATION/DEPOSITION           MOMENTUM  HORIZONTAL
 HEIGHT OF    VELOCITY       FD            DELTA    REFL.   RADIUS     VELOCITY
 BURST (M)     (M/S)    (LONG-TERM)       (S**-1)   COEF.     (M)        (M/S)
 ---------    --------  -----------       -------   -----   --------  ----------
     .0          .000     1.000000        .00000   .5500      .00        1.49
              MASS PRODUCTION PROFILE
    TIME T       MASS PRODUCED         MASS STILL        MDOT
    AFTER        UP UNTIL TIME         AIRBORNE BY
 IGNITION (SEC)     T ( G )            TIME T ( G )
 --------------  -------------        ------------
     1.000             53.0                53.0            52.9591
     2.000            106.5               106.5            53.5183
     3.000            160.6               160.6            54.1665
     4.000            215.5               215.5            54.9004
     5.000            271.3               271.3            55.7168
     6.000            327.9               327.9            56.6126
     7.000            385.5               385.5            57.5844
     8.000            444.1               444.1            58.6291
     9.000            503.8               503.8            59.7436
    10.000            564.8               564.8            60.9243
    11.000            626.9               626.9            62.1683
    12.000            690.4               690.4            63.4723
    13.000            755.2               755.2            64.8331
    14.000            821.5               821.5            66.2473
    15.000            889.2               889.2            67.7120
    16.000            958.4               958.4            69.2236
    17.000           1029.2              1029.2            70.7791
    18.000           1101.6              1101.6            72.3754
    19.000           1175.6              1175.6            74.0088
    20.000           1251.3              1251.3            75.6768
    21.000           1328.6              1328.6            77.3755
    22.000           1407.7              1407.7            79.1021
    23.000           1488.6              1488.6            80.8531
    24.000           1571.2              1571.2            82.6255
    25.000           1655.6              1655.6            84.4159
    26.000           1741.8              1741.8            86.2212
    27.000           1829.9              1829.9            88.0385
    28 000           1919.7              1919.7            89.8634
    29.000           2011.4              2011.4            91.6940
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30.000	2105.0	2105.0	93.5269
31.000	2200.3	2200.3	95.3579
32.000	2297.5	2297.5	97.1848
33.000	2396.5	2396.5	99.0042
34.000	2497.3	2497.3	100.8120
35.000	2599.9	2599.9	102.6062
36.000	2704.3	2704.3	104.3833
37.000	2810.5	2810.5	106.1387
38.000	2918.3	2918.3	107.8711
39.000	3027.9	3027.9	109.5764
40.000	3139.2	3139.2	111.2520
41.000	3252.0	3252.0	112.8931
42.000	3366.5	3366.5	114.4978
43.000	3482.6	3482.6	116.0630
44.000	3600.2	3600.2	117.5845
45.000	3719.3	3719.3	119.0603
46.000	3839.7	3839.7	120.4856
47.000	3961.6	3961.6	121.8589
48.000	4084.8	4084.8	123.1758
49.000	4209.2	4209.2	124.4336
50.000	4334.8	4334.8	125.6289
51.000	4461.6	4461.6	126.7578
52.000	4589.4	4589.4	127.8184
53.000	4718.2	4718.2	128.8076
54.000	4847.9	4847.9	129.7207
55.000	4978.5	4978.5	130.5547
56.000	5109.8	5109.8	131.3076
57.000	5241.8	5241.8	131.9751
58.000	5374.3	5374.3	132.5537
59.000	5507.4	5507.4	133.0420
60.000	5640.8	5640.8	133.4360
61.000	5774.5	5774.5	133.7310
62.000	5908.5	5908.5	133.9243
63.000	6042.5	6042.5	134.0142
64.000	6176.5	6176.5	133.9966
65.000	6310.3	6310.3	133.8677
66.000	6444.0	6444.0	133.6255
67.000	6577.2	6577.2	133.2646
68.000	6710.0	6710.0	132.7842
69.000	6842.2	6842.2	132.1802
70.000	6973.6	6973.6	131.4487
71.000	7104.2	7104.2	130.5879
72.000	7233.8	7233.8	129.5933
73.000	7362.3	7362.3	128.4614
74.000	7489.5	7489.5	127.1899
75.000	7615.3	7615.3	125.7764
76.000	7739.5	7739.5	124.2153
77.000	7862.0	7862.0	122.5063
78.000	7982.6	7982.6	120.6426
79.000	8101.2	8101.2	118.6260
80.000	8217.7	8217.7	116.4463
81.000	8331.8	8331.8	114.1064
82.000	8443.4	8443.4	111.6006
83.000	8552.3	8552.3	108.9248
84.000	8658.4	8658.4	106.0811
85.000	8761.5	8761.5	103.0576
86.000	8861.3	8861.3	99.8574
87.000	8957.8	8957.8	96.4746
88.000	9050.7	9050.7	92.9082

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    89.000          9139.9          9139.9          89.1533
    90.000          9225.1          9225.1          85.2051
    91.000          9306.1          9306.1          81.0654
    92.000          9382.9          9382.9          76.7256
    93.000          9455.0          9455.0          72.1855
    94.000          9522.5          9522.5          67.4404
    95.000          9585.0          9585.0          62.4893
    96.000          9642.3          9642.3          57.3271
    97.000          9694.2          9694.2          51.9502
    98.000          9740.6          9740.6          46.3555
    99.000          9781.1          9781.1          40.5430
   100.000          9815.6          9815.6          34.5039
                                          SUBCLOUD TRAJECTORY
                                             PEAK    MEAN                       CENTROID OR CM     EFFECTIVE
 DOWNWIND           CENTROID    GAUSSIAN CLOUD      CLOUD   CLOUD     AIR      AIR      VELOCITY     CM    BUOYANCY
 DISTANCE   TIME     HEIGHT   STD. DEVIATIONS (M)   TEMP.   TEMP.    TEMP.   DENSITY  VERT.  HOR.  HEIGHT  RADIUS
   (M)     (SEC)      (M)    SIGMAX  SIGMAY  SIGMAZ (DEG K) (DEG K) (DEG K) (G/M**3)  (M/S) (M/S)   (M)     (M)
 --------  -------  -------  ------  ------  ------ ------- ------- ------- --------  ----- -----  -----  -------
     1.00      .54      .71    1.44    1.60    2.33  313.80  306.12  301.21  1109.38   1.03  2.21    2.2   2.594
     2.84     1.26     1.30    1.44    1.86    2.66  309.67  304.48  301.12  1109.64    .66  2.81    2.7   2.896
     5.24     2.06     1.75    1.44    2.26    2.88  307.46  303.59  301.06  1109.80    .49  3.15    3.1   3.196
     8.09     2.94     2.14    1.44    2.79    3.10  306.08  303.02  301.02  1109.91    .40  3.37    3.4   3.490
    11.33     3.87     2.49    1.44    3.44    3.35  305.14  302.63  300.98  1110.02    .35  3.53    3.8   3.779
    14.92     4.87     2.81    1.44    4.18    3.62  304.44  302.33  300.94  1110.10    .31  3.67    4.2   4.066
    18.82     5.92     3.12    1.44    5.00    3.93  303.90  302.09  300.90  1110.20    .28  3.78    4.6   4.352
    23.02     7.01     3.42    1.44    5.89    4.26  303.47  301.90  300.87  1110.27    .26  3.89    5.1   4.639
    27.50     8.15     3.71    1.44    6.83    4.63  303.12  301.74  300.83  1110.34    .25  3.98    5.5   4.928
    32.24     9.33     3.99    1.44    7.82    5.02  302.82  301.61  300.80  1110.39    .23  4.06    5.9   5.220
    37.22    10.53     4.15    1.44    8.69    5.43  301.81  301.16  300.79  1110.41    .24  4.24    6.2   5.390
    42.44    11.73     4.15    1.44    9.36    5.84  301.29  300.97  300.78  1110.42    .25  4.33    6.5   5.390
    47.89    12.97     4.15    1.44   10.06    6.26  301.03  300.87  300.77  1110.45    .25  4.41    6.8   5.390
    53.78    14.28     4.15    1.44   10.80    6.71  300.89  300.81  300.75  1110.48    .25  4.48    7.2   5.390
    60.39    15.74     4.15    1.44   11.63    7.21  300.81  300.77  300.73  1110.50    .26  4.54    7.5   5.390
    67.82    17.35     4.15    1.44   12.55    7.76  300.76  300.74  300.71  1110.53    .26  4.60    8.0   5.390
    76.17    19.14     4.15    1.44   13.58    8.36  300.72  300.71  300.69  1110.55    .26  4.66    8.4   5.390
    85.54    21.13     4.15    1.44   14.72    9.03  300.70  300.69  300.67  1110.58    .26  4.71    8.9   5.390
    96.06    23.34     4.15    1.44   16.00    9.76  300.67  300.67  300.64  1110.60    .26  4.77    9.5   5.390
   107.88    25.79     4.15    1.44   17.41   10.57  300.65  300.64  300.62  1110.61    .26  4.82   10.1   5.390
   121.15    28.51     4.15    1.44   18.99   11.46  300.62  300.62  300.60  1110.63    .26  4.88   10.8   5.390
   136.06    31.53     4.15    1.44   20.74   12.43  300.60  300.59  300.57  1110.63    .25  4.94   11.6   5.390
   152.80    34.88     4.15    1.44   22.69   13.51  300.57  300.57  300.54  1110.64    .25  5.00   12.4   5.390
   171.60    38.60     4.15    1.44   24.85   14.70  300.54  300.54  300.52  1110.63    .25  5.06   13.4   5.390
   192.71    42.72     4.15    1.44   27.26   16.00  300.51  300.51  300.49  1110.62    .25  5.12   14.4   5.390
   216.42    47.30     4.15    1.44   29.94   17.43  300.49  300.49  300.46  1110.60    .25  5.18   15.5   5.390
   243.04    52.38     4.15    1.44   32.91   19.01  300.46  300.46  300.43  1110.57    .25  5.24   16.8   5.390
   272.94    58.02     4.15    1.44   36.22   20.74  300.43  300.43  300.40  1110.53    .24  5.30   18.1   5.390
   306.52    64.28     4.15    1.44   39.89   22.64  300.39  300.39  300.36  1110.47    .24  5.37   19.7   5.390
   344.23    71.22     4.15    1.44   43.97   24.73  300.36  300.36  300.33  1110.41    .24  5.43   21.3   5.390
   386.58    78.93     4.15    1.44   48.50   27.03  300.33  300.33  300.29  1110.33    .24  5.50   23.1   5.390
   434.14    87.48     4.15    1.44   53.53   29.56  300.29  300.29  300.26  1110.23    .23  5.56   25.2   5.390
   487.55    96.98     4.15    1.44   59.12   32.33  300.26  300.26  300.22  1110.12    .23  5.62   27.4   5.390
   547.53   107.52     4.15    1.44   65.33   35.37  300.22  300.22  300.18  1109.98    .23  5.69   29.8   5.390
   614.89   119.23     4.15    1.44   72.23   38.72  300.18  300.18  300.14  1109.83    .23  5.75   32.5   5.390
   690.54   132.24     4.15    1.44   79.89   42.39  300.14  300.14  300.10  1109.65    .23  5.82   35.4   5.390
   775.49   146.69     4.15    1.44   88.39   46.43  300.10  300.10  300.05  1109.45    .22  5.88   38.6   5.390
   870.90   162.74     4.15    1.44   97.84   50.86  300.05  300.05  300.01  1109.21    .22  5.94   42.1   5.390
   978.04   180.59     4.15    1.44  108.33   55.72  300.00  300.00  299.96  1108.95    .22  6.00   46.0   5.390
  1098.37   200.42     4.15    1.44  119.97   61.06  299.95  299.95  299.90  1108.66    .21  6.07   50.3   5.390
  1233.50   222.47     4.15    1.44  132.90   66.92  299.90  299.90  299.85  1108.33    .21  6.13   54.9   5.390
```

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    1385.25   247.00    4.15    1.44  147.26   73.36   299.84   299.84   299.79  1107.96    .21   6.19   60.1   5.390
    1555.67   274.28    4.15    1.44  163.20   80.43   299.78   299.78   299.72  1107.54    .21   6.25   65.7   5.390
    1747.06   304.63    4.15    1.44  180.90   88.19   299.72   299.72   299.66  1107.08    .20   6.31   71.9   5.390
    1962.00   338.41    4.15    1.44  200.55   96.70   299.65   299.65   299.58  1106.57    .20   6.36   78.7   5.390
    2203.37   376.00    4.15    1.44  222.36  106.05   299.58   299.58   299.50  1106.01    .20   6.42   86.1   5.390
    2474.45   417.86    4.15    1.44  246.58  116.31   299.50   299.50   299.42  1105.38    .20   6.48   94.3   5.390
    2778.87   464.47    4.15    1.44  273.47  127.58   299.41   299.41   299.33  1104.68    .19   6.53  103.3   5.390
    3120.74   516.39    4.15    1.44  303.31  139.94   299.32   299.32   299.23  1103.91    .19   6.58  113.2   5.390
    3504.68   574.23    4.15    1.44  336.45  153.52   299.22   299.22   299.12  1103.06    .19   6.64  124.0   5.390
    3935.85   638.68    4.15    1.44  373.24  168.42   299.11   299.11   299.01  1102.13    .18   6.69  135.9   5.390
    4420.06   710.52    4.15    1.44  414.08  184.77   299.00   299.00   298.88  1101.10    .18   6.74  148.9   5.390
    4963.84   790.59    4.15    1.44  459.42  202.72   298.87   298.87   298.74  1099.96    .18   6.79  163.3   5.390
    5574.53   879.88    4.15    1.44  509.75  222.42   298.73   298.73   298.60  1098.70    .18   6.84  179.0   5.390
    6260.34   979.44    4.15    1.44  565.63  244.04   298.58   298.58   298.43  1097.33    .17   6.89  196.2   5.390
    7030.53  1090.50    4.15    1.44  627.66  267.78   298.42   298.42   298.26  1095.81    .17   6.94  215.2   5.390
    7895.47  1214.40    4.15    1.44  696.51  293.83   298.24   298.24   298.06  1094.14    .17   6.98  236.0   5.390
    8866.82  1352.64    4.15    1.44  772.95  322.42   298.05   298.05   297.85  1092.31    .17   7.03  258.8   5.390
    9957.67  1506.92    4.15    1.44  857.81  353.81   297.83   297.83   297.62  1090.29    .16   7.07  283.8   5.390
   11182.73  1679.12    4.15    1.44  952.01  388.25   297.60   297.60   297.37  1088.08    .16   7.11  311.3   5.390
1
                  CLOUD HISTORY, FILE NAME = COMHIS
 HISTORY FILE SOURCE #  2 CONTAINS 1 SUBCLOUDS, TOTAL  198720.00 GRAMS OBSCURANT
    XN     FILL WEIGHT   MENU      OBSCURANT
  NO. OF   (LB, GAL    SELECTION    TYPE      EFFICIENCY    YIELD   NUMBER  OF
 SOURCES   OR LB TNT)    TYPE       CODE      (PERCENT)    FACTOR  SUBMUNITIONS
 -------  ----------  ---------  ---------   ----------   ------  ------------
   1.00     438.103      C.          9.        100.0       1.000      1.00
  BURN
 DURATION                             BURN RATE COEFFICIENTS
  (SEC)       B1          B2          B3          B4          B5          B6
 --------  ---------   ---------   ---------   ---------   ---------   ---------
  900.00    1.0000       .0000       .0000       .0000       .0000       .0000
 SMOULDERING   SMOULDERING
    TIME       COEFFICIENT
   (SEC)          CSMLD
 -----------   -----------
     .00          .0000
       MOVING SOURCE OR VEHICLE DUST
                                VEHICLE   VEHICLE TYPE      VEHICLE
    VEHICLE      VEHICLE        WEIGHT   (0=WHEELED,      DIRECTION
  SPEED (M/S)   WIDTH (M)      (TONS)    1=TRACKED)         (DEG)
  -----------   ---------      -------   ------------     ---------
      4.0           3.0          60.0        1.               90.0
1
              PROCESSING SUBCLOUD  1
             SUBCLOUD # 1          HISTORY FILE SOURCE #  2
                   DEBRIS       PLUME     CLOUD RISE MODEL    EXTINCTION    BALLISTIC
     MASS          CARBON      (1=PUFF,   (1=RISE, 2= NO     COEFFICIENT    SUBCLOUD
   FRACTION      (G/G OBSC)    2=PLUME)   RISE, >2=STEM)        CODE        (1=Y, 0=N)
   --------     ----------    --------   --------------     -----------    ----------
   1.000000        .000          2.            2.                9.            0.
                                              INITIAL        THERMAL        UPWARD
  INITIAL OBSCURANT RADII (M)  BUOYANCY       CLOUD        PRODUCTION      VELOCITY
 DOWNWIND CROSSWIND VERTICAL  RADIUS(M)   TEMP(DEG K)    COEF (CAL/G)      (M/S)
 -------- --------- --------  ---------   -----------    ------------    --------
    2.70      2.70     1.20       .00          .00             .00           .00
                 FALL    EVAPORATION/DEPOSITION         MOMENTUM  HORIZONTAL
 HEIGHT OF     VELOCITY      FD          DELTA    REFL.   RADIUS     VELOCITY
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BURST (M)    (M/S)   (LONG-TERM)   (S**-1)   COEF.    (M)        (M/S)
---------  --------  -----------   -------   -----  --------  ----------
   .0        .000     1.000000     .00000    .5500     .00         .00
             MASS PRODUCTION PROFILE
  TIME T        MASS PRODUCED       MASS STILL       MDOT
  AFTER         UP UNTIL TIME       AIRBORNE BY
IGNITION (SEC)      T ( G )         TIME T ( G )
--------------  -------------      ------------
   1.000             220.8              220.8         220.8000
   2.000             441.6              441.6         220.8000
   3.000             662.4              662.4         220.8000
   4.000             883.2              883.2         220.8000
   5.000            1104.0             1104.0         220.8000
   6.000            1324.8             1324.8         220.8000
   7.000            1545.6             1545.6         220.8000
   8.000            1766.4             1766.4         220.7999
   9.000            1987.2             1987.2         220.7999
  10.000            2208.0             2208.0         220.8000
  11.000            2428.8             2428.8         220.8000
  12.000            2649.6             2649.6         220.8000
  13.000            2870.4             2870.4         220.7998
  14.000            3091.2             3091.2         220.8003
  15.000            3312.0             3312.0         220.8000
  16.000            3532.8             3532.8         220.7998
  17.000            3753.6             3753.6         220.8000
  18.000            3974.4             3974.4         220.7998
  19.000            4195.2             4195.2         220.7998
  20.000            4416.0             4416.0         220.8003
  21.000            4636.8             4636.8         220.7998
  22.000            4857.6             4857.6         220.8003
  23.000            5078.4             5078.4         220.7998
  24.000            5299.2             5299.2         220.8003
  25.000            5520.0             5520.0         220.7998
  26.000            5740.8             5740.8         220.7998
  27.000            5961.6             5961.6         220.8003
  28.000            6182.4             6182.4         220.8003
  29.000            6403.2             6403.2         220.7998
  30.000            6624.0             6624.0         220.8003
  31.000            6844.8             6844.8         220.7993
  32.000            7065.6             7065.6         220.8003
  33.000            7286.4             7286.4         220.7998
  34.000            7507.2             7507.2         220.8003
  35.000            7728.0             7728.0         220.8003
  36.000            7948.8             7948.8         220.7993
  37.000            8169.6             8169.6         220.8003
  38.000            8390.4             8390.4         220.7993
  39.000            8611.2             8611.2         220.8008
  40.000            8832.0             8832.0         220.7998
  41.000            9052.8             9052.8         220.7998
  42.000            9273.6             9273.6         220.7998
  43.000            9494.4             9494.4         220.8008
  44.000            9715.2             9715.2         220.7998
  45.000            9936.0             9936.0         220.7998
  46.000           10156.8            10156.8         220.7998
  47.000           10377.6            10377.6         220.7998
  48.000           10598.4            10598.4         220.8008
  49.000           10819.2            10819.2         220.7998
  50.000           11040.0            11040.0         220.7998
  51.000           11260.8            11260.8         220.8008
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52.000	11481.6	11481.6	220.7988
53.000	11702.4	11702.4	220.8008
54.000	11923.2	11923.2	220.7998
55.000	12144.0	12144.0	220.7998
56.000	12364.8	12364.8	220.8008
57.000	12585.6	12585.6	220.7988
58.000	12806.4	12806.4	220.8008
59.000	13027.2	13027.2	220.7998
60.000	13248.0	13248.0	220.8008
61.000	13468.8	13468.8	220.7988
62.000	13689.6	13689.6	220.7998
63.000	13910.4	13910.4	220.8008
64.000	14131.2	14131.2	220.7998
65.000	14352.0	14352.0	220.8008
66.000	14572.8	14572.8	220.7988
67.000	14793.6	14793.6	220.7998
68.000	15014.4	15014.4	220.8008
69.000	15235.2	15235.2	220.7998
70.000	15456.0	15456.0	220.8008
71.000	15676.8	15676.8	220.7988
72.000	15897.6	15897.6	220.7998
73.000	16118.4	16118.4	220.8008
74.000	16339.2	16339.2	220.7998
75.000	16560.0	16560.0	220.7998
76.000	16780.8	16780.8	220.7988
77.000	17001.6	17001.6	220.8008
78.000	17222.4	17222.4	220.8008
79.000	17443.2	17443.2	220.7988
80.000	17664.0	17664.0	220.8008
81.000	17884.8	17884.8	220.8008
82.000	18105.6	18105.6	220.7988
83.000	18326.4	18326.4	220.8008
84.000	18547.2	18547.2	220.7988
85.000	18768.0	18768.0	220.8008
86.000	18988.8	18988.8	220.8008
87.000	19209.6	19209.6	220.7988
88.000	19430.4	19430.4	220.8008
89.000	19651.2	19651.2	220.7988
90.000	19872.0	19872.0	220.8008
91.000	20092.8	20092.8	220.8008
92.000	20313.6	20313.6	220.7988
93.000	20534.4	20534.4	220.8008
94.000	20755.2	20755.2	220.7988
95.000	20976.0	20976.0	220.8008
96.000	21196.8	21196.8	220.8008
97.000	21417.6	21417.6	220.7988
98.000	21638.4	21638.4	220.8008
99.000	21859.2	21859.2	220.7988
100.000	22080.0	22080.0	220.8008
101.000	22300.8	22300.8	220.8008
102.000	22521.6	22521.6	220.8008
103.000	22742.4	22742.4	220.7988
104.000	22963.2	22963.2	220.7988
105.000	23184.0	23184.0	220.8008
106.000	23404.8	23404.8	220.8008
107.000	23625.6	23625.6	220.8008
108.000	23846.4	23846.4	220.7988
109.000	24067.2	24067.2	220.7988
110.000	24288.0	24288.0	220.8008

111.000	24508.8	24508.8	220.8008
112.000	24729.6	24729.6	220.8008
113.000	24950.4	24950.4	220.7988
114.000	25171.2	25171.2	220.7988
115.000	25392.0	25392.0	220.8027
116.000	25612.8	25612.8	220.7988
117.000	25833.6	25833.6	220.7988
118.000	26054.4	26054.4	220.8008
119.000	26275.2	26275.2	220.7988
120.000	26496.0	26496.0	220.8027
121.000	26716.8	26716.8	220.7988
122.000	26937.6	26937.6	220.7988
123.000	27158.4	27158.4	220.8008
124.000	27379.2	27379.2	220.7988
125.000	27600.0	27600.0	220.8027
126.000	27820.8	27820.8	220.7988
127.000	28041.6	28041.6	220.7988
128.000	28262.4	28262.4	220.8008
129.000	28483.2	28483.2	220.7988
130.000	28704.0	28704.0	220.8027
131.000	28924.8	28924.8	220.7988
132.000	29145.6	29145.6	220.7988
133.000	29366.4	29366.4	220.8008
134.000	29587.2	29587.2	220.7988
135.000	29808.0	29808.0	220.8027
136.000	30028.8	30028.8	220.7988
137.000	30249.6	30249.6	220.7988
138.000	30470.4	30470.4	220.8008
139.000	30691.2	30691.2	220.7988
140.000	30912.0	30912.0	220.8027
141.000	31132.8	31132.8	220.7988
142.000	31353.6	31353.6	220.7988
143.000	31574.4	31574.4	220.8008
144.000	31795.2	31795.2	220.7988
145.000	32016.0	32016.0	220.8027
146.000	32236.8	32236.8	220.7988
147.000	32457.6	32457.6	220.7988
148.000	32678.4	32678.4	220.8008
149.000	32899.2	32899.2	220.7988
150.000	33120.0	33120.0	220.8008
151.000	33340.8	33340.8	220.8008
152.000	33561.6	33561.6	220.7969
153.000	33782.4	33782.4	220.8008
154.000	34003.2	34003.2	220.8008
155.000	34224.0	34224.0	220.8008
156.000	34444.8	34444.8	220.8008
157.000	34665.6	34665.6	220.7969
158.000	34886.4	34886.4	220.8008
159.000	35107.2	35107.2	220.8008
160.000	35328.0	35328.0	220.8008
161.000	35548.8	35548.8	220.8008
162.000	35769.6	35769.6	220.8008
163.000	35990.4	35990.4	220.7969
164.000	36211.2	36211.2	220.8008
165.000	36432.0	36432.0	220.8008
166.000	36652.8	36652.8	220.8008
167.000	36873.6	36873.6	220.8008
168.000	37094.4	37094.4	220.7969
169.000	37315.2	37315.2	220.8008

170.000	37536.0	37536.0	220.8008
171.000	37756.8	37756.8	220.8008
172.000	37977.6	37977.6	220.8008
173.000	38198.4	38198.4	220.7969
174.000	38419.2	38419.2	220.8008
175.000	38640.0	38640.0	220.8008
176.000	38860.8	38860.8	220.8008
177.000	39081.6	39081.6	220.8008
178.000	39302.4	39302.4	220.7969
179.000	39523.2	39523.2	220.8008
180.000	39744.0	39744.0	220.8008
181.000	39964.8	39964.8	220.8008
182.000	40185.6	40185.6	220.8008
183.000	40406.4	40406.4	220.7969
184.000	40627.2	40627.2	220.8008
185.000	40848.0	40848.0	220.8008
186.000	41068.8	41068.8	220.8008
187.000	41289.6	41289.6	220.8008
188.000	41510.4	41510.4	220.7969
189.000	41731.2	41731.2	220.8008
190.000	41952.0	41952.0	220.8008
191.000	42172.8	42172.8	220.8008
192.000	42393.6	42393.6	220.8008
193.000	42614.4	42614.4	220.7969
194.000	42835.2	42835.2	220.8008
195.000	43056.0	43056.0	220.8008
196.000	43276.8	43276.8	220.8008
197.000	43497.6	43497.6	220.8008
198.000	43718.4	43718.4	220.7969
199.000	43939.2	43939.2	220.8008
200.000	44160.0	44160.0	220.8008
201.000	44380.8	44380.8	220.8008
202.000	44601.6	44601.6	220.8008
203.000	44822.4	44822.4	220.7969
204.000	45043.2	45043.2	220.8047
205.000	45264.0	45264.0	220.7969
206.000	45484.8	45484.8	220.8008
207.000	45705.6	45705.6	220.8008
208.000	45926.4	45926.4	220.7969
209.000	46147.2	46147.2	220.8047
210.000	46368.0	46368.0	220.7969
211.000	46588.8	46588.8	220.8008
212.000	46809.6	46809.6	220.8008
213.000	47030.4	47030.4	220.7969
214.000	47251.2	47251.2	220.8047
215.000	47472.0	47472.0	220.7969
216.000	47692.8	47692.8	220.8008
217.000	47913.6	47913.6	220.8008
218.000	48134.4	48134.4	220.7969
219.000	48355.2	48355.2	220.8047
220.000	48576.0	48576.0	220.7969
221.000	48796.8	48796.8	220.8008
222.000	49017.6	49017.6	220.8008
223.000	49238.4	49238.4	220.7969
224.000	49459.2	49459.2	220.8047
225.000	49680.0	49680.0	220.7969
226.000	49900.8	49900.8	220.8008
227.000	50121.6	50121.6	220.7969
228.000	50342.4	50342.4	220.8008

229.000	50563.2	50563.2	220.8008
230.000	50784.0	50784.0	220.8047
231.000	51004.8	51004.8	220.7930
232.000	51225.6	51225.6	220.8047
233.000	51446.4	51446.4	220.8008
234.000	51667.2	51667.2	220.7969
235.000	51888.0	51888.0	220.8008
236.000	52108.8	52108.8	220.8008
237.000	52329.6	52329.6	220.7969
238.000	52550.4	52550.4	220.8008
239.000	52771.2	52771.2	220.8008
240.000	52992.0	52992.0	220.8047
241.000	53212.8	53212.8	220.7930
242.000	53433.6	53433.6	220.8047
243.000	53654.4	53654.4	220.8008
244.000	53875.2	53875.2	220.7969
245.000	54096.0	54096.0	220.8008
246.000	54316.8	54316.8	220.8008
247.000	54537.6	54537.6	220.7969
248.000	54758.4	54758.4	220.8008
249.000	54979.2	54979.2	220.8008
250.000	55200.0	55200.0	220.8047
251.000	55420.8	55420.8	220.7930
252.000	55641.6	55641.6	220.8047
253.000	55862.4	55862.4	220.8008
254.000	56083.2	56083.2	220.7969
255.000	56304.0	56304.0	220.8008
256.000	56524.8	56524.8	220.8008
257.000	56745.6	56745.6	220.7969
258.000	56966.4	56966.4	220.8008
259.000	57187.2	57187.2	220.8008
260.000	57408.0	57408.0	220.8047
261.000	57628.8	57628.8	220.7930
262.000	57849.6	57849.6	220.8047
263.000	58070.4	58070.4	220.8008
264.000	58291.2	58291.2	220.7969
265.000	58512.0	58512.0	220.8008
266.000	58732.8	58732.8	220.8008
267.000	58953.6	58953.6	220.7969
268.000	59174.4	59174.4	220.8008
269.000	59395.2	59395.2	220.8008
270.000	59616.0	59616.0	220.8047
271.000	59836.8	59836.8	220.7930
272.000	60057.6	60057.6	220.8047
273.000	60278.4	60278.4	220.8008
274.000	60499.2	60499.2	220.7969
275.000	60720.0	60720.0	220.8008
276.000	60940.8	60940.8	220.8008
277.000	61161.6	61161.6	220.8008
278.000	61382.4	61382.4	220.7969
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666.000	147052.8	147052.8	220.7969
667.000	147273.6	147273.6	220.7969
668.000	147494.4	147494.4	220.8125
669.000	147715.2	147715.2	220.7969
670.000	147936.0	147936.0	220.7969
671.000	148156.8	148156.8	220.8125
672.000	148377.6	148377.6	220.7813
673.000	148598.4	148598.4	220.7969
674.000	148819.2	148819.2	220.8125
675.000	149040.0	149040.0	220.7969
676.000	149260.8	149260.8	220.7969
677.000	149481.6	149481.6	220.8125
678.000	149702.4	149702.4	220.7969
679.000	149923.2	149923.2	220.7813
680.000	150144.0	150144.0	220.8125
681.000	150364.8	150364.8	220.7969
682.000	150585.6	150585.6	220.7969
683.000	150806.4	150806.4	220.8125
684.000	151027.2	151027.2	220.7969
685.000	151248.0	151248.0	220.7969
686.000	151468.8	151468.8	220.7969
687.000	151689.6	151689.6	220.7969
688.000	151910.4	151910.4	220.8125
689.000	152131.2	152131.2	220.7969
690.000	152352.0	152352.0	220.7969
691.000	152572.8	152572.8	220.7969
692.000	152793.6	152793.6	220.7969
693.000	153014.4	153014.4	220.7969
694.000	153235.2	153235.2	220.8125
695.000	153456.0	153456.0	220.7969
696.000	153676.8	153676.8	220.7969
697.000	153897.6	153897.6	220.8125
698.000	154118.4	154118.4	220.7969
699.000	154339.2	154339.2	220.7813
700.000	154560.0	154560.0	220.8125

701.000	154780.8	154780.8	220.7969
702.000	155001.6	155001.6	220.7969
703.000	155222.4	155222.4	220.8125
704.000	155443.2	155443.2	220.7969
705.000	155664.0	155664.0	220.7969
706.000	155884.8	155884.8	220.7969
707.000	156105.6	156105.6	220.7969
708.000	156326.4	156326.4	220.8125
709.000	156547.2	156547.2	220.7969
710.000	156768.0	156768.0	220.7969
711.000	156988.8	156988.8	220.7969
712.000	157209.6	157209.6	220.7969
713.000	157430.4	157430.4	220.7969
714.000	157651.2	157651.2	220.8125
715.000	157872.0	157872.0	220.7969
716.000	158092.8	158092.8	220.7969
717.000	158313.6	158313.6	220.8125
718.000	158534.4	158534.4	220.7969
719.000	158755.2	158755.2	220.7813
720.000	158976.0	158976.0	220.8125
721.000	159196.8	159196.8	220.7969
722.000	159417.6	159417.6	220.8125
723.000	159638.4	159638.4	220.7969
724.000	159859.2	159859.2	220.7969
725.000	160080.0	160080.0	220.7969
726.000	160300.8	160300.8	220.7969
727.000	160521.6	160521.6	220.7969
728.000	160742.4	160742.4	220.8125
729.000	160963.2	160963.2	220.7969
730.000	161184.0	161184.0	220.7969
731.000	161404.8	161404.8	220.7969
732.000	161625.6	161625.6	220.7969
733.000	161846.4	161846.4	220.7969
734.000	162067.2	162067.2	220.8125
735.000	162288.0	162288.0	220.7969
736.000	162508.8	162508.8	220.7969
737.000	162729.6	162729.6	220.8125
738.000	162950.4	162950.4	220.7969
739.000	163171.2	163171.2	220.7813
740.000	163392.0	163392.0	220.8125
741.000	163612.8	163612.8	220.7969
742.000	163833.6	163833.6	220.8125
743.000	164054.4	164054.4	220.7969
744.000	164275.2	164275.2	220.7969
745.000	164496.0	164496.0	220.7969
746.000	164716.8	164716.8	220.7969
747.000	164937.6	164937.6	220.7969
748.000	165158.4	165158.4	220.8125
749.000	165379.2	165379.2	220.7969
750.000	165600.0	165600.0	220.7969
751.000	165820.8	165820.8	220.7969
752.000	166041.6	166041.6	220.7969
753.000	166262.4	166262.4	220.7969
754.000	166483.2	166483.2	220.8125
755.000	166704.0	166704.0	220.7969
756.000	166924.8	166924.8	220.7969
757.000	167145.6	167145.6	220.8125
758.000	167366.4	167366.4	220.7813
759.000	167587.2	167587.2	220.7969

760.000	167808.0	167808.0	220.8125
761.000	168028.8	168028.8	220.7969
762.000	168249.6	168249.6	220.8125
763.000	168470.4	168470.4	220.7969
764.000	168691.2	168691.2	220.7969
765.000	168912.0	168912.0	220.7969
766.000	169132.8	169132.8	220.7969
767.000	169353.6	169353.6	220.7969
768.000	169574.4	169574.4	220.8125
769.000	169795.2	169795.2	220.7969
770.000	170016.0	170016.0	220.7969
771.000	170236.8	170236.8	220.7969
772.000	170457.6	170457.6	220.7969
773.000	170678.4	170678.4	220.7969
774.000	170899.2	170899.2	220.8125
775.000	171120.0	171120.0	220.7969
776.000	171340.8	171340.8	220.7969
777.000	171561.6	171561.6	220.8125
778.000	171782.4	171782.4	220.7813
779.000	172003.2	172003.2	220.8125
780.000	172224.0	172224.0	220.7969
781.000	172444.8	172444.8	220.7969
782.000	172665.6	172665.6	220.8125
783.000	172886.4	172886.4	220.7969
784.000	173107.2	173107.2	220.7969
785.000	173328.0	173328.0	220.7969
786.000	173548.8	173548.8	220.7969
787.000	173769.6	173769.6	220.7969
788.000	173990.4	173990.4	220.8125
789.000	174211.2	174211.2	220.7969
790.000	174432.0	174432.0	220.7969
791.000	174652.8	174652.8	220.7969
792.000	174873.6	174873.6	220.7969
793.000	175094.4	175094.4	220.7969
794.000	175315.2	175315.2	220.8125
795.000	175536.0	175536.0	220.7969
796.000	175756.8	175756.8	220.7969
797.000	175977.6	175977.6	220.8125
798.000	176198.4	176198.4	220.7813
799.000	176419.2	176419.2	220.8125
800.000	176640.0	176640.0	220.7969
801.000	176860.8	176860.8	220.7969
802.000	177081.6	177081.6	220.8125
803.000	177302.4	177302.4	220.7969
804.000	177523.2	177523.2	220.7969
805.000	177744.0	177744.0	220.7969
806.000	177964.8	177964.8	220.7969
807.000	178185.6	178185.6	220.7969
808.000	178406.4	178406.4	220.8125
809.000	178627.2	178627.2	220.7969
810.000	178848.0	178848.0	220.7969
811.000	179068.8	179068.8	220.7969
812.000	179289.6	179289.6	220.7969
813.000	179510.4	179510.4	220.7969
814.000	179731.2	179731.2	220.8125
815.000	179952.0	179952.0	220.7969
816.000	180172.8	180172.8	220.8125
817.000	180393.6	180393.6	220.7969
818.000	180614.4	180614.4	220.7813

819.000	180835.2	180835.2	220.8125
820.000	181056.0	181056.0	220.7969
821.000	181276.8	181276.8	220.7969
822.000	181497.6	181497.6	220.8125
823.000	181718.4	181718.4	220.7969
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827.000	182601.6	182601.6	220.7969
828.000	182822.4	182822.4	220.8125
829.000	183043.2	183043.2	220.7969
830.000	183264.0	183264.0	220.7969
831.000	183484.8	183484.8	220.7969
832.000	183705.6	183705.6	220.7969
833.000	183926.4	183926.4	220.7969
834.000	184147.2	184147.2	220.8125
835.000	184368.0	184368.0	220.7969
836.000	184588.8	184588.8	220.8125
837.000	184809.6	184809.6	220.7813
838.000	185030.4	185030.4	220.7969
839.000	185251.2	185251.2	220.8125
840.000	185472.0	185472.0	220.7969
841.000	185692.8	185692.8	220.7969
842.000	185913.6	185913.6	220.8125
843.000	186134.4	186134.4	220.7969
844.000	186355.2	186355.2	220.7969
845.000	186576.0	186576.0	220.7969
846.000	186796.8	186796.8	220.7969
847.000	187017.6	187017.6	220.7969
848.000	187238.4	187238.4	220.8125
849.000	187459.2	187459.2	220.7969
850.000	187680.0	187680.0	220.7969
851.000	187900.8	187900.8	220.7969
852.000	188121.6	188121.6	220.7969
853.000	188342.4	188342.4	220.7969
854.000	188563.2	188563.2	220.8125
855.000	188784.0	188784.0	220.7969
856.000	189004.8	189004.8	220.8125
857.000	189225.6	189225.6	220.7813
858.000	189446.4	189446.4	220.7969
859.000	189667.2	189667.2	220.8125
860.000	189888.0	189888.0	220.7969
861.000	190108.8	190108.8	220.7969
862.000	190329.6	190329.6	220.8125
863.000	190550.4	190550.4	220.7969
864.000	190771.2	190771.2	220.7969
865.000	190992.0	190992.0	220.7969
866.000	191212.8	191212.8	220.7969
867.000	191433.6	191433.6	220.7969
868.000	191654.4	191654.4	220.8125
869.000	191875.2	191875.2	220.7969
870.000	192096.0	192096.0	220.7969
871.000	192316.8	192316.8	220.7969
872.000	192537.6	192537.6	220.7969
873.000	192758.4	192758.4	220.8125
874.000	192979.2	192979.2	220.7969
875.000	193200.0	193200.0	220.7969
876.000	193420.8	193420.8	220.8125
877.000	193641.6	193641.6	220.7813

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   878.000          193862.4          193862.4          220.7969
   879.000          194083.2          194083.2          220.8125
   880.000          194304.0          194304.0          220.7969
   881.000          194524.8          194524.8          220.7969
   882.000          194745.6          194745.6          220.8125
   883.000          194966.4          194966.4          220.7969
   884.000          195187.2          195187.2          220.7969
   885.000          195408.0          195408.0          220.7969
   886.000          195628.8          195628.8          220.7969
   887.000          195849.6          195849.6          220.7969
   888.000          196070.4          196070.4          220.8125
   889.000          196291.2          196291.2          220.7969
   890.000          196512.0          196512.0          220.7969
   891.000          196732.8          196732.8          220.7969
   892.000          196953.6          196953.6          220.7969
   893.000          197174.4          197174.4          220.8125
   894.000          197395.2          197395.2          220.7969
   895.000          197616.0          197616.0          220.7969
   896.000          197836.8          197836.8          220.8125
   897.000          198057.6          198057.6          220.7813
   898.000          198278.4          198278.4          220.7969
   899.000          198499.2          198499.2          220.8125
   900.000          198720.0          198720.0          220.7969
                                                      SUBCLOUD TRAJECTORY
                                                       PEAK     MEAN                          CENTROID OR CM      EFFECTIVE
DOWNWIND             CENTROID     GAUSSIAN CLOUD       CLOUD    CLOUD     AIR       AIR       VELOCITY     CM     BUOYANCY
DISTANCE   TIME      HEIGHT    STD. DEVIATIONS (M)     TEMP.    TEMP.     TEMP.   DENSITY   VERT.  HOR.  HEIGHT   RADIUS
  (M)      (SEC)      (M)     SIGMAX  SIGMAY  SIGMAZ  (DEG K)  (DEG K)  (DEG K) (G/M**3)  (M/S)  (M/S)   (M)      (M)
--------  -------   -------   ------  ------  ------  -------  -------  ------- --------  -----  -----  -----   -------
    1.00     .58       .00     1.26    1.41     .69   301.82   301.82   301.82  1107.32    .19   1.71     .6     .000
    2.84    1.62       .00     1.26    1.70     .93   301.77   301.77   301.71  1107.71    .18   1.78     .7     .000
    5.24    2.86       .00     1.26    2.07    1.22   301.67   301.67   301.56  1108.24    .18   1.94    1.0     .000
    8.09    4.19       .00     1.26    2.49    1.53   301.55   301.55   301.43  1108.70    .19   2.13    1.2     .000
   11.33    5.58       .00     1.26    2.97    1.88   301.43   301.43   301.32  1109.09    .20   2.35    1.5     .000
   14.92    6.97       .00     1.26    3.49    2.24   301.33   301.33   301.22  1109.40    .21   2.56    1.8     .000
   18.82    8.38       .00     1.26    4.04    2.62   301.23   301.23   301.14  1109.67    .22   2.77    2.1     .000
   23.02    9.80       .00     1.26    4.62    3.02   301.15   301.15   301.07  1109.89    .22   2.97    2.4     .000
   27.50   11.21       .00     1.26    5.24    3.42   301.08   301.08   301.01  1110.08    .23   3.15    2.7     .000
   32.24   12.64       .00     1.26    5.88    3.84   301.02   301.02   300.95  1110.24    .23   3.32    3.1     .000
   37.22   14.07       .00     1.26    6.54    4.27   300.96   300.96   300.90  1110.38    .24   3.48    3.4     .000
   42.44   15.52       .00     1.26    7.23    4.70   300.91   300.91   300.86  1110.50    .24   3.62    3.8     .000
   47.89   16.97       .00     1.26    7.95    5.15   300.86   300.86   300.82  1110.61    .24   3.75    4.1     .000
   53.78   18.49       .00     1.26    8.71    5.62   300.82   300.82   300.78  1110.70    .25   3.87    4.5     .000
   60.39   20.16       .00     1.26    9.56    6.14   300.78   300.78   300.74  1110.79    .25   3.97    4.9     .000
   67.82   21.98       .00     1.26   10.50    6.71   300.75   300.75   300.71  1110.87    .25   4.08    5.4     .000
   76.17   23.98       .00     1.26   11.55    7.33   300.71   300.71   300.67  1110.94    .25   4.18    5.8     .000
   85.54   26.17       .00     1.26   12.71    8.02   300.67   300.67   300.64  1111.01    .25   4.27    6.4     .000
   96.06   28.58       .00     1.26   14.00    8.77   300.64   300.64   300.60  1111.07    .25   4.36    7.0     .000
  107.88   31.24       .00     1.26   15.44    9.60   300.60   300.60   300.57  1111.13    .25   4.46    7.7     .000
  121.15   34.16       .00     1.26   17.03   10.51   300.57   300.57   300.53  1111.18    .25   4.54    8.4     .000
  136.06   37.37       .00     1.26   18.81   11.51   300.53   300.53   300.49  1111.22    .25   4.63    9.2     .000
  152.80   40.92       .00     1.26   20.77   12.60   300.49   300.49   300.46  1111.25    .25   4.72   10.1     .000
  171.60   44.83       .00     1.26   22.96   13.81   300.46   300.46   300.42  1111.27    .25   4.81   11.0     .000
  192.71   49.15       .00     1.26   25.39   15.13   300.42   300.42   300.39  1111.28    .24   4.89   12.1     .000
  216.42   53.92       .00     1.26   28.08   16.58   300.39   300.39   300.35  1111.28    .24   4.97   13.2     .000
  243.04   59.18       .00     1.26   31.08   18.18   300.35   300.35   300.31  1111.27    .24   5.06   14.5     .000
  272.94   65.00       .00     1.26   34.40   19.93   300.31   300.31   300.28  1111.25    .24   5.14   15.9     .000
  306.52   71.44       .00     1.26   38.09   21.85   300.28   300.28   300.24  1111.21    .24   5.22   17.4     .000
  344.23   78.56       .00     1.26   42.19   23.96   300.24   300.24   300.20  1111.16    .24   5.30   19.1     .000
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   386.58    86.44     .00   1.26   46.74   26.27   300.20   300.20   300.16  1111.09   .23  5.38   21.0   .000
   434.14    95.16     .00   1.26   51.80   28.81   300.16   300.16   300.12  1111.00   .23  5.45   23.0   .000
   487.55   104.82     .00   1.26   57.41   31.60   300.12   300.12   300.08  1110.89   .23  5.53   25.2   .000
   547.53   115.53     .00   1.26   63.64   34.66   300.08   300.08   300.04  1110.77   .23  5.60   27.7   .000
   614.89   127.40     .00   1.26   70.55   38.02   300.04   300.04   300.00  1110.62   .23  5.68   30.3   .000
   690.54   140.56     .00   1.26   78.23   41.71   300.00   300.00   299.95  1110.45   .22  5.75   33.3   .000
   775.49   155.16     .00   1.26   86.76   45.76   299.95   299.95   299.91  1110.25   .22  5.82   36.5   .000
   870.90   171.36     .00   1.26   96.22   50.21   299.90   299.90   299.86  1110.02   .22  5.89   40.1   .000
   978.04   189.35     .00   1.26  106.73   55.08   299.86   299.86   299.81  1109.76   .22  5.96   44.0   .000
  1098.37   209.33     .00   1.26  118.39   60.44   299.80   299.80   299.75  1109.47   .21  6.02   48.2   .000
  1233.50   231.52     .00   1.26  131.34   66.32   299.75   299.75   299.69  1109.14   .21  6.09   52.9   .000
  1385.25   256.18     .00   1.26  145.71   72.77   299.69   299.69   299.63  1108.77   .21  6.15   58.1   .000
  1555.67   283.60     .00   1.26  161.67   79.85   299.63   299.63   299.57  1108.36   .21  6.22   63.7   .000
  1747.06   314.08     .00   1.26  179.38   87.62   299.57   299.57   299.50  1107.90   .20  6.28   69.9   .000
  1962.00   347.99     .00   1.26  199.05   96.15   299.50   299.50   299.43  1107.39   .20  6.34   76.7   .000
  2203.37   385.71     .00   1.26  220.88  105.51   299.42   299.42   299.35  1106.82   .20  6.40   84.2   .000
  2474.45   427.69     .00   1.26  245.12  115.78   299.34   299.34   299.26  1106.20   .20  6.46   92.4   .000
  2778.87   474.43     .00   1.26  272.02  127.06   299.26   299.26   299.17  1105.50   .19  6.51  101.4   .000
  3120.74   526.46     .00   1.26  301.89  139.44   299.16   299.16   299.07  1104.73   .19  6.57  111.3   .000
  3504.68   584.42     .00   1.26  335.04  153.02   299.06   299.06   298.96  1103.88   .19  6.62  122.1   .000
  3935.85   648.99     .00   1.26  371.85  167.93   298.96   298.96   298.85  1102.94   .18  6.68  134.0   .000
  4420.06   720.93     .00   1.26  412.70  184.30   298.84   298.84   298.72  1101.91   .18  6.73  147.0   .000
  4963.84   801.12     .00   1.26  458.06  202.26   298.71   298.71   298.59  1100.77   .18  6.78  161.4   .000
  5574.53   890.51     .00   1.26  508.41  221.97   298.57   298.57   298.44  1099.51   .18  6.83  177.1   .000
  6260.34   990.19     .00   1.26  564.30  243.60   298.42   298.42   298.27  1098.13   .17  6.88  194.4   .000
  7030.53  1101.35     .00   1.26  626.34  267.35   298.26   298.26   298.10  1096.61   .17  6.93  213.3   .000
  7895.47  1225.35     .00   1.26  695.21  293.41   298.08   298.08   297.90  1094.94   .17  6.98  234.1   .000
  8866.82  1363.69     .00   1.26  771.67  322.01   297.89   297.89   297.69  1093.11   .16  7.02  256.9   .000
  9957.67  1518.07     .00   1.26  856.54  353.40   297.67   297.67   297.46  1091.09   .16  7.07  282.0   .000
 11182.73  1690.37     .00   1.26  950.75  387.86   297.44   297.44   297.21  1088.88   .16  7.11  309.5   .000
            TOTAL TRANMITANCE FOR ALL SOURCES IS:  .0000E+00
WAVL      1.06
 NOTE: THAT THE ABOVE CARD WAS MODIFIED FOR CONSISTENCY TO:
WAVL       .1060E+01 .1060E+01 .0000E+00
                                BEGINNING          ENDING
          WAVENUMBER (CM**-1)        9433.963           9433.963
          WAVELENGTH (MICROMETERS)      1.060              1.060
          FREQUENCY (GHZ)          283018.875         283018.875
        **** EOSAEL WARNING ****
 VISIBILITY AND EXTINCTION = 0.0, VISIBILITY CHANGED TO 10.0 KM
                              VISIBILITY
                               10.00 KM
                             RUN NUMBER  2
1

                            *****************
                            *               *
                            *    COMBIC     *
                            *    PHASE 2    *
                            *               *
                            *****************
 COMBIC CLOUD HISTORY ON UNIT  9  OPENED TO: h.vehc-hc
1
                        METEOROLOGICAL CONDITIONS FROM HISTORY FILE
  WINDSPEED (10 M)  =   5.0  M/S          WIND DIRECTION    =  202.4  DEG WRT N
  RELATIVE HUMIDITY =  90.0  PERCENT      PASQUILL CATEGORY =    C    ( 2.60 )
  AIR TEMPERATURE   = 300.6  DEG K        AIR PRESSURE      =   963.  MB
  SURFACE ROUGHNESS =  .1000 M            AIR DENSITY       =  1110.  G/M**3
             MASS EXTINCTION COEFFICIENTS FROM HISTORY FILE (M**2/GRAM)
```

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OBSCURANT                         WAVELENGTH (MICROMETERS)
    CODE     .4-.7    .7-1.2      1.06     3.-5.    8.-12.      10.6    94 GHZ
---------   ------    ------    ------    ------    ------    ------    ------
       1    3.2280    2.3638    2.1094     .4127     .3043     .2792     .0010
       2    3.2280    2.3638    2.1094     .4127     .3043     .2792     .0010
       3    2.1520    2.1368    2.0302     .2668     .0601     .0750     .0010
       4    6.8510    4.5920    3.4970     .2450     .0200     .0180     .0010
       5    3.2280    2.3638    2.1094     .4127     .3043     .2792     .0010
       6    1.8600    1.6300    1.4000    1.7900    1.6800    1.6800     .0010
       7    1.8600    1.6300    1.4000    1.7900    1.6800    1.6800     .0010
       8    5.6500    4.0800    3.2500     .2450     .0230     .0270     .0010
       9     .3200     .3000     .2900     .2700     .2500     .2500     .0010
      10     .3200     .2900     .2600     .2700     .2600     .2400     .0010
      11     .0350     .0360     .0370     .0350     .0380     .0360     .0010
      12    1.5000    1.4600    1.4200     .7500     .3200     .3000     .0010
      13     .0010     .0010     .0010     .0010     .0010     .0010     .0004
      14    6.1000    3.7500    2.9400    1.3500    1.0100    1.0000     .0020
      15    6.8510    4.5920    1.4300     .0540     .0200     .0180     .0010
      16    5.3700    2.9000    2.1000     .0900     .0900     .0700     .0010
      17    6.2000    3.5000    2.5000     .2300     .0500     .0480     .0010
      18    3.3300    2.7500    2.6600     .2600     .3200     .2300     .0010
      19    1.3000    1.7400    1.7000     .0800     .1600     .3800     .0010
      20    2.0000    2.0000    2.0000    1.6000    2.0000     .0000     .0000
      21    2.0000    2.0000    1.0000     .1000     .4000     .0000     .0000
      22     .0000     .0000     .0000     .0000     .0000     .0000     .0000
      23     .0000     .0000     .0000     .0000     .0000     .0000     .0000
      24     .0000     .0000     .0000     .0000     .0000     .0000     .0000
      25     .0000     .0000     .0000     .0000     .0000     .0000     .0000
      26     .0000     .0000     .0000     .0000     .0000     .0000     .0000
      27     .0000     .0000     .0000     .0000     .0000     .0000     .0000
      28     .0000     .0000     .0000     .0000     .0000     .0000     .0000
      29     .0000     .0000     .0000     .0000     .0000     .0000     .0000
      30     .0000     .0000     .0000     .0000     .0000     .0000     .0000
1
                  HISTORY FILE CONTAINS INFORMATION ON   2 SOURCES
         NUMBER     XN                                                 NUMBER
SOURCE     OF      SCALE     FILL     MENU   OBSC  EFFICIENCY  YIELD   OF SUB-
  ID   SUBCLOUDS  FACTOR    WEIGHT   NUMBER  TYPE    PERCENT   FACTOR  MUNITIONS
------ ---------  ------  --------   ------  ----  ----------  ------  ---------
   1       1       1.00      5.40      1.     3.      70.00     5.72     1.00
   2       1       1.00    438.10      0.     9.     100.00     1.00     1.00
          BURN        VEHICLE                          BARRAGE            HIGH-EXP
SOURCE  DURATION   SPEED DIRECTION  ROUNDS  DURATION  IMPACT REGION     SOIL  DOB
  ID      (SEC)    (M/S)    DEG     PER SEC   (SEC)   X (M)   Y (M)     TYPE  (M)
------  --------   ----- ---------  ------- --------  ------  ------    ---- -----
   1       100.      .0      0.        .0       0.      0.      0.       .0   .00
   2       900.     4.0     90.        .0       0.      0.      0.       .0   .00
             WIND DIRECTION ALTERED TO  155.0 DEG WRT N
3.13.1
                                                            SOURCES ADDED
   SOURCE        XN      ACTIVE TIME LIMIT    POSITION (ORIGINAL SYSTEM)      POSITION (ROTATED SYSTEM)        MOVING SOURCE
  UNIT  ID     SCALING     BEGIN      END       X          Y           Z        X          Y           Z     SPEED   DIRECTION
    1   1       4.000      20.00    300.00     90.0       80.0         .0     116.7      -29.9          .0     .00     -359.8
2.72.7
    2   2       1.000      20.00    300.00     50.0      218.0         .0     172.4     -142.4          .0    7.60       82.0
                                                        NEW OR ALTERED LINES OF SIGHT
                                 ORIGINAL SYSTEM                                          ROTATED SYSTEM
  OBS  TGT         OBSERVER (M)                      TARGET (M)             OBSERVER (M)                     TARGET (M)      TIME (SEC)
  NO.  NO.      X         Y         Z         X         Y         Z         X         Y         Z         X         Y         Z    START   END
```

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    1    1      50.0    130.0     3.0     250.0    150.0     15.0     135.7     31.2      3.0     264.2   -123.4    15.0   20.0  100.0
    1    2      50.0    130.0     3.0     220.0    100.0      3.0     135.7     31.2      3.0     205.9   -126.5     3.0   20.0  100.0
1                    TOTAL  NUMBER
  TIME  OBS TARG    CL       OF                   TRANSMISSION
 (SEC)  NO.  NO. (G/M**2)  CLOUDS .4-.7 .7-1.2 1.06 3.-5. 8.-12. 10.6 94 GHZ
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  1 1 L      10.00   47.38   32.77    9.46
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  2 1 L      10.00   11.97   36.59   10.38
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  3 1 L      10.00   29.68   34.68    9.92
I,ROMFX1, ROMFX2, ROMFX3 =   1   .000   .004   .002
CLCON,CLCONN=   .002   .000
   30.0   1   2     .002     1     .996  .996  .996 1.000 1.000 1.000 1.000
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  1 3 M      15.00   54.17   41.87   11.60
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  2 1 L      15.00   12.72   58.66   15.36
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  3 1 M      15.00   52.96   49.74   13.38
I,ROMFX1, ROMFX2, ROMFX3 =   1   .000   .093   .045
CLCON,CLCONN=   .045   .000
   35.0   1   1     .045     1     .907  .908  .912  .988  .997  .997 1.000
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  1 5 M      15.00   55.72   33.73    9.69
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  2 1 L      15.00   12.72   58.66   15.36
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  3 2 M      15.00   53.52   45.27   12.37
I,ROMFX1, ROMFX2, ROMFX3 =   1   .004   .027  1.460
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  4 3 M      15.00   54.17   39.36   11.02
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  5 1 M      15.00   52.96   51.59   13.79
I,K,ROMFXK=   2  4   .351
I,K,ROMFXK=   2  5   .784
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  6 4 M      15.00   54.90   36.49   10.35
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  7 3 M      15.00   54.17   42.25   11.69
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  8 1 M      15.00   52.96   48.32   13.07
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  9 1 L      15.00   43.81   54.99   14.55
I,K,ROMFXK=   3  6   .064
I,K,ROMFXK=   3  7   .980
I,K,ROMFXK=   3  8  1.307
I,K,ROMFXK=   3  9   .269
CLCON,CLCONN=   .657   .000
   35.0   1   2     .657     1     .243  .246  .263  .839  .961  .952  .999
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  1 8 M      20.00   58.63   43.00   11.86
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  2 1 L      20.00   12.76   81.89   20.36
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  3 4 M      20.00   54.90   59.45   15.53
I,ROMFX1, ROMFX2, ROMFX3 =   1   .004   .180   .791
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  4 6 M      20.00   56.61   50.71   13.60
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  5 2 M      20.00   53.52   69.77   17.77
I,K,ROMFXK=   2  4   .127
I,K,ROMFXK=   2  5  1.342
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  6 7 M      20.00   57.58   46.75   12.71
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  7 5 M      20.00   55.72   54.89   14.53
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  8 3 M      20.00   54.17   64.44   16.62
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  9 0 M      20.00     .00   75.52   19.00
I,K,ROMFXK=   3  6   .029
I,K,ROMFXK=   3  7   .372
I,K,ROMFXK=   3  8  1.203
I,K,ROMFXK=   3  9   .000
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 10 7 M      20.00   57.58   44.88   12.29
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 11 6 M      20.00   56.61   48.69   13.15
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 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 12 5 M       20.00   55.72   52.74   14.05
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 13 4 M       20.00   54.90   57.17   15.03
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 14 3 M       20.00   54.17   61.89   16.06
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 15 2 M       20.00   53.52   67.00   17.17
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 16 1 M       20.00   52.96   72.64   18.39
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 17 1 L       20.00   39.10   78.66   19.67
 I,K,ROMFXK=    4 10    .012
 I,K,ROMFXK=    4 11    .062
 I,K,ROMFXK=    4 12    .226
 I,K,ROMFXK=    4 13    .566
 I,K,ROMFXK=    4 14   1.002
 I,K,ROMFXK=    4 15   1.317
 I,K,ROMFXK=    4 16   1.277
 I,K,ROMFXK=    4 17    .711
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  113 M       20.00  266.36   14.26    6.72
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  213 M       20.00  266.36   14.76    6.91
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  313 M       20.00  266.36   14.51    6.81
 I,ROMFX1, ROMFX2, ROMFX3 =   1    .666    .469    .580
 CLCON,CLCONN=    .576    .000
     40.0    1    1     1.183      2       .225   .230   .246   .728   .835   .827   .999
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  110 M       20.00   60.92   34.32    9.83
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  2 2 M       20.00   53.52   67.41   17.26
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  3 6 M       20.00   56.61   48.95   13.21
 I,ROMFX1, ROMFX2, ROMFX3 =   1    .011    .000   1.583
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  4 8 M       20.00   58.63   41.39   11.49
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  5 4 M       20.00   54.90   57.50   15.10
 I,K,ROMFXK=    2  4   1.001
 I,K,ROMFXK=    2  5    .159
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  6 9 M       20.00   59.74   37.79   10.66
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  7 7 M       20.00   57.58   45.11   12.34
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  8 5 M       20.00   55.72   53.02   14.11
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  9 3 M       20.00   54.17   62.28   16.15
 I,K,ROMFXK=    3  6    .192
 I,K,ROMFXK=    3  7   1.872
 I,K,ROMFXK=    3  8    .710
 I,K,ROMFXK=    3  9    .020
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 10 9 M       20.00   59.74   36.04   10.25
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 11 8 M       20.00   58.63   39.59   11.08
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 12 8 M       20.00   58.63   43.23   11.91
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 13 7 M       20.00   57.58   46.99   12.77
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 14 6 M       20.00   56.61   50.99   13.66
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 15 5 M       20.00   55.72   55.22   14.60
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 16 4 M       20.00   54.90   59.79   15.60
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 17 3 M       20.00   54.17   64.84   16.71
 I,K,ROMFXK=    4 10    .057
 I,K,ROMFXK=    4 11    .505
 I,K,ROMFXK=    4 12   1.514
 I,K,ROMFXK=    4 13   1.905
 I,K,ROMFXK=    4 14   1.149
 I,K,ROMFXK=    4 15    .362
 I,K,ROMFXK=    4 16    .062
 I,K,ROMFXK=    4 17    .006
 CLCON,CLCONN=    .694    .000
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I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  117 M      20.00  266.36    3.82    2.12
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  216 M      20.00  266.36    6.71    3.54
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  317 M      20.00  266.36    5.15    2.81
I,ROMFX1, ROMFX2, ROMFX3 =   1   .791  2.698  3.525
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  417 M      20.00  266.36    4.49    2.47
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  516 M      20.00  266.36    5.92    3.18
I,K,ROMFXK=   2  4  2.156
I,K,ROMFXK=   2  5  3.538
CLCON,CLCONN=  2.766   .000
    40.0   1   2    3.460     2     .093  .099  .110  .394  .480  .475  .997
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  112 M      25.00   63.47   43.76   12.03
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  2 1 L      25.00   13.29  105.73   25.34
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  3 7 M      25.00   57.58   68.08   17.41
I,ROMFX1, ROMFX2, ROMFX3 =   1   .010   .015  1.953
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  410 M      25.00   60.92   54.68   14.48
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  5 4 M      25.00   54.90   84.83   20.98
I,K,ROMFXK=   2  4   .525
I,K,ROMFXK=   2  5   .831
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  611 M      25.00   62.17   49.00   13.22
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  7 9 M      25.00   59.74   61.01   15.87
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  8 5 M      25.00   55.72   75.98   19.10
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  9 1 M      25.00   52.96   94.71   23.05
I,K,ROMFXK=   3  6   .104
I,K,ROMFXK=   3  7  1.380
I,K,ROMFXK=   3  8  1.624
I,K,ROMFXK=   3  9   .271
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 1012 M      25.00   63.47   46.34   12.62
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 1111 M      25.00   62.17   51.79   13.84
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 12 9 M      25.00   59.74   57.81   15.17
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 13 8 M      25.00   58.63   64.53   16.64
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 14 6 M      25.00   56.61   72.03   18.25
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 15 4 M      25.00   54.90   80.39   20.04
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 16 2 M      25.00   53.52   89.72   22.01
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 17 0 M      25.00     .00  100.14   24.18
I,K,ROMFXK=   4 10   .036
I,K,ROMFXK=   4 11   .260
I,K,ROMFXK=   4 12   .928
I,K,ROMFXK=   4 13  1.784
I,K,ROMFXK=   4 14  1.896
I,K,ROMFXK=   4 15  1.204
I,K,ROMFXK=   4 16   .487
I,K,ROMFXK=   4 17   .000
CLCON,CLCONN=   .828   .000
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  114 M      25.00  282.78   24.52   10.27
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  213 M      25.00  282.78   27.65   11.26
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  314 M      25.00  282.78   26.08   10.76
I,ROMFX1, ROMFX2, ROMFX3 =   1  1.958  2.758  5.686
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  414 M      25.00  282.78   25.30   10.52
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  513 M      25.00  282.78   26.86   11.01
I,K,ROMFXK=   2  4  4.262
I,K,ROMFXK=   2  5  4.931
CLCON,CLCONN=  4.394   .000
    45.0   1   1    5.222     2     .041  .046  .052  .245  .317  .313  .995
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I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  115 M      25.00   67.71   34.70    9.92
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  2 7 M      25.00   57.58   66.21   17.00
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  311 M      25.00   62.17   48.70   13.15
I,ROMFX1, ROMFX2, ROMFX3 =   1   .016   .000  1.636
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  413 M      25.00   64.83   41.48   11.51
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  510 M      25.00   60.92   56.83   14.95
I,K,ROMFXK=   2  4  1.030
I,K,ROMFXK=   2  5   .208
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  614 M      25.00   66.25   38.03   10.72
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  712 M      25.00   63.47   45.04   12.32
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  810 M      25.00   60.92   52.60   14.02
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  9 9 M      25.00   59.74   61.30   15.94
I,K,ROMFXK=   3  6   .223
I,K,ROMFXK=   3  7  1.871
I,K,ROMFXK=   3  8   .798
I,K,ROMFXK=   3  9   .032
CLCON,CLCONN=   .731   .000
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  118 M      25.00  282.78   13.17    6.29
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  216 M      25.00  282.78   18.30    8.19
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  317 M      25.00  282.78   15.66    7.24
I,ROMFX1, ROMFX2, ROMFX3 =   1  6.489  6.014 13.749
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  418 M      25.00  282.78   14.38    6.77
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  517 M      25.00  282.78   16.98    7.72
I,K,ROMFXK=   2  4 12.616
I,K,ROMFXK=   2  5 10.663
CLCON,CLCONN= 11.083   .000
    45.0   1   2   11.814     2     .006  .008  .009  .041  .060  .059  .988
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  117 M      30.00   70.78   44.31   12.16
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  2 1 L      30.00   12.79  130.28   30.36
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  310 M      30.00   60.92   75.98   19.10
I,ROMFX1, ROMFX2, ROMFX3 =   1   .017   .000  2.161
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  414 M      30.00   66.25   58.14   15.24
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  5 5 M      30.00   55.72   99.55   24.06
I,K,ROMFXK=   2  4  1.301
I,K,ROMFXK=   2  5   .188
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  616 M      30.00   69.22   50.84   13.63
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  712 M      30.00   63.47   66.48   17.06
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  8 8 M      30.00   58.63   86.97   21.43
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  9 2 M      30.00   53.52  113.90   27.02
I,K,ROMFXK=   3  6   .258
I,K,ROMFXK=   3  7  2.545
I,K,ROMFXK=   3  8   .870
I,K,ROMFXK=   3  9   .025
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 1017 M      30.00   70.78   47.46   12.87
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 1115 M      30.00   67.71   54.31   14.40
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 1213 M      30.00   64.83   62.17   16.12
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 1311 M      30.00   62.17   71.14   18.07
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 14 9 M      30.00   59.74   81.38   20.25
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 15 7 M      30.00   57.58   93.07   22.71
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 16 4 M      30.00   54.90  106.39   25.48
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT = 17 1 M      30.00   52.96  121.64   28.61
I,K,ROMFXK=   4 10   .077
I,K,ROMFXK=   4 11   .643
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I,K,ROMFXK=   4 12  2.019
I,K,ROMFXK=   4 13  2.565
I,K,ROMFXK=   4 14  1.482
I,K,ROMFXK=   4 15   .439
I,K,ROMFXK=   4 16   .074
I,K,ROMFXK=   4 17   .008
CLCON,CLCONN=    .915    .000
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  115 M      30.00  295.78   37.17   14.06
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  214 M      30.00  295.78   41.35   15.22
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  315 M      30.00  295.78   39.26   14.64
I,ROMFX1, ROMFX2, ROMFX3 =   1  2.054  2.629  6.073
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  415 M      30.00  295.78   38.21   14.35
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  515 M      30.00  295.78   40.31   14.93
I,K,ROMFXK=   2  4  4.558
I,K,ROMFXK=   2  5  4.962
CLCON,CLCONN=  4.558    .000
    50.0    1    1     5.473      2      .032   .036   .042   .229   .303   .299   .995
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  120 M      30.00   75.68   34.97    9.99
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  213 M      30.00   64.83   65.38   16.82
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  316 M      30.00   69.22   48.54   13.11
I,ROMFX1, ROMFX2, ROMFX3 =   1   .021   .000  1.699
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  418 M      30.00   72.38   41.55   11.53
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  515 M      30.00   67.71   56.36   14.85
I,K,ROMFXK=   2  4  1.064
I,K,ROMFXK=   2  5   .253
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  619 M      30.00   74.01   38.21   10.76
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  717 M      30.00   70.78   45.00   12.31
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  816 M      30.00   69.22   52.31   13.95
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  914 M      30.00   66.25   60.62   15.79
I,K,ROMFXK=   3  6   .249
I,K,ROMFXK=   3  7  1.898
I,K,ROMFXK=   3  8   .889
I,K,ROMFXK=   3  9   .044
CLCON,CLCONN=    .769    .000
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  120 M      30.00  295.78   23.15    9.84
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  217 M      30.00  295.78   30.65   12.16
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  319 M      30.00  295.78   26.81   11.00
I,ROMFX1, ROMFX2, ROMFX3 =   1  6.175  4.894 14.126
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  419 M      30.00  295.78   24.98   10.42
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  518 M      30.00  295.78   28.71   11.58
I,K,ROMFXK=   2  4 12.490
I,K,ROMFXK=   2  5  9.691
CLCON,CLCONN= 10.631    .000
    50.0    1    2    11.400      2      .006   .008   .010   .046   .067   .066   .989
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  122 M      35.00   79.10   44.72   12.25
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  2 3 M      35.00   54.17  137.50   31.82
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  315 M      35.00   67.71   78.54   19.65
I,ROMFX1, ROMFX2, ROMFX3 =   1   .024   .000  2.127
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  419 M      35.00   74.01   59.31   15.50
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  510 M      35.00   60.92  103.98   24.98
I,K,ROMFXK=   2  4  1.749
I,K,ROMFXK=   2  5   .119
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  621 M      35.00   77.38   51.58   13.79
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I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  717 M      35.00   70.78   68.19   17.43
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  812 M      35.00   63.47   90.39   22.15
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  9 6 M      35.00   56.61  119.53   28.18
I,K,ROMFXK=   3  6   .368
I,K,ROMFXK=   3  7  2.997
I,K,ROMFXK=   3  8   .683
I,K,ROMFXK=   3  9   .012
CLCON,CLCONN=  1.014   .000
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  117 M      35.00  306.40   50.46   17.63
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  216 M      35.00  306.40   55.75   18.99
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  316 M      35.00  306.40   53.00   18.29
I,ROMFX1, ROMFX2, ROMFX3 =   1  1.834  2.149  6.086
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  417 M      35.00  306.40   51.73   17.96
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  516 M      35.00  306.40   54.32   18.63
I,K,ROMFXK=   2  4  4.454
I,K,ROMFXK=   2  5  4.741
CLCON,CLCONN=  4.391   .000
   55.0   1   1   5.404     2     .028  .031  .036  .233  .314  .309  .995
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  124 M      35.00   82.63   35.18   10.04
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  218 M      35.00   72.38   64.76   16.69
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  321 M      35.00   77.38   48.41   13.09
I,ROMFX1, ROMFX2, ROMFX3 =   1   .026   .006  1.763
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  423 M      35.00   80.85   41.60   11.54
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  520 M      35.00   75.68   56.02   14.78
I,K,ROMFXK=   2  4  1.096
I,K,ROMFXK=   2  5   .296
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  624 M      35.00   82.63   38.34   10.79
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  722 M      35.00   79.10   44.97   12.31
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  821 M      35.00   77.38   52.09   13.91
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  919 M      35.00   74.01   60.15   15.69
I,K,ROMFXK=   3  6   .271
I,K,ROMFXK=   3  7  1.932
I,K,ROMFXK=   3  8   .964
I,K,ROMFXK=   3  9   .058
CLCON,CLCONN=   .805   .000
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  122 M      35.00  306.40   33.42   12.98
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  219 M      35.00  306.40   43.74   15.86
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  320 M      35.00  306.40   38.46   14.42
I,ROMFX1, ROMFX2, ROMFX3 =   1  4.946  3.634 12.522
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  421 M      35.00  306.40   35.92   13.70
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  519 M      35.00  306.40   41.08   15.14
I,K,ROMFXK=   2  4 11.282
I,K,ROMFXK=   2  5  8.468
CLCON,CLCONN=  9.359   .000
   55.0   1   2  10.165     2     .009  .011  .013  .064  .092  .091  .990
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  127 M      40.00   88.04   45.06   12.33
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  2 8 M      40.00   58.63  134.84   31.28
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  320 M      40.00   75.68   78.04   19.54
I,ROMFX1, ROMFX2, ROMFX3 =   1   .030   .000  2.371
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  424 M      40.00   82.63   59.34   15.51
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  515 M      40.00   67.71  102.67   24.71
I,K,ROMFXK=   2  4  1.869
I,K,ROMFXK=   2  5   .154
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I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  626 M      40.00   86.22   51.78   13.84
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  722 M      40.00   79.10   67.99   17.39
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  818 M      40.00   72.38   89.53   21.97
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  912 M      40.00   63.47  117.68   27.80
I,K,ROMFXK=   3  6   .410
I,K,ROMFXK=   3  7  3.208
I,K,ROMFXK=   3  8   .832
I,K,ROMFXK=   3  9   .017
CLCON,CLCONN=  1.116   .000
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  118 M      40.00  315.30   64.21   21.09
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  217 M      40.00  315.30   70.50   22.62
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  318 M      40.00  315.30   67.21   21.83
I,ROMFX1, ROMFX2, ROMFX3 =   1  1.619  1.798  5.721
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  418 M      40.00  315.30   65.71   21.46
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  517 M      40.00  315.30   68.82   22.22
I,K,ROMFXK=   2  4  4.134
I,K,ROMFXK=   2  5  4.308
CLCON,CLCONN=  4.030   .000
    60.0   1   1    5.146     2      .025  .028  .032  .250  .341  .336  .995
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  129 M      40.00   91.69   35.35   10.08
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  223 M      40.00   80.85   64.27   16.58
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  326 M      40.00   86.22   48.32   13.06
I,ROMFX1, ROMFX2, ROMFX3 =   1   .031   .008  1.819
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  428 M      40.00   89.86   41.65   11.55
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  525 M      40.00   84.42   55.75   14.72
I,K,ROMFXK=   2  4  1.124
I,K,ROMFXK=   2  5   .336
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  629 M      40.00   91.69   38.45   10.81
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  727 M      40.00   88.04   44.95   12.30
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  826 M      40.00   86.22   51.92   13.87
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  924 M      40.00   82.63   59.80   15.61
I,K,ROMFXK=   3  6   .289
I,K,ROMFXK=   3  7  1.963
I,K,ROMFXK=   3  8  1.030
I,K,ROMFXK=   3  9   .070
CLCON,CLCONN=   .837   .000
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  123 M      40.00  315.30   47.23   16.79
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  220 M      40.00  315.30   57.16   19.35
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  321 M      40.00  315.30   51.99   18.03
I,ROMFX1, ROMFX2, ROMFX3 =   1  6.896  2.268  7.288
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  422 M      40.00  315.30   49.58   17.41
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  521 M      40.00  315.30   54.46   18.67
I,K,ROMFXK=   2  4  8.239
I,K,ROMFXK=   2  5  4.664
CLCON,CLCONN=  6.272   .000
    60.0   1   2    7.110     2      .022  .025  .030  .147  .198  .196  .993
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  132 M      45.00   97.18   45.34   12.39
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  214 M      45.00   66.25  132.82   30.87
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  325 M      45.00   84.42   77.65   19.46
I,ROMFX1, ROMFX2, ROMFX3 =   1   .036   .000  2.625
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  429 M      45.00   91.69   59.37   15.51
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  520 M      45.00   75.68  101.62   24.49
I,K,ROMFXK=   2  4  1.991
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 I,K,ROMFXK=    2   5    .193
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  631 M      45.00   95.36   51.95   13.87
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  727 M      45.00   88.04   67.84   17.36
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  823 M      45.00   80.85   88.84   21.82
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  917 M      45.00   70.78  116.19   27.49
 I,K,ROMFXK=    3   6    .451
 I,K,ROMFXK=    3   7   3.429
 I,K,ROMFXK=    3   8    .975
 I,K,ROMFXK=    3   9    .023
 CLCON,CLCONN=   1.220    .000
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  120 M      45.00  322.87   78.76   24.58
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  218 M      45.00  322.87   85.45   26.15
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  319 M      45.00  322.87   82.11   25.37
 I,ROMFX1, ROMFX2, ROMFX3 =    1   1.786   1.564   4.944
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  420 M      45.00  322.87   80.43   24.98
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  519 M      45.00  322.87   83.78   25.76
 I,K,ROMFXK=    2   4   4.009
 I,K,ROMFXK=    2   5   3.550
 CLCON,CLCONN=   3.607    .000
     65.0    1    1     4.827       2      .023   .025   .030   .273   .377   .370   .995
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  134 M      45.00  100.81   35.48   10.11
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  228 M      45.00   89.86   63.87   16.49
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  331 M      45.00   95.36   48.24   13.05
 I,ROMFX1, ROMFX2, ROMFX3 =    1    .035    .011   1.865
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  433 M      45.00   99.00   41.69   11.56
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  530 M      45.00   93.53   55.53   14.67
 I,K,ROMFXK=    2   4   1.144
 I,K,ROMFXK=    2   5    .373
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  634 M      45.00  100.81   38.54   10.84
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  732 M      45.00   97.18   44.93   12.30
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  831 M      45.00   95.36   51.79   13.84
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  929 M      45.00   91.69   59.51   15.54
 I,K,ROMFXK=    3   6    .305
 I,K,ROMFXK=    3   7   1.986
 I,K,ROMFXK=    3   8   1.087
 I,K,ROMFXK=    3   9    .082
 CLCON,CLCONN=    .864    .000
 I, NCHAR, TYP,TVAL,RMMDOT,RCMX,ROMT =  124 M      45.00  322.87   62.69   20.72
 I, NCHAR, TYP,TVAL,RMMDOT,RCMX,ROMT =  222 M      45.00  322.87   70.81   22.69
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  323 M      45.00  322.87   66.58   21.68
 I,ROMFX1, ROMFX2, ROMFX3 =    1   4.818   1.222   3.244
 CLCON,CLCONN=   3.169    .000
     65.0    1    2     4.033       2      .056   .061   .069   .338   .430   .424   .996
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  137 M      50.00  106.14   45.58   12.45
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  219 M      50.00   74.01  131.14   30.53
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  330 M      50.00   93.53   77.32   19.39
 I,ROMFX1, ROMFX2, ROMFX3 =    1    .041    .000   2.876
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  434 M      50.00  100.81   59.40   15.52
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  525 M      50.00   84.42  100.75   24.31
 I,K,ROMFXK=    2   4   2.107
 I,K,ROMFXK=    2   5    .237
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  636 M      50.00  104.38   52.09   13.91
 I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  732 M      50.00   97.18   67.72   17.33
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I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  828 M      50.00   89.86   88.27   21.71
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  922 M      50.00   79.10  114.96   27.24
I,K,ROMFXK=   3  6    .489
I,K,ROMFXK=   3  7  3.698
I,K,ROMFXK=   3  8  1.122
I,K,ROMFXK=   3  9    .031
CLCON,CLCONN=  1.333    .000
    70.0   1   1    2.962      2      .034  .036  .042  .451  .614  .602  .997
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  139 M      50.00  109.58   35.60   10.14
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  233 M      50.00   99.00   63.54   16.42
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  336 M      50.00  104.38   48.18   13.03
I,ROMFX1, ROMFX2, ROMFX3 =   1    .039    .013  1.899
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  438 M      50.00  107.87   41.72   11.57
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  535 M      50.00  102.61   55.34   14.63
I,K,ROMFXK=   2  4  1.157
I,K,ROMFXK=   2  5    .405
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  639 M      50.00  109.58   38.62   10.85
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  737 M      50.00  106.14   44.92   12.30
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  836 M      50.00  104.38   51.67   13.81
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  934 M      50.00  100.81   59.27   15.49
I,K,ROMFXK=   3  6    .317
I,K,ROMFXK=   3  7  1.999
I,K,ROMFXK=   3  8  1.135
I,K,ROMFXK=   3  9    .093
CLCON,CLCONN=    .885    .000
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  125 M      50.00  329.51   78.40   24.50
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  224 M      50.00  329.51   84.60   25.95
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  324 M      50.00  329.51   81.50   25.23
I,ROMFX1, ROMFX2, ROMFX3 =   1  2.205    .683  1.360
CLCON,CLCONN=  1.388    .000
    70.0   1   2    2.273      2      .096  .100  .111  .543  .670  .661  .998
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  142 M      55.00  114.50   45.86   12.51
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  224 M      55.00   82.63  129.21   30.14
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  335 M      55.00  102.61   76.96   19.31
I,ROMFX1, ROMFX2, ROMFX3 =   1    .048    .000  3.114
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  439 M      55.00  109.58   59.44   15.53
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  530 M      55.00   93.53   99.76   24.10
I,K,ROMFXK=   2  4  2.202
I,K,ROMFXK=   2  5    .292
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  641 M      55.00  112.89   52.26   13.94
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  737 M      55.00  106.14   67.60   17.30
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  833 M      55.00   99.00   87.63   21.57
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  928 M      55.00   89.86  113.54   26.95
I,K,ROMFXK=   3  6    .528
I,K,ROMFXK=   3  7  3.877
I,K,ROMFXK=   3  8  1.285
I,K,ROMFXK=   3  9    .042
CLCON,CLCONN=  1.431    .000
    75.0   1   1    2.570      2      .032  .033  .039  .502  .690  .676  .997
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  144 M      55.00  117.58   35.74   10.17
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  238 M      55.00  107.87   63.15   16.34
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  341 M      55.00  112.89   48.10   13.02
I,ROMFX1, ROMFX2, ROMFX3 =   1    .043    .016  1.916
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I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  443 M      55.00  116.06   41.76   11.58
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  540 M      55.00  111.25   55.13   14.58
I,K,ROMFXK=   2  4  1.163
I,K,ROMFXK=   2  5   .439
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  644 M      55.00  117.58   38.71   10.87
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  742 M      55.00  114.50   44.91   12.29
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  841 M      55.00  112.89   51.54   13.78
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  939 M      55.00  109.58   58.99   15.43
I,K,ROMFXK=   3  6   .329
I,K,ROMFXK=   3  7  1.994
I,K,ROMFXK=   3  8  1.175
I,K,ROMFXK=   3  9   .106
CLCON,CLCONN=    .900    .000
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  126 M      55.00  336.80   94.71   28.27
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  225 M      55.00  336.80   99.14   29.27
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  326 M      55.00  336.80   96.84   28.76
I,ROMFX1, ROMFX2, ROMFX3 =   1    .819    .330    .544
CLCON,CLCONN=    .554    .000
    75.0    1    2     1.454      2      .121   .124   .137   .677   .825   .814   .999
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  147 M      60.00  121.86   46.04   12.55
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  230 M      60.00   93.53  128.03   29.90
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  340 M      60.00  111.25   76.74   19.26
I,ROMFX1, ROMFX2, ROMFX3 =   1    .053    .000   3.329
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  444 M      60.00  117.58   59.47   15.54
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  536 M      60.00  104.38   99.15   23.98
I,K,ROMFXK=   2  4  2.291
I,K,ROMFXK=   2  5   .347
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  646 M      60.00  120.49   52.37   13.97
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  742 M      60.00  114.50   67.53   17.29
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  838 M      60.00  107.87   87.23   21.49
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  933 M      60.00   99.00  112.68   26.77
I,K,ROMFXK=   3  6   .558
I,K,ROMFXK=   3  7  4.052
I,K,ROMFXK=   3  8  1.426
I,K,ROMFXK=   3  9   .052
CLCON,CLCONN=  1.521    .000
    80.0    1    1     2.010      2      .032   .033   .040   .584   .808   .790   .998
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  149 M      60.00  124.43   35.82   10.19
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  243 M      60.00  116.06   62.91   16.29
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  346 M      60.00  120.49   48.06   13.01
I,ROMFX1, ROMFX2, ROMFX3 =   1    .046    .018   1.928
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  448 M      60.00  123.18   41.78   11.58
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  545 M      60.00  119.06   55.00   14.55
I,K,ROMFXK=   2  4  1.166
I,K,ROMFXK=   2  5   .463
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  649 M      60.00  124.43   38.77   10.89
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  747 M      60.00  121.86   44.90   12.29
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  846 M      60.00  120.49   51.46   13.77
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  944 M      60.00  117.58   58.82   15.39
I,K,ROMFXK=   3  6   .336
I,K,ROMFXK=   3  7  1.992
I,K,ROMFXK=   3  8  1.204
I,K,ROMFXK=   3  9   .116
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CLCON,CLCONN=   .911   .000
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  128 M      60.00  341.82  110.95   31.91
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  227 M      60.00  341.82  113.39   32.45
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  327 M      60.00  341.82  112.17   32.18
I,ROMFX1, ROMFX2, ROMFX3 =   1   .226   .138   .178
CLCON,CLCONN=   .179   .000
    80.0   1   2    1.090     2      .133  .135  .149  .747  .905  .893  .999
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  152 M      65.00  127.82   46.19   12.58
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  235 M      65.00  102.61  127.00   29.69
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  345 M      65.00  119.06   76.55   19.22
I,ROMFX1, ROMFX2, ROMFX3 =   1   .058   .007  3.515
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  449 M      65.00  124.43   59.50   15.54
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  541 M      65.00  112.89   98.62   23.87
I,K,ROMFXK=   2  4  2.360
I,K,ROMFXK=   2  5   .395
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  651 M      65.00  126.76   52.46   13.99
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  747 M      65.00  121.86   67.47   17.28
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  843 M      65.00  116.06   86.89   21.41
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  938 M      65.00  107.87  111.92   26.62
I,K,ROMFXK=   3  6   .583
I,K,ROMFXK=   3  7  4.193
I,K,ROMFXK=   3  8  1.557
I,K,ROMFXK=   3  9   .062
CLCON,CLCONN=  1.599   .000
    85.0   1   1    1.741     2      .031  .031  .037  .628  .876  .856  .998
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  154 M      65.00  129.72   35.90   10.21
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  248 M      65.00  123.18   62.70   16.24
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  352 M      65.00  127.82   48.02   13.00
I,ROMFX1, ROMFX2, RCMFX3 =   1   .049   .021  1.936
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  453 M      65.00  128.81   41.81   11.59
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  550 M      65.00  125.63   54.88   14.53
I,K,ROMFXK=   2  4  1.166
I,K,ROMFXK=   2  5   .483
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  654 M      65.00  129.72   38.82   10.90
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  752 M      65.00  127.82   44.89   12.29
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  851 M      65.00  126.76   51.39   13.75
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  949 M      65.00  124.43   58.67   15.36
I,K,ROMFXK=   3  6   .342
I,K,ROMFXK=   3  7  1.984
I,K,ROMFXK=   3  8  1.225
I,K,ROMFXK=   3  9   .124
CLCON,CLCONN=   .918   .000
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  129 U      65.00  335.51  127.36   35.50
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  229 U      65.00  340.99  127.74   35.58
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  329 U      65.00  338.49  127.55   35.54
I,ROMFX1, ROMFX2, ROMFX3 =   1   .018   .017   .017
CLCON,CLCONN=   .017   .000
    85.0   1   2     .935     2      .138  .140  .154  .779  .942  .930  .999
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  157 M      70.00  131.98   46.33   12.62
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  240 M      70.00  111.25  126.07   29.50
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  350 M      70.00  125.63   76.38   19.19
I,ROMFX1, ROMFX2, ROMFX3 =   1   .062   .008  3.664
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  454 M      70.00  129.72   59.52   15.55
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I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  546 M      70.00  120.49   98.14   23.77
I,K,ROMFXK=   2  4  2.407
I,K,ROMFXK=   2  5   .441
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  655 M      70.00  130.55   52.55   14.01
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  752 M      70.00  127.82   67.42   17.26
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  848 M      70.00  123.18   86.58   21.35
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  943 M      70.00  116.06  111.24   26.48
I,K,ROMFXK=   3  6   .601
I,K,ROMFXK=   3  7  4.292
I,K,ROMFXK=   3  8  1.673
I,K,ROMFXK=   3  9   .072
CLCON,CLCONN=  1.660   .000
    90.0   1   1    1.693     2      .028  .029  .034  .636  .898  .876  .998
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  159 M      70.00  133.04   35.97   10.23
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  253 M      70.00  128.81   62.51   16.20
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  357 M      70.00  131.98   47.99   12.99
I,ROMFX1, ROMFX2, ROMFX3 =   1   .051   .023  1.933
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  458 M      70.00  132.55   41.83   11.59
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  555 M      70.00  130.55   54.78   14.50
I,K,ROMFXK=   2  4  1.165
I,K,ROMFXK=   2  5   .500
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  659 M      70.00  133.04   38.87   10.91
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  757 M      70.00  131.98   44.89   12.29
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  856 M      70.00  131.31   51.33   13.74
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  954 M      70.00  129.72   58.53   15.33
I,K,ROMFXK=   3  6   .347
I,K,ROMFXK=   3  7  1.973
I,K,ROMFXK=   3  8  1.239
I,K,ROMFXK=   3  9   .132
CLCON,CLCONN=    .921   .000
    90.0   1   2     .921     1      .138  .140  .154  .782  .946  .933  .999
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  162 M      75.00  133.92   46.46   12.65
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  245 M      75.00  119.06  125.22   29.33
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  355 M      75.00  130.55   76.22   19.16
I,ROMFX1, ROMFX2, ROMFX3 =   1   .066   .010  3.770
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  459 M      75.00  133.04   59.55   15.55
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  551 M      75.00  126.76   97.71   23.68
I,K,ROMFXK=   2  4  2.431
I,K,ROMFXK=   2  5   .483
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  660 M      75.00  133.44   52.63   14.03
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  757 M      75.00  131.98   67.37   17.25
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  853 M      75.00  128.81   86.30   21.29
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  948 M      75.00  123.18  110.62   26.35
I,K,ROMFXK=   3  6   .616
I,K,ROMFXK=   3  7  4.346
I,K,ROMFXK=   3  8  1.769
I,K,ROMFXK=   3  9   .083
CLCON,CLCONN=  1.704   .000
    95.0   1   1    1.711     2      .025  .026  .031  .633  .901  .879  .998
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  164 M      75.00  134.00   36.03   10.24
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  258 M      75.00  132.55   62.34   16.16
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  362 M      75.00  133.92   47.95   12.98
I,ROMFX1, ROMFX2, ROMFX3 =   1   .054   .025  1.925
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I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  463 M      75.00  134.01   41.85   11.60
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  560 M      75.00  133.44   54.68   14.48
I,K,ROMFXK=   2  4  1.162
I,K,ROMFXK=   2  5   .514
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  664 M      75.00  134.00   38.91   10.92
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  762 M      75.00  133.92   44.88   12.29
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  861 M      75.00  133.73   51.27   13.72
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  959 M      75.00  133.04   58.40   15.30
I,K,ROMFXK=   3  6   .352
I,K,ROMFXK=   3  7  1.959
I,K,ROMFXK=   3  8  1.248
I,K,ROMFXK=   3  9   .138
CLCON,CLCONN=    .923    .000
    95.0   1   2     .923     1     .137  .139  .154  .782  .946  .933  .999
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  167 M      80.00  133.26   46.58   12.67
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  250 M      80.00  125.63  124.47   29.18
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  360 M      80.00  133.44   76.10   19.13
I,ROMFX1, ROMFX2, ROMFX3 =   1   .069   .011  3.880
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  464 M      80.00  134.00   59.57   15.56
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  556 M      80.00  131.31   97.33   23.60
I,K,ROMFXK=   2  4  2.429
I,K,ROMFXK=   2  5   .519
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  665 M      80.00  133.87   52.71   14.04
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  762 M      80.00  133.92   67.33   17.25
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  858 M      80.00  132.55   86.06   21.24
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  953 M      80.00  128.81  110.07   26.24
I,K,ROMFXK=   3  6   .625
I,K,ROMFXK=   3  7  4.350
I,K,ROMFXK=   3  8  1.841
I,K,ROMFXK=   3  9   .093
CLCON,CLCONN=  1.732    .000
   100.0   1   1    1.732     2     .024  .025  .030  .630  .901  .878  .998
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  169 M      80.00  132.18   36.09   10.26
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  263 M      80.00  134.01   62.18   16.13
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  367 M      80.00  133.26   47.93   12.98
I,ROMFX1, ROMFX2, ROMFX3 =   1   .056   .026  1.913
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  468 M      80.00  132.78   41.86   11.60
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  565 M      80.00  133.87   54.60   14.46
I,K,ROMFXK=   2  4  1.159
I,K,ROMFXK=   2  5   .524
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  669 M      80.00  132.18   38.95   10.93
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  767 M      80.00  133.26   44.88   12.29
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  866 M      80.00  133.63   51.22   13.71
I, NCHAR, TYP,TVAL,RMMDOT,ROMX,ROMT =  964 M      80.00  134.00   58.29   15.28
I,K,ROMFXK=   3  6   .357
I,K,ROMFXK=   3  7  1.943
I,K,ROMFXK=   3  8  1.251
I,K,ROMFXK=   3  9   .144
CLCON,CLCONN=    .922    .000
   100.0   1   2     .922     1     .137  .139  .154  .782  .946  .933  .999
   105.0 NO ACTIVE LOS
   110.0 NO ACTIVE LOS
   115.0 NO ACTIVE LOS
```

```
   120.0 NO ACTIVE LOS
1
                TOTAL TRANMITANCE FOR ALL SOURCES IS:  .1538E+00
                                 END EOSAEL RUN
STOP 000
```

5.2.3 Example 3: Creating a new cloud using SUBA and SUBC

```
WAVL    1.06
COMBIC
PHAS          1.0      5.0      6.0      0.0      9.0      1.0      0.0
FILE          9.0      his.l8a1
NAME          0.0      0.0      0.0      0.0      0.0      0.0      0.0
        Testing L8A1 self-screening RP smoke grenades
MET1         90.0     2.00      2.      27.50    962.5   202.40     0.00
MUNT           1.     .794      0.       5.       95.      0.        1.
BURN         658.      0.0      0.0      0.       0.      120.  .008333
CLOU           3.      0.0      0.0      0.0      0.0      0.0      0.0
SUBA           1.    0.050      0.0      1.0      1.0      5.0      0.0
SUBC           7.      0.0      0.0      0.0      1.0      0.0      0.0
SUBA           2.    0.925      0.0      2.0      1.0      5.0      0.0
SUBC           0.      0.0      0.0      0.0      1.0      0.0      0.0
SUBA           3.    0.025      0.0      1.0      21.      5.0      0.0
SUBC           0.      0.0      0.0      0.0      1.0      0.0      0.0
DONE          0.0      0.0      0.0      0.0      0.0      0.0      0.0
END
CONTINUE
WAVL    1.06
COMBIC
PHAS          2.0      5.0      6.0     12.0      9.0      0.0      1.0
FILE          9.0      his.l8a1
NAME
        Testing L8A1 self-screening RP smoke grenades
ORIG          0.0      0.0      0.0     90.0    265.0      0.0      0.0
SLOC          1.0      1.0      0.0    300.0      0.0      0.0      2.0
SLOC          1.0      1.0      0.0    300.0      5.0      0.0      2.0
SLOC          1.0      1.0      0.0    300.0     10.0      0.0      2.0
OLOC          1.0     10.0    100.0      2.0      0.0    300.0      0.0
TLOC          1.0     10.0   -100.0      2.0      1.0      0.0      0.0
LIST          2.0      0.0    300.0      5.0
DONE          0.0      0.0      0.0      0.0      0.0      0.0      0.0
END
STOP
```

This sample illustrates the usage of the SUBA and SUBC input records used to simulate a cloud for the L8A1 self-screening RP smoke grenades. SMENU=0 on the MUNT record signifies that this cloud will be designed by the user. STYP = 5 chooses red phosphorus as the obscurant. This grenade is modeled as a combination of three subclouds. The first subcloud is a buoyant plume that contains 92.5 percent of the total smoke. The second subcloud is a buoyant puff that contains five percent of the cloud. The remaining 2.5 percent of the total smoke is in the last cloud. RISMOD=21 for the last subcloud indicates that this subcloud is a stem spanning subcloud 2 "puff" with subcloud 1 "plume". Notice SUBB records were not used. COMBIC will use internal algorithms to compute the radius, temperature and thermal production coefficient associated with a red phosphorus cloud of this fill weight. PRNT=2 option on the LIST record prints a full history including the contributions of individual clouds to the transmittance. Following is the output for the above data file. There are two items of interest. Notice that the Phase I output summarized the subcloud characteristics. These should match the parameters in the SUBA and SUBB records created by the users.

Further note the expanded transmission listing in the Phase II output. In addition to the transmittance history, it now contains for each puff:

- Integrated Path Concentration (g/m^2) for the Subcloud
- Path Length Through the Subcloud
- Coordinates of Gaussian centroid (m) of the Subcloud
- Sigmas for the Gaussian Subcloud (m)
- Total Mass (g) Contained in the Subcloud

and for each slice of cloud defined by the intersection of the LOS with the plume:

- Integrated Path Concentration (g/m^2)
- Path Length Through the Slice
- Coordinates of Gaussian centroid (m) of the Slice
- Sigmas for the Average Downwind Distance of the Slice
- Average Mass per Downwind Distance in the Slice

A rule of thumb is that 90 percent of the cloud is contained within a volume defined by 2.15 times each of the sigmas. Using the sigmas for the puff gives you a rough determination of the size of the puff. However, most sensor performance people need to relate size of the cloud to a system performance threshold CL. Unfortunately, that information cannot be derived from just the sigmas. For those people wanting cloud sizes, with the cloud length, width, and height being determined at the point the cloud is dense enough to defeat the sensor, we recommend they use the printer-plot option. However, it must be cautioned that cloud dimensions obtained by using the printer-plot option are strongly dependent upon the viewing angle.

```
From awetmore@arl.mil Thu Jan 23 14:53:52 1997
X-UIDL: cbe290de69734449f986af883857bc30
Return-Path: <awetmore@arl.mil>
Received: from natika.arl.mil by acoma.arl.mil (SMI-8.6/SMI-SVR4)
id OAA11293; Thu, 23 Jan 1997 14:53:51 -0500
Received: from curie.arl.mil by natika.arl.mil (1.37.109.4/SMI-4.1)
id AA16164; Thu, 23 Jan 97 12:56:03 -0700
Received: from [155.148.8.3] by curie.arl.mil (1.37.109.4/SMI-4.1)
id AA05078; Thu, 23 Jan 97 12:54:12 -0700
Received: from curie.arl.mil by natika.arl.mil (1.37.109.4/SMI-4.1)
id AA16157; Thu, 23 Jan 97 12:56:00 -0700
Received: by curie.arl.mil (1.37.109.4/SMI-4.1)
id AA05075; Thu, 23 Jan 97 12:54:09 -0700
From: awetmore@arl.mil (Alan E. Wetmore)
Message-Id: <9701231954.AA05075@curie.arl.mil>
Subject: no subject (file transmission)
To: awetmore@arl.mil , -s3a@arl.mil
Date: Thu, 23 Jan 97 12:54:09 MST
Mailer: Elm [revision: 70.85]
Content-Length: 32945
Status: OR
******************************************************************************
  WARNING - THIS LIBRARY CONTAINS TECHNICAL DATA WHOSE EXPORT IS RESTRICTED
  BY THE ARMS EXPORT CONTROL ACT (TITLE 22, U.S.C., SEC 2751 ET SEQ.) OR
  EXECUTIVE ORDER 12470.  VIOLATION OF THESE EXPORT LAWS ARE SUBJECT TO
                  SEVERE CRIMINAL PENALTIES.
******************************************************************************
1
                     ********************************
                     *                              *
                     *    ELECTRO-OPTICAL SYSTEMS   *
                     *                              *
                     *  ATMOSPHERIC EFFECTS LIBRARY *
                     *                              *
                     *    NOT FOR OPERATIONAL USE   *
                     *                              *
                     * EOSAEL87 REV 2.1   02/23/90  *
                     *                              *
                     ********************************
WAVL      1.06
 NOTE: THAT THE ABOVE CARD WAS MODIFIED FOR CONSISTENCY TO:
WAVL        .1060E+01 .1060E+01 .0000E+00
                                        BEGINNING            ENDING
             WAVENUMBER (CM**-1)        9433.963            9433.963
             WAVELENGTH (MICROMETERS)      1.060               1.060
             FREQUENCY (GHZ)          283018.875          283018.875
          **** EOSAEL WARNING ****
 VISIBILITY AND EXTINCTION = 0.0, VISIBILITY CHANGED TO 10.0 KM
                                     VISIBILITY
                                      10.00 KM
1
                     ********************************
                     *                              *
                     *         C O M B I C          *
                     *                              *
```

```
                    *COMBINED OBSCURATION MODEL FOR*
                    * BATTLEFIELD-INDUCED AEROSOLS *
                    *   NOT FOR OPERATIONAL USE    *
                    *                              *
                    * EOSAEL87 REV 2.3   12/12/90  *
                    *                              *
                    ********************************
1
                               ****************
                               *              *
                               *    COMBIC    *
                               *    PHASE 1   *
                               *              *
                               ****************
 COMBIC WARNING: FILE(                                          his.l8a1  )
  WILL BE OVER WRITTEN
 COMBIC CLOUD HISTORY ON UNIT  9  OPENED TO:       his.l8a1
1
                                       METEOROLOGICAL CONDITIONS
  REFERENCE HEIGHT     10.00  METERS    WIND SPEED          2.00  METERS/SEC      TEMPERATURE       27.49  DEG C
  SURFACE ROUGHNESS  .10000  METERS    WIND DIRECTION     202.4  DEG WRT NORTH   PRESSURE           963.  MB
  INVERSION HEIGHT     995.  METERS    PASQUILL CATEGORY    2                    RELATIVE HUMIDITY  90.0  PERCENT
                                       BOUNDARY LAYER PARAMETERS
  FRICTION VELOCITY           .213  M/SEC       PASQUILL CLASS    1.60      AIR DENSITY                1110.4  G/M**3
  1./MONIN-OBUKHOV LENGTH  -.05987  M**-1       KAZANSKI-MONIN   -.8109     MEAN STATIC SBAR (10-50M) -.000409  SEC**-2
  SENSIBLE HEAT FLUX          49.7  WATT/M**2   COLD REGION FLAG    0       SURFACE BUOYANCY FLUX        .0014  M**2/S**3
  OMEGA                       .874              SBAR MODEL FLAG     0
                                       DIFFUSION COEFFICIENTS
  A COEFFICIENT     .316     B COEFFICIENT     .900     C COEFFICIENT     .233     D COEFFICIENT     .845
                                          SURFACE CONDITIONS
  SNOW COVER FLAG       0        SILT CONTENT   50.0  PERCENT        SOD DEPTH   .000  METERS
1                               VERTICAL  PROFILE  MODEL
                         ATMOSPHERIC TEMPERATURE      S, STATIC        EDDY
  HEIGHT  WINDSPEED  CONSTANT SBAR   VARIABLE S    STABILITY    DISSIPATION
   (M)      (M/S)    MODEL (DEG K)  MODEL (DEG K)  PARAMETER  RATE (M**2/S**3)
  ------  ---------  -------------  -------------  ----------  ----------------
     1.0     1.13       300.85         301.32      -.01228233      .01889
     2.0     1.43       300.83         301.04      -.00505972      .00863
     3.0     1.59       300.81         300.90      -.00293463      .00561
     4.0     1.70       300.78         300.81      -.00197406      .00424
     5.0     1.78       300.76         300.75      -.00144432      .00349
     6.0     1.84       300.74         300.70      -.00111580      .00302
     7.0     1.89       300.72         300.66      -.00089552      .00271
     8.0     1.93       300.69         300.62      -.00073934      .00249
     9.0     1.97       300.67         300.59      -.00062386      .00233
    10.0     2.00       300.65         300.56      -.00053562      .00220
    15.0     2.12       300.54         300.45      -.00029655      .00186
    20.0     2.19       300.43         300.36      -.00019430      .00172
    25.0     2.25       300.32         300.29      -.00013977      .00164
    30.0     2.29       300.20         300.22      -.00010670      .00159
    35.0     2.33       300.09         300.15      -.00008489      .00156
    40.0     2.35       299.98         300.09      -.00006962      .00154
    45.0     2.38       299.87         300.03      -.00005843      .00152
    50.0     2.40       299.76         299.98      -.00004995      .00151
    55.0     2.42       299.65         299.92      -.00004334      .00150
    60.0     2.44       299.53         299.86      -.00003807      .00149
    65.0     2.45       299.42         299.81      -.00003378      .00149
    70.0     2.47       299.31         299.76      -.00003025      .00148
```

```
   75.0    2.48      299.20        299.70     -.00002729      .00148
   80.0    2.49      299.09        299.65     -.00002478      .00147
   85.0    2.50      298.98        299.60     -.00002264      .00147
   90.0    2.51      298.87        299.54     -.00002078      .00147
   95.0    2.52      298.76        299.49     -.00001917      .00147
  100.0    2.53      298.64        299.44     -.00001776      .00074
  125.0    2.57      298.09        299.18     -.00001272      .00074
  150.0    2.60      297.53        298.93     -.00000968      .00073
  175.0    2.62      296.98        298.68     -.00000769      .00073
  200.0    2.64      296.42        298.43     -.00000630      .00073
  225.0    2.66      295.87        298.18     -.00000528      .00073
  250.0    2.67      295.32        297.93     -.00000451      .00073
  275.0    2.69      294.76        297.68     -.00000391      .00073
  300.0    2.70      294.21        297.43     -.00000343      .00072
  325.0    2.71      293.66        297.19     -.00000304      .00072
  350.0    2.72      293.11        296.94     -.00000272      .00072
  375.0    2.73      292.56        296.69     -.00000246      .00072
  400.0    2.73      292.01        296.45     -.00000223      .00072
  450.0    2.75      290.91        295.95     -.00000187      .00072
  500.0    2.76      289.82        295.46     -.00000160      .00072
  550.0    2.77      288.73        294.97     -.00000138      .00072
  600.0    2.78      287.63        294.48     -.00000121      .00072
  650.0    2.79      286.55        293.98     -.00000108      .00072
  700.0    2.80      285.46        293.49     -.00000096      .00072
  750.0    2.80      284.38        293.00     -.00000087      .00072
  800.0    2.81      283.29        292.51     -.00000079      .00072
  850.0    2.82      282.22        292.02     -.00000072      .00072
  900.0    2.82      281.14        291.53     -.00000066      .00072
  950.0    2.83      280.06        291.04     -.00000061      .00072
 1000.0    2.83      278.99        290.55     -.00000056      .00072
1
                       MASS EXTINCTION COEFFICIENTS (M**2/GRAM)
 OBSCURANT                        WAVELENGTH (MICROMETERS)
   CODE       .4-.7    .7-1.2     1.06     3.-5.     8.-12.    10.6     94 GHZ
 ---------   ------    ------    ------    ------    ------    ------   ------
     1       3.2280    2.3638    2.1094     .4127     .3043     .2792    .0010
     2       3.2280    2.3638    2.1094     .4127     .3043     .2792    .0010
     3       2.1520    2.1368    2.0302     .2668     .0601     .0750    .0010
     4       6.8510    4.5920    3.4970     .2450     .0200     .0180    .0010
     5       3.2280    2.3638    2.1094     .4127     .3043     .2792    .0010
     6       1.8600    1.6300    1.4000    1.7900    1.6800    1.6800    .0010
     7       1.8600    1.6300    1.4000    1.7900    1.6800    1.6800    .0010
     8       5.6500    4.0800    3.2500     .2450     .0230     .0270    .0010
     9        .3200     .3000     .2900     .2700     .2500     .2500    .0010
    10        .3200     .2900     .2600     .2700     .2600     .2400    .0010
    11        .0350     .0360     .0370     .0350     .0380     .0360    .0010
    12       1.5000    1.4600    1.4200     .7500     .3200     .3000    .0010
    13        .0010     .0010     .0010     .0010     .0010     .0010    .0004
    14       6.1000    3.7500    2.9400    1.3500    1.0100    1.0000    .0020
    15       6.8510    4.5920    1.4300     .0540     .0200     .0180    .0010
    16       5.3700    2.9000    2.1000     .0900     .0900     .0700    .0010
    17       6.2000    3.5000    2.5000     .2300     .0500     .0480    .0010
    18       3.3300    2.7500    2.6600     .2600     .3200     .2300    .0010
    19       1.3000    1.7400    1.7000     .0800     .1600     .3800    .0010
    20        .0000     .0000     .0000     .0000     .0000     .0000    .0000
    21        .0000     .0000     .0000     .0000     .0000     .0000    .0000
    22        .0000     .0000     .0000     .0000     .0000     .0000    .0000
    23        .0000     .0000     .0000     .0000     .0000     .0000    .0000
    24        .0000     .0000     .0000     .0000     .0000     .0000    .0000
```

```
      25      .0000     .0000     .0000     .0000     .0000     .0000     .0000
      26      .0000     .0000     .0000     .0000     .0000     .0000     .0000
      27      .0000     .0000     .0000     .0000     .0000     .0000     .0000
      28      .0000     .0000     .0000     .0000     .0000     .0000     .0000
      29      .0000     .0000     .0000     .0000     .0000     .0000     .0000
      30      .0000     .0000     .0000     .0000     .0000     .0000     .0000
1
                    CLOUD HISTORY, FILE NAME = COMHIS
 HISTORY FILE SOURCE #  1 CONTAINS 3 SUBCLOUDS, TOTAL    2684.72 GRAMS OBSCURANT
     XN    FILL WEIGHT   MENU     OBSCURANT
  NO. OF   (LB, GAL   SELECTION   TYPE     EFFICIENCY    YIELD   NUMBER  OF
 SOURCES  OR LB TNT)    TYPE      CODE      (PERCENT)   FACTOR  SUBMUNITIONS
 -------  ----------  ---------  ---------  ----------   ------  ------------
   1.00       .794      0.         5.        95.0       7.847      1.00
   BURN
 DURATION                             BURN RATE COEFFICIENTS
   (SEC)       B1          B2          B3          B4          B5          B6
 --------  ---------   ---------   ---------   ---------   ---------   ---------
  658.00     .0000       .0000       .0000       .0000    120.0000       .0083
 SMOULDERING   SMOULDERING
    TIME       COEFFICIENT
   (SEC)          CSMLD
 -----------   -----------
      .00         .0000
1
          PROCESSING SUBCLOUD  1
         SUBCLOUD # 1        HISTORY FILE SOURCE #  1
                DEBRIS      PLUME    CLOUD RISE MODEL    EXTINCTION   BALLISTIC
    MASS        CARBON     (1=PUFF,   (1=RISE, 2= NO     COEFFICIENT   SUBCLOUD
  FRACTION    (G/G OBSC)   2=PLUME)   RISE, >2=STEM)        CODE       (1=Y, 0=N)
  --------    ----------   --------   --------------    -----------  ----------
   .925000       .000        2.            1.               5.           0.
                                         INITIAL        THERMAL       UPWARD
 INITIAL OBSCURANT RADII (M)  BUOYANCY      CLOUD       PRODUCTION    VELOCITY
 DOWNWIND CROSSWIND VERTICAL  RADIUS(M)  TEMP(DEG K)  COEF (CAL/G)     (M/S)
 -------- --------- --------  ---------  -----------  ------------   --------
   17.54     17.54     3.00      2.43       303.68        9318.31        .65
                FALL    EVAPORATION/DEPOSITION         MOMENTUM  HORIZONTAL
 HEIGHT OF    VELOCITY      FD         DELTA    REFL.   RADIUS    VELOCITY
 BURST (M)     (M/S)    (LONG-TERM)   (S**-1)   COEF.    (M)        (M/S)
 ---------   --------  -----------   -------   -----  --------  ----------
     .0         .000    1.000000      .00000  1.0000     .00        .59
               MASS PRODUCTION PROFILE
    TIME T      MASS PRODUCED        MASS STILL
    AFTER       UP UNTIL TIME        AIRBORNE BY
 IGNITION (SEC)     T ( G )         TIME T ( G )
 --------------  -------------      ------------
     11.942           236.2              236.2
     23.884           450.0              450.0
     35.826           643.6              643.6
     47.768           818.9              818.9
     59.710           977.5              977.5
     71.652          1121.1             1121.1
     83.593          1251.1             1251.1
     95.535          1368.8             1368.8
    107.477          1475.4             1475.4
    119.419          1571.9             1571.9
    131.361          1659.2             1659.2
```

```
    143.303            1738.2             1738.2
    155.245            1809.8             1809.8
    167.187            1874.6             1874.6
    179.129            1933.2             1933.2
    191.071            1986.3             1986.3
    203.013            2034.4             2034.4
    214.955            2077.9             2077.9
    226.897            2117.3             2117.3
    238.838            2152.9             2152.9
    250.780            2185.2             2185.2
    262.722            2214.4             2214.4
    274.664            2240.9             2240.9
    286.606            2264.8             2264.8
    298.548            2286.5             2286.5
    310.490            2306.1             2306.1
    322.432            2323.9             2323.9
    334.374            2340.0             2340.0
    346.316            2354.6             2354.6
    358.258            2367.7             2367.7
    370.200            2379.7             2379.7
    382.142            2390.5             2390.5
    394.083            2400.3             2400.3
    406.025            2409.1             2409.1
    417.967            2417.1             2417.1
    429.909            2424.4             2424.4
    441.851            2431.0             2431.0
    453.793            2436.9             2436.9
    465.735            2442.3             2442.3
    477.677            2447.2             2447.2
    489.619            2451.6             2451.6
    501.561            2455.6             2455.6
    513.503            2459.2             2459.2
    525.445            2462.4             2462.4
    537.387            2465.4             2465.4
    549.328            2468.1             2468.1
    561.270            2470.5             2470.5
    573.212            2472.7             2472.7
    585.154            2474.7             2474.7
    597.096            2476.5             2476.5
    609.038            2478.1             2478.1
    620.980            2479.6             2479.6
    632.922            2481.0             2481.0
    644.864            2482.2             2482.2
    656.806            2483.3             2483.3
    668.748            2483.4             2483.4
    680.690            2483.4             2483.4
    692.632            2483.4             2483.4
                                                  SUBCLOUD TRAJECTORY
                                                        PEAK     MEAN                      CENTROID OR CM        EFFECTIVE
 DOWNWIND            CENTROID    GAUSSIAN CLOUD         CLOUD    CLOUD     AIR      AIR      VELOCITY      CM     BUOYANCY
 DISTANCE    TIME     HEIGHT   STD. DEVIATIONS (M)      TEMP.    TEMP.    TEMP.   DENSITY  VERT.  HOR.   HEIGHT   RADIUS
   (M)      (SEC)      (M)    SIGMAX  SIGMAY  SIGMAZ  (DEG K)  (DEG K)  (DEG K) (G/M**3)  (M/S)  (M/S)   (M)      (M)
 --------  -------  -------  ------  ------  ------  -------  -------  ------- --------  -----  -----  -----  -------
      .10      .16      .10    8.16    8.22    1.45   307.19   303.59   301.23  1109.39    .62    .62    1.3   2.468
     1.00     1.36      .75    8.16    8.61    2.10   305.67   302.89   301.07  1109.90    .46    .88    2.0   2.714
     2.00     2.39     1.18    8.16    8.97    2.48   304.69   302.46   300.99  1110.13    .37   1.06    2.5   2.893
     4.00     4.11     1.74    8.16    9.61    3.02   303.66   302.01   300.92  1110.31    .29   1.25    3.2   3.188
     6.00     5.64     2.14    8.16   10.21    3.46   303.11   301.76   300.87  1110.42    .25   1.36    3.8   3.441
    10.00     8.43     2.78    8.16   11.34    4.25   302.48   301.47   300.81  1110.53    .21   1.49    4.7   3.874
```

```
     16.00    12.24    3.13    8.16   12.68    5.11   301.63   301.07   300.78  1110.57    .14   1.62    5.4   4.125
     25.00    17.61    3.13    8.16   14.37    6.10   301.20   300.92   300.77  1110.59    .14   1.68    6.2   4.125
     36.00    23.97    3.13    8.16   16.40    7.27   300.96   300.82   300.73  1110.63    .14   1.73    7.1   4.125
     49.85    31.76    3.13    8.16   18.92    8.70   300.83   300.76   300.69  1110.66    .14   1.78    8.2   4.125
     55.98    35.12    3.13    8.16   20.02    9.31   300.74   300.70   300.65  1110.67    .14   1.83    8.7   4.125
     62.87    38.81    3.13    8.16   21.25   10.00   300.69   300.67   300.63  1110.66    .15   1.87    9.2   4.125
     70.60    42.89    3.13    8.16   22.62   10.76   300.65   300.64   300.62  1110.66    .15   1.90    9.8   4.125
     79.29    47.40    3.13    8.16   24.15   11.60   300.63   300.62   300.60  1110.64    .15   1.93   10.5   4.125
     89.05    52.39    3.13    8.16   25.86   12.53   300.61   300.60   300.58  1110.62    .15   1.95   11.2   4.125
    100.00    57.93    3.13    8.16   27.76   13.57   300.59   300.58   300.57  1110.60    .15   1.98   12.0   4.125
    112.30    64.08    3.13    8.16   29.88   14.71   300.57   300.56   300.55  1110.57    .15   2.00   12.9   4.125
    126.12    70.91    3.13    8.16   32.24   15.97   300.55   300.55   300.53  1110.53    .15   2.02   14.0   4.125
    141.64    78.49    3.13    8.16   34.86   17.37   300.53   300.52   300.50  1110.48    .15   2.04   15.1   4.125
    159.06    86.93    3.13    8.16   37.79   18.92   300.50   300.50   300.48  1110.42    .15   2.07   16.3   4.125
    178.63    96.30    3.13    8.16   41.04   20.63   300.48   300.48   300.46  1110.35    .14   2.09   17.6   4.125
    200.61   106.72    3.13    8.16   44.66   22.52   300.46   300.46   300.43  1110.27    .14   2.11   19.2   4.125
    225.28   118.30    3.13    8.16   48.69   24.60   300.43   300.43   300.41  1110.17    .14   2.13   20.8   4.125
    253.00   131.18    3.13    8.16   53.17   26.91   300.41   300.41   300.38  1110.06    .14   2.15   22.6   4.125
    284.13   145.50    3.13    8.16   58.15   29.46   300.38   300.38   300.35  1109.94    .14   2.17   24.7   4.125
    319.08   161.43    3.13    8.16   63.69   32.27   300.35   300.35   300.32  1109.79    .14   2.19   26.9   4.125
    358.34   179.15    3.13    8.16   69.84   35.38   300.32   300.32   300.29  1109.63    .14   2.22   29.4   4.125
    402.42   198.86    3.13    8.16   76.68   38.81   300.29   300.29   300.26  1109.44    .14   2.24   32.1   4.125
    451.93   220.79    3.13    8.16   84.29   42.60   300.26   300.26   300.22  1109.23    .14   2.26   35.2   4.125
    507.53   245.20    3.13    8.16   92.74   46.79   300.22   300.22   300.18  1108.99    .14   2.28   38.5   4.125
    569.97   272.36    3.13    8.16  102.13   51.40   300.18   300.18   300.14  1108.72    .14   2.30   42.2   4.125
    640.09   302.61    3.13    8.16  112.56   56.50   300.14   300.14   300.10  1108.42    .13   2.32   46.2   4.125
    718.83   336.28    3.13    8.16  124.15   62.13   300.10   300.10   300.05  1108.08    .13   2.34   50.7   4.125
    807.27   373.78    3.13    8.16  137.02   68.34   300.05   300.05   300.00  1107.71    .13   2.36   55.7   4.125
    906.58   415.55    3.13    8.16  151.32   75.19   300.00   300.00   299.94  1107.29    .13   2.38   61.1   4.125
   1018.12   462.09    3.13    8.16  167.20   82.75   299.94   299.94   299.88  1106.82    .13   2.40   67.2   4.125
   1143.37   513.94    3.13    8.16  184.83   91.10   299.88   299.88   299.82  1106.31    .13   2.42   73.8   4.125
   1284.04   571.73    3.13    8.16  204.42  100.31   299.81   299.81   299.74  1105.73    .13   2.43   81.2   4.125
   1442.01   636.15    3.13    8.16  226.17  110.47   299.74   299.74   299.67  1105.10    .13   2.45   89.3   4.125
   1619.41   707.97    3.13    8.16  250.33  121.68   299.66   299.66   299.58  1104.39    .12   2.47   98.2   4.125
   1818.64   788.07    3.13    8.16  277.15  134.05   299.57   299.57   299.49  1103.61    .12   2.49  108.1   4.125
   2042.38   877.39    3.13    8.16  306.93  147.69   299.48   299.48   299.39  1102.74    .12   2.50  119.0   4.125
   2293.64   977.05    3.13    8.16  339.99  162.75   299.38   299.38   299.27  1101.78    .12   2.52  131.0   4.125
   2575.82  1088.23    3.13    8.16  376.71  179.36   299.26   299.26   299.15  1100.73    .12   2.54  144.3   4.125
   2892.71  1212.30    3.13    8.16  417.47  197.68   299.14   299.14   299.02  1099.56    .12   2.55  158.9   4.125
   3248.59  1350.78    3.13    8.16  462.73  217.90   299.00   299.00   298.87  1098.26    .12   2.57  175.0   4.125
   3648.25  1505.37    3.13    8.16  512.98  240.21   298.85   298.85   298.71  1096.83    .12   2.59  192.8   4.125
   4097.08  1677.97    3.13    8.16  568.77  264.81   298.69   298.69   298.53  1095.26    .11   2.60  212.4   4.125
   4601.13  1870.70    3.13    8.16  630.71  291.95   298.51   298.51   298.33  1093.52    .11   2.62  234.1   4.125
   5167.19  2085.96    3.13    8.16  699.47  321.90   298.31   298.31   298.11  1091.60    .11   2.63  258.0   4.125
   5802.88  2326.40    3.13    8.16  775.80  354.93   298.09   298.09   297.88  1089.48    .11   2.64  284.3   4.125
   6516.79  2595.02    3.13    8.16  860.55  391.37   297.86   297.86   297.62  1087.14    .11   2.66  313.4   4.125
   7318.52  2895.16    3.13    8.16  954.63  431.56   297.59   297.59   297.33  1084.57    .11   2.67  345.5   4.125
   8218.89  3230.57    3.13    8.16 1059.08  475.90   297.30   297.30   297.01  1081.72    .11   2.68  380.9   4.125
   9230.02  3605.44    3.13    8.16 1175.03  524.82   296.98   296.98   296.66  1078.59    .10   2.70  419.9   4.125
  10365.55  4024.47    3.13    8.16 1303.75  578.78   296.63   296.63   296.27  1075.15    .10   2.71  462.9   4.125
  11640.78  4492.93    3.13    8.16 1446.64  638.30   296.24   296.24   295.85  1071.35    .10   2.72  510.4   4.125
  13072.90  5016.70    3.13    8.16 1605.27  703.95   295.81   295.81   295.38  1067.16    .10   2.73  562.8   4.125
  14681.20  5602.40    3.13    8.16 1781.37  776.38   295.34   295.34   294.87  1062.55    .10   2.75  620.6   4.125
  16487.37  6257.42    3.13    8.16 1976.86  856.27   294.82   294.82   294.30  1057.48    .10   2.76  684.3   4.125
1
          PROCESSING SUBCLOUD  2
         SUBCLOUD # 2        HISTORY FILE SOURCE #  1
               DEBRIS      PLUME    CLOUD RISE MODEL    EXTINCTION   BALLISTIC
     MASS      CARBON     (1=PUFF,   (1=RISE, 2= NO     COEFFICIENT  SUBCLOUD
```

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 FRACTION   (G/G OBSC)   2=PLUME)   RISE, >2=STEM)       CODE     (1=Y, 0=N)
 --------   ----------   --------   --------------   -----------  ----------
  .050000       .000        1.            1.              5.          0.
                                       INITIAL      THERMAL      UPWARD
INITIAL OBSCURANT RADII (M)  BUOYANCY    CLOUD      PRODUCTION   VELOCITY
DOWNWIND CROSSWIND VERTICAL  RADIUS(M)  TEMP(DEG K)  COEF (CAL/G)   (M/S)
-------- --------- --------  ---------  -----------  ------------  --------
  3.32      3.32     2.49       1.16       433.30       9318.31      1.62
             FALL    EVAPORATION/DEPOSITION         MOMENTUM  HORIZONTAL
HEIGHT OF   VELOCITY     FD         DELTA    REFL.   RADIUS    VELOCITY
BURST (M)    (M/S)   (LONG-TERM)   (S**-1)  COEF.    (M)        (M/S)
---------   --------  -----------  -------  -----  --------  ----------
  7.0         .000    1.000000     .00000  1.0000     .00        .94
            INITIAL MASS IN THIS PUFF =        134.2 GM
                                              SUBCLOUD TRAJECTORY
                                                   PEAK     MEAN                       CENTROID OR CM       EFFECTIVE
DOWNWIND           CENTROID     GAUSSIAN CLOUD     CLOUD    CLOUD     AIR      AIR       VELOCITY     CM    BUOYANCY
DISTANCE   TIME     HEIGHT    STD. DEVIATIONS (M)  TEMP.    TEMP.     TEMP.   DENSITY  VERT.  HOR.  HEIGHT   RADIUS
  (M)      (SEC)     (M)     SIGMAX  SIGMAY  SIGMAZ  (DEG K)  (DEG K)  (DEG K) (G/M**3)  (M/S)  (M/S)   (M)     (M)
--------  -------  -------  ------  ------  ------  -------  -------  ------- --------  -----  -----  -----  -------
     .10      .09     7.15    1.59    1.59    1.20   925.79   412.00   300.73  1110.48   1.65   1.16    7.2   1.195
    1.00      .69     8.11    1.91    1.88    1.44   463.96   349.96   300.70  1110.48   1.50   1.68    8.1   1.432
    2.00     1.26     8.92    2.20    2.16    1.66   392.13   331.61   300.68  1110.47   1.33   1.81    9.0   1.632
    4.00     2.33    10.21    2.73    2.65    2.03   346.28   317.37   300.64  1110.44   1.11   1.91   10.3   1.953
    6.00     3.36    11.28    3.21    3.10    2.36   329.56   311.56   300.61  1110.39    .97   1.96   11.4   2.218
   10.00     5.37    13.05    4.10    3.92    2.94   316.18   306.63   300.58  1110.32    .80   2.02   13.1   2.655
   16.00     8.31    15.17    5.32    5.04    3.72   309.08   303.89   300.53  1110.20    .66   2.06   15.4   3.182
   25.00    12.63    17.73    7.02    6.60    4.76   305.21   302.36   300.49  1110.06    .54   2.11   17.8   3.817
   36.00    17.80    20.29    8.96    8.38    5.90   303.34   301.59   300.44  1109.86    .46   2.14   20.7   4.452
   49.85    24.21    22.99   11.27   10.50    7.23   302.26   301.14   300.40  1109.69    .39   2.17   23.1   5.125
   55.98    27.03    24.06   12.26   11.40    7.79   301.97   301.02   300.39  1109.62    .37   2.19   24.2   5.392
   62.87    30.17    25.19   13.36   12.40    8.41   301.73   300.91   300.37  1109.53    .35   2.20   25.4   5.674
   70.60    33.68    26.39   14.57   13.50    9.08   301.51   300.82   300.36  1109.43    .33   2.21   26.6   5.973
   79.29    37.60    27.66   15.90   14.72    9.81   301.33   300.73   300.34  1109.34    .31   2.22   27.9   6.290
   89.05    41.97    28.45   17.30   15.98   10.53   300.83   300.51   300.33  1109.29    .01   2.24   28.6   6.489
  100.00    46.83    28.45   18.72   17.26   11.19   300.58   300.42   300.33  1109.29    .01   2.25   28.6   6.489
  112.30    52.27    28.45   20.30   18.69   11.92   300.45   300.37   300.33  1109.28    .02   2.26   28.7   6.489
  126.12    58.37    28.45   22.06   20.27   12.74   300.39   300.35   300.33  1109.27    .02   2.27   28.9   6.489
  141.64    65.20    28.45   24.02   22.03   13.64   300.36   300.34   300.32  1109.26    .03   2.27   29.1   6.489
  159.06    72.86    28.45   26.20   24.00   14.64   300.34   300.33   300.32  1109.25    .04   2.27   29.4   6.489
  178.63    81.45    28.45   28.63   26.18   15.75   300.33   300.32   300.32  1109.22    .04   2.28   29.7   6.489
  200.61    91.08    28.45   31.32   28.60   16.98   300.32   300.32   300.31  1109.20    .05   2.28   30.2   6.489
  225.28   101.89    28.45   34.32   31.30   18.35   300.31   300.31   300.31  1109.16    .05   2.28   30.8   6.489
  253.00   114.00    28.45   37.65   34.30   19.86   300.31   300.31   300.30  1109.11    .06   2.29   31.5   6.489
  284.13   127.58    28.45   41.35   37.63   21.53   300.30   300.30   300.29  1109.06    .06   2.29   32.4   6.489
  319.08   142.80    28.45   45.47   41.34   23.37   300.29   300.29   300.28  1108.99    .07   2.30   33.5   6.489
  358.34   159.85    28.45   50.04   45.46   25.42   300.28   300.28   300.26  1108.90    .07   2.30   34.7   6.489
  402.42   178.95    28.45   55.12   50.03   27.68   300.26   300.26   300.25  1108.80    .08   2.31   36.1   6.489
  451.93   200.33    28.45   60.77   55.12   30.18   300.25   300.25   300.23  1108.69    .08   2.32   37.8   6.489
  507.53   224.26    28.45   67.04   60.76   32.94   300.23   300.23   300.21  1108.56    .08   2.32   39.7   6.489
  569.97   251.03    28.45   74.00   67.04   35.99   300.21   300.21   300.19  1108.40    .08   2.33   41.8   6.489
  640.09   280.98    28.45   81.74   74.01   39.36   300.19   300.19   300.16  1108.23    .08   2.34   44.3   6.489
  718.83   314.46    28.45   90.33   81.75   43.08   300.16   300.16   300.13  1108.02    .08   2.35   47.0   6.489
  807.27   351.88    28.45   99.87   90.35   47.20   300.13   300.13   300.10  1107.80    .08   2.36   50.1   6.489
  906.58   393.71    28.45  110.47   99.89   51.74   300.10   300.10   300.07  1107.54    .08   2.37   53.5   6.489
 1018.12   440.44    28.45  122.24  110.50   56.76   300.06   300.06   300.03  1107.25    .08   2.39   57.3   6.489
 1143.37   492.65    28.45  135.31  122.27   62.30   300.02   300.02   299.99  1106.93    .08   2.40   61.6   6.489
 1284.04   550.96    28.45  149.82  135.35   68.41   299.98   299.98   299.94  1106.56    .08   2.41   66.3   6.489
 1442.01   616.08    28.45  165.93  149.87   75.16   299.93   299.93   299.89  1106.16    .08   2.43   71.6   6.489
```

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   1619.41   688.81   28.45  183.82  165.99   82.62  299.88  299.88  299.83 1105.71   .08  2.44   77.4  6.489
   1818.64   770.02   28.45  203.68  183.89   90.84  299.82  299.82  299.77 1105.20   .08  2.45   83.8  6.489
   2042.38   860.70   28.45  225.74  203.77   99.92  299.76  299.76  299.70 1104.64   .08  2.47   91.0  6.489
   2293.64   961.94   28.45  250.22  225.83  109.94  299.69  299.69  299.62 1104.02   .08  2.48   98.9  6.489
   2575.82  1074.99   28.45  277.41  250.33  120.99  299.62  299.62  299.54 1103.33   .08  2.50  107.6  6.489
   2892.71  1201.23   28.45  307.59  277.53  133.19  299.53  299.53  299.45 1102.56   .08  2.51  117.3  6.489
   3248.59  1342.18   28.45  341.09  307.73  146.65  299.44  299.44  299.35 1101.71   .08  2.52  128.0  6.489
   3648.25  1499.58   28.45  378.29  341.26  161.51  299.34  299.34  299.24 1100.77   .07  2.54  139.8  6.489
   4097.08  1675.36   28.45  419.59  378.48  177.89  299.23  299.23  299.12 1099.73   .07  2.55  152.8  6.489
   4601.13  1871.67   28.45  465.44  419.80  195.98  299.11  299.11  298.99 1098.58   .07  2.57  167.2  6.489
   5167.19  2090.93   28.45  516.34  465.67  215.93  298.98  298.98  298.85 1097.31   .07  2.58  183.0  6.489
   5802.88  2335.84   28.45  572.84  516.60  237.94  298.83  298.83  298.69 1095.90   .07  2.60  200.6  6.489
   6516.79  2609.44   28.45  635.57  573.14  262.22  298.67  298.67  298.51 1094.35   .07  2.61  219.9  6.489
   7318.52  2915.10   28.45  705.20  635.90  289.01  298.49  298.49  298.32 1092.64   .07  2.62  241.2  6.489
   8218.89  3256.61   28.45  782.51  705.57  318.57  298.30  298.30  298.10 1090.74   .07  2.64  264.8  6.489
   9230.02  3638.24   28.45  868.32  782.92  351.17  298.08  298.08  297.87 1088.66   .07  2.65  290.8  6.489
  10365.55  4064.71   28.45  963.59  868.79  387.14  297.85  297.85  297.61 1086.35   .07  2.66  319.5  6.489
  11640.78  4541.37   28.45 1069.35  964.11  426.82  297.59  297.59  297.33 1083.81   .07  2.68  351.1  6.489
  13072.90  5074.17   28.45 1186.74 1069.92  470.60  297.30  297.30  297.02 1081.01   .07  2.69  386.0  6.489
  14681.20  5669.78   28.45 1317.07 1187.39  518.88  296.99  296.99  296.67 1077.93   .06  2.70  424.5  6.489
  16487.37  6335.68   28.45 1461.74 1317.79  572.15  296.64  296.64  296.29 1074.53   .06  2.71  467.0  6.489
1
From awetmore@arl.mil Thu Jan 23 14:54:58 1997
X-UIDL: b5f5be76e21549eb073fd9a20c7a1558
Return-Path: <awetmore@arl.mil>
Received: from natika.arl.mil by acoma.arl.mil (SMI-8.6/SMI-SVR4)
id OAA11321; Thu, 23 Jan 1997 14:54:39 -0500
Received: from curie.arl.mil by natika.arl.mil (1.37.109.4/SMI-4.1)
id AA16181; Thu, 23 Jan 97 12:56:49 -0700
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id AA05099; Thu, 23 Jan 97 12:54:58 -0700
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id AA16175; Thu, 23 Jan 97 12:56:46 -0700
Received: by curie.arl.mil (1.37.109.4/SMI-4.1)
id AA05094; Thu, 23 Jan 97 12:54:55 -0700
From: awetmore@arl.mil (Alan E. Wetmore)
Message-Id: <9701231954.AA05094@curie.arl.mil>
Subject: no subject (file transmission)
To: awetmore@arl.mil, -s3b@arl.mil
Date: Thu, 23 Jan 97 12:54:54 MST
Mailer: Elm [revision: 70.85]
Content-Length: 46084
Status: OR
          PROCESSING SUBCLOUD  3
         SUBCLOUD # 3        HISTORY FILE SOURCE #  1
                  DEBRIS      PLUME    CLOUD RISE MODEL   EXTINCTION   BALLISTIC
     MASS         CARBON     (1=PUFF,   (1=RISE, 2= NO    COEFFICIENT   SUBCLOUD
   FRACTION    (G/G OBSC)   2=PLUME)   RISE, >2=STEM)        CODE      (1=Y, 0=N)
   --------    ----------   --------   --------------    -----------   ----------
    .025000        .000        1.            12.               5.           0.
                                             INITIAL        THERMAL      UPWARD
  INITIAL OBSCURANT RADII (M)  BUOYANCY       CLOUD        PRODUCTION   VELOCITY
  DOWNWIND CROSSWIND VERTICAL  RADIUS(M)  TEMP(DEG K)   COEF (CAL/G)     (M/S)
  -------- --------- --------  ---------  -----------   ------------   --------
     3.32      3.32     2.49       .00          .00        9318.31        .00
                 FALL    EVAPORATION/DEPOSITION          MOMENTUM   HORIZONTAL
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 HEIGHT OF   VELOCITY     FD          DELTA    REFL.   RADIUS    VELOCITY
 BURST (M)    (M/S)   (LONG-TERM)    (S**-1)   COEF.    (M)        (M/S)
 ---------   --------  -----------   -------   -----  --------  ----------
    .0         .000     1.000000      .00000  1.0000     .00        .00
              INITIAL MASS IN THIS PUFF =          67.1 GM
                                                SUBCLOUD TRAJECTORY
                                                   PEAK     MEAN                       CENTROID OR CM      EFFECTIVE
 DOWNWIND             CENTROID     GAUSSIAN CLOUD      CLOUD    CLOUD     AIR      AIR        VELOCITY      CM     BUOYANCY
 DISTANCE    TIME      HEIGHT    STD. DEVIATIONS (M)   TEMP.    TEMP.    TEMP.   DENSITY   VERT.  HOR.   HEIGHT    RADIUS
   (M)       (SEC)      (M)     SIGMAX  SIGMAY  SIGMAZ (DEG K)  (DEG K)  (DEG K) (G/M**3)  (M/S)  (M/S)    (M)      (M)
 --------   -------   -------   ------  ------  ------ -------  -------  ------- --------  -----  -----   -----   -------
      .10       .14      3.22     1.01    5.92    2.34  300.46   300.46   300.46  1112.01  24.52   1.62     3.2     5.175
     1.00      1.04      4.19     1.38    6.18    2.59  300.37   300.37   300.37  1112.22   1.09   1.71     4.2     6.028
     2.00      1.90      4.96     1.69    6.46    2.82  300.32   300.32   300.32  1112.31    .91   1.77     5.0     6.724
     4.00      3.38      6.03     2.14    6.96    3.21  300.26   300.26   300.26  1112.39    .72   1.84     6.0     7.791
     6.00      4.76      6.88     2.51    7.44    3.53  300.22   300.22   300.22  1112.42    .62   1.88     6.9     8.680
    10.00      7.28      8.24     3.14    8.36    4.08  300.17   300.17   300.17  1112.44    .54   1.94     8.2    10.195
    16.00     10.82      9.73     3.88    9.59    4.85  300.12   300.12   300.12  1112.43    .42   1.99     9.7    12.126
    25.00     15.92     11.30     4.77   11.21    5.96  300.08   300.08   300.08  1112.38    .31   2.04    11.3    14.659
    36.00     21.92     12.87     5.73   13.09    7.17  300.04   300.04   300.04  1112.32    .26   2.07    12.9    17.448
    49.85     29.22     14.66     6.86   15.39    8.50  300.00   300.00   300.00  1112.24    .24   2.11    14.7    20.693
    55.98     32.42     15.40     7.34   16.40    9.06  299.99   299.99   299.99  1112.20    .23   2.12    15.4    22.074
    62.87     35.92     16.20     7.85   17.51    9.62  299.98   299.98   299.98  1112.15    .23   2.14    16.2    23.547
    70.60     39.82     16.99     8.40   18.74   10.15  299.96   299.96   299.96  1112.10    .20   2.15    17.0    25.066
    79.29     44.22     17.69     8.95   20.09   10.56  299.95   299.95   299.95  1112.06    .16   2.16    17.7    26.550
    89.05     49.02     18.31     9.50   21.55   10.90  299.94   299.94   299.94  1112.02    .13   2.17    18.3    28.022
   100.00     54.32     19.01    10.12   23.16   11.26  299.93   299.93   299.93  1111.97    .13   2.18    19.0    29.628
   112.30     60.22     19.77    10.79   24.96   11.65  299.91   299.91   299.91  1111.92    .13   2.19    19.8    31.391
   126.12     67.02     20.66    11.57   27.02   12.08  299.90   299.90   299.90  1111.86    .13   2.20    20.7    33.390
   141.64     74.22     21.77    12.20   29.21   12.52  299.88   299.88   299.88  1111.79    .15   2.21    21.8    35.298
   159.06     82.42     23.14    12.81   31.70   12.99  299.86   299.86   299.86  1111.69    .17   2.23    23.1    37.315
   178.63     91.62     24.67    13.49   34.49   13.48  299.84   299.84   299.84  1111.58    .17   2.24    24.7    39.528
   200.61    101.82     26.35    14.24   37.58   13.98  299.82   299.82   299.82  1111.45    .17   2.26    26.4    41.921
   225.28    113.22     28.22    15.07   41.02   14.49  299.79   299.79   299.79  1111.31    .16   2.28    28.2    44.524
   253.00    125.82     30.27    16.00   44.81   15.01  299.76   299.76   299.76  1111.15    .16   2.29    30.3    47.319
   284.13    140.02     32.56    17.03   49.07   15.53  299.73   299.73   299.73  1110.97    .16   2.31    32.6    50.372
   319.08    155.82     35.09    18.18   53.81   16.04  299.70   299.70   299.70  1110.77    .16   2.33    35.1    53.657
   358.34    173.22     37.85    19.44   59.00   16.53  299.67   299.67   299.67  1110.55    .16   2.34    37.8    57.147
   402.42    192.82     40.93    20.86   64.84   17.00  299.63   299.63   299.63  1110.30    .16   2.36    40.9    60.932
   451.93    214.62     44.33    22.42   71.31   17.44  299.59   299.59   299.59  1110.02    .16   2.38    44.3    64.975
   507.53    238.82     48.07    24.15   78.47   17.84  299.55   299.55   299.55  1109.70    .15   2.39    48.1    69.273
   569.97    266.02     52.24    26.07   86.49   18.19  299.50   299.50   299.50  1109.35    .15   2.41    52.2    73.887
   640.09    296.52     56.87    28.22   95.45   18.49  299.45   299.45   299.45  1108.96    .15   2.43    56.9    78.812
   718.83    330.02     61.91    30.56  105.27   18.71  299.39   299.39   299.39  1108.53    .15   2.44    61.9    83.942
   807.27    367.52     67.49    33.16  116.21   18.85  299.33   299.33   299.33  1108.05    .15   2.46    67.5    89.370
   906.58    409.02     73.61    36.01  128.28   18.90  299.26   299.26   299.26  1107.52    .15   2.48    73.6    95.022
  1018.12    456.02     80.47    39.22  141.89   18.86  299.19   299.19   299.19  1106.92    .15   2.49    80.5   101.015
  1143.37    508.02     87.98    42.73  156.89   18.70  299.11   299.11   299.11  1106.27    .14   2.51    88.0   107.178
  1284.04    565.52     96.21    46.58  173.41   18.42  299.03   299.03   299.03  1105.55    .14   2.52    96.2   113.467
  1442.01    630.52    105.41    50.89  192.00   18.00  298.93   298.93   298.93  1104.74    .14   2.54   105.4   119.974
  1619.41    702.52    115.49    55.62  212.50   17.44  298.83   298.83   298.83  1103.85    .14   2.56   115.5   126.480
  1818.64    783.52    126.71    60.89  235.46   16.71  298.71   298.71   298.71  1102.86    .14   2.57   126.7   132.993
  2042.38    872.52    138.90    66.62  260.56   15.84  298.59   298.59   298.59  1101.78    .14   2.59   138.9   139.212
  2293.64    973.52    152.58    73.05  288.91   14.78  298.45   298.45   298.45  1100.56    .14   2.60   152.6   145.194
  2575.82   1084.52    167.45    80.04  319.91   13.57  298.30   298.30   298.30  1099.24    .13   2.61   167.4   150.507
  2892.71   1209.52    184.00    87.82  354.64   12.21  298.13   298.13   298.13  1097.77    .13   2.63   184.0   155.102
  3248.59   1348.52    202.19    96.38  393.04   10.77  297.95   297.95   297.95  1096.16    .13   2.64   202.2   158.768
  3648.25   1504.52    222.36   105.88  435.91    9.37  297.75   297.75   297.75  1094.36    .13   2.66   222.4   161.870
  4097.08   1677.52    244.46   116.28  483.18    8.30  297.53   297.53   297.53  1092.40    .13   2.67   244.5   166.007
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   4601.13  1871.52   268.95  127.81  535.87    8.04   297.29   297.29   297.29  1090.22    .13   2.68  268.9 175.483
   5167.19  2087.52   295.87  140.50  594.19    9.06   297.02   297.02   297.02  1087.82    .12   2.70  295.9 195.018
   5802.88  2329.52   325.67  154.53  659.13   11.40   296.72   296.72   296.72  1085.17    .12   2.71  325.7 224.949
   6516.79  2599.52   358.49  170.00  731.13   14.81   296.40   296.40   296.40  1082.26    .12   2.72  358.5 262.233
   7318.52  2901.52   394.74  187.08  811.15   19.08   296.04   296.04   296.04  1079.04    .12   2.73  394.7 304.941
   8218.89  3238.52   434.67  205.90  899.86   24.11   295.65   295.65   295.65  1075.50    .12   2.74  434.7 352.279
   9230.02  3615.52   478.76  226.68  998.44   29.87   295.21   295.21   295.21  1071.60    .12   2.75  478.8 404.405
  10365.55  4036.52   527.35  249.59 1107.77   36.37   294.73   294.73   294.73  1067.31    .12   2.77  527.4 461.560
  11640.78  4507.52   581.00  274.87 1229.24   43.65   294.20   294.20   294.20  1062.58    .11   2.78  581.0 524.355
  13072.90  5034.52   640.22  302.79 1364.20   51.76   293.62   293.62   293.62  1057.37    .11   2.79  640.2 593.394
  14681.20  5622.52   705.41  302.79 1513.70   60.74   292.98   292.98   292.98  1051.65    .11   2.80  705.4 593.394
  16487.37  6281.52   777.50  302.79 1680.06   70.62   292.27   292.27   292.27  1045.34    .11   2.81  777.5 593.394
                TOTAL TRANMITANCE FOR ALL SOURCES IS:  .0000E+00
WAVL      1.06
 NOTE: THAT THE ABOVE CARD WAS MODIFIED FOR CONSISTENCY TO:
WAVL       .1060E+01 .1060E+01 .0000E+00
                                            BEGINNING          ENDING
                WAVENUMBER (CM**-1)          9433.963          9433.963
                WAVELENGTH (MICROMETERS)        1.060             1.060
                FREQUENCY (GHZ)            283018.875        283018.875
              **** EOSAEL WARNING ****
 VISIBILITY AND EXTINCTION = 0.0, VISIBILITY CHANGED TO 10.0 KM
                                       VISIBILITY
                                        10.00 KM
                                      RUN NUMBER  2
1
                                     ****************
                                     *              *
                                     *   COMBIC     *
                                     *   PHASE 2    *
                                     *              *
                                     ****************
PHAS       .2000E+01 .5000E+01 .6000E+01 .1200E+02 .9000E+01 .0000E+00 .1000E+01
 FILE            9.0        his.l8a1
 COMBIC CLOUD HISTORY ON UNIT  9  OPENED TO:        his.l8a1
 NAME
          Testing L8A1 self-screening RP smoke grenades
 ORIG            0.0        0.0        0.0       90.0      265.0        0.0       0.0
1
                                  METEOROLOGICAL CONDITIONS FROM HISTORY FILE
  WINDSPEED (10 M)  =   2.0  M/S            WIND DIRECTION     =  202.4  DEG WRT N
  RELATIVE HUMIDITY =  90.0  PERCENT        PASQUILL CATEGORY =    B    ( 1.60 )
  AIR TEMPERATURE   = 300.6  DEG K          AIR PRESSURE       =   963.  MB
  SURFACE ROUGHNESS =  .1000 M              AIR DENSITY        =  1110.  G/M**3
                MASS EXTINCTION COEFFICIENTS FROM HISTORY FILE (M**2/GRAM)
  OBSCURANT                       WAVELENGTH (MICROMETERS)
    CODE       .4-.7    .7-1.2    1.06     3.-5.    8.-12.    10.6     94 GHZ
  ---------   ------    ------   ------    ------   ------    ------   ------
      1       3.2280    2.3638   2.1094    .4127     .3043     .2792    .0010
      2       3.2280    2.3638   2.1094    .4127     .3043     .2792    .0010
      3       2.1520    2.1368   2.0302    .2668     .0601     .0750    .0010
      4       6.8510    4.5920   3.4970    .2450     .0200     .0180    .0010
      5       3.2280    2.3638   2.1094    .4127     .3043     .2792    .0010
      6       1.8600    1.6300   1.4000   1.7900    1.6800    1.6800    .0010
      7       1.8600    1.6300   1.4000   1.7900    1.6800    1.6800    .0010
      8       5.6500    4.0800   3.2500    .2450     .0230     .0270    .0010
      9        .3200     .3000    .2900    .2700     .2500     .2500    .0010
     10        .3200     .2900    .2600    .2700     .2600     .2400    .0010
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      11      .0350    .0360    .0370    .0350    .0380    .0360    .0010
      12     1.5000   1.4600   1.4200    .7500    .3200    .3000    .0010
      13      .0010    .0010    .0010    .0010    .0010    .0010    .0004
      14     6.1000   3.7500   2.9400   1.3500   1.0100   1.0000    .0020
      15     6.8510   4.5920   1.4300    .0540    .0200    .0180    .0010
      16     5.3700   2.9000   2.1000    .0900    .0900    .0700    .0010
      17     6.2000   3.5000   2.5000    .2300    .0500    .0480    .0010
      18     3.3300   2.7500   2.6600    .2600    .3200    .2300    .0010
      19     1.3000   1.7400   1.7000    .0800    .1600    .3800    .0010
      20      .0000    .0000    .0000    .0000    .0000    .0000    .0000
      21      .0000    .0000    .0000    .0000    .0000    .0000    .0000
      22      .0000    .0000    .0000    .0000    .0000    .0000    .0000
      23      .0000    .0000    .0000    .0000    .0000    .0000    .0000
      24      .0000    .0000    .0000    .0000    .0000    .0000    .0000
      25      .0000    .0000    .0000    .0000    .0000    .0000    .0000
      26      .0000    .0000    .0000    .0000    .0000    .0000    .0000
      27      .0000    .0000    .0000    .0000    .0000    .0000    .0000
      28      .0000    .0000    .0000    .0000    .0000    .0000    .0000
      29      .0000    .0000    .0000    .0000    .0000    .0000    .0000
      30      .0000    .0000    .0000    .0000    .0000    .0000    .0000
1
                                        HISTORY FILE CONTAINS INFORMATION ON   1 SOURCES
         NUMBER     XN                                                 NUMBER
 SOURCE    OF      SCALE    FILL     MENU   OBSC  EFFICIENCY  YIELD   OF SUB-
   ID   SUBCLOUDS  FACTOR  WEIGHT   NUMBER  TYPE    PERCENT  FACTOR  MUNITIONS
 ------ ---------  ------ --------  ------  ----  ---------- ------  ---------
    1       3        1.00      .79     0.     5.     95.00     7.85     1.00
           BURN        VEHICLE                   BARRAGE               HIGH-EXP
 SOURCE  DURATION  SPEED DIRECTION  ROUNDS  DURATION  IMPACT REGION  SOIL  DOB
   ID      (SEC)   (M/S)    DEG    PER SEC   (SEC)    X (M)   Y (M)  TYPE  (M)
 ------  --------  ----- ---------  ------- -------- ------  ------  ---- -----
    1      658.      .0     0.        .0       0.      0.      0.     .0   .00
            WIND DIRECTION ALTERED TO  265.0 DEG WRT N
 SLOC              1.0       1.0      0.0     300.0      0.0       0.0       2.0
                                                       SOURCES ADDED
   SOURCE          XN       ACTIVE TIME LIMIT     POSITION (ORIGINAL SYSTEM)      POSITION (ROTATED SYSTEM)        MOVING SOURCE
  UNIT  ID       SCALING      BEGIN      END        X          Y          Z         X          Y          Z        SPEED  DIRECTION
     1   1        1.000        .00     300.00      .0         .0         2.0        .0         .0         2.0       .00    -359.8
 SLOC              1.0       1.0      0.0     300.0      5.0       0.0       2.0
     2   1        1.000        .00     300.00     5.0         .0         2.0       5.0        -.4         2.0       .00    -359.8
 SLOC              1.0       1.0      0.0     300.0     10.0       0.0       2.0
     3   1        1.000        .00     300.00    10.0         .0         2.0      10.0        -.9         2.0       .00    -359.8
 OLOC              1.0      10.0    100.0       2.0      0.0     300.0       0.0
 TLOC              1.0      10.0   -100.0       2.0      1.0       0.0       0.0
                                                   NEW OR ALTERED LINES OF SIGHT
                               ORIGINAL SYSTEM                                             ROTATED SYSTEM
  OBS  TGT         OBSERVER (M)               TARGET (M)               OBSERVER (M)               TARGET (M)        TIME (SEC)
  NO.  NO.      X         Y         Z        X         Y        Z        X        Y        Z        X        Y        Z    START   END
   1    1     10.0     100.0      2.0      10.0    -100.0      2.0     18.7     98.7      2.0      1.2   -100.5      2.0     .0  300.0
 LIST              2.0       0.0     300.0       5.0
 DONE              0.0       0.0       0.0       0.0       0.0       0.0       0.0
1                  SUBCLOUD  CLOUD                                                  PATH-
   TIME  OBS TARG     CL    NUMBER               TRANSMISSION                       LENGTH          MAX. CONTRIBUTION TO CLOUD
  (SEC)  NO.  NO.  (G/M**2)          .4-.7 .7-1.2 1.06 3.-5. 8.-12. 10.6 94 GHZ   METERS    X        Y     Z    SIGX  SIGY  SIGZ   WBAR
                     1.151     3                                                  58.1    11.1      -.9   2.6    .0   8.7   2.2 6.47E+00
                      .481     2                                                  63.0     9.6      -.4   3.4    .0   9.8   3.2 4.22E+00
                      .031     2                                                  19.8    11.4      -.4  11.1   2.6   7.5   3.6 6.71E+01
                      .317     1                                                  67.8     9.6       .0   4.1    .0  11.2   4.2 3.75E+00
    5.0    1    1    1.980     3      .002  .009  .015  .442  .547  .575  .998
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               2.031   3                                              60.1  11.2   -.9   2.8   .0   8.7  2.2 1.18E+01
                .860   2                                              66.0   9.6   -.4   3.9   .0   9.8  3.2 8.14E+00
                .552   1                                              72.0   9.6    .0   4.8   .0  11.2  4.2 7.17E+00
                .016   1                                              24.3  14.6    .0  13.5  3.7   9.3  4.7 6.72E+01
  10.0  1  1   3.459   3   .000  .000  .001  .240  .349  .381  .997
               2.166   3                                              60.8  11.2   -.9   2.9   .0   8.7  2.2 1.27E+01
               1.182   2                                              67.1   9.6   -.4   4.1   .0   9.8  3.2 1.15E+01
                .769   1                                              73.5   9.6    .0   5.0   .0  11.2  4.2 1.04E+01
  15.0  1  1   4.117   3   .000  .000  .000  .183  .286  .317  .996
               2.020   3                                              61.1  11.2   -.9   2.8   .0   8.7  2.2 1.18E+01
               1.172   2                                              67.6   9.6   -.4   4.0   .0   9.8  3.2 1.14E+01
                .908   1                                              74.2   9.6    .0   5.2   .0  11.2  4.2 1.27E+01
  20.0  1  1   4.100   3   .000  .000  .000  .184  .287  .318  .996
               1.998   3                                              61.3  11.2   -.9   2.8   .0   8.7  2.2 1.17E+01
               1.146   2                                              68.0   9.6   -.4   4.0   .0   9.8  3.2 1.11E+01
                .868   1                                              74.6   9.6    .0   5.1   .0  11.2  4.2 1.20E+01
  25.0  1  1   4.011   3   .000  .000  .000  .191  .295  .326  .996
               1.866   3                                              61.5  11.2   -.9   2.8   .0   8.7  2.2 1.09E+01
               1.115   2                                              68.2   9.6   -.4   4.0   .0   9.8  3.2 1.08E+01
                .851   1                                              74.9   9.6    .0   5.1   .0  11.2  4.2 1.17E+01
  30.0  1  1   3.832   3   .000  .000  .000  .206  .312  .343  .996
               1.841   3                                              61.6  11.2   -.9   2.8   .0   8.7  2.2 1.07E+01
               1.057   2                                              68.4   9.6   -.4   4.0   .0   9.8  3.2 1.02E+01
                .805   1                                              75.2   9.6    .0   5.1   .0  11.2  4.2 1.10E+01
  35.0  1  1   3.702   3   .000  .000  .000  .217  .324  .356  .996
               1.767   3                                              61.6  11.2   -.9   2.8   .0   8.7  2.2 1.03E+01
               1.033   2                                              68.5   9.6   -.4   4.0   .0   9.8  3.2 9.92E+00
                .791   1                                              75.3   9.6    .0   5.0   .0  11.2  4.2 1.08E+01
  40.0  1  1   3.591   3   .000  .000  .001  .227  .335  .367  .996
               1.682   3                                              61.7  11.2   -.9   2.8   .0   8.7  2.2 9.74E+00
                .967   2                                              68.6   9.6   -.4   3.9   .0   9.8  3.2 9.24E+00
                .766   1                                              75.5   9.6    .0   5.0   .0  11.2  4.2 1.04E+01
  45.0  1  1   3.415   3   .000  .000  .001  .244  .354  .385  .997
               1.651   3                                              61.7  11.2   -.9   2.8   .0   8.7  2.2 9.55E+00
                .956   2                                              68.6   9.6   -.4   3.9   .0   9.8  3.2 9.11E+00
                .735   1                                              75.5   9.6    .0   5.0   .0  11.2  4.2 9.87E+00
  50.0  1  1   3.341   3   .000  .000  .001  .252  .362  .393  .997
               1.536   3                                              61.7  11.2   -.9   2.7   .0   8.7  2.2 8.85E+00
                .918   2                                              68.7   9.6   -.4   3.9   .0   9.8  3.2 8.73E+00
                .720   1                                              75.6   9.6    .0   5.0   .0  11.2  4.2 9.64E+00
  55.0  1  1   3.173   3   .000  .001  .001  .270  .381  .412  .997
               1.532   3                                              61.8  11.2   -.9   2.7   .0   8.7  2.2 8.82E+00
                .883   2                                              68.7   9.6   -.4   3.9   .0   9.8  3.2 8.37E+00
                .681   1                                              75.6   9.6    .0   4.9   .0  11.2  4.2 9.05E+00
  60.0  1  1   3.096   3   .000  .001  .001  .279  .390  .421  .997
               1.442   3                                              61.8  11.2   -.9   2.7   .0   8.7  2.2 8.28E+00
                .858   2                                              68.7   9.6   -.4   3.9   .0   9.8  3.2 8.12E+00
                .667   1                                              75.6   9.6    .0   4.9   .0  11.2  4.2 8.84E+00
  65.0  1  1   2.968   3   .000  .001  .002  .294  .405  .437  .997
               1.401   3                                              61.8  11.2   -.9   2.7   .0   8.7  2.2 8.03E+00
                .808   2                                              68.7   9.6   -.4   3.9   .0   9.8  3.2 7.61E+00
                .631   1                                              75.6   9.6    .0   4.9   .0  11.2  4.2 8.32E+00
  70.0  1  1   2.840   3   .000  .001  .003  .310  .421  .452  .997
               1.361   3                                              61.8  11.2   -.9   2.7   .0   8.7  2.2 7.79E+00
                .793   2                                              68.7   9.6   -.4   3.9   .0   9.8  3.2 7.45E+00
                .617   1                                              75.6   9.6    .0   4.8   .0  11.2  4.2 8.11E+00
  75.0  1  1   2.771   3   .000  .001  .003  .319  .430  .461  .997
               1.277   3                                              61.7  11.2   -.9   2.7   .0   8.7  2.2 7.29E+00
                .754   2                                              68.7   9.6   -.4   3.8   .0   9.8  3.2 7.01E+00
```

```
               .604   1                                               75.6   9.6   .0  4.8   .0 11.2  4.2 7.92E+00
   80.0  1  1  2.635  3  .000 .002 .004 .337 .448 .479 .997
              1.262   3                                               61.7  11.2  -.9  2.7   .0  8.7  2.2 7.20E+00
               .742   2                                               68.6   9.6  -.4  3.8   .0  9.8  3.2 6.87E+00
               .570   1                                               75.5   9.6   .0  4.8   .0 11.2  4.2 7.43E+00
   85.0  1  1  2.574  3  .000 .002 .004 .346 .457 .487 .997
              1.173   3                                               61.7  11.2  -.9  2.7   .0  8.7  2.2 6.67E+00
               .723   2                                               68.6   9.6  -.4  3.8   .0  9.8  3.2 6.67E+00
               .558   1                                               75.5   9.6   .0  4.8   .0 11.2  4.2 7.26E+00
   90.0  1  1  2.454  3  .000 .003 .006 .363 .474 .504 .998
              1.163   3                                               61.7  11.2  -.9  2.7   .0  8.7  2.2 6.62E+00
               .690   2                                               68.6   9.6  -.4  3.7   .0  9.8  3.2 6.31E+00
               .525   1                                               75.5   9.6   .0  4.7   .0 11.2  4.2 6.79E+00
   95.0  1  1  2.379  3  .000 .004 .007 .375 .485 .515 .998
              1.109   3                                               61.7  11.2  -.9  2.6   .0  8.7  2.2 6.30E+00
               .675   2                                               68.6   9.6  -.4  3.7   .0  9.8  3.2 6.14E+00
               .515   1                                               75.4   9.6   .0  4.7   .0 11.2  4.2 6.65E+00
  100.0  1  1  2.299  3  .001 .004 .008 .387 .497 .526 .998
              1.059   3                                               61.7  11.2  -.9  2.6   .0  8.7  2.2 6.01E+00
               .636   2                                               68.5   9.6  -.4  3.6   .0  9.8  3.2 5.74E+00
               .497   1                                               75.4   9.6   .0  4.7   .0 11.2  4.2 6.37E+00
  105.0  1  1  2.193  3  .001 .006 .010 .404 .513 .542 .998
              1.036   3                                               61.6  11.2  -.9  2.6   .0  8.7  2.2 5.87E+00
               .628   2                                               68.5   9.6  -.4  3.6   .0  9.8  3.2 5.66E+00
               .482   1                                               75.4   9.6   .0  4.6   .0 11.2  4.2 6.12E+00
  110.0  1  1  2.146  3  .001 .006 .011 .412 .520 .549 .998
               .964   3                                               61.6  11.2  -.9  2.6   .0  8.7  2.2 5.45E+00
               .602   2                                               68.5   9.6  -.4  3.6   .0  9.8  3.2 5.39E+00
               .474   1                                               75.3   9.6   .0  4.6   .0 11.2  4.2 5.98E+00
  115.0  1  1  2.040  3  .001 .008 .014 .431 .538 .566 .998
               .959   3                                               61.6  11.2  -.9  2.6   .0  8.7  2.2 5.42E+00
               .584   2                                               68.4   9.6  -.4  3.6   .0  9.8  3.2 5.21E+00
               .451   1                                               75.3   9.6   .0  4.5   .0 11.2  4.2 5.63E+00
  120.0  1  1  1.994  3  .002 .009 .015 .439 .545 .573 .998
               .898   3                                               61.6  11.2  -.9  2.6   .0  8.7  2.2 5.07E+00
               .568   2                                               68.4   9.6  -.4  3.5   .0  9.8  3.2 5.05E+00
               .443   1                                               75.2   9.6   .0  4.5   .0 11.2  4.2 5.50E+00
  125.0  1  1  1.909  3  .002 .011 .018 .455 .559 .587 .998
               .877   3                                               61.6  11.2  -.9  2.6   .0  8.7  2.2 4.94E+00
               .538   2                                               68.4   9.6  -.4  3.5   .0  9.8  3.2 4.75E+00
               .419   1                                               75.2   9.6   .0  4.4   .0 11.2  4.2 5.16E+00
  130.0  1  1  1.834  3  .003 .013 .021 .469 .572 .599 .998
               .848   3                                               61.5  11.2  -.9  2.6   .0  8.7  2.2 4.78E+00
               .527   2                                               68.3   9.6  -.4  3.5   .0  9.8  3.2 4.65E+00
               .413   1                                               75.1   9.6   .0  4.4   .0 11.2  4.2 5.06E+00
  135.0  1  1  1.788  3  .003 .015 .023 .478 .580 .607 .998
               .797   3                                               61.5  11.2  -.9  2.6   .0  8.7  2.2 4.48E+00
               .495   2                                               68.3   9.6  -.4  3.4   .0  9.8  3.2 4.34E+00
               .403   1                                               75.1   9.6   .0  4.3   .0 11.2  4.2 4.92E+00
  140.0  1  1  1.695  3  .004 .018 .028 .497 .597 .623 .998
               .785   3                                               61.5  11.2  -.9  2.6   .0  8.7  2.2 4.41E+00
               .489   2                                               68.3   9.6  -.4  3.4   .0  9.8  3.2 4.28E+00
               .384   1                                               75.1   9.6   .0  4.3   .0 11.2  4.2 4.65E+00
  145.0  1  1  1.658  3  .005 .020 .030 .504 .604 .629 .998
               .726   3                                               61.5  11.2  -.9  2.6   .0  8.7  2.2 4.07E+00
               .474   2                                               68.2   9.6  -.4  3.4   .0  9.8  3.2 4.14E+00
               .377   1                                               75.0   9.6   .0  4.3   .0 11.2  4.2 4.55E+00
  150.0  1  1  1.576  3  .006 .024 .036 .522 .619 .644 .998
               .724   3                                               61.5  11.2  -.9  2.6   .0  8.7  2.2 4.07E+00
```

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               .452  2                                             68.2   9.6   -.4   3.4   .0   9.8   3.2 3.93E+00
               .357  1                                             75.0   9.6    .0   4.2   .0  11.2   4.2 4.27E+00
155.0  1  1   1.532  3  .007  .027  .039  .531  .627  .652  .998
               .685  3                                             61.4  11.2   -.9   2.5   .0   8.7   2.2 3.84E+00
               .440  2                                             68.2   9.6   -.4   3.4   .0   9.8   3.2 3.82E+00
               .350  1                                             74.9   9.6    .0   4.2   .0  11.2   4.2 4.18E+00
160.0  1  1   1.475  3  .009  .031  .045  .544  .638  .662  .999
               .658  3                                             61.4  11.2   -.9   2.5   .0   8.7   2.2 3.69E+00
               .413  2                                             68.1   9.6   -.4   3.3   .0   9.8   3.2 3.57E+00
               .335  1                                             74.9   9.6    .0   4.1   .0  11.2   4.2 3.98E+00
165.0  1  1   1.405  3  .011  .036  .052  .560  .652  .675  .999
               .641  3                                             61.4  11.2   -.9   2.5   .0   8.7   2.2 3.59E+00
               .407  2                                             68.1   9.6   -.4   3.3   .0   9.8   3.2 3.51E+00
               .324  1                                             74.8   9.6    .0   4.1   .0  11.2   4.2 3.84E+00
170.0  1  1   1.372  3  .012  .039  .055  .568  .659  .682  .999
               .597  3                                             61.4  11.2   -.9   2.5   .0   8.7   2.2 3.34E+00
               .386  2                                             68.1   9.6   -.4   3.3   .0   9.8   3.2 3.33E+00
               .318  1                                             74.8   9.6    .0   4.1   .0  11.2   4.2 3.75E+00
175.0  1  1   1.301  3  .015  .046  .064  .584  .673  .695  .999
               .593  3                                             61.4  11.2   -.9   2.5   .0   8.7   2.2 3.32E+00
               .375  2                                             68.1   9.6   -.4   3.3   .0   9.8   3.2 3.23E+00
               .300  1                                             74.7   9.6    .0   4.0   .0  11.2   4.2 3.53E+00
180.0  1  1   1.268  3  .017  .050  .069  .592  .680  .702  .999
               .552  3                                             61.3  11.2   -.9   2.5   .0   8.7   2.2 3.09E+00
               .365  2                                             68.0   9.6   -.4   3.3   .0   9.8   3.2 3.13E+00
               .294  1                                             74.7   9.6    .0   4.0   .0  11.2   4.2 3.45E+00
185.0  1  1   1.211  3  .020  .057  .078  .607  .692  .713  .999
               .542  3                                             61.3  11.2   -.9   2.5   .0   8.7   2.2 3.03E+00
               .344  2                                             68.0   9.6   -.4   3.3   .0   9.8   3.2 2.95E+00
               .276  1                                             74.7   9.6    .0   4.0   .0  11.2   4.2 3.22E+00
190.0  1  1   1.163  3  .023  .064  .086  .619  .702  .723  .999
               .521  3                                             61.3  11.2   -.9   2.5   .0   8.7   2.2 2.91E+00
               .337  2                                             68.0   9.6   -.4   3.3   .0   9.8   3.2 2.88E+00
               .272  1                                             74.6   9.6    .0   4.0   .0  11.2   4.2 3.16E+00
195.0  1  1   1.130  3  .026  .069  .092  .627  .709  .730  .999
               .492  3                                             61.3  11.2   -.9   2.5   .0   8.7   2.2 2.75E+00
               .314  2                                             67.9   9.6   -.4   3.2   .0   9.8   3.2 2.68E+00
               .263  1                                             74.6   9.6    .0   3.9   .0  11.2   4.2 3.06E+00
200.0  1  1   1.069  3  .032  .080  .105  .643  .722  .742  .999
               .483  3                                             61.3  11.2   -.9   2.5   .0   8.7   2.2 2.70E+00
               .310  2                                             67.9   9.6   -.4   3.2   .0   9.8   3.2 2.64E+00
               .251  1                                             74.5   9.6    .0   3.9   .0  11.2   4.2 2.90E+00
205.0  1  1   1.045  3  .034  .085  .110  .650  .728  .747  .999
               .446  3                                             61.2  11.2   -.9   2.5   .0   8.7   2.2 2.49E+00
               .299  2                                             67.9   9.6   -.4   3.2   .0   9.8   3.2 2.54E+00
               .245  1                                             74.5   9.6    .0   3.9   .0  11.2   4.2 2.84E+00
210.0  1  1    .991  3  .041  .096  .124  .664  .740  .758  .999
               .446  3                                             61.2  11.2   -.9   2.5   .0   8.7   2.2 2.49E+00
               .286  2                                             67.8   9.6   -.4   3.2   .0   9.8   3.2 2.43E+00
               .231  1                                             74.5   9.6    .0   3.8   .0  11.2   4.2 2.66E+00
215.0  1  1    .964  3  .045  .102  .131  .672  .746  .764  .999
               .420  3                                             61.2  11.2   -.9   2.5   .0   8.7   2.2 2.34E+00
               .278  2                                             67.8   9.6   -.4   3.2   .0   9.8   3.2 2.36E+00
               .226  1                                             74.4   9.6    .0   3.8   .0  11.2   4.2 2.60E+00
220.0  1  1    .924  3  .051  .113  .142  .683  .755  .773  .999
               .405  3                                             61.2  11.2   -.9   2.5   .0   8.7   2.2 2.26E+00
               .261  2                                             67.8   9.6   -.4   3.2   .0   9.8   3.2 2.20E+00
               .214  1                                             74.4   9.6    .0   3.8   .0  11.2   4.2 2.46E+00
225.0  1  1    .880  3  .058  .125  .156  .695  .765  .782  .999
```

```
                  .394     3                                            61.2    11.2    -.9   2.5    .0   8.7   2.2 2.19E+00
                  .256     2                                            67.8     9.6    -.4   3.2    .0   9.8   3.2 2.16E+00
                  .209     1                                            74.3     9.6     .0   3.8    .0  11.2   4.2 2.39E+00
  230.0   1   1   .859     3    .063  .131  .163  .702  .770  .787  .999
                  .368     3                                            61.1    11.2    -.9   2.5    .0   8.7   2.2 2.05E+00
                  .241     2                                            67.7     9.6    -.4   3.1    .0   9.8   3.2 2.04E+00
                  .204     1                                            74.3     9.6     .0   3.8    .0  11.2   4.2 2.33E+00
  235.0   1   1   .813     3    .072  .146  .180  .715  .781  .797  .999
                  .364     3                                            61.1    11.2    -.9   2.5    .0   8.7   2.2 2.02E+00
                  .236     2                                            67.7     9.6    -.4   3.1    .0   9.8   3.2 1.99E+00
                  .192     1                                            74.3     9.6     .0   3.7    .0  11.2   4.2 2.19E+00
  240.0   1   1   .792     3    .078  .154  .188  .721  .786  .802  .999
                  .339     3                                            61.1    11.2    -.9   2.5    .0   8.7   2.2 1.88E+00
                  .229     2                                            67.7     9.6    -.4   3.1    .0   9.8   3.2 1.93E+00
                  .188     1                                            74.2     9.6     .0   3.7    .0  11.2   4.2 2.14E+00
  245.0   1   1   .755     3    .087  .168  .203  .732  .795  .810  .999
                  .334     3                                            61.1    11.2    -.9   2.5    .0   8.7   2.2 1.86E+00
                  .216     2                                            67.6     9.6    -.4   3.1    .0   9.8   3.2 1.82E+00
                  .176     1                                            74.2     9.6     .0   3.7    .0  11.2   4.2 2.00E+00
  250.0   1   1   .726     3    .096  .180  .216  .741  .802  .816  .999
                  .320     3                                            61.1    11.2    -.9   2.4    .0   8.7   2.2 1.77E+00
                  .210     2                                            67.6     9.6    -.4   3.1    .0   9.8   3.2 1.77E+00
                  .173     1                                            74.2     9.6     .0   3.7    .0  11.2   4.2 1.96E+00
  255.0   1   1   .703     3    .103  .190  .227  .748  .807  .822  .999
                  .304     3                                            61.1    11.2    -.9   2.4    .0   8.7   2.2 1.68E+00
                  .196     2                                            67.6     9.6    -.4   3.1    .0   9.8   3.2 1.65E+00
                  .166     1                                            74.1     9.6     .0   3.7    .0  11.2   4.2 1.88E+00
  260.0   1   1   .666     3    .117  .207  .245  .760  .817  .830  .999
1                SUBCLOUD  CLOUD                                        PATH-
  TIME  OBS TARG    CL     NUMBER              TRANSMISSION             LENGTH          MAX. CONTRIBUTION TO CLOUD
 (SEC)  NO.  NO. (G/M**2)        .4-.7 .7-1.2 1.06 3.-5. 8.-12. 10.6 94 GHZ METERS   X      Y     Z   SIGX  SIGY  SIGZ    WBAR
                  .298     3                                            61.0    11.2    -.9   2.4    .0   8.7   2.2 1.65E+00
                  .193     2                                            67.6     9.6    -.4   3.1    .0   9.8   3.2 1.62E+00
                  .159     1                                            74.1     9.6     .0   3.7    .0  11.2   4.2 1.79E+00
  265.0   1   1   .650     3    .123  .215  .254  .765  .821  .834  .999
 SUBCLOUD    8 REMOVED
 SUBCLOUD    5 REMOVED
 SUBCLOUD    2 REMOVED
                  .276     3                                            61.0    11.2    -.9   2.4    .0   8.7   2.2 1.53E+00
                  .185     2                                            67.5     9.6    -.4   3.1    .0   9.8   3.2 1.55E+00
                  .155     1                                            74.1     9.6     .0   3.7    .0  11.2   4.2 1.75E+00
  270.0   1   1   .616     3    .137  .233  .273  .775  .829  .842  .999
                  .275     3                                            61.0    11.2    -.9   2.4    .0   8.7   2.2 1.52E+00
                  .178     2                                            67.5     9.6    -.4   3.1    .0   9.8   3.2 1.49E+00
                  .146     1                                            74.0     9.6     .0   3.6    .0  11.2   4.2 1.64E+00
  275.0   1   1   .599     3    .145  .243  .283  .781  .833  .846  .999
                  .258     3                                            61.0    11.2    -.9   2.4    .0   8.7   2.2 1.43E+00
                  .173     2                                            67.5     9.6    -.4   3.1    .0   9.8   3.2 1.45E+00
                  .143     1                                            74.0     9.6     .0   3.6    .0  11.2   4.2 1.60E+00
  280.0   1   1   .574     3    .157  .258  .298  .789  .840  .852  .999
                  .250     3                                            61.0    11.2    -.9   2.4    .0   8.7   2.2 1.38E+00
                  .163     2                                            67.5     9.6    -.4   3.0    .0   9.8   3.2 1.36E+00
                  .134     1                                            74.0     9.6     .0   3.6    .0  11.2   4.2 1.51E+00
  285.0   1   1   .547     3    .171  .274  .315  .798  .847  .858  .999
                  .243     3                                            61.0    11.2    -.9   2.4    .0   8.7   2.2 1.34E+00
                  .160     2                                            67.4     9.6    -.4   3.0    .0   9.8   3.2 1.33E+00
                  .131     1                                            73.9     9.6     .0   3.6    .0  11.2   4.2 1.47E+00
  290.0   1   1   .533     3    .179  .283  .325  .802  .850  .862  .999
                  .227     3                                            61.0    11.2    -.9   2.4    .0   8.7   2.2 1.25E+00
```

```
                      .150    2                                                      67.4     9.6     -.4   3.0    .0   9.8   3.2 1.25E+00
                      .128    1                                                      73.9     9.6      .0   3.6    .0  11.2   4.2 1.43E+00
   295.0   1   1      .505    3     .196  .303  .345  .812  .858  .868  .999
                      .224    3                                                      60.9    11.2     -.9   2.4    .0   8.7   2.2 1.24E+00
                      .147    2                                                      67.4     9.6     -.4   3.0    .0   9.8   3.2 1.22E+00
                      .120    1                                                      73.9     9.6      .0   3.6    .0  11.2   4.2 1.35E+00
   300.0   1   1      .492    3     .204  .313  .354  .816  .861  .872 1.000
1
               TOTAL TRANMITANCE FOR ALL SOURCES IS:   .3542E+00
                              END EOSAEL RUN
STOP 000
```

5.2.4 Example 4: Using the printer plot option VIEW and GREY to determine cloud sizes

```
WAVL    1.06
COMBIC
PHAS          2.0      5.0      6.0     12.0      9.0      0.0      1.0
FILE    9.0      his.l8a1
FILE    12.0     l8a1.pic
NAME
        Producing a contour representation for L8A1 smoke grenades
ORIG          0.0      0.0      0.0     90.0    270.0      0.0      0.0
LIST          0.0     10.0     30.0     10.0
NAME
        One munition at {0., 0., 0.,) starting at T=0.
SLOC          1.0      1.0      0.0    300.0      0.0      0.0      2.0
OLOC          1.0     40.0   -500.0     25.0      0.0    300.0      0.0
TLOC          1.0     40.0    500.0     25.0      1.0      0.0      0.0
VIEW          1.0      1.0    100.0     50.0     50.0     25.0     90.0
GREY          9.0     .001    0.901      0.0      1.0      1.0      0.0
DONE          0.0      0.0      0.0      0.0      0.0      0.0      0.0
END
STOP
```

This samples uses the same history file generated by the Phase I inputs from the previous example. In this example, we demonstrate the usage of the VIEW and GREY records and how to use the printer plot to obtain cloud size. Above are the Phase II inputs for this sample. UNITC=12.0 on the PHAS record opens the file pic.l8a1. The printer plot is stored in this file. The LIST record controls the times that a printer plot will be displayed by specifying a start time, end time and a delta time. In this example, the printer plot will occur from 5–15 s every five seconds. The munition is located at the origin and starts at 0 s. A first time user often has difficulty setting up the printer plot to best view the scenario. There are many ways of determining the length of a cloud. The method chosen here is to use the printer plot option to view the cloud crosswind in the horizontal direction.

The CLOPT parameter on the GREY record is equal to 0.0 for this example. Therefore this is a transmission plot. WAVEL = 1.0 indicating this is a visible transmission plot. Transmission ranges from 0 to 1.0. In this example SMINV =.001 means that any LOS with a transmittance of less one-tenth of one percent is printed as a "*" and SMAXV=.901 means that any LOS with a transmittance greater than 90.1 percent is printed as "blank". There are DIVIS grey scales between the extremes defined by SMINV and SMAXV with a separation given by (SMAXV-SMINV)/DIVIS = .10.

The most difficult part of using the printer-plot is the placement of the window. Ideally, you would like the cloud to fill the entire window in order to obtain the highest resolution possible. This involves experience, though the inexperienced can alway make a preliminary COMBIC run to help set the appropriate parameters. The main problem is determining the central LOS for OLOC--TLOC used to define the printer plot (see Figure 4.3). The following seven steps illustrate the analysis process used to define the above set of inputs.

1. Estimate the ultimate height of the cloud for the last time step defined by the LIST record. A good guess for the height of a L8A1 cloud for Pasquill stability B at 30 s is 50 m. This defines VLOSW or the vertical length of the window. Divide this number in half. This is now the height of the central LOS (ZOBS and ZTAR of OLOC and TLOC respectively).

2. Estimate the ultimate length of the cloud for the last time step defined by the LIST record. A good guess is to refer to the vertical profile section of the Phase I output to determine the windspeed at the height of step one. We see that the windspeed at a height of 50 m is 2.4 m/s. We then use the following equation to estimate the length of the cloud.

   L(*cloud*) = windspeed(*at ultimate height*) * [maximum time - starting time of the munition] + 20 or 30 m.

   This equation yields a rough estimate of the longest possible length of the cloud as well as the horizontal width of the window (CLOSW). Twenty to thirty meters is added since the source is usually not a point source, but has a finite width. In this example, the windspeed at a height of 50 m is 2.4 m/s, maximum time the printer plot is output is 30 s, and the starting time of the munition is 0 s. Adding 28 meters yields the maximum possible length of the cloud and CLOSW of the VIEW record as 100 m.

3. Draw on a scratch of paper, the x-y coordinate axis, the munition location, and label which direction North is with respect to the axis (XORDIR on the ORIG record).

4. Also label the direction the wind is coming from (WNDIR from the ORIG record).

5. Draw a rough cloud. Remember it has to go in the direction the wind is blowing. Label the length of the cloud as L m (in this case 100 m).

6. Determine the half-way point in your cloud and then shift this point 20-30 m upwind. Draw a line perpendicular to the wind direction through this point. This is now your central LOS. Make sure it is long enough so the endpoints are outside of the cloud. The height defined in step one and the x,y values read from your graph defines the observer and target location.

7. Run COMBIC and make corrections if necessary.

Though, this seems complicated, most users develop with time an instinctive feel on how to utilize the OLOC and TLOC records to produce a printer plot. Using the VIEW and GREY is dependent upon the users personal preferences and the requirements of the research. The maximum number of characters across the page (CLOSD) can only be 100. However, it was decided to use only 50 characters in the horizontal direction so this 100 m wide picture could be viewed on the screen (limit of 80 characters). This yields a resolution of (100 m)/(50 char) or 2 m/char. It was decided to keep the same resolution in the vertical direction which defines the number of characters in the vertical direction (VLOSW) to be 25.

To determine cloud length and height, it is a simple matter to determine which grey scale corresponds to the defeat threshold. The user then simply counts characters and multiplies by the resolution to obtain the dimension in meters. The user must observe two cautions however. First, the cloud length and height is valid for crosswind cases only. If the user views the cloud on an alongwind LOS, this would probably yield different values for the height. This is because the path length through the cloud is longer than the crosswind case. Similarly, viewing the cloud "top-down" could yield different values for the length of the cloud. Secondly, using a single length, width, and height to describe a complicated cloud like this one, can yield problems.

```
 TIME =   1.000E+01 X0 =   4.000E+01 Y0 =  -5.000E+02 Z0 =  2.500E+01
RANGE =   1.000E+03 AL =      .00000 BT =      1.000 GM =        .000
```

```
          FULL-WIDTH OF VIEW, CROSS-LOS HORIZONTAL =  1.000E+02 CROSS-LOS VERTICAL =   5.000E+01
                    DISPLAYED SCALE = TRANSMISSION, WAVELENGTH =  1.
                    PIXELS: HORIZONTAL =  50 VERTICAL =    25
                    GREY SCALE RANGES =   9.
           .000000 -        .001000 = *
           .001000 -        .101000 = 1
           .101000 -        .201000 = 2
           .201000 -        .301000 = 3
           .301000 -        .401000 = 4
           .401000 -        .501000 = 5
           .501000 -        .601000 = 6
           .601000 -        .701000 = 7
           .701000 -        .801000 = 8
           .801000 -        .901000 = 9
           .901000 -       1.001000 =
1   VERTICAL                                HORIZONTAL
          -5.000E+01     -2.000E+01      1.000E+01      4.000E+01
              +--------------+--------------+--------------+--------------
     2.500E+01+
              -
              -
              -
              -
              -
              -
              -
              -
              -
     5.000E+00+
              -
              -              999
              -            964458
              -            6211159
              -           841**128
              -          9621**127
              -          7411**138
              -         8521111269
              -         631112369
    -1.500E+01+       984211235
              -     97431111234
              - 975321111111234
              - 521111111111234
              - 4111*1111223344
              +--------------+--------------+--------------+--------------
          -5.000E+01     -2.000E+01      1.000E+01      4.000E+01
1
           TIME =   2.000E+01 XO =   4.000E+01 YO =  -5.000E+02 ZO =  2.500E+01
          RANGE =   1.000E+03 AL =       .00000 BT =       1.000 GM =        .000
          FULL-WIDTH OF VIEW, CROSS-LOS HORIZONTAL =  1.000E+02 CROSS-LOS VERTICAL =   5.000E+01
                    DISPLAYED SCALE = TRANSMISSION, WAVELENGTH =  1.
                    PIXELS: HORIZONTAL =  50 VERTICAL =    25
                    GREY SCALE RANGES =   9.
           .000000 -        .001000 = *
           .001000 -        .101000 = 1
           .101000 -        .201000 = 2
           .201000 -        .301000 = 3
           .301000 -        .401000 = 4
           .401000 -        .501000 = 5
           .501000 -        .601000 = 6
```

```
           .601000 -       .701000 = 7
           .701000 -       .801000 = 8
           .801000 -       .901000 = 9
           .901000 -      1.001000 =
1   VERTICAL                                HORIZONTAL
          -5.000E+01     -2.000E+01      1.000E+01      4.000E+01
               +--------------+--------------+--------------+--------------
     2.500E+01+
              -
              -
              -
              -
              -
              -
              -
              -                       9999
              -                    998777889
     5.000E+00+                   98765445679
              -                  9875332234679
              -                  97532111234689
              -                 986421111124689
              -                 975321111124689
              -                9864321111235789
              -               9875332222235689
              -             99875432233445789
              -         98877654322334456799
              -        9754444433222345679
    -1.500E+01+       96422122222222346789
              -    97321111111111222345689
              - 97543111111111111223345679
              - 52111111111111112223445678
              - 41111111111122222333455679
               +--------------+--------------+--------------+--------------
          -5.000E+01     -2.000E+01      1.000E+01      4.000E+01
1
           TIME =   3.000E+01 XO =   4.000E+01 YO =  -5.000E+02 ZO =  2.500E+01
          RANGE =   1.000E+03 AL =      .00000 BT =       1.000 GM =        .000
          FULL-WIDTH OF VIEW, CROSS-LOS HORIZONTAL =  1.000E+02 CROSS-LOS VERTICAL =   5.000E+01
                    DISPLAYED SCALE = TRANSMISSION, WAVELENGTH =  1.
                    PIXELS: HORIZONTAL =  50 VERTICAL =    25
                    GREY SCALE RANGES =   9.
           .000000 -       .001000 = *
           .001000 -       .101000 = 1
           .101000 -       .201000 = 2
           .201000 -       .301000 = 3
           .301000 -       .401000 = 4
           .401000 -       .501000 = 5
           .501000 -       .601000 = 6
           .601000 -       .701000 = 7
           .701000 -       .801000 = 8
           .801000 -       .901000 = 9
           .901000 -      1.001000 =
1   VERTICAL                                HORIZONTAL
          -5.000E+01     -2.000E+01      1.000E+01      4.000E+01
               +--------------+--------------+--------------+--------------
     2.500E+01+
              -
              -
              -
```

```
           -
           -                                 9999999
           -                                9988788899
           -                               987766667899
           -                              9876544456789
           -                             987654333456789
 5.000E+00+                             9986543222345689
           -                            9875432222235689
           -                           98765432222235689
           -                          987654332222345689
           -                        9988765433333456789
           -                     99998776544433344456789
           -                 99988887765544444455667899
           -              998877766665544444455667888999
           -           9887665554444444433444567899 9
           -         9765443333323333333334456678
-1.500E+01+        97432222211111222222233344567 89
           -      97421111111111111122222334456789
           -  9764311111111111111111112222334456789
           -  621111111111111111111111112222334556789
           -  4211111111111111111111122222333 44556789
            +-------------+-------------+-------------+-------------
       -5.000E+01    -2.000E+01     1.000E+01     4.000E+01
 1
```

5.2.5 Example 5: Using the printer plot option VIEW, GREY and TPOS for a top-down view

```
WAVL      1.06
COMBIC
PHAS             2.0      5.0       6.0      12.0      9.0       0.0      1.0
FILE      9.0        h.vehc-hc
FILE      12.0       topdown.pic
NAME
        Producing a  top-down contour representation fo- a battlefield scenario
ORIG             0.0      0.0       0.0      31.0     155.0
LIST             1.0      30.0      60.0     10.0
NAME
         Four munition at {90., 80., 0.,) starting at T=20.
NAME
         One vehicle {50., 218., 0.,) starting at T=20.  Traveling 7.6m/s at
NAME
 82 degrees wrt North
SLOC             1.0      4.0       20.0     300.0     90.0      80.0     0.0
VEH1             2.0      1.0       20.0     50.0      300.0
VEH2             50.0     218.0     0.0      82.0      7.6
OLOC             1.0      150.0     175.0    500.0     0.0       300.0    0.0
TLOC             1.0      150.0     175.0    0.0       1.0       0.0      0.0
VIEW             1.0      1.0       300.0    300.0     60.0      60.0     31.0
GREY             10.0     .001      5.001    1.0       1.0       1.0      0.0
DONE             0.0      0.0       0.0      0.0       0.0       0.0      0.0
END
STOP
```

This example opens the history file produced by example 2. Two smoke sources consisting of four fixed HC pots and one vehicle generating fog oil are used for this scenario. This illustrates how to obtain CL for a top-down view point. The central LOS was chosen to completely encompass the resultant smoke clouds. The method to determine the central LOS follows closely the method in the previous example except for two important differences. First, a top-down view is defined as observing from an altitude (in this case 500 m) straight down, therefore, XOBS=XTAR, YOBS=YTAR, ZOBS=500, and XTAR=0. Secondly, the length of the smoke cloud produced by a moving vehicle is the vector sum of the vehicle speed and direction with the wind speed and direction. The user should sketch a rough picture for the last time step (60 s) and determine the center of the picture. The x,y coordinates of this central point are the coordinates of the observer and target. The rough sketch should also yield a value for the size of the window. This example also illustrates the usage of RTAT of the `VIEW` record. RTAT is used to eliminate the ambiguity of the term "horizontal" for top-down looking LOS. RTAT is the angle in degrees of the horizontal viewing axis with respect to north. In this case, it was decided to have the horizontal viewing axis point in the x-direction, therefore, RTAT=31.0. Below is the printer plot stored in the file topdown.pic.

```
       TIME =    3.000E+01 XO =    2.290E+02 YO =  -2.650E+01 ZO =  5.000E+02
      RANGE =    5.000E+02 AL =         .00000 BT =          .000 GM =      -1.000
      FULL-WIDTH OF VIEW, CROSS-LOS HORIZONTAL =  3.000E+02 CROSS-LOS VERTICAL =   3.000E+02
                DISPLAYED SCALE = TRANSMISSION, WAVELENGTH =  1.
                PIXELS: HORIZONTAL =  60 VERTICAL =    60
                GREY SCALE RANGES =  10.
       .000000 -         .001000 = *
       .001000 -         .002152 = 1
       .002152 -         .004632 = 2
       .004632 -         .009970 = 3
       .009970 -         .021458 = 4
       .021458 -         .046183 = 5
       .046183 -         .099399 = 6
       .099399 -         .213934 = 7
       .213934 -         .460444 = 8
       .460444 -         .991000 = 9
       .991000 -        2.132900 =
1   VERTICAL                             HORIZONTAL
       0.000E+00      7.500E+01      1.500E+02      2.250E+02
             +--------------+--------------+--------------+--------------
   3.250E+02+
             -
             -
             -
             -
             -
             -
             -
             -
             -
   2.750E+02+
             -
             -
             -
             -
             -
             -
             -             70
             -          95359
             -          063380
   2.250E+02+          083260
             -           05239
```

```
              -             8327
              -             05240
              -              8228
              -              0415
              -               8120
              -               0317
              -                812
              -                 310
     1.750E+02+                 915
              -                  21
              -                  9*
              -
              -
              -
              -
              -
              -
              -
     1.250E+02+
              -                  08
              -                  952
              -                  94111
              -                  821111
              -                  71*11148
              -                  41*114790
              -                  1**158
              -                  **17
              -                   1
     7.500E+01+
              -
              -
              -
              -
              -
              -
              -
              -
              -
               +--------------+--------------+--------------+--------------
           0.000E+00      7.500E+01      1.500E+02      2.250E+02
1
           TIME =   4.000E+01 X0 =   2.290E+02 Y0 =  -2.650E+01 Z0 =   5.000E+02
          RANGE =   5.000E+02 AL =      .00000 BT =        .000 GM =      -1.000
          FULL-WIDTH OF VIEW, CROSS-LOS HORIZONTAL =  3.000E+02 CROSS-LOS VERTICAL =   3.000E+02
                    DISPLAYED SCALE = TRANSMISSION, WAVELENGTH =  1.
                    PIXELS: HORIZONTAL =  60 VERTICAL =    60
                    GREY SCALE RANGES =  10.
           .000000 -       .001000 = *
           .001000 -       .002152 = 1
           .002152 -       .004632 = 2
           .004632 -       .009970 = 3
           .009970 -       .021458 = 4
           .021458 -       .046183 = 5
           .046183 -       .099399 = 6
           .099399 -       .213934 = 7
           .213934 -       .460444 = 8
           .460444 -       .991000 = 9
           .991000 -      2.132900 =
1   VERTICAL                                HORIZONTAL
```

```
      0.000E+00      7.500E+01      1.500E+02      2.250E+02
          +--------------+--------------+--------------+--------------
3.250E+02+
         -
         -
         -
         -
         -
         -
         -
         -
         -
2.750E+02+                    000
         -                 888900
         -              087667800
         -            009876668900
         -             00876567900
         -             00976557800
         -             00986556890
         -              00976567900
         -              00986556800
         -               0086556890
2.250E+02+               0097545790
         -                008645680
         -                0097545800
         -                 097545790
         -                  08644690
         -                  09744580
         -                   0853479
         -                   09643590
         -                    0743480
         -                    0953370
1.750E+02+                     073359
         -                    00842480
         -                    00862370
         -                    09852250
         -                    09752139
         -                   008642113
         -                   0975321113
         -                   086422111237
         -                   9753211112358
         -                   96321111114679
1.250E+02+                  08521111111578900
         -                  9631111121168900
         -                  95211111331590
         -                  8311111246120
         -                  81111113684*
         -                  61**113680
         -                  3***13790
         -                  1**148
         -                  **16
         -                   1
7.500E+01+
         -
         -
         -
         -
         -
         -
```

```
                -
                -
                -
                +--------------+--------------+--------------+--------------
            0.000E+00      7.500E+01      1.500E+02      2.250E+02
1
            TIME =   5.000E+01 XO =   2.290E+02 YO =  -2.650E+01 ZO =  5.000E+02
           RANGE =   5.000E+02 AL =      .00000 BT =        .000 GM =      -1.000
           FULL-WIDTH OF VIEW, CROSS-LOS HORIZONTAL =  3.000E+02 CROSS-LOS VERTICAL =   3.000E+02
                     DISPLAYED SCALE = TRANSMISSION, WAV:LENGTH =  1.
                     PIXELS: HORIZONTAL =  60 VERTICAL =    60
                     GREY SCALE RANGES =  10.
            .000000 -       .001000 = *
            .001000 -       .002152 = 1
            .002152 -       .004632 = 2
            .004632 -       .009970 = 3
            .009970 -       .021458 = 4
            .021458 -       .046183 = 5
            .046183 -       .099399 = 6
            .099399 -       .213934 = 7
            .213934 -       .460444 = 8
            .460444 -       .991000 = 9
            .991000 -      2.132900 =
1   VERTICAL                            HORIZONTAL
            0.000E+00      7.500E+01      1.500E+02      2.250E+02
                +--------------+--------------+--------------+--------------
       3.250E+02+
                -
                -                           00
                -                        90000
                -                      888990000
                -                  988888890000
                -               009987777899000
                -              0009987777889000
                -              0009987777889000
                -              00009887777899000
       2.750E+02+               0009987777899000
                -               0009987777789000
                -                000987777789000
                -                000998777789900
                -                0000987767789000
                -                 000987767789000
                -                 000998766789000
                -                  00098766778900
                -                  00098766678900
                -                   00998766789000
       2.250E+02+                   00098766678000
                -                    0098766678900
                -                    0098766678900
                -                     008766667900
                -                     0097655678900
                -                     0097543468900
                -                     0097543237900
                -                    00987543222400
                -                    00987532222230
                -                    009865322122236
       1.750E+02+                    0987543211122346
                -                   0098653221112234579
                -                   09875432211122456789
```

```
              -                    0986432211112246789900
              -                    08753221111123468990000
              -                   0986422111111235789000
              -                   09743211112222357900000
              -                   086321111122222358900
              -                   9742111112233334800
              -                   853111111235433470
     1.250E+02+                  0742111112356643369
              -                  9621111124688533590
              -                  9411111246899742480
              -                  8211*111368900842370
              -                  711**113589   962260
              -                  51**112580    083249
              -                  3***12680      94238
              -                  1**137         06226
              -                  **16            82140
              -                   1              04139
     7.500E+01+                                   7118
              -                                   0216
              -                                    513
              -                                    911
              -                                     319
              -                                     9*5
              -                                      1
              -
              -
              -
               +--------------+--------------+--------------+--------------
           0.000E+00      7.500E+01      1.500E+02      2.250E+02
1
           TIME =   6.000E+01 XO =   2.290E+02 YO =  -2.650E+01 ZO =   5.000E+02
          RANGE =   5.000E+02 AL =       .00000 BT =        .000 GM =      -1.000
          FULL-WIDTH OF VIEW, CROSS-LOS HORIZONTAL =  3.000E+02 CROSS-LOS VERTICAL =   3.000E+02
                    DISPLAYED SCALE = TRANSMISSION, WAVELENGTH =  1.
                    PIXELS: HORIZONTAL =  60 VERTICAL =     60
                    GREY SCALE RANGES =  10.
           .000000 -       .001000 = *
           .001000 -       .002152 = 1
           .002152 -       .004632 = 2
           .004632 -       .009970 = 3
           .009970 -       .021458 = 4
           .021458 -       .046183 = 5
           .046183 -       .099399 = 6
           .099399 -       .213934 = 7
           .213934 -       .460444 = 8
           .460444 -       .991000 = 9
           .991000 -      2.132900 =
1   VERTICAL                                HORIZONTAL
           0.000E+00      7.500E+01      1.500E+02      2.250E+02
               +--------------+--------------+--------------+--------------
     3.250E+02+                 000009998888888889900000
              -                  00000998888888889900000
              -                  00000998888888889990000
              -                  00000999888888888990000
              -                   00000998888888889900000
              -                   00000998888888889900000
              -                   00000999888888888990000
              -                    000009988878888990000
              -                    000009988877888990000
```

```
              -                     00009988877888900000
     2.750E+02+                     00000998877788990000
              -                      0000998877788990000
              -                      0000998877788990000
              -                      0000998787778899000
              -                       000998777778899000
              -                       0009987666778990000
              -                        009987655568890000
              -                        009987654445899000
              -                        009987654433469000
              -                        009987554333335000
     2.250E+02+                       00098765443333334000
              -                       00098765433223333460
              -                       00998765432222334456
              -                      00098765433222233445678
              -                      000987654322222234456779
              -                      00987654332222223456678890
              -                      009875433222222234567889900
              -                     009876543222222233456789900000
              -                     009865433222222233457899000000
              -                     09876433222222223455789000000
     1.750E+02+                     0986533222222223345589900000
              -                    008754322212222333455890000
              -                    09864322111222333445789000
              -                    0975322111122334445578900
              -                    0864221111123345555558900
              -                   09753211111223456555558900
              -                   08642111111234567665557900
              -                   97521111111235678765557800
              -                   963111111123568898765578900
              -                   852111111134689999765568900
     1.250E+02+                  9731111111246890009865567900
              -                  9521111112357900 00875557800
              -                  8311**11135790   00976556800
              -                  721***1125790    00986556790
              -                  61***112579       0087545790
              -                  41***12479        00975456800
              -                  2***1258           0986445800
              -                  1**127             0086445790
              -                  **15                097544690
              -                   *                  008544680
     7.500E+01+                                       09643580
              -                                       09743470
              -                                        0853369
              -                                        09633590
              -                                         0732460
              -                                         0821260
              -                                          953
              -
              -
              -
              +--------------+--------------+--------------+--------------
           0.000E+00      7.500E+01      1.500E+02      2.250E+02
1
```

5.3 Subroutines and Functions

5.3.1 Phase I Subroutines

- COMBIC is a small driver routine that selects the independent submodules DSPH1 (Dust/Smoke Phase I) and DSPH2.
- DSPH1 is an I/O subroutine that reads and stores user input records in blocks and eventually calls PHAS1 to begin calculations for one obscurant source type.
- PHAS1 is a main Phase I routine that produces the output cloud history file for each obscurant source specified by the user. PHAS1 calls CMASS, DMASS, SMASS, and TRAJ for each source subcloud that is produced (1-5).
- SMASS is a routine that computes the basic smoke quantities of yield factor, total mass, and thermal production.
- CMASS is a routine that analytically computes the cumulative profile of obscurant mass produced by the source and the average production value for later scaling. CMASS calls CRATE.
- CRATE is a routine that returns the cumulative mass production of the burn (or mass production) function.
- DMASS is a routine that returns the dust production and thermal production of HE–generated dust. The routines VOLAC and CRATR are called.
- VOLAC is a routine that computes the basic crater volume scaling factor for HE–generated dust. VOLAC calls CRATR.
- CRATR is a routine that returns the ratio of the apparent crater volume for a cased HE to the crater volume produced by an equivalent uncased charge.
- TRAJ is a routine that calculates the time history of cloud positions, dimensions, and downwind travel times through a major loop over many time steps. TRAJ calls RISE and DIFUS.
- RISE is a routine that returns the buoyant height, radius, rise velocity, and temperature for a given instantaneous Gaussian puff or continuous Gaussian plume for a single input time.
- DIFUS is a routine that serves both the purpose of returning the atmospheric-induced cloud diffusion coefficients and determining a best linear expansion coefficient for use in Phase II approximations.
- SBAR1 is a routine that determines values relevant to the modeled atmospheric boundary layer.
- LODDAT is a routine that loads history values into transfer arrays.
- SDWRIT is a routine that writes history values to the file.
- UZ is a routine that returns the windspeed for any input height, the static stability parameter, and the eddy dissipation rate for terminating cloud rise.
- EXTIN is a routine that loads default values for mass extinction coefficients or replaces defaults with user provided values. EXTIN calls WPHCD.
- WPHCD is a routine that computes relative humidity dependent WP and HC extinction coefficients.

5.3.2 Phase I Functions

- `YIELD` is a function that returns the mass scaling for relative humidity dependent WP and HC smoke.
- `COLD` is a function that modifies the yield factor for cold regions.
- `PASQL` is a function that calculates Pasquill stability category based on meteorological inputs. `PASQL` calls `ALPHA`.
- `ALPHA` is a function that returns the solar elevation for given day, time, and site location.
- `SBAR1` is a function that determines values relevant to the modeled atmospheric boundary layer.
- `CNORM` is a function subprogram for the cumulative normal distribution.
- `CNORF` is a table lookup function for the cumulative normal distribution.

5.3.3 Phase II Subroutines

Phase II routines include I/O of user records, initialization and loading of cloud histories, setup and maintenance of active sources and active LOS, an outermost loop over time, updating of cloud positions and dimensions, a second level loop over all LOS, and an innermost loop over all clouds for each LOS to compute contributions to transmission reduction. The routines are:

- `DSPH2` is a subroutine called by `COMBIC` to process user input records. Unlike `DSPH1` in Phase I, `DSPH2` takes some immediate action following each user input through calls to `PHAS2`.
- `SETUP` is the initialization routine for Phase II.
- `ADDCLD` adds obscurant source to the scenario.
- `ADDLOS` adds a line of sight to the scenario.
- `BTRANS` finds transmission for a given line of sight.
- `UPDAT` is a routine that has different functions, depending on how it is called. Provides the leading edge position and dimensions or trailing edge position and dimensions following burnout.
- `PHAS2` schedules other routines and increments the scenario clock.
- `DISPER` computes the dispersion lengths for both stable and unstable atmospheres.
- `EXTIN` loads default values for mass extinction coefficients or replaces defaults with user provided values. `EXTIN` calls `WPHCD`.
- `WPHCD` computes relative humidity dependent WP and HC extinction coefficients.
- `TRNFRM` rotates coordinates between different coordinate systems.
- `LOOKUP` accesses the cloud history tables for cloud dimensions and mass for use by `BTRANS`.
- `DROPC` maintains active cloud arrays by removing an active cloud and returning array storage to the inactive pool.
- `SDREAD` loads cloud histories as needed from the history file.

- CONIN tests for intersection of the LOS with a crude estimate of the volume that contains an extended continuous cloud.
- PUFCL integrates concentration over a given path through a Gaussian puff and rejects the cloud if it is not sufficiently close to or does not intersect the path.
- CONCL integrates concentration along a path segment through a continuous Gaussian plume.
- ROMBERG integrates concentration along a path segment through a continuous Gaussian plume. This routine is used to provide a faster way of integrating through plumes. It useds the Romberg method of integration for times when the LOSs are not perpendicular to the wind direction.
- ROMF computes $\dot{M}$ and part of the CL integral.
- FILLIN used in the Romberg Method of Integration.
- FILNEG used in the Romberg Method of Integration.
- CNTUR provides printer plots of cloud contours.
- TERRA a dummy terrain routine demonstrating how terrain interface can be achieved.

5.3.4 Phase II Functions

- CNORM computes the cumulative normal distributions.
- CNORF is a table lookup routine of CNORM values used to save calculation time.

Appendix A. Phase I Physics

A.1 Cloud Descriptions: The Phase I Output File

COMBIC describes obscurant clouds as combinations of subclouds. Each subcloud is defined as either a single Gaussian puff or as a continuous Gaussian plume. COMBIC further distinguishes subclouds as buoyant or nonbuoyant, depending upon whether heat is released into the cloud during the formation process.

A Gaussian puff is an ellipsoidal volume with concentration which is greatest at its center (x_c, y_c, z_c) and which decreases with distance according to scaling lengths (σ_x, σ_y, σ_z). The concentration at any point, (x, y, z) relative to a Gaussian puff centered on (x_c, y_c, z_c) and containing a total mass of obscurant [Sauter and Hansen, 1990] M, is then

$$C(x, y, z) = \frac{M}{(2\pi)^{3/2}\sigma_x\sigma_y\sigma_z} e^{-D^2/2} \tag{A.1}$$

where D is a dimensionless scaled distance:

$$D^2 = \left(\frac{x - x_c}{\sigma_x}\right)^2 + \left(\frac{y - y_c}{\sigma_y}\right)^2 + \left(\frac{z - z_c}{\sigma_z}\right)^2 \tag{A.2}$$

In general COMBIC allows for a scavenging coefficient, δ, for the removal of mass by deposition or evaporation. Evaporation of volatiles can still result in some long-term, non-volatile component, f_d, of the original mass, however. Then M becomes time dependent:

$$M(t) = M[f_d + (1 - f_d)e^{-\delta t}] \tag{A.3}$$

The Gaussian ellipsoid may also be rotated so that its principal axes no longer lie along the X, Y, and Z directions. This "canting" of a cloud is useful in modeling the tilted stem of an HE-produced dust cloud. The canting rotation in COMBIC is restricted to an angle Φ about the cross-wind Y axis, tilting the ellipsoid principal Z axis toward or away from the downwind X axis. A full description of the Gaussian puff history is thus the set of values (M, δ, Φ, x_c, y_c, z_c, σ_x, σ_y, σ_z) defined wrt the time since the munition began to burn. Figure A.1 displays the geometric meaning of these quantities. Note that the so-called radii of the puff are between 2 and 3 times larger than the σ values, depending on definition, and are not shown. Also note that the wind speed in the figures is u and in the equations is μ.

The continuous Gaussian plume is described by a similar concentration equation:

$$C(x_c; , y, z) = \frac{\dot{m}}{2\pi\sigma_y\sigma_z\mu} e^{-\frac{1}{2}\left[\left(\frac{y - y_c}{\sigma_y}\right)^2 + \left(\frac{z - z_c}{\sigma_z}\right)^2\right]} \tag{A.4}$$

where μ is the windspeed and $\dot{m}$ is the time rate of obscurant production which applies at the location (x_c, y_c, z_c).

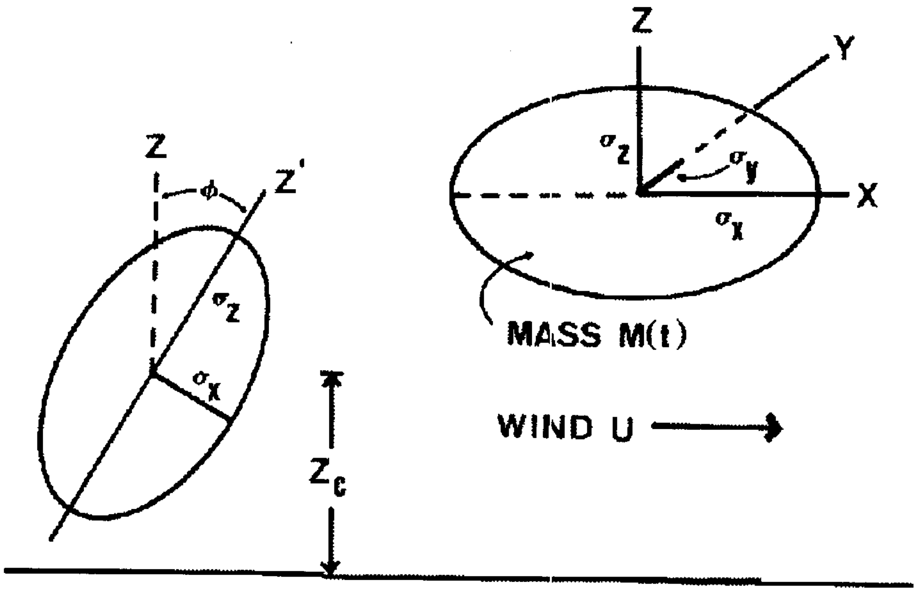

Figure A.1: Parameters that describe a Gaussian puff.

Although it appears as simple as the concentration equation for the Gaussian puff, the concentration of the Gaussian plume is complicated by the fact that the variables depend on the downwind distance x_c from the source as well as on time. Figure A.2 shows the relevant geometry of the plume parameters. In principle, the cloud history would, therefore, require a two-dimensional, space-time array of (y_c, z_c, σ_y, σ_z, u, $\dot{m}$, δ) values for an appropriate two parameter table of x_c and t values.

However, with the aid of simplifying assumptions, these potentially huge tables can be reduced considerably in size. First, the array of downwind table entries, or grid points, does not need to be equally spaced. In fact, the expansion and rise of the plume change more rapidly near the source and more slowly at great distances downwind.

Gaussian diffusion models have been handicapped in the past by the use of empirical power laws to establish the orthogonal dispersion lengths. As will be discussed in more detail in a later section, the diffusion sigmas and the vertical rise of the center line (y_c, z_c) for puffs are not Eulerian, but a Lagrangian function based upon a moving coordinate system.

The functional dependence of these quantities on x_c permits them to be written in converging Taylor series. For example, expanding σ about x_c:

$$\begin{aligned}\sigma(x) &= \sigma(x_c) + \frac{d\sigma(x)}{dx}\bigg|_{x=x_c}(x-x_c) + \frac{d^2\sigma(x)}{dx^2}\bigg|_{x=x_c}\frac{1}{2}(x-x_c)^2 + \dots \\ &= \sigma(x_c) + \left[1 + B\left(\frac{x-x_c}{x_c}\right) + \frac{1}{2}B(B-1)\left(\frac{x-x_c}{x_c}\right)^2 + \dots\right] \qquad \text{(A.5)}\end{aligned}$$

This expansion, and a similar one for z_c, represents one way to use exact values given at a series of grid points, x_c, to find approximate values between the grid points. Clearly, if x is sufficiently close to x_c, then terms higher than the first power in $(x - x_c)$ can be neglected. Specifically, assume that the absolute value of $(x - x_c)/x_c$ is kept smaller than some chosen value, say 0.06. It can be shown that linear interpolation between a grid of x_c values satisfying this condition will be quite accurate. This implies that the grid should be chosen with a spacing that increases with larger downwind distances x_c. The previous versions of COMBIC used a downwind distance grid in which each new interval is a factor 1.123 wider than the previous interval. That allowed the range from 50 m downwind to 5800 m downwind to be covered by just 41 grid points. Arbitrary points were chosen for the range of 0 to 50 m downwind. However, to apply the Romberg method of integration, the user must tabulate the downwind distance x in each subcloud trajectory at values such that a simple transformation of the downwind distances will be equally spaced. The tabulated values in COMBIC (done in phase I) satisfy this requirement for $x \geq 49.85$. The function is $x = (49.85)(1.123)^{n-10}$. But for $x < 49.85$ an exponential function will not approach zero in a finite number of steps. What is required is a power function of the form n^p that will "spline" with the exponential function at the breakpoint; that is, both the power function and its first order derivative must agree with those of the exponential function at the breakpoint. This can best be accomplished by

$$x = n^{1.508352871} \; for \; n < 13 \,. \qquad \text{(A.6)}$$

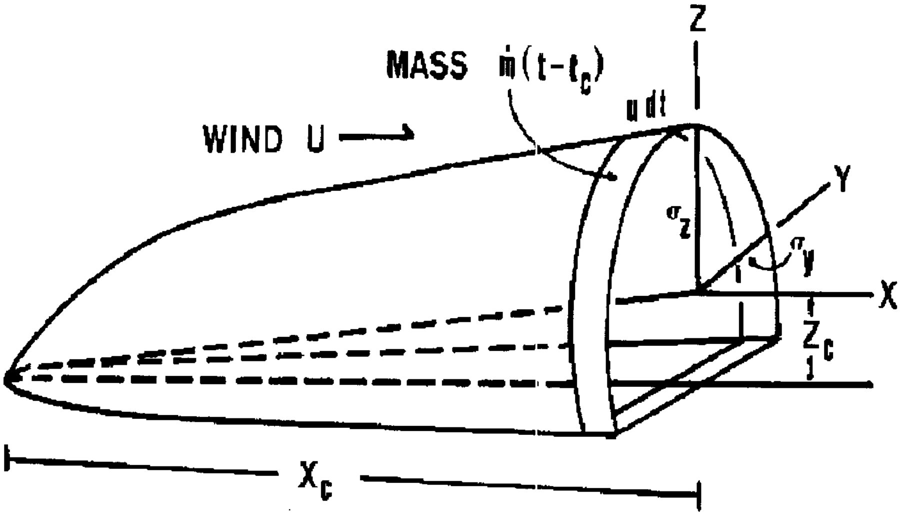

Figure A.2: Parameters that describe a Gaussian plume.

$$x = (47.887223) \cdot (1.123026355)^{n-13} \text{ for } n \geq 13 \,. \tag{A.7}$$

The first 15 tabulated values of the downwind distance by these formulas are 1.00, 2.84, 5.24, 8.09, 11.33, 14.92, 18.82, 23.02, 27.50, 32.24, 37.22, 42.44, 47.89, 53.78, 60.39. The breakpoint is at $n = 13$ where $x = 47.89$. This modification requires a minor change in the tabulation of subcloud trajectories from the way they are done in COMBIC87, but it promises smoothness at the breakpoint. (This smoothness is desired to prevent Romberg from "thinking" that the integrand has some peculiarity at the breakpoint).

The COMBIC model uses a uniform wind direction everywhere in the scenario. In the plume reference frame, x is the downwind coordinate, and y is the cross-wind coordinate. Therefore, the y value for the center line of the plume is a constant, and y can be eliminated from the cloud tables. Similarly, the deposition or evaporation coefficient is assumed constant. Thus, only the four variables (z_c, σ_y, σ_z, $\dot{m}$) must be tabulated. Of these, the mass production rate, $\dot{m}$, depends only on time and on downwind distance from the source if an average, constant thermal production rate is assumed. The scaling for variable thermal production is discussed in section A.4.

The time required for an obscurant to move from the source to each downwind grid point is tabulated in Phase I. The cumulative mass production function is stored in a separate array SNW every second for burn times < 900 s. from ignition to the end of obscurant production. The cumulative production function M(t) is determined from the production rate $\dot{m}$ by:

$$M(t) = \int_0^t \dot{m}(t')dt' \tag{A.8}$$

Tabulating the mass rate table (as a function of time after ignition) so that it is incremented every second rather than the way it was done in COMBIC87 and earlier versions results in several advantages. No searching is required and interpolation time is decreased by up to 50 percent over the old method.

Assuming approximately 50 tabulated points for each of 4 parameters for the continuous plume (z_c, σ_y, σ_z, t) and up to 900 values store in the ($\dot{m}$) SNWD and 6 parameters for the Gaussian puff (z_c, σ_x, σ_y, σ_z, t, d) COMBIC Phase I output files contain about 300-1200 entries per subcloud depending upon the burn time. The amount of detail or the number of physically different regions in the cloud determines the number of subclouds. Up to 5 subclouds per cloud can be produced by COMBIC phase I routines and accessed by COMBIC phase II routines. For most obscurants, one subcloud is sufficient.

A.2 Path Integration Methods: Phase II Transmission Calculations

Assume that a history file or tables describing obscurant subcloud position, dimensions, and mass distribution have been generated. Then, given observer and target pairings, the object of Phase II calculations is to determine the transmittance between each pair. In this section, the formulas used to rapidly find the CL integral for use in equation 2.1 are derived.

A.2.1 The Path Integral through Gaussian Puffs

COMBIC uses a fast analytic solution for path integrals through Gaussian puffs. The method treats the cases of target and/or observer inside the cloud and further tests for nonintersection early in the calculation process, thus providing a built-in cloud rejection technique. First, the derivation is given. Then an interpretation of the equations is given in terms of a geometric diagram.

The observer-target LOS is defined in terms of direction cosines:

$$\alpha = \frac{x_t - x_o}{R}, \beta = \frac{y_t - y_o}{R}, \gamma = \frac{z_t - z_o}{R}, \tag{A.9}$$

where (x_o, y_o, z_o) and (x_t, y_t, z_t) are observer and target coordinates. R is the range of the target from the observer:

$$R = \left[(x_o - x_t)^2 + (y_o - y_t)^2 + (z_o - z_t)^2\right]^{1/2} \tag{A.10}$$

A point on the LOS a distance r from the observer in the direction of the target thus has coordinates (x, y, z) that satisfy

$$x = x_o + \alpha r, \tag{A.11}$$

$$y = y_o + \beta r, \tag{A.12}$$

$$z = z_o + \gamma r, \tag{A.13}$$

where r can vary between 0 and R.

The CL product, equation A.21, is derived as follows. First, all coordinates are transformed to a new frame. In the transformation, all distances in x are divided by σ_x; all distances in y are divided by σ_y; and all distances in z are divided by σ_z. Define the vectors

$$\vec{S} = \left(\frac{\alpha}{\sigma_x}\right)\hat{\imath} + \left(\frac{\beta}{\sigma_y}\right)\hat{\jmath} + \left(\frac{\gamma}{\sigma_z}\right)\hat{k} \tag{A.14}$$

and

$$\vec{X} = \left(\frac{x_o - x}{\sigma_x}\right)\hat{\imath} + \left(\frac{y_o - y}{\sigma_y}\right)\hat{\jmath} + \left(\frac{z_o - z}{\sigma_z}\right)\hat{k} \tag{A.15}$$

The LOS in the new frame, from equation A.9 through A.13, is then

$$\vec{X} = -r\vec{S} \tag{A.16}$$

Note that the LOS in the new frame remains a straight line since S is a constant vector. In the new frame, the ellipsoidal Gaussian distribution has now become spherically symmetric (figure A.3). The vector from the puff centroid (x_c, y_c, z_c) to the observer in the new frame is

$$\vec{X_c} = \left(\frac{x_o - x_c}{\sigma_x}\right)\hat{\imath} + \left(\frac{y_o - y_c}{\sigma_y}\right)\hat{\jmath} + \left(\frac{z_o - z_c}{\sigma_z}\right)\hat{k} \tag{A.17}$$

This vector is denoted as $\bar{X}$ on figure A.3

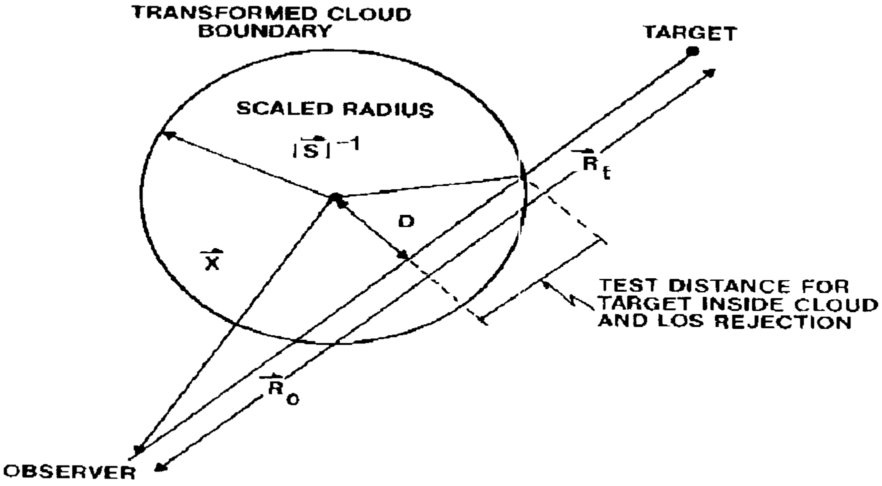

Figure A.3: Scaled parameters for path-integration and cloud rejection.

The closest approach distance of the LOS to the puff centroid in the new frame is the vector cross-product magnitude given by:

$$D = \frac{\left|\vec{X} \text{ x } \vec{X_c}\right|}{\left|\vec{X}\right|} = \frac{\left|\vec{S} \text{ x } \vec{S_c}\right|}{\left|\vec{S}\right|} \tag{A.18}$$

We will call this the "sigma scaled closest approach distance." Similarly, the sigma scaled range from the closest point of approach to the observer is the vector dot product

$$R_o = \frac{\left|\vec{X} \bullet \vec{X_c}\right|}{\left|\vec{X}\right|} = \frac{\left|\vec{S} \bullet \vec{X_c}\right|}{\left|\vec{S}\right|} \tag{A.19}$$

and the scaled range to the target from the closest point of approach is

$$R_t = R_o + R|\vec{S}| \tag{A.20}$$

In terms of these quantities, the CL integral becomes the path integral from the observer point P_o to the target point P_t over the concentration (equations (3) and (4)) written in terms of the vectors just defined. But, this integral is just the well-known, one-dimensional integral of a Gaussian over a finite interval. The magnitude of S in the denominator of the result is due to the change of variables from the increment dr to the increment d(rS):

$$\begin{aligned} CL &= \int_{P_o}^{P_t} \frac{M}{(2\pi)^{3/2}\sigma_x\sigma_y\sigma_z} e^{-\frac{1}{2}(\vec{X}-\vec{X_c})^2} dr \\ &= \frac{M[\Phi(R_t) - \Phi(R_o)]}{(2\pi)\sigma_x\sigma_y\sigma_z|\vec{S}|} e^{-\frac{1}{2}D^2} \end{aligned} \tag{A.21}$$

where Φ is the cumulative normal function. The definition of Φ is given in equation A.184.

While the derivation may not be obvious, there is a geometric interpretation shown in Figure A.3. The original Gaussian puff has an ellipsoidal shape if the sigmas are different. The sigmas are in units of length. Define a new frame of reference in which distances along each direction x, y, z are in terms of new units (sigmas) found by dividing distance along those coordinates by the appropriate sigma. This new frame has two important properties. First, the Gaussian puff now has spherical symmetry. Second, the LOS remains a straight line.

The vector S has no obvious physical interpretation. The magnitude of S, however, is a scaling factor in inverse units of distance, and converts the distances in the new frame to units we can term "sigmas." D, found by equation (23), is the closest approach distance in sigma units. If D is 3 or larger, the puff does not contribute to the CL because the LOS lies outside the 3 sigma edge, and the calculation is terminated. If D is less than 3, then the distances R_o and R_t are computed by the dot product (equation A.19 and A.20). R_o and R_t are signed quantities. If R_o is less than -3, then the observer lies on the near side of the cloud. If R_o is larger than 3, then both observer and target lie on the far side of the cloud. In this case, the LOS never reaches the cloud so the CL is 0.

Similarly, if R_t is larger than 3, then the target lies on the far side of the cloud, while if it is less than -3, both the target and observer lie on the near side of the cloud. In the latter case, the CL is again 0. For R_o and/or R_t smaller than 3 in absolute value, the observer and/or target potentially lie inside the cloud. The cumulative normal distribution terms take care of the correction factors automatically in these cases.

Note the EOSAEL82 routine for the path integration's suggested lines of code that could be added to find the point on the LOS closest to the cloud. A COMBIC user subsequently pointed out that the method did not work. The user was right. The suggested code change determines the point of maximum concentration on the LOS for a given cloud. This is not necessarily the geometrically closest point to the cloud center. Since the code was only in the form of comments, it did not affect most users. To anyone who did implement these code additions, we regret the misinformation.

Specifically, the distance from the observer to the point of maximum concentration is R_o/S. This distance can be used with equations A.11 through A.13 to find the coordinates of the point.

A.2.2 The Path Integral Through Gaussian Plumes

Integration through the Gaussian plume is fast and simple only if the LOS is nearly crosswind. In that case, the values of the plume height z_c and the y and z components of σ are nearly constant all along the LOS. The CL integral is very similar to that for the Gaussian puff:

$$CL = \left(\frac{\dot{m}}{\mu}\right)\frac{[\Phi(R_t) - \Phi(R_o)]}{(2\pi)^{1/2}\sigma_y\sigma_z S}e^{-\frac{1}{2}D^2} \tag{A.22}$$

where

$$D = S^{-1}|(S_y\bar{X}_z - S_z\bar{X}_y)| \tag{A.23}$$

$$R_o = S^{-1}|(S_y\bar{X}_y - S_z\bar{X}_z)| \tag{A.24}$$

$$R_t = R_o + R|\vec{S}| \tag{A.25}$$

where R is again the scalar distance between the observer and target and the quantities S and X are defined by

$$\vec{S} = S_y\vec{j} + S_z\vec{k} = \left(\frac{\beta}{\sigma_y}\right)\vec{j} + \left(\frac{\gamma}{\sigma_z}\right)\vec{k} \tag{A.26}$$

$$\vec{X} = X_y\vec{j} + X_z\vec{k} = \left(\frac{y_o - \bar{y}}{\sigma_y}\right)\vec{j} + \left(\frac{z_o - \bar{z}}{\sigma_z}\right)\vec{k} \tag{A.27}$$

and

$$S = (S_y^2 + S_z^2)^{1/2} \tag{A.28}$$

The obscurant production rate in equation A.22 is evaluated as discussed in section A.1 and below.

The simple formula is valid for crosswind LOS, including slant path or downward-looking paths, and, based on the power law expansions given in section A.2.1,

$$\sigma(x) = \sigma(x_c)[1 + B\left(\frac{x - x_c}{x_c}\right) + \ldots] \tag{A.29}$$

when linear and higher order terms are negligible. COMBIC assumes, for the purpose of calculation speed, that if x varies by no more than ±5 percent of x_c (which corresponds to one downwind step in the phase I tables) inside the cloud, then the crosswind approximation can be used. This approximation is roughly an angle within 6° of crosswind for Pasquill category A (unstable) and within 25° of crosswind for Pasquill category E (stable).

The scaling of the vertical position of the plume or puff for thermal rise does not account for second-order effects of vertical wind shear. First order effects of wind shear are included.

The first statement describes the approximation that assumes that the trailing edge of the plume transports downwind with the same time profile as the leading edge. The result is the familiar effect of Gaussian models in which the obscuration tends to fall off rapidly following burnout of the munition. This rapid falloff is somewhat of a problem for bulk WP but not for the other obscurants.

For more general LOS, a different algorithm is required. The general CL integral for a gaussian plume is

$$CL = \int_0^R \frac{\dot{m}/u}{2\pi\sigma_y\sigma_z} e^{-1/2\left[\left(\frac{y-y_c}{\sigma_y}\right)^2 + \left(\frac{z-z_c}{\sigma_z}\right)^2\right]} dr \tag{A.30}$$

Changing the variable of integration from r, the distance along the LOS, to x, the downwind distance, and evaluating $\dot{m}$ at $t = t(x)$, the CL integral becomes

$$CL = \int_{x_1}^{x_2} \frac{\dot{m}/u}{2\pi\sigma_y\sigma_z\alpha} e^{-\mathbf{X^2}/2} dx \tag{A.31}$$

where

$$\mathbf{X^2} = \left[\frac{(x - x_0)\beta/\alpha + y_0 - y_c}{\sigma_y}\right]^2 + \left[\frac{(x - x_0)\gamma/\alpha + z_0 - z_c}{\sigma_z}\right]^2 . \tag{A.32}$$

The cloud is assumed to have been rejected if it does not intersect the LOS. In eq. A.31 the downwind coordinates, x_1 and x_2, the limits of integration, are the points of intersection of the LOS with the cloud. (For example, if the observer is inside the cloud then $x_1 = x_0$; if the target is inside the cloud then $x_2 = x_t$. Either x_1 or x_2 might be the downwind distance of the leading or of the trailing edge or of the point of intersection with the 3σ limit of the cloud.) Note that this transformation of coordinates cannot be made if $\alpha = 0$, that is, if the LOS is directly crosswind. If α is very small, eq. A.31 will be ill-conditioned because CL would then be a quotient of two small values. However, if the LOS is nearly crosswind the CL integral is quickly and accurately approximated by the algorithms at the beginning of this section.

A.2.3 Contributions From Ground Reflection of the Plume

COMBIC computes ground reflection of the Gaussian plume in a manner different from COMBIC84 and COMBIC87. The method applied is the traditional one in which the reflection cloud is assumed to exist with centroid as far below (or above) ground as the centroid of the real cloud is above (or below) the ground. In COMBIC92 the amount of computation time and memory required to accomplish this modification is minimal.

By simply replacing z_c in eq. A.32 with its negative, eq. A.31 will result in the CL for the reflected cloud (assuming that 100 percent of the below-ground portion is reflected). By multiplying this by the reflection coefficient, R_e, and adding to eq. A.31 we get the CL for the cloud, including the reflected portion:

$$CL = \int_{x_1}^{x_2} \frac{\dot{m}}{2\pi\sigma_y\sigma_z\alpha\, u}\, h(x)\, dx \tag{A.33}$$

$$\begin{aligned} h(x) &= e^{-1/2\left(\frac{(x-x_0)\beta/\alpha+y_0-y_c}{\sigma_y}\right)^2} \\ &\quad\times \left[e^{-1/2\left(\frac{(x-x_0)\gamma/\alpha+z_0-z_c}{\sigma_y}\right)^2} + R_e * e^{-1/2\left(\frac{(x-x_0)\gamma/\alpha+z_0+z_c}{\sigma_y}\right)^2}\right] . \end{aligned} \tag{A.34}$$

COMBIC assumes the reflected mass has the same above-ground distributions as the real cloud. For clouds with centroids near ground level, COMBIC92 will compute somewhat higher values for CL than COMBIC87 in the lower portions of the cloud and lower values in the higher portions.

A.2.4 Changing the Variable of Integration

COMBIC92 utilizes the Romberg method of integration (see section A.2.7) to compute the CL integral. This method requires that the integrand be defined at equally spaced values of the variable of integration. The variable of integration is changed from the downwind distance x to the index n of eqs. A.6 and A.7.

$$dx = \frac{(1.51)\cdot x}{Ind(x)}\, dn \text{ for } n < 13 \tag{A.35}$$

$$dx = ln(1.123)\cdot x \cdot dn \text{ for } n \geq 13 . \tag{A.36}$$

Define, where $h(x)$ is given by eq. A.35),

$$g(x) = \frac{[Ind(x_2) - Ind(x_1)]\cdot x \cdot ln(1.123)\cdot h(x)}{2\pi\sigma_y\sigma_z\alpha\, u} . \tag{A.37}$$

$$f(x) = \frac{(1.51)g(x)}{\ln(1.123)Ind(x)} = \frac{13}{Ind(x)}g(x) \text{ for } n < 13 . \tag{A.38}$$

$$f(x) = g(x) \;\; for\; n \geq 13 . \tag{A.39}$$

Then the CL integral of eq. A.33 becomes

$$CL = \int_{Ind(x_1)}^{Ind(x_2)} \dot{m} f(x)\, dn . \tag{A.40}$$

The CL integral is now set in the form $\int_a^b f(x)\, dx$. The integrands a = index(x_1) and b = index(x_2) are evenly spaced according to the requirements of the

Romberg method of integration. The method iterates through certain steps, each theoretically (and in some cases, dramatically) a better approximation of the integral than the previous step. During each step $\dot{m}$ and $f(x)$ is computed for different points along the LOS. Comparison with the previous step is used as an approximation of the accuracy of the current step.

A.2.5 Rejecting Nonintersecting Plumes from the Path Integration

The second function of Phase II is to provide a means for rejecting continuous plumes that do not contribute to the CL of a given LOS. This is accomplished through definition of a simple geometric volume that describes the extent of each cloud at any given simulation time. The volume is a box with vertical sides that expand in separation with downwind distance. The top of the box is a plane which slopes downward toward the source. The volume is designed to enclose the actual plume used in the path integrations. The "corner" coordinates of the actual plume at the leading downwind edge of the cloud are (x_d, y_d, z_d). Similarly, the coordinates of the upwind corner are (x_u, y_u, z_u). The munition source is at (x_m, y_m, z_m).

Rejection of LOS by testing for intercepts with these surfaces is straight forward. Consider the test for the ends of the box. Let s be some range between the observer and target, that is

$$x = \alpha s + x_o \tag{A.41}$$

Then no intercept can occur with the downwind edge if

$$s_i = \frac{(x_d + x_m - x_o)}{\alpha} \tag{A.42}$$

is greater than R or less than zero. If the test is passed, then s_i is saved as a candidate for the range of entry into the cloud if s is negative (target upwind of the observer), or as a candidate for the range to exit from the cloud if α is positive. The test on x_u is similar. For the side of the box on the positive y side of the plume, the test is on the intersection of the straight lines

$$y = y_u' + y_m + (x - x_u)\left(\frac{y_d' - y_u'}{x_d - x_u}\right) \tag{A.43}$$

and

$$y = \beta s + y_o \tag{A.44}$$

which results in the value for the candidate of

$$s_i' = \frac{(y_u' + y_m - y_o)(x_d - x_u) + (x_o - x_u)(y_d' - y_u')}{\beta(x_d - x_u) - \alpha(y_d' - y_u')} \tag{A.45}$$

Again, the cloud is rejected if the value lies outside the interval defined by the candidate entry or exit range from the previous tests. These tests continue on the other side of the cloud, on the top, and on the bottom. If the test fails at any point, the calculation for this cloud and this LOS terminates. If all the tests are passed, the resulting entry and exit points define the range over which the CL path integral must be performed.

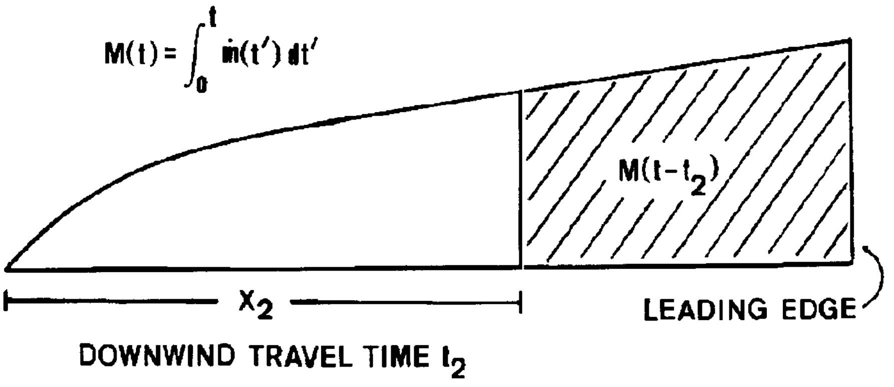

Figure A.4: The downwind obscurant mass beyond x_2 originating from a point source.

A.2.6 Corrections for Area Sources

Consider first the obscurant from a point source as shown in Figure A.4. For any given time t, COMBIC determines the total amount of obscurant that has been transported beyond (that is, downwind of) any given point, x_2

$$M_d = M(t - t_2(x_2)) \tag{A.46}$$

where t_2 is the time required for the obscurant to travel from the source to the point x_2, and M is the cumulative mass emitted by the source as a function of time. Figure A.4 shows this region of the plume.

The case of an extended source area is more complicated. It takes longer for obscurant from the upwind region of the source area to reach the downwind point in the plume than it does for an obscurant originating in the downwind region of the source area to reach that same point. For a Gaussian distributed source and an evaporation term of the form given in equation A.3 for the Gaussian puff, the exact solution for the mass downwind of point x_2 (associated with a downwind time t_2 from the source) at time t is:

$$M_d = \int_0^T \dot{m}(t')\phi\left[\frac{t-t_2-t'}{\sigma_s/\mu}\right]\left[f_d+(1-f_d)e^{-\delta(t-t')}\right]dt' \qquad \text{(A.47)}$$

where the upper limit T on the integration is [1]

$$T = \left\{\begin{array}{ll} t-t_2+2.15\frac{\sigma_s}{\mu} & \text{for } t_2 > 2.15\frac{\sigma_s}{\mu} \\ t & \text{for } t_2 < 2.15\frac{\sigma_s}{\mu} \end{array}\right\} \qquad \text{(A.48)}$$

The distance σ_s is the Gaussian standard deviation for the source, and μ is the windspeed inside the source region. The integration limit separates the cases of the point t_2 downwind of the source region from the case of t_2 being inside the source region. The problem with tabulating the results of equations A.47 and A.48 directly is that they depend both on the current time t and the downwind time t_2. The need exists for an approximate equation in which only differences in t and t_2 appear.

Assume for the moment that the evaporation term is incorporated into the mass definition m. Integrate equation A.47 by parts for the case of a point downwind of the source. Use the facts that M(0) is zero, the cumulative normal distribution is unity from about $2.15\frac{\sigma_s}{\mu}$ to infinity and zero from minus infinity to $-2.15\frac{\sigma_s}{\mu}$; then

$$M_d = \int_{t-t_2-2.15\frac{\sigma_s}{\mu}}^{t-t_2+2.15\frac{\sigma_s}{\mu}} \frac{M(t')\mu}{(2\pi)^{1/2}\sigma_s} e^{-\frac{1}{2}\left(\frac{t-t_2-t'}{\frac{\sigma_s}{\mu}}\right)^2} dt' \qquad \text{(A.49)}$$

Next expand M(t) in a Taylor series about (t - t_2):

$$M(t') = M(t-t_2) + \frac{dM}{dt'}(t'-t+t_2) + \frac{1}{2}\frac{d^2M}{dt'^2}(t'-t+t_2)^2 + \ldots \qquad \text{(A.50)}$$

where the derivatives are evaluated at (t - t_2). Substitute into equation (60) and integrate the first three terms:

$$M_d = M(t-t_2) + 0 + \left(\frac{1}{2}\frac{\sigma_s^2}{\mu^2}\right)\frac{d^2}{dt'^2}M(t-t_2) + \ldots \qquad \text{(A.51)}$$

One way to approximate the second derivative is by finite differences:

$$\frac{d^2}{dt^2}M(t-t_2) = \left(\frac{\mu}{\sigma_s}\right)^2\left[M(t-t_2-\frac{\sigma_s}{\mu}) - 2M(t-t_2) + M(t-t_2+\frac{\sigma_s}{\mu})\right] \qquad \text{(A.52)}$$

Substituting into equation A.51, the amount of obscurant downwind of the point x_2 is thus

$$M_d = \frac{1}{2}\left[M(t-t_2-\frac{\sigma_s}{\mu}) + M(t-t_2+\frac{\sigma_s}{\mu})\right] \qquad \text{(A.53)}$$

---

[1] 2.15 comes from $e^{(-x^2/2)}$=10%

This can be written in an analogous way for a source with uniform mass distribution in the source region. Assume the source region extends over a length $2\,\Delta L$, and the windspeed in the source area is μ. The time required for obscurant to travel from one side of the source region to the other, Δt_s, is found from:

$$2\,\Delta t_s = \frac{2(\Delta L)}{\mu} = 2\frac{\sigma_s}{\mu} \tag{A.54}$$

Taking into account this spread, Δt_s, upwind and downwind of the center of the source area, the mass that is downwind of point x_2 is approximately

$$M_d = .5\,[M(t - t_2 + \Delta t_s) + M(t - t_2 - \Delta t_s)] \tag{A.55}$$

This result applies for the case when x_2 is neither in the source area itself nor in the leading edge of the plume, as in figure A.5. Another way of looking at equation A.55 is to realize that M_d is an average of the mass at $t - t_2$ for the interval $2\Delta t_s$ for a uniform source. COMBIC92 stores the mass every second. This is a significant change since COMBIC87 which stored the mass, no matter how long the burn time, in an array of 55 values. The larger array means greater accuracy in determining M and an improved run time. Then no searching is required and interpolation time is decreased by about 50 percent over the old method. Furthermore, instead of computing M_d in Phase II, it is computed and stored in Phase I in the SNW array. Equation A.55 is a straight average at $t - t_2 - \Delta t_s$ and $t - t_2 + \Delta t_s$. A more accurate approach is to assume the source is non-uniform and to average for every second for $2\Delta t_S$ seconds. COMBIC92 not only uses mass but mass rate as was shown in eq.A.40. Mass rate is stored in the SNWD arrays. These are also averaged over $2\Delta t_s$ s for all times in that the associated downwind distance is not in the leading edge of the plume or the source region.

To better understand the approximation involved in equation A.55, consider the different case of finding the total mass that is inside a source area at time t. Break up the source region into intervals dx. Integrate all the mass inside one interval, including any mass produced upwind at earlier times that has been transported into interval dx by time t. Then integrate over all the increments of the source region:

$$\begin{aligned} M_s &= (2\,\Delta L)^{-1} \int_0^{2\Delta L} dx \int_0^{\frac{x}{\mu}} dt' \dot{m}(t - t') \\ &= (2\,\Delta L)^{-1} \int_0^{2\Delta L} dx \left[M(t) - M(t - \frac{x}{\mu}) \right] \\ &= M(t) - (2\,\Delta L)^{-1} \int_0^{2\Delta L} dx M(t - \frac{x}{\mu}) \end{aligned} \tag{A.56}$$

The remaining integral depends on the form of the cumulative mass function M. COMBIC uses puffs to represent rapid obscurant releases and reserves plumes for the less abrupt, continuous releases. Thus, M is a monotonic, increasing function that is relatively smooth. We choose to approximate the second integrand by the average evaluated at its limits. The result is:

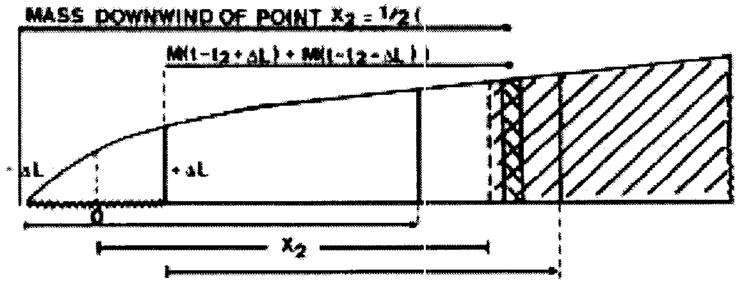

Figure A.5: The downwind mass beyond point x_2 originating from an area source.

$$M_s = M(t) - .5\left[M(t) + M(t + 2\Delta L/\mu)\right] \tag{A.57}$$

If equation A.57 defines the total obscurant inside the source region at time t, then the total obscurant mass downwind of the source region must be $M(t) - M_s$, or:

$$M_d = .5\left[M(t) + M(t + 2\Delta t_s)\right] \tag{A.58}$$

Note this corresponds to the answer from equation A.55 for a downwind travel time from the center of the source region of $t = \Delta$. This is by definition the downwind edge of the source region, so the answers should and do agree.

COMBIC92 uses $\dot{m}$ tables in ways quite similar to the way COMBIC87 uses m tables. Tables of m are needed for crosswind or nearly crosswind LOS. Tables of $\dot{m}$ are needed when the Romberg method is applied. Corrections for area source for the $\dot{m}$ tables for COMBIC92 is simply accomplished by taking the derivative of mass with respect to time.

$$\dot{m}_d = .5\left[\dot{m}(t - t_2 + \Delta t_s) + \dot{m}(t - t_2 - \Delta t_s)\right] \tag{A.59}$$

If t_2 is greater than $t - \Delta t_s$ then the point x_2 is within the diffuse leading edge of the plume. First, equations A.60 and A.61 checks to determine if the source has finished burning.

$$t_d = \min\left(T_{burn} + \Delta t_s, t + \Delta t_s\right) \tag{A.60}$$

$$t_{dd} = \min\left(t_2, t_d\right) \tag{A.61}$$

T_{burn} is the total burn duration, necessary for determining the presence of the diffuse trailing edge after burnout. The mass rate $\dot{m}$ is assumed to vary linearly with $\dot{m}(\Delta t_s)$. Equation A.62 then computes $\dot{m}_{ave}(t)$.

$$\dot{m}_{ave}(t) = \dot{m}_{ave}(\Delta t_s)\left[\frac{t_d - t_{dd}}{2\Delta t_s}\right] \tag{A.62}$$

$\dot{m}_{ave}(t)$ is the average mass rate based upon $\dot{m}_{ave}(\Delta t_s)$ that was precomputed in Phase I and stored in the SNWD array.

If $t_2 < \Delta t_s$ or $t_2 < t - T_{burn} + \Delta t_s$, then the point is within the area source of the plume and $\dot{m}_{ave}(t)$ varies quadratically with $\dot{m}_{ave}(t^-)$. t^- checks to see if the source has finished burning

$$t^- = \min(t - \Delta t_s, T_{burn} - \Delta t_s) \tag{A.63}$$

$$\dot{m}_{ave}(t) = \dot{m}_{ave}(t^-)\left[1.0 - \left(\frac{\Delta t_s - t_2}{2\Delta t_S}\right)^2\right] \tag{A.64}$$

Again $\dot{m}_{ave}(t^-)$ is stored in the Phase I SNWD array.

As an example let's choose x_2, the downwind distance from the center of the source to the integration point to be at the extreme leading edge of the plume.

At this point and the current time, only the smoke from the extreme downwind edge of the source has arrived. t_2, the time from the center of the source area to the point x_2 is $t + \Delta t_s$. From equations A.60 to A.62 it can be that $\dot{m}(t)$ is zero which is reasonable since the smoke has just reached that point.

As a further example, consider the case of the point x_2 at the upwind edge of the source region. Then $t_2 = -\Delta t_s$. It is easy to determine from equations A.63 through A.64 that $\dot{m}_d$ is simply zero. Similarly, consider the case of the midpoint of the source region where $t_2 = 0$. The result is that

$$\dot{m}_{ave} = \frac{3}{4} M(t^-) \tag{A.65}$$

For the evaporation term of equations A.3 and A.47 to be included in the cumulative mass function, several sets of histories must be stored in Phase I; one set for $\dot{m}$ (in addition to m stored in the SNW arrays similar to the previous versions of COMBIC), the other set for the integral in equation A.67 (which is the same integral as in earlier version of COMBIC referred to as XSIG). The first is attributed to the constant f_d, term, while the second is attributed to the exponential decay term. They are defined from:

$$\dot{m}(t) = f_d \dot{m}(t) + (1 - f_d) e^{-\delta t} \left[\delta \int_0^t e^{+\delta t'} \dot{m}(t') dt' + e^{\delta t} \dot{m} \right] \tag{A.66}$$

which simplifies to

$$\dot{m}(t) = \dot{m}(t) - \delta (1 - f_d) e^{-\delta t} \int_0^t e^{+\delta t'} \dot{m}(t') dt' \tag{A.67}$$

A.2.7 The Romberg Integration Method

This section explains the classical Romberg integration method. Its application to the CL integral is detailed in section A.2.4. For details and theory, see almost any text in numerical analysis. The notation used here has been adapted to its ultimate application.

Unless greatly modified, the Romberg method requires that the integrand be defined at equally spaced values of the variable of integration. This equal spacing is accomplished by the indexing discussed in section A.2.4.

Three features of the Romberg method make it nicely adaptable to approximating the CL for LOS not too nearly crosswind:

a. Comparison of one step of the iterative method of Romberg with the previous step will yield an approximate percentage error of the latter step from the true value of CL. This fact allows the user to specify the maximum percentage error that can be tolerated. The number of iterations made is only the number required to achieve the necessary accuracy.

b. After as few as two iterations, the approximation might be terminated because the anticipated CL value is small enough to be below a threshold value that has been specified by the user as negligible.

c. Similarly, the approximation might be terminated if the CL is determined to be large enough to make the transmittance below some threshold value specified by the user.

The Romberg method consists of a series of steps. The initializing step is simply the trapezoidal rule for the interval $[a, b]$. It is never accepted as an accurate value.

Step 0

$$S_{0,0} = \frac{b-a}{2}[f(a) + f(b)] \,.$$

Step 1

$$\begin{aligned} S_{1,0} &= \frac{b-a}{4}\left[f(a) + 2f\left(\frac{b+a}{2}\right) + f(b)\right] \\ &= \frac{1}{2}S_{0,0} + \frac{b-a}{2}f\left(\frac{a+b}{2}\right) \\ S_{0,1} &= (4S_{1,0} - S_{0,0})/3 \end{aligned}$$

The approximation $S_{1,0}$ is the trapezoidal rule for the intervals $[a, (a+b)/2]$ and $[(a+b)/2, b]$. The approximation $S_{0,1}$ is Simpson's rule for the interval $[a, b]$; it is an extrapolation (called Richardson's extrapolation) of $S_{1,0}$ and $S_{0,0}$. If $S_{0,1}$ is smaller than a threshold value specified by the user, then the integral can be assumed negligible and further steps are not needed. Or if $S_{0,1}$ is greater than a given threshold value, further steps are not needed because the transmittance will be negligible.

Step 1 Test. Compute the absolute value of percent relative difference between $S_{0,0}$ and $S_{0,1}$:

$$100.\left[\frac{|S_{0,0} - S_{0,1}|}{S_{0,1}}\right] \,.$$

If this percentage difference is less than a user specified value, the approximation of the integral can be terminated here. If not, step 2 is performed.

Step 2

$$\begin{aligned} S_{2,0} &= \frac{1}{2}S_{1,0} + \frac{b-a}{4}\left[f\left(\frac{3a+b}{4}\right) + f\left(\frac{a+3b}{4}\right)\right] \\ S_{1,1} &= (4S_{2,0} - S_{1,0})/3 \\ S_{0,2} &= (16S_{1,1} - S_{0,1})/15 \end{aligned}$$

Step 2 Test. Compute

$$100.\left[\frac{|S_{0,1} - S_{0,2}|}{S_{0,2}}\right]$$

and compare with the user specified value. In general Step n:

$$\begin{aligned} S_{n,0} &= \frac{1}{2}S_{n-1,0} + \frac{b-a}{2^n}\sum_{i=1}^{2^{n-1}} f\left[\frac{(2^n+1-2i)a + (2i-1)b}{2^n}\right] \\ S_{n-1,1} &= (4S_{n,0} - S_{n-1,0})/3 \\ S_{n-2,2} &= (16S_{n-1,1} - S_{n-2,1})/15 \\ S_{n-j,j} &= (4^j S_{n-j+1,j-1} - S_{n-j,j-1})/(4^j - 1) \quad (for\ j = 1\ to\ n) \end{aligned}$$

The sequence $S_{0,0}$, $S_{0,1}$, $S_{0,2}$, $\cdots$, $S_{0,n}$, $\cdots$ theoretically approaches $\int_a^b f(x)\,dx$. The only limitations are the practicability of evaluating the function $f(x)$ at a large number of values and certain requirements on the higher order derivatives of $f(x)$.

In several examples using the technique, accuracy of 15 percent or better was achieved as early as step 2, which requires only five evaluations of $f(x)$. Accuracy of 1 percent is not unusual at step 3, which requires only nine evaluations of $f(x)$. To provide for rapidly changing mass production functions (such as for phosphorus based smoke) it is suggested that coding allow up to 4 steps, which requires 17 evaluations

A.2.8 Barrage Emissions

The barrage is treated as a large number of smoke or dust sources that are distributed in some Gaussian pattern of downwind standard deviation σ_b and that impact or ignite with a uniform distribution over T_{bar} seconds. The combined effect of the spatial spread due to the barrage pattern and the spatial spread of individual munitions is easily seen to remain Gaussian with a spatial variance:

$$\sigma_s^2 = \sigma_m^2 + \sigma_b^2 \tag{A.68}$$

where σ_s is the source "sigma" for the combined effect of the barrage "sigma", σ_b, and the individual munition "sigmas", σ_m. This follows directly by evaluating the concentration equation when written as an expectation over impacts having Gaussian probability of igniting at x:

$$\begin{aligned} C(x) &= \int\limits_{-\infty}^{\infty} \frac{1}{2\pi\sigma_m\sigma_b} e^{-\frac{1}{2}\left(\frac{x-x'}{\sigma_m}\right)^2} e^{-\frac{1}{2}\left(\frac{x'}{\sigma_b}\right)^2} dx' \\ &= \frac{1}{(2\pi)^{\frac{1}{2}}\left(\sigma_m^2+\sigma_b^2\right)^{\frac{1}{2}}} e^{-\frac{x^2}{2\left(\sigma_m^2+\sigma_b^2\right)}} \end{aligned} \tag{A.69}$$

The effective mass emission rate resulting from uniform impacts or ignitions over time T_{bar} of munitions with individual emission durations T_{burn} is easy to write as:

$$m(\dot{t}) = \begin{cases} \frac{1}{M_m T_{bar}} \int\limits_0^t \dot{m}_m(t')dt' \text{ for } 0 < t < \mathrm{Min}(T_{bar}, T_{burn}) \\ \\ \frac{1}{T_{bar}} \text{ for } T_{burn} < t < T_{bar}(\text{ if } T_{bar} > T_{burn}) \\ \\ \frac{1}{M_m T_{bar}} \int\limits_{t-T_{bar}}^{T_{burn}} \dot{m}_m dt' \text{ for } T_{bar} < t < T_{bar} + T_{burn} \end{cases} \tag{A.70}$$

where M_m is the total mass of one munition, and $\dot{m}_m$ is the munition mass emission function. It should be noted that the total emission time is now $T_{bar} + T_{burn}$. If the barrage lasts longer than the individual munition burn duration, then the obscurant production is constant over the middle period of the barrage.

A.3 The Diffusion Model in COMBIC

Ambient turbulence in the atmosphere causes a decrease in obscurant concentration as the puff or plume diffuses (expands) downwind. The effect of diffusion in COMBIC is contained in the parameters σ_x, σ_y and σ_z. These are directly related to cloud dimensions. Two methodologies are used to define the σs. The old methodology used in previous COMBIC is still valid for downwind travel time < 30 s.

The values of the sigma's for puffs, in relation to the downwind travel distance from the source $\bar{x}$, is dependent on the Fractional Stability Category, wind speed, scaling ratio and surface roughness length [Hansen and Pena, 1990b; Hansen and Pena, 1990a] for downwind distance greater than the distance associated with a downwind travel time of 30 s. For instantaneous Gaussian puffs, the equations for finding the longitudinal dispersion length is,

$$\sigma_{x_l} = \left[\sigma_{x_o}^2 + \sigma_{x_s}^2 + \sigma_{x_t}^2\right]^{.5} \tag{A.71}$$

where σ_{x_o} represents the initial expansion or "source sigma". The parameters σ_{x_s} and σ_{x_t} are the vertical wind shear influences and longitudinal diffusivity of a puff, respectively.

$$\sigma_{x_s} = \frac{0.012}{\sigma_z} \left\{ \left[\frac{x}{\ln 0.53 \frac{\sigma_z}{\sigma_o} + \psi_m\left(\frac{z}{L}\right)} \right]^3 \frac{\phi_M^2}{\phi_H} \right\}^{\frac{1}{2}} \tag{A.72}$$

$$\sigma_{x_t} = \frac{3}{\bar{\mu}} \left[\ln .53 \frac{\sigma_z}{\sigma_o} + \psi_M\left(\frac{z}{L}\right) \right]^{-2} x \tag{A.73}$$

where ϕ_M is the dimensionless wind shear, ϕ_H is the dimensionless lapse rate, ψ_m is the diabatic influence function for momentum and L is the Obukhov scaling length.

The lateral dispersion length σ_y is considered to be time dependent, highly sensitive to sampling and averaging times, and responsive to changes in surface roughness length, and is represented as

$$\sigma_y = \left[\frac{z_o}{10000}\right]^{\frac{1}{3}} \left[\frac{t}{0.1}\right]^{\frac{1}{3}} \sigma_\theta f_1(x) x \tag{A.74}$$

where σ_θ is found as a function of Pasquill Stability Categories, z_o is the surface roughness length and can be determined from Table A.1

$$\sigma_\theta = 9.714 - 4.925(P) + 0.402(P)^2 + 0.118(P)^3 \tag{A.75}$$

The function f_1(x) is given by

$$f_1(x) = \left[1 + 0.308x^{0.4548}\right]^{-1} \tag{A.76}$$

for alongwind distance of 10^4 m or less. For distances greater then 10^4 m,

$$f_1(x) = 0.33(x)^{-\frac{1}{2}} \tag{A.77}$$

The vertical dispersion length is found to be independent of alongwind travel time, but is dependent upon the surface roughness length (see Table A.1), and is represented by:

$$\sigma_z = \left[\frac{z_0}{0.1}\right]^{\frac{1}{3}} \sigma_\phi f_2(x) x \qquad (A.78)$$

where σ_ϕ is a function of Pasquill Stability Categories,

$$\sigma_\phi = 5.048 - 1.996(P) + 0.060(P)^2 + 0.056(P)^3 \qquad (A.79)$$

and f_2(x) for downwind distances of 5 * 10^3 m or less is,

$$f_2(x) = \left[1 + 0.0422x^{.4548}\right]^{-1} \qquad (A.80)$$

and for distances greater than 5000 m.

$$f_2(x) = 0.33\left[\frac{5000}{x}\right]^{\frac{1}{2}} \qquad (A.81)$$

Reliable estimates for concentration for a relatively diffusing plume can be found by considering the trivariate (x,y,z) diffusion of a Gaussian puff. Multiple puffs may be then advected or transported along the mean wind direction to represent the plume. The resultant dispersion of gases and aerosols will, of necessity, be less than those simulated or observed for a continuous diffusion situation. The key to successfully modeling expanding clusters of puffs may be found in correctly postulating the form of the longitudinal dispersion of a puff. For continuous Gaussian plumes, the equations are slightly different [Hansen, 1990]:

$$\begin{aligned} \sigma_x &= 0 && (A.82)\\ \sigma_y &= \sigma_\theta f_1(x) x && (A.83)\\ & && (A.84) \end{aligned}$$

The dependence of these diffusive expansion coefficients on downwind travel distance from the source $\bar{x}$ for X < the distance the cloud reaches after 30 s is assumed to follow a power law with constants that are functions of the Pasquill category and surface roughness parameter [Hansen, 1979; Pasquill, 1974a]. For continuous Gaussian plumes, EOSAEL82 COMBIC used the forms:

$$\begin{aligned} \sigma_x(\bar{x}) &= 0 && (A.85)\\ \sigma_y(\bar{x}) &= A_i \bar{x}^{0.9} && (A.86)\\ \sigma_z(\bar{x}) &= C_{ij} \bar{x}^{D_{ij}} && (A.87) \end{aligned}$$

where i is the Pasquill category index, and j is a surface roughness index for z_o of 1, 10, or 100 cm.

Figure A.6 and figure A.7 illustrates how the cloud dimensions change for different Pasquill stabilities for a generic WP munition.

The values for the instantaneous Gaussian puff are

$$\sigma_x(\bar{x}) = 0.740 A_i \bar{x}^{0.9} \qquad (A.88)$$

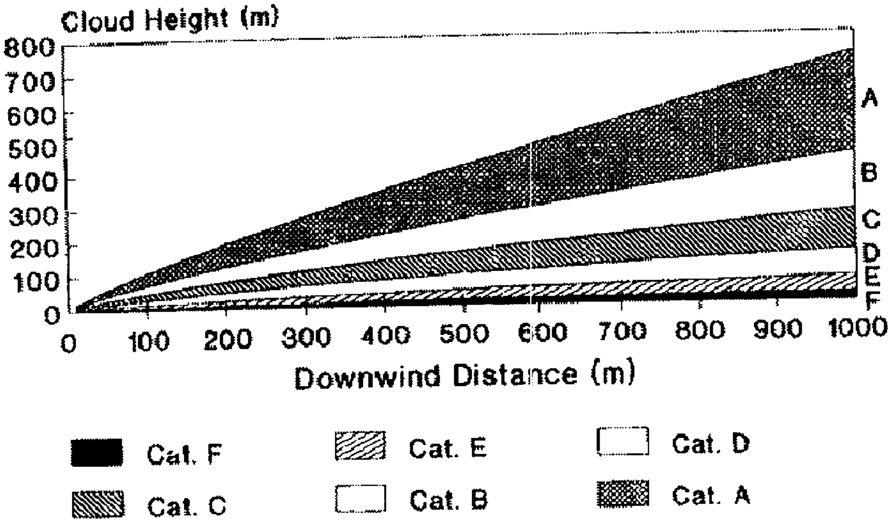

Figure A.6: Cloud diffusive width (2.15σ) for different Pasquill categories.

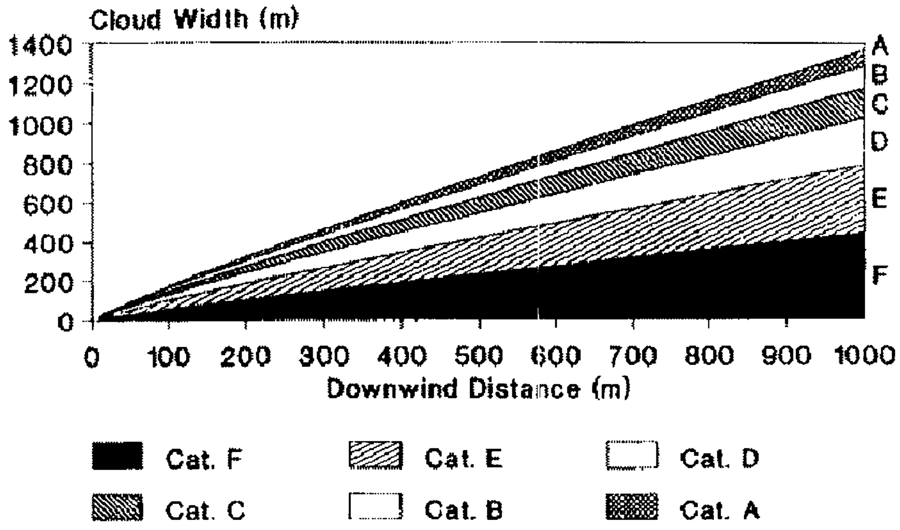

Figure A.7: Cloud diffusive height (2.15σ) for different Pasquill categories.

$$\sigma_y(\bar{x}) = 0.667 A_i \bar{x}^{0.9} \tag{A.89}$$

and

$$\sigma_z(\bar{x}) = C_{ij} \bar{x}^{D_{ij}} \tag{A.90}$$

Values for the constants A, C, and D used in the EOSAEL82 version of COMBIC were those of Hansen [1979], as derived from Pasquill [1974a], and are given in table A.2. Since EOSAEL84, COMBIC retains the functional forms of these equations but now uses continuous interpolating coefficients in surface roughness and Pasquill stability class. This expands the model from the specific conditions imposed by table A.2 to the general case. In addition, the sigma expansion coefficients are modified by initial source terms. Initialization is discussed in the later sections on individual obscurant types.

It was desirable for the COMBIC84 model to allow diffusion to be computed for any surface roughness. For consistency with the boundary layer model extensions, it was further desirable to fit the dependence of the diffusion parameters on stability category so that interpolation can be performed between stability categories.

To accomplish this goal, Pasquill's original results were re-examined, [Hansen, 1979]. Pasquill used gradient transport theory, a stability categorization not too different from the current COMBIC boundary layer model and observed data. He produced a table of diffusion coefficients and three graphs to extend these diffusion coefficients to other roughness lengths and to intermediate stability values.

These results have been fit with interpolating functions in dependent variables P, Pasquill parameter, and z_o, surface roughness length in m. The form of the functions was somewhat determined by the boundary layer equations. For example, from equation A.87

$$\ln \sigma_z = \ln C(P; z_o) + D(P; z_o) \ln x \tag{A.91}$$

while for neutral stability

$$x = \frac{\mu t}{k} \ln(\frac{z}{z_o}) \tag{A.92}$$

Thus, it is reasonable to choose the form

$$D(P; z_o) = \delta_1(P) + \delta_2(P) \ln[\ln(\frac{z_R}{z_o})] \tag{A.93}$$

to separate the surface roughness dependence of D. A reference height of z_R of 7.5 m was chosen for consistency with the COMBIC boundary layer model. The Pasquill parameter dependence was found from Pasquill's graphs and table to be similar to a skewed hyperbolic sine curve about neutral conditions ($P = 3.6$). A double exponential was therefore chosen, and the resulting equations are:

$$\delta_1 = 0.5629[1 + .4543e^{-0.4P} - 0.002347e^{0.75P}] \tag{A.94}$$

$$\delta_2 = 0.1 + 0.0084 \ln P \tag{A.95}$$

Exponents $D(P;z_o)$ from equation A.93 at the same values for P and z_o used by Pasquill in his tabulation are shown in table A.3. Pasquill's values are also given for comparison. Agreement is good with differences from Pasquill's two-digit precision only in categories D (z_o = 0.1 m) and E (z_o = 1.0 m). These differences produce less than 4 percent difference in vertical diffusion over 1 km downwind distance.

The multiplying coefficients for vertical diffusion $C(P,z_o)$ have similarly been fit by a product of three terms. The first term merely converts from Pasquill's units of km to COMBIC's units of m. The second contains the Pasquill parameter dependence. The third term contains the surface roughness dependence. Note the occurrence of the D exponent factors in the C coefficient.

$$C(P; z_o) = C_m(D) C_p(P) C_z(D; z_o) \tag{A.96}$$

with

$$C_m(D) = 1000^{[1-D(P;z_o)]} \tag{A.97}$$

$$C_p(P) = .00397 + .193e^{-.61P} + .00516P^{8.27}e^{-2.7P} \tag{A.98}$$

$$C_z(D; z_o) = \frac{D(P; z_o)}{D(P; 0.1)}(1.2 + .0091 \ln z_o)^{[2.3+\ln z_o]} \tag{A.99}$$

Table A.4 compares the C coefficients found from equations A.96, A.98, A.99, neglecting C_m to produce units of kilometers comparable to Pasquill's. Agreement is good, with some differences attributable to round-off. The results for Pasquill category B (z_o = 0.01 m) and E (z_o = 1.0 m) show maximum disagreement. The latter value produces 6 percent differences in vertical diffusion from Pasquill's.

Thus, the parameterized equations for C and D are good interpolators of diffusion for surface roughness and Pasquill parameter variations. The percentage differences from Pasquill's original results are not significant. Uncertainties in the choice of a surface roughness for particular terrain are at least 10 percent. Diffusion coefficients should not be extrapolated for surface roughness of 5 m or larger, however. Comparisons with Pasquill's graphs show errors increasing rapidly above this surface roughness. Similarly, comparisons for Pasquill parameters less than 0.2 show that the interpolation equations underestimate Pasquill's C coefficients by 10 to 30 percent in this region of extreme instability.

Finally, table A.3 gives the results of table A.4 for C converted to units of meters using equation A.97. These are the values used in COMBIC. They can be compared directly with the COMBIC82 values in table A.2.

Pasquill found horizontal (crosswind) diffusion to be virtually independent of surface roughness. The coefficients A in equation A.87 were fit, therefore, only to the Pasquill parameter using the tabulated coefficients found in Hansen's work [1979]. The result is:

$$A(P) = 0.1754 - 0.018P + 0.2535e^{-0.1578P^2} \qquad \text{(A.100)}$$

Table A.6 lists the interpolation results compared with Hansen's suggested values. The agreement is excellent.

Table A.1: Surface Roughness Lengths

Type of Surface	Surface Roughness (m)
Farmland	
Natural snow surface (farmland)	0.003
Long grass(0.6 m), crops	0.05
Few trees, summer	0.07
Hedge rows	0.10
Wheat	0.22
Alfalfa	0.0272
Corn (2.2 m)	0.74
Trees, hedges, few buildings	0.20
Agricultural areas, Asia	0.08
Tall crops, scattered obstacles	0.25
Citrus orchards	0.35
Orchards, summer	2.00
Forest, wooded areas	
Subtropical Savannah, scattered trees	0.25
Fairly level wooded country	0.30
Forest clearings, cutover areas	0.40
Fairly level coniferous, 15-20 m trees	1.10
Rolling terrain, 20 m trees	2.00
Fir forest	2.83
Smooth open woods (pine in connecticut)	2.83
Fir forest	2.83
Pine forest (20 m trees)	2.83
Pine forest (19 m trees) (England)	2.83
Forested plateau (crossed by small valleys, 10 m trees)	2.83
Slightly rolling terrain, forested, some buildings	2.83
Forested ridges (150-200 m high)(Tennessee)	2.83
Forested ridges, hills	3.50
Mountains, unforested	
Rolling hills, low mountains	0.75
Plains	
Fairly level grass, few trees, winter	0.01
Fairly level grass, few trees, summer	0.02
Closely mown grass	0.001
Short grass	0.0014
Grass(.05 -.06 m)	0.0075
Grass(.6- .7 m)	0.114
Uncut grass, isolated trees	0.03
Brush, scrub growth, open	0.15
Brush, scrub growth, dense	0.25

Table A.1: Surface Roughness Lengths

Type of Surface	Surface Roughness (m)
Urban land-use	
Villages	0.40
Towns	0.55
Light density residential	1.08
Park	1.27
Office	1.75
Airfields	0.03
Central business district	3.21
Heavy density residential	3.70
Other	
Smooth mud flats	0.00001
Blacktop or concrete	0.00002
Dry lake bed	0.00003
Smooth desert	0.001
Normal sea	0.001
Tundra	0.004

Table A.2: Coefficients of Diffusive Expansion used in COMBIC82

			Surface Roughness Lengths					
			z_o= 1 cm		z_o= 10 cm		z_o= 100 cm	
Index	Pasquill Category	A_i	C_{i1}	D_{i1}	C_{i2}	D_{i2}	C_{i3}	D_{i3}
$i = 1$	A	0.40	0.154	0.94	0.279	0.90	0.615	0.83
$i = 2$	B	0.32	0.133	0.89	0.225	0.85	0.539	0.77
$i = 3$	C	0.22	0.121	0.85	0.213	0.81	0.533	0.72
$i = 4$	D	0.143	0.108	0.81	0.195	0.76	0.456	0.68
$i = 5$	E	0.102	0.078	0.78	0.139	0.73	0.348	0.65
$i = 6$	F	0.076	0.062	0.72	0.117	0.67	0.309	0.58

Table A.3: Comparison of Interpolating functions for vertical diffusion exponent D with Pasquill's table.

				SURFACE ROUGHNESS, z_o					
				INTERPOLATING FUNCTION			PASQUILL'S TABLE		
Pasquill Category	P	δ_1	δ_2	.01m	0.1m	1.m	01m	1m	1.m
A	0.6	.762	.0957	.943	.902	.829	.94	.90	.83
B	1.6	.693	.1039	.890	.845	.766	.89	.85	.77
C	2.6	.644	.1080	.848	.802	.720	.85	.80	.72
D	3.6	.604	.1108	.813	.766	.681	.81	.76	.68
E	4.6	.562	.1128	.775	.727	.641	.78	.73	.65
F	5.6	.502	.1145	.718	.669	.582	.72	.67	.58

Table A.4: Comparison of Interpolating functions for vertical diffusion coefficients C with Pasquill's table

Pasquill Category	P	INTERPOLATING FUNCTION			PASQUILL'S TABLE		
		z_o=.01 m	z_o=0.1 m	z_o=1.0 m	z_o=.01 m	z_o=0.1 m	z_o=1.0 m
A	0.6	.103	.138	.193	.102	.140	.190
B	1.6	.060	.080	.110	.062	.080	.110
C	2.6	.042	.056	.076	.043	.056	.077
D	3.6	.029	.038	.051	.029	.038	.050
E	4.6	.017	.022	.029	.017	.023	.031
F	5.6	.0095	.012	.016	.009	.012	.017

Table A.5: Comparison of Interpolating functions for vertical diffusion coefficients C when X is meters

		EOSAEL84 COMBIC DIFFUSION COEFFICIENT C			PASQUILL'S TABLE CONVERTED TO X IN METERS		
Pasquill Category	P	z_o=.01 m	z_o=0.1 m	z_o=1.0 m	z_o=.01 m	z_o=0.1 m	z_o=1.0 m
A	0.6	.153	.272	.629	.154	.279	.615
B	1.6	.128	.233	.554	.132	.225	.539
C	2.6	.120	.220	.526	.121	.223	.532
D	3.6	.106	.191	.462	.108	.199	.456
E	4.6	.080	.145	.346	.078	.149	.348
F	5.6	.067	.118	.287	.062	.117	.309

Table A.6: Comparison of Interpolating Function and Crosswind Diffusion Coefficients A of Hansen

Pasquill Category	P	Interpolating Function $A(P)$	Hansen's Suggested A Coefficients
A	0.6	0.404	0.40
B	1.6	0.316	0.32
C	2.6	0.216	0.22
D	3.6	0.143	0.143
E	4.6	0.102	0.102
F	5.6	0.076	0.076

A.4 The COMBIC Model for Buoyant Rise

The rise and stabilization of warm obscurant clouds due to buoyancy (that is, the difference in air density or temperature inside and outside the clouds) are very much influenced by the local temperature gradient and turbulent diffusivity of the atmosphere. A warm volume of air, whether natural or due to an exothermic obscurant source, will rise and expand through entrainment of ambient air. Entrainment and mixing cools the volume and makes it more dense. If the volume eventually comes to equilibrium with surrounding air, it will cease to rise, perhaps overshooting the equilibrium point at first. This phenomenon is particularly true at night when the earth has cooled by radiation to a temperature below that of the air above it, and the sensible heat flux from the surface is negative (downward).

Increasing ambient air temperature with height increases the stability and produces an eventual equilibrium of a rising warm volume. The reverse is true during daylight hours when the sensible heat flux becomes positive (upward). A volume of ambient air raised somewhat into cooler surrounding air will acquire buoyancy, thus promoting a further rise, and hence the conditions are termed unstable. The atmosphere is not a quiescent fluid, however. Unstable conditions and low windspeeds produce warm rising columns of air near the surface. Cooler air convects to replace it. Increasing windspeed also promotes mixing (mechanical turbulence) which tends to drive the atmosphere to more neutral conditions. This turbulence produces a local eddy diffusivity that will tend to break up and halt the rise of slightly buoyant volumes.

Buoyant rise is described through a set of three differential equations and several constitutive relations. A review and a comparison of numerical solutions and analytic approximations to the differential equations were made with respect to the methods used in earlier EOSAEL models [Hoock and Sutherland, 1982]. The analytic solutions, attributable to Morton, Taylor and Turner [1956], and to Briggs [1969], were found to be adequate under the assumption of a constant stability parameter (that is, constant change in air temperature with height). They were insufficient, however, to account for the early formation of dust from high explosives and for more general initial velocity conditions. Therefore, since the EOSAEL84 version, COMBIC now solves the differential equations directly. The following sections derive the equations and show the differences from the earlier version. Much of the work of this section parallels and was heavily influenced by the work of Weil [1982], which compares similar differential equations to the approximate buoyancy solutions. Weil compared plume rise from diesel fires with the data base on stack effluents and found good model agreement. He also performed limited analysis of data from high explosive dust tests.

A.4.1 The Differential Equations for Rise and Advection

The rise of a warm mass of air m (g) at temperature T (K) in an ambient atmosphere of temperature T_a is governed by conservation of mass, momentum, and energy. Energy conservation will be considered first. Throughout this section, the term "thermal volume" refers to the warm mass of air, regardless of shape, for which the rise and expansion is to be found.

If an increment of ambient air dm is entrained into the thermal volume, the change in internal energy of the thermal volume is balanced by the work performed:

$$\begin{aligned} dU &= mC_V dT + (T - T_a)C_V\, dm \\ &= dQ - P\, dV \end{aligned} \qquad (A.101)$$

where C_V is the specific heat of air at constant volume, dQ is the thermal energy, P is the pressure and dV is the volume change in the region. We assume the expansion is adiabatic, so the change dQ is zero. The work done can be rewritten using the equation of state and the adiabatic assumption, resulting in:

$$PdV = -C_V \left(\frac{\gamma - 1}{\gamma} \right) \frac{mT}{P} dP \qquad (A.102)$$

The γ factor is the ratio of specific heats of air at constant pressure to that at constant volume and is approximately 1.41. Substitution of equation A.102 into A.101 and collection of terms leads to a basic differential equation for temperature:

$$\left(\frac{\gamma - 1}{\gamma} \right) \frac{dP}{P} = \frac{dT}{T} + \left(1 + \frac{T_a}{T} \right) \frac{dm}{m} \qquad (A.103)$$

Although this form could be used directly, it is more convenient to eliminate the pressure term. A model used by Thompson [1982; 1979a], for the rise of thermal fireballs, assumes that

$$P(z) = P_o e^{-z/H_p} \qquad (A.104)$$

where H_p is a reference height, about 8400 m, specified more explicitly by

$$H_p = \left(\frac{\gamma - 1}{\gamma} \right) \frac{C_P T_a}{g} \qquad (A.105)$$

and g is acceleration due to gravity (9.8 m/s^2). Using equation A.104, the temperature equation takes on the form used by Thompson:

$$\frac{1}{T} \frac{dT}{dt} = \left(\frac{T_a}{T} - 1 \right) \frac{1}{m} \frac{dm}{dt} - \left(\frac{\gamma - 1}{\gamma} \right) \frac{w}{H_p} \qquad (A.106)$$

where t is time and w is vertical velocity of the thermal volume. A still more convenient form to use with the COMBIC boundary layer model results from introducing the static stability parameter s (sec^{-2}). The static stability parameter should not be confused with the dynamic Pasquill stability class [S. R. Hanna and Hosker, 1982]. The parameter s is defined by the temperature gradient of the atmosphere with height,

$$\begin{aligned} s &= \frac{g}{T_a} \frac{d\theta}{dz} \\ &= \frac{g}{T_a} \frac{dT_a}{dz} + \left(\frac{\gamma - 1}{\gamma} \right) \frac{g}{H_p} \end{aligned} \qquad (A.107)$$

θ is the potential temperature and z is height. Under perfectly neutral conditions, s is identically zero. The change in temperature with height is then the natural adiabatic lapse rate of -0.0098°C/m. In terms of s, equation A.106 can be written in the form:

$$\frac{d}{dt}\frac{T}{T_a} = \left(1 - \frac{T}{T_a}\right)\frac{1}{m}\frac{dm}{dt} - \frac{s}{g}\left(\frac{T}{T_a}\right)w \tag{A.108}$$

An advantage of using this differential equation is that the variables' mass, vertical velocity, and the ratio of the mean temperature inside the thermal volume to that of ambient air are more convenient.

The second differential equation is derived from conservation of momentum. The change in momentum of the rising thermal volume is balanced against all external forces on the volume. COMBIC includes three: buoyancy, drag, and momentum entrainment:

$$\frac{d(mw)}{dt} = m_a g - mg + w_a\frac{dm}{dt} - \frac{1}{2}C_D\rho_a A_\perp(w - w_a)|w - w_a| \tag{A.109}$$

The buoyant force is the difference in weight (mg) of the thermal volume and the weight m_a g of the same volume of ambient air. The drag term includes the empirical coefficient C_D of 0.8, a value suggested by Thompson [1979b] as representative for tactical high explosives. The component of the volume's area perpendicular to the motion and the density ρ_a of the ambient air are also included. The drag term is proportional to the square of the difference in the upward velocity (w) of the thermal volume and the upward velocity (w_a) of the air outside the volume. For most applications, the latter is zero. For dust generated from a buried high explosive, however, there is a rapid upward ballistic flow of soil from the crater, up to 20 m/s and lasting 1 to 2 s. The drag term partly accounts for the momentum imparted by the soil to the thermal volume, given a model of the upward soil velocity as a function of time. The absolute value is necessary only to insure that the drag force operates in the correct direction, opposing the motion of the thermal volume relative to outside air. The remaining term accounts for the direct entrainment (dm/dt) of outside air of nonzero velocity (if any) w_a.

A similar momentum equation is used for the horizontal component of the motion of the thermal volume:

$$\frac{d(mu)}{dt} = u_a\frac{dm}{dt} - \frac{1}{2}C_D\rho_a A_\perp(u - u_a)|u - u_a| \tag{A.110}$$

where u is the horizontal velocity of the thermal volume and u_a the horizontal windspeed outside the volume. This is an especially convenient way to advect the thermal volume in the ambient wind u_a.

The momentum equations will be rewritten below to include the same variables as in the energy equation A.108. The third and final equation, needed to rewrite equation A.109 and equation A.110, describes the mass balance. The mass of the thermal volume increases by entraining air from outside. Entrainment is fundamentally an empirical notion. The assumption, put forth by G. I. Taylor [1945], is that the rate of mass entrainment is proportional to the product of the surface area A of the thermal volume and the relative velocity between inner and outer regions:

$$\frac{dm}{dt} = \alpha\rho_a A|\vec{v} - \vec{v}_a| \tag{A.111}$$

where α is the entrainment coefficient. Written in terms of mass instead of area, this becomes:

$$\frac{1}{m}\frac{dm}{dt} = \mu \frac{\rho_a}{\rho} \frac{|\vec{v} - \vec{v}_a|}{R} \tag{A.112}$$

where μ is a suitably redefined entrainment coefficient in terms of α. The vector difference is between v, the velocity of the thermal volume, and v_a, the velocity of outside air. Similarly, the ratio of densities ρ is between the outer and inner regions. The vectors $\vec{v}$ and $\vec{v}_a$ have horizontal components u and u_a vertical components w and w_a appearing in equations A.109 and A.110. The vectors can even have some crosswind components. $\vec{v}$ can be thought of as the wind blowing around the puff.

The equations thus far are very general. They apply equally well to instantaneous puffs and continuous plumes. The entrainment and drag terms, however, contain explicit reference to surface areas in contact with outside air. Thus the geometries of puffs and plumes must be handled separately. The empirical entrainment coefficient also varies with geometry.

COMBIC models instantaneous thermal fireballs as spheroids with horizontal radius R_h and vertical radius R_z. The mass is defined by

$$m_t = \frac{4}{3}\pi R_h^2 R_z \rho \tag{A.113}$$

where the subscript "t" refers to these instantaneous "thermals," the historic term given to rising spherical regions. The surface area of a spheroid is:

$$A_t = 2\pi R_h^2 \begin{cases} 1 + \frac{\sin^{-1}[(1-e^2)^{1/2}]}{e(1-e^2)^{1/2}} & (0 < \mathrm{e} < 1) \\ 2 & (\mathrm{e} = 1) \\ 1 + \frac{\ln[e+(e^2-1)^{1/2}]}{e(e^2-1)^{1/2}} & (\mathrm{e} > 1) \end{cases} \tag{A.114}$$

where e is the ratio R_h/R_z, separating cases of prolate ($e > 1$) from oblate ($e < 1$) spheroids. The entrainment coefficient used in equation A.112 for thermals is

$$\mu = 3\alpha_t \tag{A.115}$$

where α_t is 0.25 taken from lab and field experiments [Weil, 1982; Turner, 1969]. The $1/R$ term in equation A.112 is thus one-third the area to volume ratio:

$$\frac{1}{R} = \frac{A_t}{4\pi R_h^2 R_z} \tag{A.116}$$

Continuous plumes are modeled as a sequence of disk-like regions formed by taking slices perpendicular to the plume center-line axis. The thickness of each slice is defined as

$$\triangle L = |\vec{v}| \triangle t \tag{A.117}$$

where $\triangle t$ is a constant time step used in solving the differential equations; for convenience, let us say 1 s, and v is the velocity of the plume mass at each new slice position along the plume. v is the velocity along the center line of the plume. Remember, not all plumes are horizontal. For constant thermal production, then, each slice in sequence along the plume axis results from extrapolating, via the differential equations, one time step forward from the previous slice. The mass in a slice and the area of the ring in contact with outside air are:

$$m_p = \pi \rho R^2 \triangle L \tag{A.118}$$

and

$$A_p = 2\pi R \triangle L \tag{A.119}$$

The entrainment coefficient is known to vary with the angle of the plume centerline axis from the vertical. A vertical plume has

$$\mu = 2\alpha_{pv} \tag{A.120}$$

with $\alpha_{pv} = 0.116$ [Weil, 1982; Turner, 1969]. A horizontal or "bent" plume (the only plume type treated in the EOSAEL82 COMBIC plume rise model) has an entrainment coefficient

$$\mu = 2\alpha_{ph} \tag{A.121}$$

where $\alpha_{ph} = 0.60$ [Briggs, 1969; Hoult *et al.*, 1969]. For intermediate cases, COMBIC uses an effective plume entrainment coefficient similar to that of Hoult, Fay and Forney [1969], which is consistent with the EOSAEL FITTE fire plume model:

$$\mu = 2\left[\alpha_{pv}\left(\frac{w}{v}\right)^2 + \alpha_{ph}\left(\frac{u}{v}\right)^2\right] \tag{A.122}$$

With these definitions and with the important assumption of pressure equilibrium between the thermal volume and the outside air:

$$\rho T = \rho_a T_a \tag{A.123}$$

the momentum equations can be simplified to determine the velocity changes at each time step:

$$\frac{dw}{dt} = \left(\frac{T}{T_a} - 1\right) g - \frac{1.4}{m}\frac{dm}{dt}(w - w_a) \tag{A.124}$$

and

$$\frac{du}{dt} = -\frac{1.4}{m}\frac{dm}{dt}(u - u_a) \tag{A.125}$$

In summary, the COMBIC buoyancy model solves equations A.108, A.112, A.124 and A.125 for the quantities

$$\frac{d}{dt}\left(\frac{T}{T_a}\right), \frac{1}{m}\frac{dm}{dt}, \frac{dw}{dt}, \text{ and } \frac{du}{dt} \tag{A.126}$$

from which T, m, w, u, z, and x are updated at each time step. The mass definitions, equations A.113 and A.118, are used to find the new radii at each time step. Equation A.123 and the atmospheric boundary layer model for ambient temperature and density are used at the new height to determine the thermal volume density ρ. In all, the process is straightforward and efficient, with computation times that are very competitive with the EOSAEL82 analytic model.

A.4.2 Adjustments, Initial Conditions and Scaling in the Buoyancy Model

Adjustment can be made for the effect of obscurant mass m_a on the changes in vertical velocity w:

$$\left(\frac{dw}{dt}\right)_{corr} = \left(\frac{m}{m+m_a}\right)\frac{dw}{dt} - \left(\frac{m_a}{m+m_a}\right)g \qquad \text{(A.127)}$$

The obscurant mass does not enter into the energy or entrainment equations. The magnitude of this aerosol correction is usually small. For example, 10 kg of obscurant initially in a sphere of radius 2 m represents only 20 percent of the total mass of obscurant plus air in the sphere. This percentage then rapidly decreases as the region grows, entraining 1.2 kg for every m^3 of air.

The temperature used in the differential equations is the mean value for the thermal volume. It is often of interest, however, to have an estimate of the expected peak temperature. Analysis [Hoock and Sutherland, 1982] and comparison with data indicate that a reasonable estimate for the peak temperature T_{peak} in HE, WP and diesel fire plumes in terms of the mean temperature T and the ambient air temperature T_a is given by

$$T_{peak} = \left(\frac{0.4T_a}{T_a - 0.6T}\right)T \qquad \text{(A.128)}$$

for mean temperatures less than 1.66 T_a. This is easily derived from the often used assumption that the air density defect is Gaussian about a central minimum value [Turner, 1969; Batchelor, 1954; Turner, 1962; Richards, 1963]:

$$\rho(r) - \rho_a = [\rho(0) - \rho_a]e^{-(\frac{r}{b})^2} \qquad \text{(A.129)}$$

The mean value of ρ is found by averaging over the buoyancy radius R:

$$\begin{aligned}\rho_{ave} &= (\pi R^2)^{-1}\int_0^R 2\pi r\rho(r)dr \\ &= \rho_a + [\rho(0) - \rho_a](\pi R^2)^{-1}\int_0^R 2\pi r e^{-(\frac{r}{b})^2}dr \\ &= \rho_a + \left(\frac{b}{R}\right)^2\left[1 - e^{-(\frac{R}{b})^2}\right][\rho(0) - \rho_a] \qquad \text{(A.130)}\end{aligned}$$

From the pressure equilibrium condition, equation A.123,

$$\rho_{ave}T = \rho_a T_a = \rho(0)T_{peak} \qquad \text{(A.131)}$$

The mean temperature T is related to the peak temperature by substitution of A.131 into equation A.130:

$$\frac{1}{T} = \frac{1}{T_a} + \left(\frac{b}{R}\right)^2 \left[1 - e^{-\left(\frac{R}{b}\right)^2}\right] \left[\frac{1}{T_{peak}} - \frac{1}{T_a}\right] \qquad \text{(A.132)}$$

Given T_{peak}, T and T_a, then b is determined from R. The parameter b affects only the peak temperature printed out from Phase I calculations. It does not otherwise affect internal model calculations. Equation A.128 results from the COMBIC default value of b/R of 0.669. This ratio approximates Turner's value of 0.633 and is consistent with the 1250K peak temperature of the FITTE modeled fire plume.

COMBIC uses default values for Q, the thermal energy per unit obscurant or explosive mass, and assumes that T is initially 1.44 T_a. This determines an initial buoyancy radius. For thermal puffs,

$$R = \left[\frac{3WQT}{4\pi\rho_a T_a C_P (T - T_a)}\right]^{1/3} \qquad \text{(A.133)}$$

For continuous plumes,

$$R = \left[\frac{\dot{m}_{obs} QT}{v\pi\rho_a T_a C_P (T - T_a)}\right]^{1/2} \qquad \text{(A.134)}$$

For model generality, the user may optionally input all but one of the values: R, the initial buoyancy radius, T, the initial temperature, Q, thermal energy per unit mass of obscurant or explosive and v, the initial upward velocity. Equations A.133 and A.134 are used to find the unknown.

Thompson [1980b] employs correction factors for the temperature dependence of the specific heat of air and modifies the entrainment coefficient for the low plume density. COMBIC assumes these modifications are negligible, except within the first meter(s) of a large fire. In addition, COMBIC does not include directly the radiative losses of very high temperature plumes. Weil [1982] suggests that 50 percent of the potential diesel oil fire energy is lost to a combination of incomplete combustion and radiation near the flames. COMBIC uses this 50 percent factor to modify the buoyancy source term for diesel/ motor-oil/rubber fires.

A jet is a plume injected into the atmosphere with high velocity. For nonthermal jets the initial flux (mass of air and obscurant per unit area per unit time), the starting radius, and the initial velocity are all related. By default, COMBIC uses stored initial velocities (if any) and radii. The user may optionally provide these values.

Drag and entrainment slow and expand the jet. A vertical velocity may induce positive or negative buoyancy depending on the static stability parameter s. Models for estimating the static stability parameter are discussed in section 1.9.

Scaling the effects of buoyancy on obscurant rise is an important function in COMBIC. The Phase I calculations are for a single thermal production value. For plumes, the thermal production rate is taken to be that of the geometric mean between the maximum rate and the rate averaged over the entire burn duration, that is,

$$\dot{Q}_m = \left(\frac{\dot{m}_{max} M_{tot}}{T_{burn}}\right)^{1/2} Q \qquad \text{(A.135)}$$

For continuous plume elements that have an actual thermal production $\dot{Q}$ different from $\dot{Q}_m$, the scaled height is then

$$z = \left(\frac{\dot{Q}}{\dot{Q}_m} \right)^{1/3} z_m \tag{A.136}$$

where z_m is the plume height determined in Phase I from the mean production rate $\dot{Q}_m$.

Similarly, the scaled height for puff rise is

$$z = \left(\frac{Q}{Q_m} \right)^{1/4} z_m \tag{A.137}$$

The height z_m is that associated with Phase I calculations for a total puff of thermal energy Q_m. This is used in Phase II calculations for extending Phase I histories to obscurant sources approximately one-third to three times as large as those treated in the Phase I calculation. Phase II takes such scaling into account automatically. The Q_m value is passed in the data file to Phase II.

These results are easily linked to the analytic approximation of Morton, Taylor and Turner [1956] used in EOSAEL82 COMBIC. Neglecting drag and momentum entrainment terms, equation A.124 can be differentiated once with time and equation A.108 substituted for the temperature derivative:

$$\begin{aligned} \frac{d^2}{dt^2}(mw) &= mg\frac{d}{dt}\left(\frac{T}{T_a}\right) + \left(\frac{T}{T_a} - 1\right) g \frac{dm}{dt} \\ &= -s(mw)\left(\frac{T}{T_a}\right) \end{aligned} \tag{A.138}$$

The EOSAEL82 rise model used the assumptions of Morton, Taylor and Turner [1956] that:

a. the stability parameter is constant, taken to be the average value over the region of plume rise;

b. the temperature ratio in equation A.138 can be set to unity, which is also called the "Boussinesq Approximation," and

c. the density ratio in the entrainment equation A.112 can similarly be set to one.

With these restrictive assumptions, the solution of equation A.138 is simply that of an harmonic oscillator. For a stable atmosphere, the parameter s, defined in equation A.107, is positive. The result is:

$$(mw) = (m_o w_o \cos\left(s^{1/2} t\right) + \frac{F\pi\rho}{s^{1/2}} \sin\left(s^{1/2} t\right) \tag{A.139}$$

where for puffs,

$$F = \frac{MQg}{\pi C_P \rho_a T_a} \tag{A.140}$$

M is the mass (gm) of obscurant in the puff producing Q cal/gm. For plumes:

$$F = \frac{\dot{m}Qg}{\pi C_P \rho_a T_a} \tag{A.141}$$

The square-root of s is called the Brunt-Vaisala frequency. $\dot{m}$ is the mean production rate of obscurant (g/s) producing Q cal/g of heat.

F has units of $\mathrm{m}^4/\mathrm{s}^2$ for puffs and $\mathrm{m}^4/\mathrm{s}^3$ for plumes. The difference in units arises because the plume masses m and m_o (the initial mass) are for elements or slices of the plume that are moving with velocity w, that is, a mass flux.

The entrainment equation under the above assumptions leads directly to the solution:

$$r = \alpha z \tag{A.142}$$

where $r = 0$ at $z = 0$. Neglecting the initial momentum term and substituting the solution for the thermal puff is simply:

$$(mw) = \frac{4}{3}\pi\rho\alpha_T^3 z^3 \frac{dz}{dt} \tag{A.143}$$

This results from equation A.139 in an expression for cloud centroid height:

$$z = \left(\frac{3WQg}{\pi\alpha_T^3 \rho_a T_a C_P s}\right)^{1/4} [1 - \cos\left(s^{1/2}t\right)]^{1/4} \tag{A.144}$$

For bent plumes, however,

$$(mw) = \pi\rho\alpha_{ph}^2 z^2 u \frac{dz}{dt} \tag{A.145}$$

This results in a somewhat different expression for cloud height:

$$z = \left(\frac{3\dot{m}_{obs}Qg}{\pi\alpha_{ph}^2 \rho_a u T_a C_P s}\right)^{1/3} [1 - \cos\left(s^{1/2}t\right)]^{1/3} \tag{A.146}$$

The scaling exponent, 1/3 for continuous plumes and 1/4 for puffs, which are used in COMBIC via equations A.136 and A.137 are thus demonstrated.

Low windspeeds and large, hot buoyancy regions are associated with plumes that are more vertical than horizontal in their motion. A plume is considered vertical in COMBIC as long as

$$\frac{dz}{dx} > 1 \tag{A.147}$$

This is equivalent to the condition that the plume axis is tilted at an angle less than 45° from the vertical. At the point where the plume bends over and no longer satisfies equation A.147 COMBIC stores the time of rise t_c, the downwind distance x_c, the height z_c and the sigmas σ_x, σ_y. Up to this point, the plume is considered to be Gaussian distributed in concentration perpendicular to the near vertical plume axis. Thus, plume slices are nearly horizontal.

During the vertical rise phase, equation A.4 is modified to describe the concentration as Gaussian distributed horizontally in x and y. The plume velocity replaces the wind velocity in equation A.4. Obscurant from the vertical phase is assumed to act as an effective source at x_c, z_c, t_c for the "bent-plume" phase. The vertical rise phase is not applicable for obscurant clouds that never satisfy equation A.147

The end of puff and plume rise is determined by at least three factors. First, the thermal volume can come into buoyant equilibrium with the ambient atmosphere. This condition will occur if the atmosphere is stable, in which case the thermal region becomes less buoyant with height. Second, stabilization occurs if a strong inversion exists creating a locally stable layer. Third, rise will cease when the rate of energy dissipation by the ambient atmosphere becomes comparable to the thermal volume kinetic energy. These conditions are given mathematically at the end of the next section.

A.5 The COMBIC Boundary Layer Model

COMBIC requires the user to input a set of meteorological parameters at a single reference height (default 10 m). The boundary layer model then produces vertical temperature, density, and windspeed profiles that are physically consistent with the user inputs and that are necessary for transport, diffusion, and buoyancy calculations.

Required user inputs, in order of importance to transport and diffusion are:

1. windspeed u_r (m/s) at reference height z_r
2. wind direction θ_w, the compass heading (degrees), from which the wind blows
3. Pasquill stability category, denoted on input as 1 through 7 for categories A through G
4. temperature T_r (K) at reference height z_r
5. pressure p_r (mbar) used to generate a starting density
6. relative humidity (percent), which is important for effects on obscurants but not on diffusion.

Optional user inputs are now allowed to better define the environmental inputs and model in terms of:

1. Reference height z_r (m, default 10 m).
2. Surface roughness length z_o (m, default 0.1 m).
3. Height of temperature inversion h_i (m, default to internal model).
4. Choice of vertical temperature profile models: average stability parameter, constant with height; or varying stability parameter profile approaching neutral with height (default).

The user can also choose to have the Pasquill stability category computed from a set of input observations including:

1. Ceiling height (m) of the lowest cloud layer. Only two categories matter, however, above 2000 m or below.
2. Cloud Cover (percent). Only conditions with greater than or less than 50 percent matter to the model.

3. Julian Date (1-365).
4. Longitude of site (degrees) with the west longitude positive.
5. Time of Day (local standard time in hours and fractional hours).
6. Ground conditions (1 = Bare ground, 2 = snow patch, < 6 in, 3= snow > 6 in deep).
7. Surface roughness length (m)

This widely used procedure to determine Pasquill category is documented fully elsewhere [Hansen, 1979; Pasquill, 1961]. Briefly, how ever, the method uses date, longitude and local time to determine a solar elevation angle [Woolf, 1968]. Cloud cover and solar elevation determine a Net Radiation Index (NRI). The NRI is modified for ceiling height if the cloud cover exceeds 40 percent. Windspeed and NRI are then used in a table lookup of the Pasquill Stability Category.

Surface roughness z_o, (m), is now a variable in the COMBIC model. The default is 0.1 m. As shown in section 1.7, changes in surface roughness of an order of magnitude produce significant changes in diffusion. Surface roughness also affects wind and temperature profiles with height and other meteorological quantities near ground level. A rule of thumb for estimating z_o is to take 10 to 20 percent of the highest local terrain and vegetation features upwind of the plume and over the plume path. Examples of z_o are: $3x10^{-5}$ to $3x10^{-4}$ m for dry lakes and smooth, unvegetated deserts; .001 to .007 m for closely mown grass; .03 to .11 m for long grass and rural areas; .16 to .25 m for open to dense areas of scrub brush and other vegetation; and .3 to 1.1 m for cleared forests, corn fields, thin forests, villages and light suburban areas. While errors of a factor of 2 are not particularly significant in effects of z_o, factors of 10 may be significant.

The reference height z_r (m) is also now arbitrary. A common height for measured winds and temperature is 10 m, the model default. The user is allowed to change that reference height, but the user should avoid a reference height that is too low, particularly one approaching the surface roughness length, or one that is extremely high.

The boundary layer model for vertical temperature and winds is based on a nomogram first published by Pasquill [1974b] from the unpublished work of F. B. Smith. That nomogram, used in EOSAEL82 COMBIC, relates the Pasquill category to the sensible heat flux from the surface and to the windspeed at 10 m height. The surface roughness was fixed at 0.1 m. Since, EOSAEL84, COMBIC model now uses an extension of the nomogram, derived by Sutherland and Bach [1984] and based, in part, on more recent published results by F. B. Smith [1979]. It allows for arbitrary surface roughness, reference height, and a variable Pasquill stability parameter.

We define the Pasquill Stability Class to be a continuous parameter P that differs from the user input stability category value P_c by

$$P = P_c - 0.4 \tag{A.148}$$

The user inputs a value of P_c, that follows the alphabetic sequence of: (1) Pasquill Stability Category A (very unstable), (2) category B (moderately unstable), (3) category C (slightly unstable), (4), category D (neutral), (5) category E (slightly stable) and (6) category F (moderately stable). These may now be input as decimal values with fractions.

P is further related to a modified Kazanski-Monin parameter, K_m, by

$$P = 3.6e^{+K_m} \tag{A.149}$$

The modification to K_m accounts explicitly for surface roughness z_o, sensible heat flux H (watt/m^2, positive upward), the wind friction velocity u_* (m/s), the ambient air temperature T_a (K), and the air density ρ_a (g/m^3):

$$K_m = -gk^2 H \left[2\Omega_c \rho_a C_P T_a u_*^2 a \ln(b/z_o)\right]^{-1} \tag{A.150}$$

The empirical constants a and b have been determined [Sutherland and Bach, 1984] to be 10.0 and 7.5 m, respectively. The constants Ω_c and C_P are the angular rate of rotation of the earth (7.273 x 10^{-5} rad/s) and the specific heat of air at constant pressure (1.013 J/g K). Von Karman's constant k is 0.4, and g is 9.8 m/s^2.

During a clear day, the sensible heat flux becomes positive (upward) and K_m becomes negative. The atmosphere is then neutral to unstable. At night, the reverse is true. The crossover point (K_m = zero) is at the Pasquill stability parameter P value of 3.6, within the neutral category D (3 to 4) range.

H is not easily measured and thus can not be required as a user input. However, if H were easily measured then it would be a logical replacement for the Pasquill stability parameter in determining K_m. The wind friction velocity u_* must also be determined for equation A.150. Both of these parameters are found from the user input windspeed and temperature as follows.

The wind friction velocity u_* is related to the input windspeed u_r at reference height z_r by [S. R. Hanna and Hosker, 1982]

$$u_* = ku_r[\ln\left(\frac{z_r}{z_o}\right) + f\left(\frac{z_r}{L}\right)]^{-1} \tag{A.151}$$

where L is the Monin-Obukhov length (m). The function f is defined by Hanna et al.,[1982]

$$f(z/L) = \begin{cases} 5z/L & \text{(Stable, } 4 < \text{P)} \\ 0 & \text{(Neutral, } 3 < \text{P} < 4\text{)} \\ -\ln\left(\frac{1+\Psi^2}{2}\right) - 2\ln\left(\frac{1+\Psi}{2}\right) + 2\tan^{-1}\Psi - \pi/2 & \text{(Unstable, P} < 3\text{)} \end{cases} \tag{A.152}$$

where

$$\Psi = (1 - 15z/L)^{1/4} \tag{A.153}$$

The Monin-Obukhov length, L, is determined from [S. R. Hanna and Hosker, 1982]

$$L = -\frac{\rho_a C_P T_a u_*^3}{gkH} \tag{A.154}$$

Substituting from equations A.149 and A.150, eliminating H:

$$L = u_* k[2\Omega_c a \ln(b/z_o)\ln(P/3.6)]^{-1} \tag{A.155}$$

L has the same sign as K_m. The absolute value of the Monin-Obukhov length is an estimate of the depth of the mechanically mixed layer near the surface. For neutral conditions L is infinite; for stable conditions L is positive, and for unstable conditions L is negative. The sign appears through the logarithmic term in P in equation A.155.

Since equations A.151 and A.155 contain only the unknowns u_* and L, they can be solved simultaneously. For unstable conditions, this is done by iteration, that is, relaxation. The starting value for L is taken to be the estimate suggested by Irwin [Hansen, 1979; Irwin, 1979]):

$$L^{-1} = mz_o^n \tag{A.156}$$

with constants m and n given by -0.114 and -0.103 for Pasquill Category A; -0.038 and -0.171 for category B; and -0.008 and -0.305 for category C respectively. The iteration rapidly converges, with u_* determined from equation A.151 then placed into equation A.155 to find a revised L for use again in equation A.151.

For neutral conditions, L is infinite. Trivially,

$$u_* = \frac{u_r k}{ln\left(\frac{z_r}{z_o}\right)} \tag{A.157}$$

For stable conditions, substituting equation A.155 into equation A.151:

$$u_* = \frac{u_r k^2 - 10 z_r \Omega_c a \ln\left(\frac{h}{z_o}\right) \ln\left(\frac{P}{3.6}\right)}{k \ln\left(\frac{z_r}{z_o}\right)} \tag{A.158}$$

The u_* from equation A.158 is cut off at a minimum of two-thirds the neutral value from equation A.157 for physical consistency. A final value of L is then obtained from equation A.155.

The vertical windspeed profile for the constant values of u_* and L is then defined to be purely a function of height:

$$u = \frac{u_*}{k}\left[\ln\left(\frac{z}{z_o}\right) + f\left(\frac{z}{L}\right)\right] \tag{A.159}$$

with $f(z/L)$ determined from equation A.152 and equation A.153.

For puffs and plumes well above the surface, the puff centroid height or plume center-line height z_c is used in equation A.159 to determine the windspeed. But for puffs and plumes touching the surface, the larger of 1.1 z_o and the cloud center of mass height z_{cm} is used. This height is given by

$$z_{cm} = \bar{z} + \frac{\sigma_z e^{-\frac{1}{2}\left(\frac{\bar{z}}{\sigma_z}\right)^2}}{(2\pi)^{1/2}\Phi\left(\frac{z_c}{\sigma_z}\right)} \tag{A.160}$$

Φ is the cumulative normal distribution.

Figure A.8, which shows the relation between u_r, P and H, is worth studying. Higher windspeeds promote mixing and thus more neutral conditions. Higher sensible heat flux H at a given windspeed sets up greater turbulence and lower stability. The values in the region of changeover from H positive, daytime, to H negative, nighttime, are all convergent on neutral stability. However, small changes in H at very low windspeeds near the changeover point result in large stability changes, especially at night. These conditions warrant further research. At present, under these conditions, the COMBIC model can, on occasion, predict obscurant behavior poorly.

The sensible heat flux H is determined from equation A.150 once u_* has been found. An equation suggested by Smith [1979] relates H (watts/m^2) to the global solar irradiance G (watts/m^2) during daytime as

$$H = -0.40(G - 100) \tag{A.161}$$

G typically is from 0 to 900 watts/m^2. Since global irradiance is sometimes available from field measurements, it is tempting to use it as a COMBIC input to replace P. However, equation A.161 is an estimate and as such does not include the effects of different states of terrain, wind, etc. Therefore, pending further research or a better model, global irradiance is not an alternative input to COMBIC.

The surface buoyancy flux is required in estimating the limiting heights of plumes and puffs. It is denoted H_b (m^2/s^3) and is computed from [S. R. Hanna and Hosker, 1982]:

$$H_b = -\frac{u_*^3}{kL} = \frac{gH}{\rho_a C_p T_a} \tag{A.162}$$

The final basic profiles are temperature and density. Temperature, found from the static stability parameter s, equation A.107, is proportional to the Richardson number R_i [Pasquill, 1974b]:

$$s = \frac{g}{T_a}\frac{d\theta}{dz} = R_i \left(\frac{du}{dz}\right)^2 \tag{A.163}$$

where

$$R_i = \frac{z}{L}\left(1 + \alpha\frac{z}{L}\right)^{-1} \tag{A.164}$$

and α is zero for unstable or five for stable conditions. The stability parameter is zero for neutral conditions. Taking the derivative of equation A.159 with z,

$$\frac{du}{dz} = \frac{u_*}{k}\left(\frac{1}{z} + \frac{\alpha'}{L}\right) \tag{A.165}$$

where

$$\sigma' = \begin{cases} 5 & \text{(stable)} \\ 15/(\Psi(1+\Psi)(1+\Psi^2)) & \text{(unstable)} \end{cases} \tag{A.166}$$

Thus,

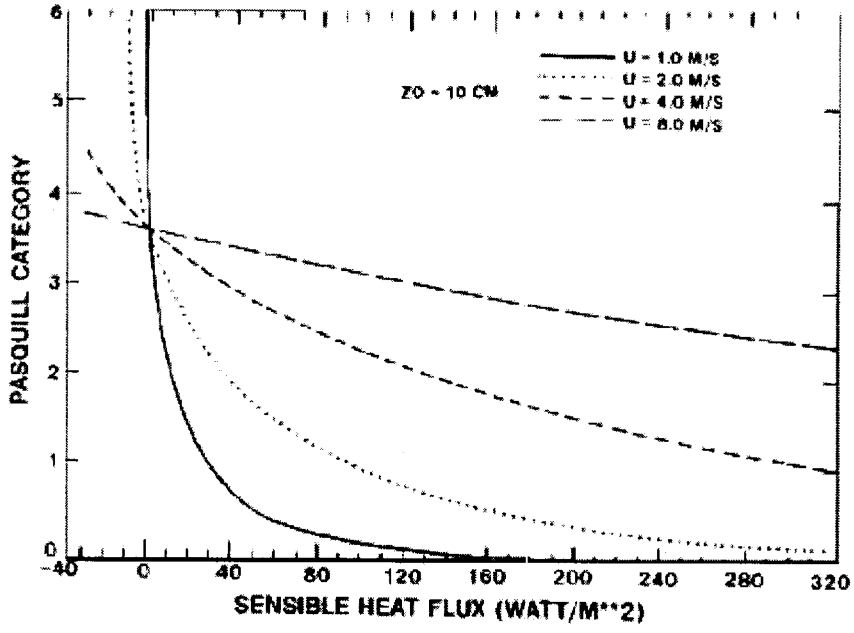

Figure A.8: Stability categories as a function of windspeed and sensible heat flux for given surface roughness.

$$s_z = \frac{u_*^2}{k^2 L z} \begin{cases} (1 + 5z/L) & \text{(stable)} \\ 0 & \text{(neutral)} \\ \left[1 + \frac{15}{\Psi(1+\Psi)(1+\Psi^2)}\right]^2 & \text{(unstable)} \end{cases} \tag{A.167}$$

Both the stable and unstable values of s decrease in absolute value to zero with height. Thus, the profile and stability become increasingly neutral with height. This is a desirable property.

COMBIC includes a boundary layer model option for the definition of s. As discussed in the previous section, the analytic buoyancy solution is strictly true only if the stability parameter is constant with the height. Average values for s are, therefore, optionally computed in the COMBIC boundary layer model. The profile of s falls off by about an order of magnitude, typically, between 10 and 50 m in unstable conditions. This range was chosen as the limits ($z_1 = 10$ and $z_2 = 50$) in computing an average s. For stable conditions,

$$\begin{aligned}(\bar{s}) &= \frac{1}{z_2 - z_1}\int_{z_1}^{z_2} s(z)dz \\ &= \frac{u_*^2}{k^2L}\left[\frac{\ln(z_2/z_1)}{z_2 - z_1} + \frac{5}{L}\right] \qquad \text{(A.168)}\end{aligned}$$

For unstable conditions, the integral is not trivial. The squared term in equation A.167 ranges from about 0.25 to 1.0. We take 0.6 as typical. Using this, for unstable conditions, we estimate

$$\bar{s} = 0.60\frac{u_*^2}{k^2L}\left[\frac{\ln(z_2/z_1)}{z_2 - z_1}\right] \qquad \text{(A.169)}$$

The ambient temperature gradient is (in K/m):

$$\frac{dt_a}{dz} = \frac{s}{g}T_a - 0.0098 \qquad \text{(A.170)}$$

This relation is used in the buoyancy model to find temperature change in the ambient atmosphere with height. For the option of a constant s,

$$T_a(z) = .0098g/\bar{s} + (T_r - .0098g/\bar{s})\, e^{\bar{s}(z-z_r)/g} \qquad \text{(A.171)}$$

where T_r is the temperature at reference height z_r. For near- neutral conditions, s/g is small. To lowest order in s/g, approximately

$$T_a(z) = T_r + \left(\frac{\bar{s}}{T_r} - .0098\right)(z - z_r) \qquad \text{(A.172)}$$

In the context of this linear change in temperature with height, a constant stability parameter is sometimes referred to as a constant lapse condition.

The ambient air density profile follows from the derivative of the equation of state. Since T_a is known at each height, a convenient equation for use by the buoyancy model is:

$$\frac{d(\rho_a T_a)}{dz} = \frac{1}{R}\frac{dp}{dz} = -\frac{\rho_a G}{R} = -0.0342\rho_a \qquad \text{(A.173)}$$

The starting density is found from the user input pressure p_r (mbar) from

$$\rho_r = \frac{346.9p_r}{T_r} \qquad \text{(A.174)}$$

where p_r (g/m^3) and T_r (K) are for reference height z_r. (The user actually inputs the temperature in units of °C. The input is converted internally to K).

The mixing layer is usually capped by an inversion [S. R. Hanna and Hosker, 1982]. This inversion is one of the possible limits on the rise of a buoyant puff or plume. Danard [1984] has reviewed nine methods for estimating the mixing layer height. None were particularly accurate for the 34 measurements used in his comparison. COMBIC now allows the user to input inversion height optionally if that information is available. Among the best methods examined by Danard is that by Brown [1981]. It has been chosen for the COMBIC boundary layer model. The inversion height h_i is:

$$h_i = \frac{0.3\pi k u_*}{2\Omega_c \left[1 + 0.15 f\left(\frac{h_i}{\pi L}\right)\right]} \tag{A.175}$$

where f is the function defined by equations A.152 and A.153. The implicit dependence in equation A.175 on h_i is weak and converges after a few iterations, with $f = 0$ the starting value. Following Danard, h_i is limited to the range of 688 to 6880 times u_*.

Under stable atmospheric conditions, puffs and plumes reach an equilibrium height at which their temperature equals that of the atmosphere and thus their buoyancy goes to zero. The maximum rise height can be easily determined for a constant stability parameter s from equations A.139 through A.146. The maximum height is above the equilibrium level, however. Generally, the puff or plume overshoots the equilibrium height, then falls back, as can be seen from the equations. The often-cited semi-empirical formulas for rise in a stable atmospherel [Briggs, 1969; Weil, 1982; S. R. Hanna and Hosker, 1982] assume an average stability parameter s. For a bent plume, for example, the equilibrium height under stable conditions is:

$$h_e = 2.55 \left(\frac{F}{us}\right)^{1/3} \tag{A.176}$$

where F is from equation A.141 and s is from equation A.169. The windspeed u is that at 10 m, the lower height limit of the COMBIC stability parameter average. For an inclined jet, a plume with momentum but little thermal buoyancy, in the notation of section 1.8,

$$h_e = 1.5 \left(\frac{mw}{\pi \rho_a u}\right)^{1/3} s^{-1/6} \tag{A.177}$$

where m, w and ρ_a are initial values in the rise equation. For low windspeed, the limited rise of a buoyant vertical plume in stable conditions is

$$h_e = 5.3 F^{1/4} s^{-3/8} \tag{A.178}$$

For the vertical jet, in the notation of section 1.8,

$$h_e = 2.44 \left(\frac{mw}{\pi \rho_a s}\right)^{1/4} \tag{A.179}$$

The units of F and s are m^4/s^3 and s^{-2} respectively. The units of m are g/s by the definition of mass in each plume slice. Thus, mw/ρ is equivalent to $(Rw)^2$, where R is the slice radius. The ρ_a term in place of ρ in equation A.177 and equation A.179 accounts for density differences [S. R. Hanna and Hosker, 1982]. For thermal puffs in a stable environment,

$$h_e = 2.63 \left(\frac{F}{s} \right)^{1/4} \tag{A.180}$$

where F, given by equation A.140, has units of $\mathrm{m}^4/\mathrm{s}^2$. These equations for limits in a stable atmosphere are used in COMBIC as estimates of where the buoyant rise can be expected to end. The solution of the differential equations for rise, of course, comes to a temperature stabilized equilibrium itself.

Under neutral conditions, the rise height of an inclined jet has been estimated to be [Briggs, 1969; Weil, 1982]:

$$h_e = 6R \left(\frac{w}{u} - 1 \right) \tag{A.181}$$

where R is the initial radius of the jet and w and u are the initial upward plume speed and the horizontal windspeed, respectively. Under convective (unstable) atmospheric conditions, a tentative formula for buoyant plumes is [Weil, 1982; S. R. Hanna and Hosker, 1982]:

$$h_e = 3 \left(\frac{F}{u} \right)^{3/5} H_b^{-2/5} \tag{A.182}$$

where F is the plume buoyancy flux defined by equation A.141 and H_b is the surface buoyancy flux defined by equation A.162.

A more general test for the final rise can be applied in all cases and atmospheric conditions. Briggs (1969), has suggested that ambient atmospheric turbulence dilutes plume buoyancy in its final rise stages. In this "break-up" model, the rise is terminated when the ambient eddy dissipation rate ϵ exceeds the internal dissipation rate of the plume. This condition is:

$$\epsilon(z) > 1.5 \frac{w^3}{z} \tag{A.183}$$

The plume (or puff) rise velocity is w, and its height above the ground is z. The ambient eddy dissipation rate is (Hanna et al., 1982)

$$\begin{aligned} \epsilon(z) &= u_*^2 \frac{du}{dz} + \frac{g}{t_a} (w_a' T_a')_{ave}. \\ &= u_*^2 \frac{du}{dz} \left\{ \begin{array}{ll} 0 & \text{stable, neutral)} \\ H_b & \text{unstable, z} < 0.1 h_i) \\ \frac{1}{2} H_b & \text{unstable, z} > 0.1 h_i) \end{array} \right. \end{aligned}$$

The second term contains only 1/2 the surface buoyancy flux when the eddy dissipation rate is assumed to be computed above the surface layer (0.1, h_i). This factor takes into account convective downdrafts and updrafts that contribute to the plume or puff dilution [Briggs, 1969; Weil, 1982]. (The surface buoyancy term is not included, of course, for stable and neutral conditions). The windspeed derivative is taken from equation A.165 and equation A.166.

Finally, for this section, the COMBIC model requires the cumulative Normal distribution with zero mean and unit variance:

$$\Phi(x) = \frac{1}{(2\pi)^{1/2}} \int_{\infty}^{x} e^{-\frac{1}{2}(x')^2} dx' \qquad (A.184)$$

This function is approximated by the rational polynomial expression given in Abramowitz and Stegun [1964]

$$p = |x| \qquad (A.185)$$

define

$$g = \frac{1}{2}\left[1 + a_1 p + a_2 p^2 + a_3 p^3 + a_4 p^4 + a_5 p^5 + a_6 p^6\right]^{-16} \qquad (A.186)$$

where

$$\begin{aligned} a_1 &= 0.049867347, & (A.187)\\ a_2 &= 0.0211410062, & (A.188)\\ a_3 &= .0032776263, & (A.189)\\ a_4 &= 0.000038003575, & (A.190)\\ a_5 &= 0.000048890636, & (A.191)\\ a_6 &= .000005382975 & (A.192) \end{aligned}$$

Then,

$$\Phi(x) = \begin{cases} g & \text{if} x > 0 \\ 1 - g & \text{if} x < 0 \end{cases} \qquad (A.193)$$

Note that EOSAEL 82 COMBIC used a version of this approximation associated with the error function. It differed from this approximation in that a square root of two factor was divided into the x argument before calling the function. That is no longer necessary and is no longer done before each call to the routine. The square root of two factor is already contained in the approximation coefficients.

Appendix B. Smoke and Dust Models

B.1 The Smoke Model - Source Characteristics and Cloud Description

The smoke types modeled in COMBIC are:

bulk white phosphorus (WP)

WP wedges, wicks and plasticized white phosphorus (PWP)

red phosphorus (RP)

hexachloroethane (HC)

fog oil (SGF2)

winterized fog oil (SGF2 with kerosene)

diesel fuel (DF) smoke (generator disseminated by vaporization and condensation)

polyethylene glycol (PEG200)

IR screener

diesel fuel, motor oil and rubber fire mixtures

User inputs can potentially specify other smokes. Anthracene, chlorosulfonic acid (FS), brass, graphite, kaolin and titanium tetrachloride (FM) smoke extinction coefficients are provided in the code, although none of the menu-specified sources in the model use these compounds as their defaults.

Any cloud can also be specified as a moving source (for example, vehicle–generated smoke). Simplified treatment of many sources ignited within an extended area over an extended time period is provided as an option for simulating barrages. The barrage option greatly reduces computation time at the expense of cloud detail. As a continuous source, the barrage may also be specified to be a moving source of obscurant. Moving sources are, however, restricted to straight-line motion at constant speed. With suitable ingenuity, the user can simulate a change in direction by "turning off" a moving source at some point along its path and initiating a new source at that time and location moving with a different speed or direction. Scaling laws are provided to transform a basic cloud history computed in Phase I (for example, 40 gal per hour diesel oil generation) into the appropriate clouds produced by one or more moving generators having completely different speeds and directions in Phase II calculations. Phase II also allows scaling of source strength, and thus the same history can be used for a range of obscurant production, for example rescaling 40 gal per hour fog oil to 20 gal per hour production rate.

Phase I calculations perform the following functions for smoke. The total mass of airborne aerosol is computed for the specified source. The total thermal energy released in the production process is computed. If the source is continuous, an array of cumulative, (that is, time integrated) mass production values is generated at equally spaced time intervals over the total production time. If the barrage option is specified, an effective continuous mass production profile is computed. For instantaneous sources, this is the time-averaged mass production. For continuous sources, the barrage duration is folded into the single round, mass production profile. Time-dependent evaporation or deposition corrections, if any, are made in the cumulative mass production history. Further adjustment for evaporation or deposition, if any, is made during Phase II calculations. Other mechanisms for removing aerosol are the settling velocity of the cloud and the ground reflection factor. Initial cloud dimensions, that is, "source sigmas," are specified for the cloud. The buoyancy radius, which can be smaller than the obscurant cloud radius, is determined. Finally, cloud position and dimensions are computed for the given meteorological conditions by iteration over small time steps. The influence of the atmospheric boundary layer, presented in the section A.5, on position and dimensions is determined using the cloud buoyancy and diffusion models, sections A.3 and A.4, to produce a time history for each subcloud making up the cloud.

B.1.1 Total Smoke Mass - The MUNT Input Record for Smoke

There are many parameters and initial conditions that define different obscurants and obscurant sources (munitions, generators, smoke pots). Phase I of COMBIC allows the user to input all parameters and initial conditions to define a source fully if so desired. For most users, however, this option is far too detailed. So, at the other extreme, one can select a set of values stored internally. These values are provided from a "menu" of obscurant munitions and are keyed to a single number, the source "type code" I_s. Other intermediate levels of detail are possible through input. The user may choose a source type I_s, for example, and then modify selected parameters stored for I_s, or the user may use default characteristics that have been assigned to the different obscurant types I_t in the code.

Source characteristics related to the total mass of smoke produced are input on a single record with the "MUNT" record. Note the addition of three new sources and one new obscurant. The input parameters are:

X_n = The total number of individual smoke sources detonated, ignited, generated, etc., at nearly the same point and at the same time. These smoke sources are modeled as if they form a single, combined source cloud. X_n may be input with a decimal (that is, a fractional value). It scales both the amount of smoke and the amount of heat produced in the resulting cloud. The default value is 1.0.

W_f = The fill weight of one individual smoke source. W_f is in pounds except for the specific liquids: fog oil (SGF2), PEG200, diesel fuel (DF), fog oil cut with kerosene and diesel-fuel/oil/rubber mixtures that produce battlefield fire smoke. These liquids have input units of gallons.

I_s = Source menu code number. The sources stored in COMBIC are listed in table B.1. An input of 0.0 implies the source is user defined.

I_t = Obscurant type code number. This parameter is used primarily to select the different mass extinction coefficients (optical properties) stored in the code for different obscurants. But, if I_s is input as 0.0, then I_t is also used to select default models for other parameters (that is, yield factor, efficiency, initial cloud size, and so forth). If I_t is zero, then a non-zero I_s must be input to specify a type of obscurant or all parameters must be input. A separate smoke type is now assigned to RP. The type codes are:

0. = I_t is assigned by the I_s internal table
1. = bulk white phosphorus (WP) munition
2. = WP wedges, wicks and plasticized WP (PWP) munitions
3. = hexachloroethane (HC) smoke pots and munitions
4. = fog oil (SGF2) produced by generator or smoke pot
5. = red phosphorus (RP) munition
6. = IR screener, generator disseminated
7. = IR screener, munition
8. = diesel fuel (DF) produced by generator (vaporization, condensation)
9. = dust, vehicular (discussed in section B.2)
10. = dust, high explosive (HE), small particle, persistent mode (discussed in section B.2)
11. = dust, HE, large particle mode
12. = carbon, HE debris product
13. = dust/soil, HE, very large, ballistic soil aggregates
14. = fire smoke from diesel fuel, oil and rubber mix
15. = kerosene and fog oil mixture for cold regions
16. = polyethylene glycol (PEG 200) mix of alcohols
17. = anthracene (not used in I_s menu)
18. = chlorosulfonic acid (FS, not used in I_s menu)
19. = titanium tetrachloride (FM, not used in I_s menu)
20. = IR(M76)
21. = O.A. Brass
22. = GRAPH7525
23. = Kaolin
24.–30. = user defined by extinction (EXTC record) and other inputs

E_f = The efficiency of the source in percent (0.0-100.0). Efficiency reduces the fill weight to provide the actual weight of smoke burned and released into the air. Efficiency below 100 percent is due to one or more factors including: unburned residue in the munition; screener deposited on the ground below the munition; smoke materials buried in mud or snow; and inert components in the smoke mix. Examples of inert residues are the felt or binders in WP wedges and PWP, and the components of aluminum and hydrocarbons in HC that are by products of the reactions producing $ZnCl_2$ smoke. Note that COMBIC attempts to be consistent in defining fill weight and efficiency so as not to include the weight of the canister, cartridge or other container enclosing the smoke mix. Other sources of fill weight information, including smoke munition technical manuals, often include the container weight. The efficiency must be correspondingly reduced when using these data.

Y_f = The yield factor, a dimensionless multiplier that has a value of unity for non-hygroscopic smokes. The yield factor accounts for additional weight of water condensed from the air onto the smoke droplets. Y_f depends, therefore, on relative humidity. But it also includes the weight of water formed in burning the fill to produce smoke. This is the case for phosphorus based smokes, where the reaction that forms phosphoric acid droplets produces smoke with about three times the original weight of unburned phosphorus, even at "zero" relative humidity. As with efficiency, yield factor is occasionally given other definitions in the literature.

N_s = The number of submunitions for the combined source of X_n individual sources, each of fill weight W_f. N_s does not affect the total amount of smoke produced. It is used to model the reduction in cloud rise that results when a single heat-producing region is separated into N_s parts. Some munitions use this technique of separating parts of a burning munition to reduce buoyancy. Cloud regions are independent when cooler ambient air can mix freely and surround each submunition.

In terms of the above parameters, the total mass of airborne smoke M_a is given by

$$M_a = CX_nW_f\left(\frac{E_f}{100}\right)Y_f \tag{B.1}$$

where C converts pounds to grams (453.6 g/lb) or gallons to grams (3785 g/gal water, 3483 g/gal fog oil, 3218 g/gal diesel fuel, 4266 g/gal PEG200) [Baer, 1984b]. Table B.1 gives model defaults for various menu-selected sources. Data in the table have been accumulated from technical and field manuals, field tests, consultation with the US Army Chemical Research and Development Center, and from various model analyses [Cichowicz, 1983; Baer, 1984b; Pamphlet, 1981; Manual, 1967a; Manual, 1967b; and Aerosol Working Group, 1979; Ground, 1978b; Ground, 1978a; Bowman *et al.*, 1979; Nelson and Farmer, 1981; Dolce and Metz, 1977; Ground, 1977; Rubel, 1983; Muhly, 1983; Yon *et al.*, 1983; Wentsel *et al.*, 1984; Pennsyle, 1982a; Ebersole, 1982; Sutherland, 1983; Pennsyle, 1982b; Matise, 1984; Baer, 1984a]

Table B.1: COMBIC Model Default Fill Weights and Efficiencies

Munition Type	Fill Weight	Source Code	Efficiency	Obsc. Code	# of Sub-munitions
155-mm HC M1 canister	5.40	1	70	3	1
155-mm HC M2 canister	2.80	2	70	3	1
105-mm HC canister	1.57	3	70	3	1
155-mm HC M116B1 projectile*	19.00	4	70	3	4
105-mm HC M84A1 projectile*	4.73	5	70	3	3
Smoke pot, HC M5*	31.00	6	70	3	1
Smoke pot, HC M4A2*	27.00	7	70	3	1
60-mm WP M302A1 cartridge*	0.76	8	100	1	1
81-mm WP M375A2 cartridge*	1.60	9	100	1	1
4.2-in WP M328A1 cartridge*	8.14	10	100	1	1
2.75-in WP M156 rocket*	2.12	11	100	1	1
155-mm WP M110E2 projectile*	15.60	12	100	1	1
105-mm WP M60A2 cartridge*	3.83	13	100	1	1
4.2-in PWP M328A1	8.14	14	60	2	1
5-in PWP Zuni MK4	13.52	15	60	2	1
2.75-in WP wedge	0.463	16	66	2	1
2.75-in WP M259 rocket*	4.63	17	66	2	10
3-in WP wick	0.139	18	71	2	1
6-in WP wick	0.234	19	67	2	1
155-mm WP M825 projectile*	16.43	20	74	2	116
81-mm RP wedge	0.128	21	53	5	1
I81-mm RP XM819 cartridge*	2.834	22	48	5	28
Generator, ABC M3A3*	10.0**	23	100	4	1
Generator, VEESS*	11.0**	24	100	8	1
Smoke Pot, Fog Oil M7A1*	1.7**	25	100	4	1
155-mm HE (dust)***	14.9	26	-	10	1
105-mm HE (dust)***	6.04	27	-	10	1
4.2-in HE (dust)***	7.45	28	-	10	1
10-lb C4 (dust)***	13.4	29	-	10	1
Diesel fuel/oil/rubber fire	150.**	30	26	14	1
Muzzle Blast	2.00	31	-	10	1
M76 IR Grenade	2.98	32	60	20	1
L8A1/L8A3 Grenade	0.794	33	95	5	1

*Inventory smoke sources.

**Fill weight in gallons. Note that smoke emission rate also depends on the emission or "burn duration" for this source.

***HE munitions default to live-fire delivery casing lengths of 0.6096, 0.4064, and 0.4064 m; casing diameters of .1778, .1016, and .1016 m; and dip angles of 10, 10, and 60, respectively. All default charges are surface detonations.

Users of EOSAEL84 COMBIC should be aware that RP is assigned a separate obscurant type to accommodate a "cold-regions" option. Matise [1984] determined from SMOKE WEEK VI data that the mass of phosphorus smoke from RP fragments burning in snow is 20 percent of that produced by burning on no snow cover. The initial puff of smoke from the munition air-burst is not affected. WP and felt-impregnated WP fragments, however, were observed to continue to burn after impact on snow. COMBIC therefore provides a "snow-cover" option on TERA, a terrain input record which sets 20 percent efficiency for RP munition fragments in snow. This is, of course, based on limited data and should only be taken as representative of the snow conditions similar to the SMOKE WEEK VI test. The snow-cover input is not used for any other purpose in COMBIC at present.

EOSAEL92 has three new smoke sources as part of the default tables — muzzle blast, M76 IR grenade and the L8A3 RP grenade. Concern has arisen that the dust produced by firing guns can attenuate transmission. This has been added for those researchers who want to model the effects of muzzle blast. Muzzle blast in COMBIC is simulated as a buried static 2 lb C-4 dust production. It is modeled as a instantaneous puff of dust. The puff is treated as an instantaneous, non-buoyant cloud of persistent dust with total cloud reflection from the ground plane. Initial cloud radius is 15 m x 10 m x 7 m.

Smoke from battlefield fire has been added to COMBIC following the EOSAEL FITTE battlefield fire model. The menu provides the source characteristics for a mixture of 150-gal diesel fuel, 15 quarts of motor oil, and 660 lb of rubber. This is representative of a burning truck. Extinction coefficients, mass production, and thermal production are based on field measurements of this mixture. A burning tank is approximately equivalent to the menu source but with an X_n scale factor of 3.33. A burning jeep is approximately equivalent to the menu source but with an X_n of 0.333. The number of gallons of diesel fuel has been chosen as the user "fill weight" input. The efficiency is assigned as 26 percent. The FITTE model uses 16 percent efficiency, but in that model the user enters all three combustible components. The COMBIC efficiency lumps all components together and relates them to the amount of diesel fuel input.

Pennsyle [1982b] and Baer [1984a] have provided values for HC canisters, munitions, and pots resulting in a decrease in the default HC efficiency in COMBIC from 77 to 70 percent. The mix in HC munitions contains [Cichowicz, 1983]; 5.5 to 9 percent Al, 45.5 to 48 percent ZnO, and 45 to 47 percent C_2C_{16} by weight. Using gram molecular weights, it is easy to determine that the percentage weight of $ZnCl_2$ (smoke) per weight of original mix is 76 to 80.4 percent. This represents, then, the theoretical maximum efficiency of HC.

Earlier versions of COMBIC used 77 percent. Baer shows that the burn efficiency of most HC sources is 90 percent (although a value as low as 85 percent was obtained for one HC smoke pot). This means that about 10 percent of HC fill is unburned. The COMBIC model, therefore, uses 90 percent of the maximum possible 77 percent, that is 70 percent, as the HC efficiency. Pennsyle defined fill weight to include the canister weight along with the weight of HC inside the canister. His efficiencies are based on measured elemental zinc captured from HC smoke produced in a wind tunnel (Dugway Proving Ground, 1977). Correcting Pennsyle's values to conform to the COMBIC definition of fill weight (which excludes the canister weight) the resulting efficiencies are 50 to 65 percent. This is lower than the 70 percent value derived above. The efficiency of the method for zinc collection is unknown, but presumably is less than 100 percent and accounts for the additional 5 to 15 percent difference in the separate analyses.

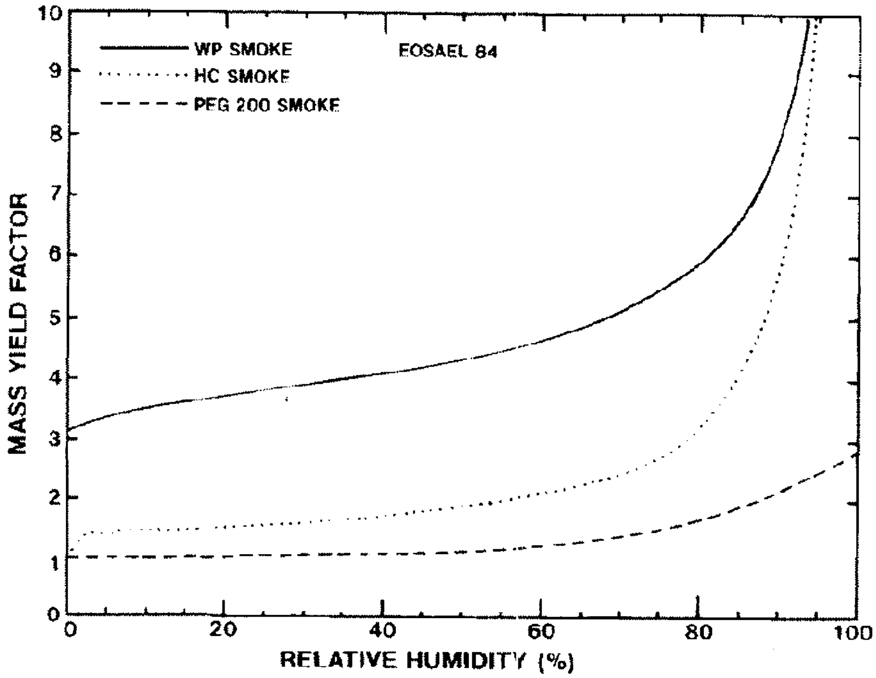

Figure B.1: Relative humidity-dependent yield factors for WP, HC, and PEG200 smokes.

The yield factor is one for all obscurants except phosphorus smoke, HC and PEG200. These obscurants have relative humidity dependent yield factors. A number of laboratory measurements of yield factors and theoretical analyses have been made [Rubel, 1978; Rubel, 1981b; Tarnove, 1981; Hanel, 1976; Sutherland, 1981; Baer and Rubel, 1984]

Sutherland [1981] has produced semi-empirical fits to HC and WP yield factors. Baer and Rubel [1984] have produced fits to HC, WP and PEG200. Their PEG200 curve fit is now used in COMBIC. Figure B.1 shows the humidity dependent yield factors used in COMBIC for these smokes.

In addition, Matise [1984] has investigated the effects of cold environment on yield factors. For temperatures below freezing comparable to those at Smoke Week VI, the absolute humidity is sharply reduced. Depletion of water vapor within HC and phosphorus clouds further reduces the effective relative humidity inside the cloud. Thus, the yield factor is smaller, particularly at ambient relative humidities above 80 percent. This effect is shown in figure B.2. The user may specify, through a flag on the MET1 input record, that these cold-regions yield factors are to be used. The yield factor depends on temperature and on cloud dimensions. In the current version of COMBIC, the cloud size assumed for the cold regions option has a sigma of 20 m, and the effective yield factor is computed only once for each source. Corrections have not been determined for cold-regions effects on PEG200.

B.1.2 Mass Extinction Coefficients - The EXTC Input Record for Smoke

Extinction per unit mass of airborne aerosol (m^2/g) depends on four factors: (1) the index of refraction of the obscurant; (2) the distribution of particle sizes;

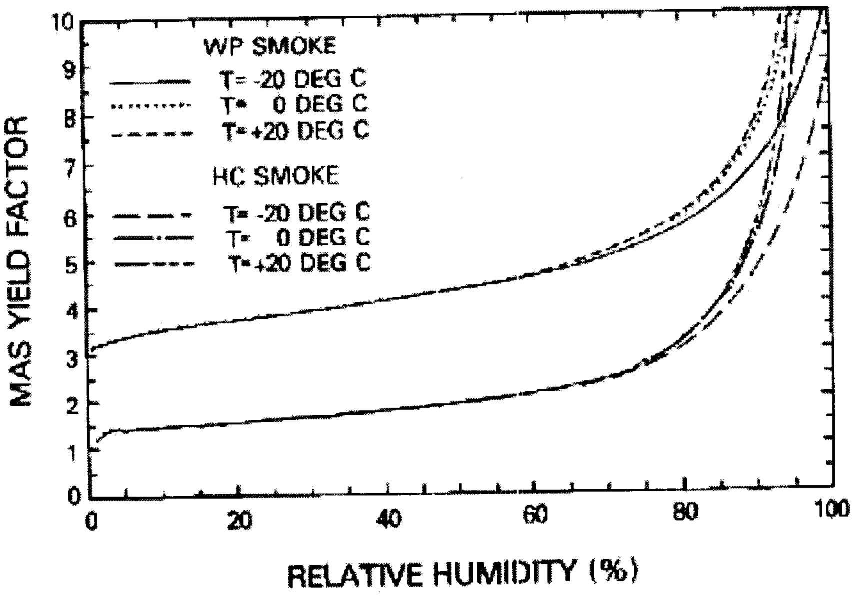

Figure B.2: Cold-regions effects on WP and HC yield factors.

(3) shape and orientation of particles; and (4) the effect of dilution by water absorbed from the air, for example, on mass, size distribution, and effective refractive index. COMBIC assumes that the mass extinction coefficients for smoke are constant over time intervals of interest in obscuration problems. Thus, the details of the above dependencies have been considered outside the model and the results, which are most heavily weighted toward measurement rather than theory, are stored in the code.

The assumption of time-independence is reasonable but not strictly true. Smoke size distributions and hygroscopic growth are established within a fraction of a second of release into the air. Submicrometer sizes for inventory smokes insure that size-dependent, fall velocities in the atmosphere have little, if any, effect on altering size distribution. Milham [1982], for example, measured approximately a 30 percent increase in mass extinction of WP smoke at 9 μm to 10 μm wavelength over a 1-hour period in a laboratory chamber.

Larger screening materials may settle more rapidly. If they are relatively monodispersed, however, their extinction per unit mass also changes slowly. Dust is a special case because of its broad size range and is, therefore, modeled by breaking up the size range regions. This is further discussed in section B.2. Large particle carbonaceous agglomerates from diesel fuel/oil/rubber mixtures are also known to fall out of the resulting smoke cloud. However, quantitative measurements of the effect of this in changing mass extinction are lacking, and we are forced at this time to use available, constant extinction coefficients. Fortunately, a "rule of thumb" in estimating mass extinction is that particles that are comparable in size to the wavelength contribute most to mass extinction coefficients due to the area to mass ratio of the particles.

The effect of evaporation on extinction in addition to the loss of mass potentially should be modeled. It is not in the code at present. Turbulent fluctuations in size distributions have been studied [Huang and Frost, 1985] and their effect on extinction coefficient. Integrated over typical optical paths, however, these fluctuations are negligible for COMBIC applications.

Mass extinction coefficients in COMBIC are based primarily on field and laboratory measurements [Ground, 1978b; Ground, 1978a; Bowman *et al.*, 1979; Nelson and Farmer, 1981; Dolce and Metz, 1977; Ground, 1977; Baer, 1984a; Milham and Anderson, 1983; Pinnick and Jennings, 1980; Shirkey, 1980; R. H. Frickel and Steubing, 1979; Maddix *et al.*, 1982; R. D. Khanna and Sutherland, 1984; AMC, 1967; Bruce, 1984] Values stored are averaged over the EOSAEL wavelength regions: 0.4 μm to 0.7 μm, 0.9 μm to 1.2 μm, 1.06 μm, 3 μm to 5 μm, 8 μm to 12 μm, 10.6 μm and 94 GHz. Coefficients for other wavelengths or obscurants may be input to the code via the EXTC record.

The relative humidity dependent mass extinction values for WP and HC smokes are shown in figures B.3 and B.4. The band-averaged value over 8 μm to 12 μm for WP has been slightly modified from EOSAEL 82. Extinction coefficients for the other aerosols are given in table B.2. Diesel fuel, PEG200, FS and FM coefficients are from Milham (1983). Fog oil and kerosene mixture coefficients are from Matise (1984). Millimeter wavelength (94 GHz) values are nominal upper bounds except for diesel, oil, and rubber fire smoke (private communication with C. Bruce, 1984). The extinction for the new obscurants are from An Obscuration Sciences Smoke Data Compendium: Experimental Smokes.

Table B.2: Extinction Coefficients for default obscurant types

Obscurant		Wavelength (μm)						
Type	Name	.4-.7	.7-1.2	1.06	3 to 5	8 to 12	10.6	94 GHz
1.	White phosphorus	(See figure B.3)						
2.	PWP, WP wedges	(See 4igure B.3)						
3.	Hexachloroethane	(See figure B.4)						
4.	Fog oil	6.851	4.592	3.479	0.245	0.020	.018	0.001
5.	Red phosphorus	(See figure B.3)						
6.	IR (generator)	1.860	1.630	1.400	1.790	1.680	.680	0.001
7.	IR (munition)	1.860	1.630	1.400	1.790	1.680	.680	0.001
8.	Diesel fuel	5.650	4.080	3.250	0.245	0.023	0.027	0.001
9.	Vehicular dust	0.320	0.300	0.290	0.270	0.250	0.250	0.001
10.	HE dust, small	0.320	0.290	0.260	0.270	0.260	0.240	0.001
11.	HE dust, large	0.035	0.036	0.037	0.035	0.038	0.036	0.002
12.	Carbon debris	1.500	1.460	1.420	0.750	0.320	0.300	0.001
13.	HE dust, ballistic	0.001	0.001	0.001	0.001	0.001	0.001	0.0004
14.	Diesel/oil/rubber	6.100	3.750	2.94	1.350	1.010	1.000	0.002
15.	Fog oil/kerosene	6.851	4.592	1.430	0.054	0.020	0.018	0.001
16.	PEG 200	5.370	2.900	2.100	0.090	0.090	0.070	0.001
17.	Anthracene	6.200	3.500	2.500	0.230	0.050	0.048	0.001
18.	FS	3.330	2.750	2.660	0.260	0.320	0.230	0.001
19.	FM	1.300	1.740	1.700	0.080	0.160	0.380	0.001
20.	IR (M76)	1.000	1.000	1.000	1.000	1.000	1.000	0.001
21.	O.A. Brass	1.300	1.400	1.400	1.400	1.400	1.400	0.001
22.	GRAPH7525	1.800	2.000	2.000	2.000	2.000	2.000	0.001
23.	Kaolin	2.000	1.000	1.000	0.100	0.400	0.400	0.001
24.-30.	User-defined	User-defined						

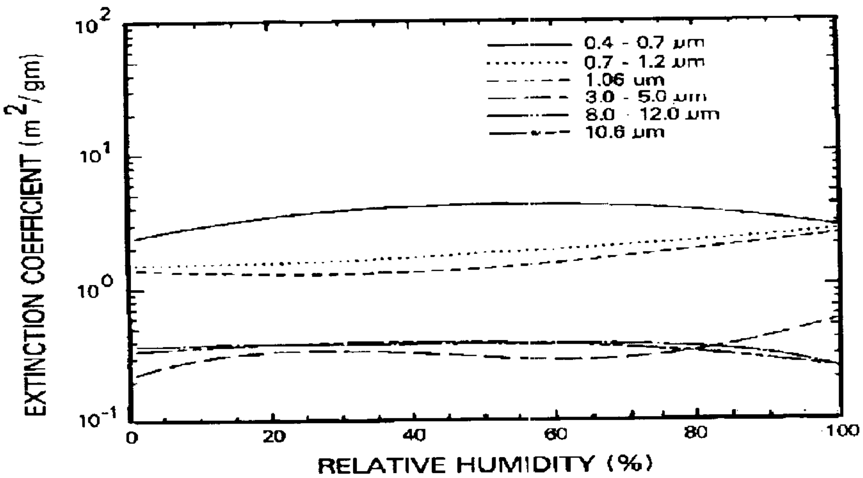

Figure B.3: Mass extinction coefficient for WP smoke.

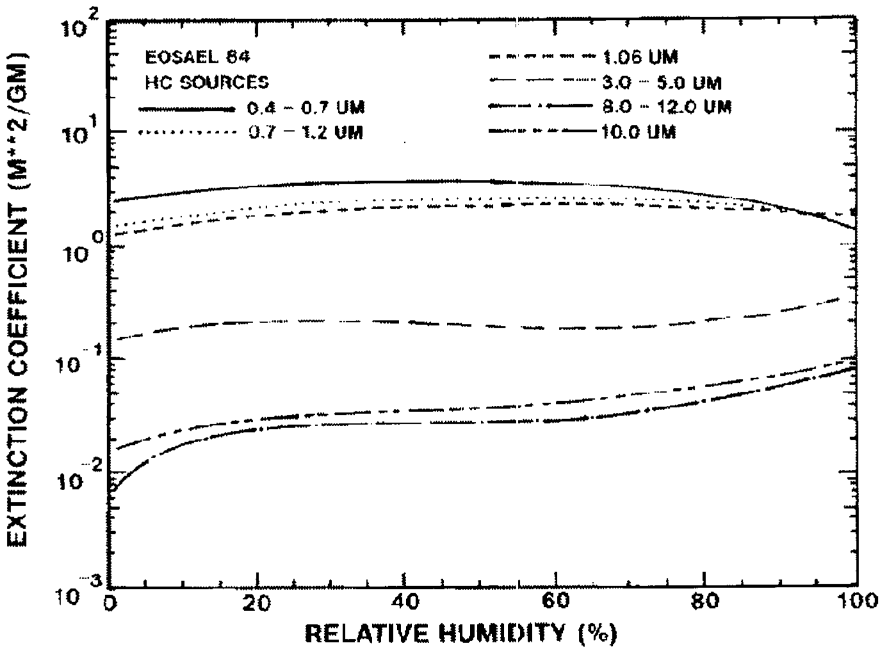

Figure B.4: Mass extinction coefficient for HC smoke.

B.1.3 Partitioning Smoke Among Subcloud Units - The `CLOU` and `SUBA` Records

The "model" for each obscurant cloud type released into the atmosphere is a mathematical representation of one or more Gaussian regions called "subclouds." Each subcloud can be an instantaneous Gaussian puff or a continuous Gaussian plume. It can also be defined as a rising, that is, a buoyant cloud; a stabilized non-rising cloud; or an instantaneous, Gaussian "stem" cloud spanning the region between two other subclouds. At the option of the user, up to five subclouds can be defined. The definition begins with the input of a "CLOU" record that contains the number of subclouds to be generated. One "SUBA" record is then input for each subcloud with the following parameters:

- $S_n =$ subcloud designator 1-5.
- $f_n =$ fraction (dimensionless 0 to 1) of the cloud mass M_a to be placed in this subcloud.
- $C_n =$ the relative amount of debris carbon, that is, g carbon/g obscurant mixed with the primary obscurant. This parameter is currently used with HE dust only. The weight of carbon is not part of the fill weight of the primary obscurant. The effect of this parameter is effectively to increase the mass extinction coefficient to include the extinction of C_n g of carbon per gram of primary obscurant.
- $S_t =$ subcloud "type" flag, 1. = instantaneous, 2. = continuous.
- $S_r =$ subcloud "rise" flag, 1. = buoyant (that is, rise calculations are performed), 2. = stabilized (that is, no rise calculation performed) or a number of the two-digit form "ij" with "ij" from 12. to 43. identifying the subcloud as a stem stretching from subcloud i to subcloud j.
- $S_e =$ extinction coefficient flag 1–30 selecting a specific set of extinction coefficients from the I_t list in section B.1.1. This allows the model to assign different extinction coefficient sets to different subclouds. This is necessary, particularly for HE dust.
- $S_b =$ "ballistic rise" model flag, used at present with HE dust in section B.1. The flag is either 0. = non-ballistic or 1. = ballistic.

Menu-selected sources have the following cloud structures. For HC smoke, types 1 to 7, a single continuous subcloud is modeled, containing 100 percent of the HC smoke and no residual carbon. The subcloud is slightly buoyant and uses the HC ($I_t = 3$) extinction coefficients. There is no ballistic rise phase.

For fog-oil, diesel fuel, fog oil with kerosene, PEG200 or generator-produced, IR screener (types 23 to 25), a single continuous subcloud is modeled. One hundred percent of the obscurant material is contained in this subcloud. The material type is selected by the I_t parameter on the `MUNT` card if a `SUBA` record is not input ($I_t = 4, 6, 8, 15$, or 16). The cloud is slightly buoyant; there is no residual carbon, and the cloud has no ballistic rise phase.

Diesel fire smoke (munition type 30) similarly is a single, continuous, highly buoyant cloud containing 100 percent of the obscurant material. The obscurant type is 14. There is no residual carbon; carbonaceous aerosols are already included in the measured extinction coefficient, and there is no ballistic rise phase.

Bulk WP, types 8 to 13, contain three subclouds. The first is a highly buoyant instantaneous puff containing 51 percent of the total smoke mass. The second subcloud is a slightly buoyant, continuous cloud containing 23 percent of the smoke mass. The third subcloud is a stem connecting the buoyant puff and the leading edge of the continuous cloud. The stem contains the remaining 26 percent of the smoke mass. For the 155-mm WP cloud ($I_s = 12$), the instantaneous puff is assumed to contain only 23 percent of the smoke mass; the stem contains 11 percent, and the continuous cloud contains 66 percent of the smoke mass. There is no residual carbon and no ballistic rise phase. The obscurant is bulk WP ($I_t = 1$) for all subclouds.

WP wicks, WP wedges and PWP, types 14 to 19, and RP munitions, types 21 to 22, produce two subclouds. A small fraction of the obscurant, 7.5 percent, is placed in an instantaneous, buoyant Gaussian puff. The remainder is in a continuous, buoyant subcloud, with no stem region. The 155-mm M825 WP wedge munition, type 20, neglects any instantaneous puff component altogether, and thus has 100 percent of the phosphorus smoke in a single continuous, buoyant subcloud. These munitions have no residual carbon or ballistic rise phase. They burn more slowly than the bulk WP munitions and for a longer period of time. This difference is modeled through a "burn function," discussed in section B.1.1, mass production rate.

The extinction coefficients for all phosphorus clouds are identical. The assignment of different obscurant types (I_t = 1, 2 and 5) is simply a convenient way to produce default values if the CLOU and SUBA, SUBB SUBC records are not input and if a menu-defined set of characteristics is not selected ($I_s = 0$). The default (generic) WP clouds contain three subclouds, as above, with 51 percent, 23 percent, and 26 percent of the smoke divided between the instantaneous puff, continuous residual cloud and the connecting stem cloud, respectively. The PWP, WP wicks and wedges and the RP generic clouds contain two subclouds as above with 7.5 percent of the smoke in an instantaneous buoyant puff and the remaining 92.5 percent in a continuous buoyant cloud. The separate RP type code allows the efficiency to be modified for snow cover (section B.1.1) and does not otherwise distinguish RP from the other PWP and WP wedge munitions.

The M76 IR grenade is modeled as a non-buoyant single puff. Diane Frederick of AMSAA has determined that the extinction is 1.0 for most wavelengths. The L8A1 grenade is modeled as three subclouds with 92.5 percent of the mass in a buoyant plume, 5 percent of the mass in a buoyant puff and the remaining 2.5 percent in a stem connecting the two. The L8A1 burns for 658 seconds and does not smolder.

The default generic cloud structures for the other obscurants parallel the models above with a single, continuous subcloud for each munition. Given no detailed CLOU and SUB"-" record inputs, the generic subcloud structure for anthracene and FS smokes are modeled to be similar to HC, and the FM smoke cloud structure is modeled to be similar to fog-oil type sources.

B.1.4 Initial Cloud Dimensions, Thermal Production, and Evaporation/Depletion: The SUBB and SUBC Input Records

Initial values are required by the transport, diffusion, and rise submodels. These are (optionally) defined on input records designated "SUBB" and "SUBC." If present, these records must immediately follow the corresponding SUBA record for each subcloud. Values on the SUBB record define obscuration radii and thermal production parameters:

R_x, R_y, R_z = initial obscuration radii (m) in the downwind, crosswind and vertical directions.

R_o, T_o, q, w_o = initial buoyancy radius (m), initial mean temperature of the cloud (K), thermal production coefficient (calorie per gram obscurant) and initial upward velocity component of the cloud.

The Gaussian cloud "sigmas" are defined in terms of radius to be

$$\sigma = \frac{R}{2.15} \tag{B.2}$$

The obscuration radii are obtained from user input, from the source menu or from models for each generic source type. For bulk WP, the generic model for the radii of the initial burst is:

$$R_x = R_y = 7.75\,(X_n W_f)^{0.3}\,, \tag{B.3}$$

and

$$R_z = 0.33 R_y \tag{B.4}$$

These equations are the basis for Pennsyle's [1982b] suggested initial burst radii for the bulk WP in the munition menu. This model was also used in EOSAEL82. The R_z values in that version, however, were taken to be three to five times those from equation B.5. This was done so that a WP stem subcloud could be neglected. Note that the fill weight is the original value in pounds and not the converted mass from equation B.2.

The obscuration radii for the continuous source region are taken to be the fragment dispersion radii defined by (private communication with D. Bromley, [1982]):

$$R_x = R_y = 16.4\,(X_n W_f)^{0.3}\,, \tag{B.5}$$

that were used in EOSAEL82 COMBIC, and, arbitrarily, the initial radius in the vertical direction is:

$$R_z = 3.0 \tag{B.6}$$

WP wedges, PWP and RP munitions are more difficult to assign generic initial obscurant cloud sizes. Submunition dispersal varies depending on munition design. Approximately, however, for the instantaneous burst

$$R_x = R_y = 7.75\,(0.075 X_n W_f)^{0.3}\,, \tag{B.7}$$

and

$$R_z = 0.75 R_y \tag{B.8}$$

If a value is not from the menu or is not provided by the user, COMBIC assigns dispersion radii for the continuous cloud component of

$$R_x = R_y = 19.\,(X_n W_f)^{0.3}\,, \tag{B.9}$$

and

$$R_z = 3.0m \tag{B.10}$$

similar to the bulk WP radii. The error in B.10 and B.11 can be as large as 10 to 15 percent apparently, based on the range of dispersion radii for WP wicks, wedges, RP and PWP rounds. If the smoke source is an individual wedge or other submunition, the COMBIC generic model uses equation B.5 which is the same as that used for bulk phosphorus.

Table B.3 and T_b is the burn duration gives the initial obscuration radii for the instantaneous and continuous subclouds produced by the menu sources. HC smoke pots and canisters are assumed to produce initial obscuration radii of

$$R_x = R_y = 1.31 \left(\frac{M_a}{N_s T_b} \right)^{0.3} , \tag{B.11}$$

and

$$R_z = 1.2 R_y \tag{B.12}$$

where M_a is from equation B.1 and T_b is the burn duration (sec), discussed further in section B.1.5. Full HC munitions tend to have three or four canisters that are ejected from the munition base. The distance between canisters for a full munition is assumed to be 30 m. COMBIC further assumes the submunitions are deployed crosswind. Thus, the radius R_y is set to 30 m, and the radius R_x uses equation B.12. These initial values can be overridden by user input.

Generators produce clouds from small nozzles. COMBIC assigns nominal initial obscuration radii in meters

$$R_x = R_y = R_z = 0.2 \tag{B.13}$$

Fog oil pots are also given these values. The initial value is not critical for COMBIC applications.

The obscuration radius for the continuous plume from a diesel fuel/oil/rubber fire is determined from

$$R_x = R_y = 10.7 \left(\frac{X_n W_f}{T_b} \right)^{0.5} , \tag{B.14}$$

and

$$R_z = 0.3 R_y \tag{B.15}$$

where W_f is the diesel fuel measured in gallons. This radius is consistent with all the FITTE model source conditions.

The buoyancy radius R_o, the mean initial cloud temperature T_o, and the initial vertical velocity of the cloud w_o are inputs to the cloud rise routine. The rise of the cloud depends critically on the combination of temperature and radius for instantaneous thermal puffs and on all three parameters for continuous buoyant plumes. This is because the combination of these factors determines the initial

Table B.3: Initial obscuration radii(m) for COMBIC menu smokes

Munition Type	Source Code	Instantaneous Puff			Continuous Plume		
		R_x	R_y	R_z	R_x	R_y	R_z
155-mm HC M1 canister	1	–	–	–	3.1	3.1	3.7
155-mm HC M2 canister	2	–	–	–	2.8	2.8	3.4
105-mm HC canister	3	–	–	–	2.1	2.1	2.5
155-mm HC M116B1 projectile*	4	–	–	–	3.0	3.0, 30	3.6
105-mm HC M84A1 projectile*	5	–	–	–	2.1	2.1, 30	2.5
Smoke pot, HC M5*	6	–	–	–	2.6	2.6	3.2
Smoke pot, HC M4A2*	7	–	–	–	2.7	2.7	3.3
60-mm WP M302A1 cartridge*	8	7.1	7.1	2.4	15.1	15.1	3.0
81-mm WP M375A2 cartridge*	9	8.9	8.9	3.0	18.9	18.9	3.0
4.2-in WP M328A1 cartridge*	10	14.5	14.5	4.8	30.8	30.8	3.0
2.75 in WP M156 rocket*	11	9.7	9.7	3.2	20.5	20.5	3.0
155-mm WP M110E2 projectile*	12	17.7	17.7	5.9	37.4	37.4	3.0
105-mm WP M60A2 cartridge*	13	11.6	11.6	3.9	24.5	24.5	3.0
4.2-in PWP M328A1	14	6.7	6.7	5.0	35.0	35.0	3.0
5-in PWP Zuni MK4	15	7.8	7.8	5.9	41.0	41.0	3.0
2.75-in WP wedge	16	2.8	2.8	2.0	3.8	3.8	3.0
2.75-in WP M259 rocket*	17	5.6	5.6	4.3	34.0	34.0	3.0
3-in WP wick	18	2.0	2.0	1.6	2.6	2.6	3.0
6-in WP wick	19	2.3	2.3	1.8	3.1	3.1	3.0
155-mm WP M825 projectile*	20	0.0	0.0	0.0	60.0	60.0	3.0
81-mm RP wedge	21	1.9	1.9	0.6	4.2	4.2	3.0
181-mm RP XM819 cartridge*	22	4.9	4.9	1.6	17.0	17.0	3.0
Generator, ABC M3A3*	23	0.0	0.0	0.0	0.29	0.2	0.2
Generator, VEESS*	24	0.0	0.0	0.0	0.29	0.2	0.2
Smoke Pot, Fog Oil M7A1*	25	0.0	0.0	0.0	0.29	0.2	0.2
Diesel fuel/oil/rubber fire	30	0.0	0.0	0.0	3.09	3.09	1.03
Muzzle Blast	31	15	10.0	7.0	-	-	-
M76 IR grenade	32	10.8	10.8	10.8	0.0	0.0	0.0
L8A1 RP grenade	33	17.54	17.54	3.0	3.32	3.32	2.49

amount of thermal energy in the buoyant region. The constraining equations are A.133 and equation A.134. The user should be very careful that the relevant equation is satisfied if all parameters are input.

The preferred method for instantaneous puffs is to input or use model defaults for T_o and Q, the thermal production in cal/(g of obscurant). The code then determines R_o from equation A.133. Generally, R_o is smaller than the obscurant radius, approaching zero as T_o is increased or Q is decreased. As long as equation A.133 is satisfied, however, the actual puff rise is relatively insensitive to the assumed input temperature. For example, the analytic rise model of Morton, Taylor, and Turner, discussed in section A.4, assumes infinite temperature and zero radius at a virtual source point $4R_o$ m below the source. The default procedure in COMBIC is to use $T_o = 1.44\ T_a$ and a Q value dependent on obscurant type. This initial mean temperature is consistent with thermal imagery of HE and WP fireballs. The model is also insensitive to initial upward velocity w_o for buoyant puffs. In rising through a quiescent atmosphere, the drag and entrainment cooling will rapidly slow a fast moving thermal puff. Typical rise velocities after 1 or 2 s are 2 to 3 m/s for hot thermal puffs generated from tactical smoke and HE.

For continuous buoyant plumes, the preferred method depends on whether the cloud rises at high velocities or with high temperature. The default method depends on the type of obscurant. If w_o is high (greater than 20 m/s), then the buoyancy radius R_o is set equal to the momentum radius R_m. The momentum radius is defined by

$$R_m = \left[\frac{\dot{m}_{air}}{\rho \pi v_o}\right]^{1/2} \tag{B.16}$$

that follows from the definition of the mass of air inside the initial plume slice as defined in section A.4. If appropriate, the velocity v_o is the total initial velocity including the vertical and horizontal components. R_o, v_o, and Q are then used in equation A.134 to find a corresponding temperature for the region. Otherwise, if the initial velocity is not great, the preferred method uses T_o of 1.44 T_a, or user input; R_o equal to the source radius, or user input; and Q for the given obscurant or user input to determine w_o. For diesel fuel/oil/rubber fires, w_o is typically about 2.5 m/s. For smoke generators, both R_o and R_m are small, 1 to 3 cm typically, and the initial velocity is high, 100-150 m/s. The rise equations rapidly slow this velocity with distance, however, as air entrains into the region. For continuous HC and other smokes, the velocity is small, often less than 1 m/s rise.

For phosphorus-based smoke, the thermal production coefficient defaults to

$$Q = 6600 + 580(Y_f - 3.16) \tag{B.17}$$

This is based on 6600 cal/g produced in burning phosphorus first to P_4O_6, 5860 cal/g, and then to H_3PO_4, 740 cal/g. An additional 580 cal/g is liberated in the conversion of water vapor to liquid water. The zero humidity base value of 3.16 in the yield factor is subtracted to account for the water already included in forming the phosphoric acid. The 3.16 value is one plus the ratio of atomic weights of three hydrogen atoms plus four oxygen atoms to the atomic weight of one phosphorus atom. Other phosphorus-based acids are known to be likely constituents along with phosphoric acid. The overall value given by equation B.18 is probably close to the true thermal production coefficient for phosphorus smoke, however.

For HC smoke munitions, the corresponding coefficient is

$$Q = 900 - 3.333T_b + 580(Y_f - 1.0) \tag{B.18}$$

Values of 300 to 940 cal/g have been reported in the literature for HC [Cichowicz, 1983]. The variation is due to the amount of aluminum in the mix. For a munition with 5.5 to 9 percent aluminum, the burn duration T_b varies from 150 down to 60 s [Cichowicz, 1983] Equation B.19 is the model developed for the previous version of COMBIC to take the burn time into account. For smoke pots, a typical mix is 1 pound of fast burning HC layered in with 30 pounds of slow burning HC. So, for smoke pots and large munitions, the limiting value is assumed of

$$Q = 400 + 580(Y_f - 1.0) \tag{B.19}$$

For diesel fuel/oil/rubber, Q is assigned a default of 7185 cal/g diesel fuel. This value is a weighted total that includes the thermal production of motor oil and rubber similar to the effective efficiency derived in the last section. It further includes a 50 percent reduction to account for thermal radiation losses [Weil, 1982]. Q for anthracene is 9500 cal/g [AMC, 1967]. Default values for FS and FM smoke had not been decided on at press time.

Smoke generators are usually assumed to produce a nonbuoyant cloud, despite their high exit temperatures. Model calculations tend to confirm this, but under certain conditions buoyancy may be marginally important, depending on generator design. Reports are available on generator design parameters and characteristics of the smoke vaporization-condensation process [AMC, 1967; Tarnove and Gordon, 1983]. The default COMBIC model for generator production assumes two figures of merit representative of an M3A3 generator. First, a 12:1 ratio in the number of gallons of smoke produced per gallon of diesel fuel required to vaporize the smoke, S_f, is assumed. Second, the smoke to air ratio, S_a, is 0.8:1 by weight. Relevant parameters for the smoke generation that are independent of the figures of merit are given in table B.4.

Table B.4: Smoke generator Thermal Characteristics

Obscurant	q_v (cal/g) Vaporization**	q_c (cal/g) Condensation	Density Ratio ρ_d/ρ_s	Boiling Point T_c (K)
Fuel (DF)	11,000***	—	—	—
Fog oil	-258	51	0.92	640
Diesel fuel	-197	58	1.00	540
PEG200	-303	59	0.75	580

*[Tarnove and Gordon, 1983].
**Raising smoke from 70° F to boiling point plus 20° F and then vaporizing it.
***Generator fuel (g) burned to vaporize smoke.

The thermal source term for the burned diesel fuel is

$$Q_s = \frac{11000}{S_f}\left(\frac{\rho_d}{\rho_s}\right) \tag{B.20}$$

in cal/g smoke produced. S_f is the smoke to fuel ratio, and the density ratio is given in table 5. From the table, q_v cal/g smoke is required to heat and to vaporize the liquid smoke material. The internal air mixture is similarly heated. The air-vapor mixture exits the generator, entrains air, and cools to a condensation temperature. Neglecting any additional thermal terms relating particle size and vapor pressure, it can be assumed that the energy available in heating ambient air to the condensation temperature T_c and thus cooling the plume is

$$Q = Q_s - \frac{.273}{S_a}(T_c - T_a) + q_v + q_c \tag{B.21}$$

The value .273 cal/g K is the specific heat of DF combustion products [BCL, 1979]. S_a is the smoke to air ratio; T_a the ambient air temperature, and T_c is taken to be the mean boiling point temperature from Table B.4. Q is the thermal production value used in equation A.134 for initial radius determination. For fog-oil, diesel fuel, and PEG200, the Q values are 520, 695, and 345 cal/g smoke, respectively, at temperatures of 640, 540, and 580 K. Other generators may have significantly different characteristic ratios S_a and S_f, but equations B.20 and B.21 can be used with Table B.4 to compute input values for Q.

These thermal production coefficients produce marginal buoyancy in a 5 m/s wind, at a 10 m reference height, and under neutral conditions, as can be seen from the following arguments. First, neglect the initial momentum of the plume. The plume is nearly horizontal, so use the windspeed for v in equation A.146 and a very small value for s, such as .000001. The predicted plume rise from equation A.146 is 7.5 m over the first 0.1 km downwind for a 36 gal/h (35 g/s) fog oil plume. The diffusion radius of the plume for a surface roughness of 0.1 m is 15 m at 0.1 km downwind.

This indicates that the plume rise can be significant even for the relatively small values of Q for fog oil compared to other smokes. However, atmospheric turbulence places a limitation on plume rise. From equation A.157 the friction velocity is 0.29 m/s. From equations A.159 and A.183, the eddy dissipation rate will halt plume rise once the plume vertical velocity falls below 0.34 m/s. For the example here, the plume rise velocity is in the range of 0.2 to 0.3 m/s. Thus, the model predicts that the rise will be limited to less than 7.5 m and the buoyancy effect is, at best, marginal.

The buoyancy radius in this example is about 3 cm. Next consider the effect of high initial plume velocity. Generator exit velocities are typically 100-120 m/s to promote the formation of optimum particle sizes for obscuring visual wavelengths. Airflow in the above example is 44 g/s at the exit nozzle, under the assumed parameter S_a of 0.8 and 35 g/s fog oil production. The exit temperature, before the air-vapor mixture cools and condenses can be estimated from

$$T_{max} = T_a + \frac{(Q_s + q_v)}{\left(\frac{.273}{S_a} + 0.58\right)} \tag{B.22}$$

where 0.58 is the (liquid) specific heat of fog oil in cal/g K. Values for diesel fuel and PEG200 are .55 and .72 cal/g K [Tarnove and Gordon, 1983]. The exit temperature is about 960 K, which is fairly consistent with reported values for inside the nozzle. From equation A.131 and an assumed ambient air density of 1200 g/m^3, the density of the air-vapor mixture just as it leaves the nozzle is 369 g/m^3. Assume 100 m/s velocity. Then, from equation B.17, the momentum radius is 2 cm, not too different from the buoyancy radius when the plume has cooled to 640 K. If pointed upwards in the 5 m/s wind as assumed in the example, equation A.181 predicts the maximum height will be 3 to 4 m. Thus, the momentum rise or "jet" action may also be marginally significant.

COMBIC allows the user to input a momentum radius on the "SUBC" input record. The parameters on this record are:

- Z_b = burst or release height (m) of the obscurant above local terrain.
- v_f = terminal fall velocity (m/s) of particles in the cloud.
- f_d, δ = evaporation/deposition parameters defining equation A.3:

$$M(t) = M[f_d + (1 - f_d)e^{-\delta t}] \tag{B.23}$$

  where M(t) is the time dependent mass and M an initial mass.

- R_e = ground "reflection" coefficient (0.–1.) required for equation A.35. If 0, the obscurant sticks to the ground for a non-rising cloud. If 1, the obscurant is completely reflected from the ground.
- R_j = initial momentum radius (m) for plumes with high initial velocities, that is, "jets."
- u_o = initial horizontal velocity (m/s) of the plume or puff, positive with the wind, negative against the wind.

Default burst heights and fall velocities are zero for smoke. The reflection coefficient defaults to 0.55, an arbitrary value found from model comparisons with data.

The evaporation/deposition parameters that are nonzero are given in table B.5. The generator-produced smoke coefficients are fits to Rubel's data and analysis of droplet evaporation [Rubel, 1981a]. Field experiments [Tarnove, 1981], however, tend to suggest that PEG200 may be as persistent as fog oil. These findings are somewhat contradictory, and further research is needed. Table B.5, is computed by utilizing equation A.3 and shows that it takes 97 min to evaporate 30 percent of the initial smoke for fog oil, 3.7 min for diesel fuel, and 18.4 min for PEG200. Diesel fuel evaporates more rapidly because it contains volatiles. For IR screener, the rate has been reduced almost two orders of magnitude from that utilized in EOSAEL82 COMBIC. The earlier values were based on preliminary and limited observations, primarily qualitative, at smoke week tests.

The current values are based on recent deposition data [Wentsel *et al.*, 1984] and analysis with a modified form of the Van der Hoven method [S. R. Hanna and Hosker, 1982] for source depletion. The estimated deposition velocity from the data is .043 cm/s ± 0.011. This value is reasonable when compared with dry deposition theory [S. R. Hanna and Hosker, 1982] but is still rather uncertain, however, since only five data points were used.

Table B.5: Default evaporation/Deposition Parameters

Obscurant	f_d (dimensionless)	$\delta(s^{-1})$
Fog oil (SGF2)	0.65	0.000333
Diesel fuel (DF)	0.10	0.001850
PEG200	0.25	0.000463
IR	0.00	0.000154

B.1.5 Mass Production Rate — The BURN and BARG Input Records for Smoke

The SUBA, SUBB, and SUBC records will probably be little used except to input characteristics of munitions that are very different from those in the code menus. The BURN and BARG input records, however, are often used. The BURN record specifies the total length of time the source emits smoke, and the BARG record "scales up" the obscurant clouds for many sources acting over a period of time within a well-defined area.

The mass production rate (or "burn function") is parameterized for the specific smoke source as

$$\dot{M}(t) = \frac{1}{T_b}\left[B_1 + B_2\left(\frac{t}{T_b}\right) + B_3\left(\frac{t}{T_b}\right)^2 + B_4\left(\frac{t}{T_b}\right)^3 + B_5 B_6 T_b e^{(-B_6 t)}\right] \tag{B.24}$$

where $\dot{M}$ is a rate (g/s), t is time since ignition (s), and T_b is the total production time (s). The user can input all six coefficients as well as a total burn duration on the BURN input record.

Integrating equation B.25, the total mass produced between time 0 (ignition) and time t is the cumulative mass function:

$$M(t) = B_1\left(\frac{t}{T_b}\right) + \frac{1}{2}B_2\left(\frac{t}{T_b}\right)^2 + \frac{1}{3}B_3\left(\frac{t}{T_b}\right)^3 + \frac{1}{4}B_4\left(\frac{t}{T_b}\right)^4 + B_5\left(1 - e^{(-B_6 t)}\right) \tag{B.25}$$

The burn durations and burn coefficients for all menu sources are given in table B.7. Users who only have EOSAEL82 should notice some changes in the table. There are additional obscurants and some parameters are different for the values for the M825, 155-mm, WP round.

COMBIC tests the cumulative integral, equation B.25, against the total mass of smoke and rescales the coefficients to insure that 100 percent of the smoke is emitted by time T_b:

$$\dot{M}_a = \frac{M_a}{M(t_b)}\dot{M}(t) \tag{B.26}$$

It is customary to define burn rate coefficients like B_1 through B_6 so that the total cumulative mass M(T_b) is either one or the total mass. Because of the rescaling above, however, the user can apply any convenient convention.

The burn function of COMBIC was slightly modified for three munitions. XM819 RP, M825 WP and M110 WP [Ayres and Baca, 1987]. The new function allows for better modeling the end of the burn function for some munitions. It allows the munition to smoulder. The new function now is

$$\begin{aligned} \dot{M}(T)^{new} &= \dot{M}(T)^{old} && < T_{SMLD} \\ \dot{M}(T)^{new} &= \dot{M}(T_{SMLD})^{old} e^{-\frac{CSMLD}{T_{burn}-T_{SMLD}}(T-T_{SMLD})} && T > T_{SMLD} \end{aligned} \tag{B.27}$$

where T_{SMLD} is the time at which the munition starts to smoulder and CSMLD is the exponential decaying factor. CSMLD and T_{SMLD} is zero for all other munitions, thus defaulting to the original burn function. If the user desires to use the new burn function for other munitions or change the existing parameters, it can be done through a new card record defined below. If the parameters of the records are entered as zeros, default values will be used. The user can override the new burn function for the three munitions by setting CSMLD to zero, T_{SMLD} to a non-zero number and setting T_{burn} back to its original value. In all situations, T_{burn} must be greater than T_{SMLD}. Table B.6 lists T_{SMLD} and CSMLD for the munitions in the COMBIC source table that are believed to exhibit smoldering.

Table B.6: Production rate coefficients for three munitions to allow for smoldering

Munition Type	Burn Dur. (sec)	Production Rate Coefficients							
		B1	B2	B3	B4	B5	B6	CSMLD	T_{SMLD}
155-mm WP M110E2	240	0.2	-0.2	0.0	0.0	1.	0.6	3.0	8.
155-mm WP M825	780	3.324	-9.466	9.599	-3.161	0.	0.0	1.3	480.
I81-mm RP XM819	600	5.088	-20.268	25.938	-10.40	0.	0.0	3.0	150.

The barrage approximation provides the means for a user to save computation time when a large number of sources ignite either at random or uniformly over a period of time within a relatively small area. Users of EOSAEL82 COMBIC should notice some changes.

The area is no longer in hectares. Rather, the user may now specify an area by giving its alongwind and crosswind dimensions in meters. The constraint that the dimensions be in the alongwind and crosswind directions is, unfortunately, due to the problems associated with calculations for an arbitrary orientation. The rate of impacts is now in terms of the number of rounds per second in the user-defined area rather than the number of rounds per hectare per minute. The barrage duration is in seconds. These changes keep the units as consistent as possible between records. Furthermore, in setting up input records, it was generally necessary to compute the old parameters by hand from the more convenient inputs now used.

Barrage parameters are input on a “BARG” record. The record contains:

Table B.7: COMBIC Model default burn durations and coefficients

Munition Type	Burn Duration (s)	Production Rate Coefficients					
		B_1	B_2	B_3	B_4	B_5	B_6
155-mm HC M1 canister	100	0.537	0.476	4.779	-5.472	0.0	0.0
105-mm HC canister	120	0.2218	3.915	-1.737	-2.400	0.0	0.0
155-mm HC M116B1 proj*	100	0.537	0.476	4.779	-5.472	0.0	0.0
105-mm HC M84A1 proj*	120	0.2218	3.915	-1.737	-2.400	0.0	0.0
Smoke pot, HC M5*	900	1.0	0.0	0.0	0.0	0.0	0.0
Smoke pot, HC M4A2*	750	1.0	0.0	0.0	0.0	0.0	0.0
60-mm WP M302A1 cart*	45	0.6	-0.6	0.0	0.0	1.0	0.2
81-mm WP M375A2 cart*	45	0.6	-0.6	0.0	0.0	1.0	0.2
4.2-in WP M328A1 cart*	45	0.6	-0.6	0.0	0.0	1.0	0.2
2.75-in WP M156 rocket*	45	0.6	-0.6	0.0	0.0	1.0	0.2
155-mm WP M110E2 proj*	60	0.2	-0.2	0.0	0.0	1.0	0.6
105-mm WP M60A2 cart*	75	0.6	-0.6	0.0	0.0	1.0	0.2
4.2-in PWP M328A1	180	0.6	-0.4	0.0	0.0	0.15	0.3
5-in PWP Zuni MK4	180	0.6	-0.4	0.0	0.0	0.15	0.3
2.75-in WP wedge	240	0.521	2.106	-1.11	-0.748	0.0	0.0
2.75-in WP M259 rocket*	240	0.521	2.106	-1.11	-0.748	0.0	0.0
3-in WP wick	470	1.631	0.678	-5.907	4.012	0.0	0.0
6-in WP wick	390	1.808	-2.556	2.883	-2.008	0.0	0.0
155-mm WP M825 proj*	612	3.3236	-9.4664	9.5994	-3.1612	0.0	0.0
81-mm RP wedge	260	0.653	-3.136	15.309	-12.87	0.0	0.0
181-mm RP XM819 cart*	240	5.088	-20.268	25.938	-10.400	0.0	0.0
Generator, ABC M3A3*	900	1.0	0.0	0.0	0.0	0.0	0.0
Generator, VEESS*	900	1.0	0.0	0.0	0.0	0.0	0.0
Smoke Pot, Fog Oil M7A1*	600	1.0	0.0	0.0	0.0	0.0	0.0
155-mm HE (dust)	-	1.0	0.0	0.0	0.0	0.0	0.0
105-mm HE (dust)	-	1.0	0.0	0.0	0.0	0.0	0.0
4.2-in HE (dust)	-	1.0	0.0	0.0	0.0	0.0	0.0
10-lb C4 (dust)	-	1.0	0.0	0.0	0.0	0.0	0.0
Diesel fuel/oil/rubber	800	1.0	0.0	0.0	0.0	0.0	0.0

*Inventory smoke sources

$\dot{N}_B$ = a rate of impacts or ignitions in rounds per second in the user-defined impact region.

t_B = duration of the barrage (s). This time does not include the burn duration of a single smoke round but only the time over which rounds impact or ignite.

D_x = The alongwind length of the area in which the barrage occurs (m). Note that this is not a radius or halfwidth but the diameter or full width of the impact region.

D_y = The crosswind length of the area in which the barrage occurs (m).

The definition of a "round" is whatever obscurant mass results from a `MUNT` input record. Thus, if the `MUNT` record has a scale factor X_n of 5.0 (meaning five units of whatever is being computed in phase I), then each "round" in the barrage is actually five units. The effect of the barrage is thus equal to N_B, `MUNT`, or `SLOC` records being input each second.

The source region is actually elliptical, with the area determined from:

$$A = (\pi/4) D_x D_y \tag{B.28}$$

The barrage option does three basic things. First, it changes the total mass and the mass emission rate, combining individual rounds. Second, it modifies the initial cloud dimensions to fill the barrage impact area. Third, it combines instantaneous puffs into continuous clouds, having the same rise characteristics as the puff subclouds.

The total mass of smoke produced by the barrage cloud must equal the smoke produced by individual "rounds" defined by M_a in equation B.2. This means that the total obscurant produced is

$$M_{aB} = \dot{N}_B t_B M_a \tag{B.29}$$

The effective barrage burn rate function, discussed in section A.2, equation A.70, is computed internally by the code. Thus, the user does not need to input any special "barrage" burn function. As stated in that section, the effective smoke duration will become the total time of the barrage impacts as well as the duration of a single round.

The source cloud was also discussed in section A.2, and there it was shown that the effect of combining a random impact pattern with the dimensions of a single cloud is to sum the squares of the "sigmas." The "sigma" for the barrage region is defined to be a Gaussian region containing 95 percent of the rounds. This produces a factor of 4.47 for scaling the input "diameter" of the region:

$$\sigma_{By} = \left[\sigma_y^2 + \left(\frac{D_y}{4.470}\right)^2\right]^{1/2} \tag{B.30}$$

and

$$\sigma_{Bx} = \left[\sigma_x^2 + \left(\frac{D_x}{4.470}\right)^2\right]^{1/2} \tag{B.31}$$

Barrage clouds are modeled as continuous Gaussian plumes. Phosphorus smokes are modeled as the superposition of two clouds. The first is computed to have the same trajectory as that produced by the instantaneous puff of the basic "round." To compute the probability that heated regions will overlap is relatively simple. Assuming a well-mixed volume of initial radius of 6 m for the heated region of a puff with mean temperature 55 K above ambient, the rise over 50 m requires about 30 s and the average volume, including expansion, is about 8000 m^3. A 50-m high region over a 10,000 m^2 area contains 500,000 m^3 or about 63 such cloud volumes. The probability that at least two puffs will overlap in the region is less than 53 percent for a barrage rate of 0.3 rounds per second. At a barrage rate of 0.53 rounds per second, the probability has risen to 90 percent, and at 0.73 rounds per second, it reaches 99 percent. The coupling between individual puffs, however, does not really become appreciable until a rate of 1.67 rounds per second is reached due to the $Q^{1/4}$ scaling of buoyant rise. By that point, the buoyancy of the average continuous cloud begins to dominate. Therefore, the barrage-produced cloud is modeled as two continuous Gaussian clouds, one with the rise trajectory of an individual round puff and the other with the buoyant rise determined by the rate of release of heat from the effective barrage burn function computed by the code.

B.2 Model for High-Explosive and Vehicular Generated Dust

HE and vehicular-produced dust obscuration are fundamentally more difficult to model than smoke due to the variations in the natural sources. COMBIC models HE dust generated by static uncased, static cased, and live-fire munitions detonated at any depth or height of burst and for any angle of impact, that is, munition orientation. A model is provided to extend the crater volume prediction to include any user-defined munition and to treat various soil types. A sod depth correction has been added to reduce the computed volume of ejecta from the crater and the amount of dust accordingly. COMBIC approaches the problem of the broad range of sizes of dust particles by dividing the model into clouds of three size ranges. A very large particle "mode" has been added that accounts for the ballistic soil and large agglomerates that remain airborne for only a few seconds. This change was required to better model the effects on millimeter wavelengths. A large particle mode component is included to partly address the dust size distribution from 20 μm to 200 μm, which falls out somewhat more slowly than the very large mode. Finally, a small size "persistent" mode that remains suspended for long periods and contributes the most extinction per unit mass is included.

A submunition option allows the approximate treatment of explosive subunits that form separate craters. The barrage option treats large numbers of munitions impacting over a small area and relatively continuous time interval as a simplified continuous source of dust. The vehicular dust option models the movement of the source and provides scaling relationships for the amount of dust as a function of vehicle speed, weight, and silt content.

HE-generated dust clouds are treated as five subcloud components: (1) a buoyant small particle puff, (2) a buoyant, large particle stem that settles out with time, (3) a nonbuoyant puff to model the small particle dust skirt, (4) a connecting small particle stem between the skirt and the buoyant clouds and (5) a very-large particle puff that follows a ballistic trajectory. Carbon particulates produced during the detonation process are partitioned among the buoyant clouds and stem.

A major problem in modeling HE dust is to define the quantity of dust lofted into the atmosphere. Measurements [Pinnick, 1982; Pinnick *et al.*, 1982] show that the size distribution is extremely broad with an appreciable mode of particles larger than 20 μm. Size distribution measurements performed at different locations also suggest that the airborne distributions of small particles are not as strongly correlated to the percentage of clay (less than 2 μm diameter), silt (2 μm to 70 μm diameter), and sand (greater than 70 μm diameter) of the parent soil as one might expect.

This difference may be due in part to the soil analysis technique that breaks up soil agglomerates, to the agglomeration of particles by explosive shock, and to other factors. The definition of dust optical properties in terms of extinction per unit mass is also made difficult by the wide range of particle sizes. Particles much larger than the wavelength of interest contribute a large part to the mass but only a small part to the extinction. They also settle out of the cloud, and thus the size distribution is time dependent. The characterization of dust clouds is, therefore, more empirical than for smoke.

Modeling begins with the prediction of the crater volume that is the source of most of the HE-generated dust. The crater volume is dependent on the explosive yield, which is measured in terms of the equivalent yield of TNT;

the depth of burst; soil type; charge orientation; and means of delivery. The COMBIC model is that developed by Thompson [Thompson and DeVore, 1982; Thompson, 1980a]. The apparent crater volume is assumed to scale for any explosive yield W (although Thompson's argument in choosing 1.111 over 1 is that the charges are "small," 1000 lb or less) as

$$V_{ac} = S_{ac} W^{1.111} \tag{B.32}$$

where W is in pounds of TNT, and V_{ac} is in m^3. The apparent crater scaling factor S_{ac} contains all other dependent factors. DRTRAN [Duncan, 1981], an earlier EOSAEL dust model on which some of COMBIC is based, used polynomial fits to scaled crater depth and radius as a function of burst depth and soil conditions. Thompson found that the curves could be reduced to a single representation for static uncased charges. Figure B.5 shows the resultant curve, and Table B.8 presents the multiplicative scale factors for the various soil types. For equal yield, soil type, and burst depth, significant differences occur between craters formed by uncased and cased explosives and those formed by static explosions and live-fire delivery. From a first principle's approach, the fraction of energy carried away by the shell casing fragments, F_s, was determined in terms of the work done by expanding combustion products to be 37.5 percent of the total yield [Thompson and DeVore, 1982].

Table B.8: Soil dependent parameters – Maximum crater scaling factors and airborne dust fractions of apparent crater volume

Soil Type and Code	Bare Charge Peak Scaled Crater Volume m^3 (lb TNT)$^{-1.111}$	Fraction of Apparent Crater Mass in			
		Ballistic Cloud	Large-Particle Stem	Small-Particle Fireball	Small-Particle Stem
Rock	0.0175	.09914	.05824	.00029	.00090
Dry cohesive soils	0.0218	.05470	.03223	.00253	.00734
Dry sandy soil	0.0654	.04825	.02844	.00148	.00423
Dry to moist sandy soils	0.1550	.07204	.04238	.00088	.00366
Wet sand and moist cohesive soils	0.3050	.11842	.07358	.00063	.00283
Wet cohesive soils	0.6980	.20137	.12163	.00017	.00072
*The partitioning applies to the fraction of total apparent crater mass (1500 kg/m^3) which becomes airborne.					

When the munition is assumed to be a tapered cylinder with flat ends, the quantity and energy of fragments impacting the crater region can be determined.

This determination depends on the length and diameter of the casing, the depth or height of the munition, and the orientation of the munition. Two limiting cases are considered. The fraction of energy coupled to the ground, F_{ch}, for a horizontal munition at any depth and the fraction, F_{cv}, for a vertically oriented munition at any depth are each modeled. The value for any intermediate orientation is then assumed to be

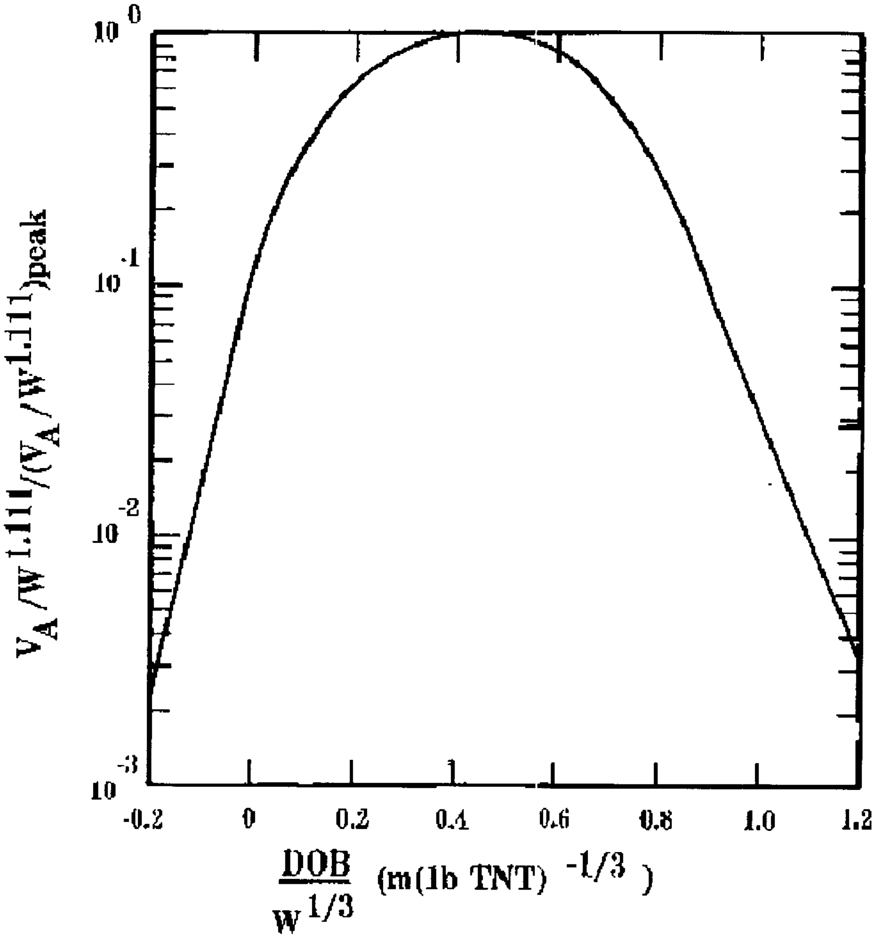

Figure B.5: Universal apparent crater vclume for bare changes.

$$F_c = ((F_{ch}\cos\theta)^2 + (F_{cv}\sin\theta)^2)^{1/2} \tag{B.33}$$

When the apparent crater volume is assumed to be proportional to the total energy coupled into the ground, the yield coupled into the ground must be

$$W_g = [F_s F_c + (1 - F_s)F_b]W \tag{B.34}$$

where F_b is the normalized crater scaling profile, Figure B.5, for depths above 0.45 m (lb TNT)$^{-0.33}$ and 0.947 otherwise. The model then iteratively finds the yield of the uncased charge that, at the same depth as the munition, produces the same yield W_g coupled to the ground. The apparent crater volume produced by this equivalent bare charge must, assuming that equal energy coupling into the ground lofts equal amounts of dust, be in fact the apparent crater volume. The final function of the crater model is to provide an estimate of the difference in volume between static and live-fire delivered munitions. Based on the observed asymmetry of live-fire produced craters and the increase in volume with inclination angle θ, the modeled dependence is

$$V_{ac}(\text{LIVE}) = (0.4 + 0.6\sin\theta)V_{ac}(\text{STATIC}) \tag{B.35}$$

If the casing dimensions are for submunitions and the total yield W is distributed equally among the submunitions, then the total of the N_s crater volumes is

$$V_{ac} = N_s S_{ac}\left(\frac{W}{N_s}\right)^{1.111} \tag{B.36}$$

The crater scaling factor S_{ac} implicitly depends on the depth, orientation, and yield of a single submunition. It may optionally be input by the user as a yield factor on the MUNT input record.

COMBIC uses sod depth to correct the volume of the crater to that containing soil. The method parallels that used in the original EOSAEL DRTRAN2 model. The corrected volume is

$$V_{ac}' = V_{ac}\left[1 - \frac{d_{sod}}{.38V_{ac}^{1/3}}\right]^3 \tag{B.37}$$

where the sod thickness d_{sod} (depth) is in meters, input optionally on the TERA record.

The total lofted fraction of dust from the apparent crater is only a small fraction of the apparent volume. Large detonations are reported to result in dust volumes that range from a few tenths of a percent to 30 percent [Gould, 1981] of the apparent crater volume. Preliminary results from measurements at a test at Fort Carson in 1983 [Long *et al.*, 1984], for example, show a range of values of 0.3 to 1.7 percent of measured crater volumes produced airborne dust. Table B.8 shows the

fractions of the apparent crater volume that are assumed to be in each of the modeled dust subclouds from HE. These are the fractions that would be input on an optional "SUBA" record, for example. The values were chosen partly from comparisons with data. They were also required to follow certain observed features in measured dust, as well. Measured size distributions [Pinnick, 1982;

Pinnick *et al.*, 1982; Pinnick *et al.*, 1983] are not entirely consistent, but they do tend to suggest that the mass of dust less than 10 μm radius (the "small particle mode") and that from 10 μm to 100 μm radius, (the "large particle" mode) have the trends and range of values shown in the table. These modes separate in a bi-modal, log-normal, particle size distribution. The very large particle "ballistic" region of the cloud is assumed to cover the range from 100 μm up to 1.0 cm. From large HE detonations, the large particle ballistic mode tends to have a power law distribution [Seebaugh and Linnerud, 1978] with exponents 3.75 for cohesive soils, suggesting more large particles, and 4.0 for noncohesive soils. These distributions have been matched at the 100 μm point to the large particle mode in determining the mass in the ballistic cloud.

In addition, a nonbuoyant, small particle, surface dust cloud is modeled which is assigned a mass equal to 1.875 times the sum of the masses of the small particle buoyant region and the small particle stem. The small particle regions have 0.3 cm/s fall velocity. The large particle cloud stem is given an average fall velocity of 0.92 m/s, that of a 75 μm particle of specific gravity 1.5. The ballistic mode particles follow an initial cloud geometry that injects them upward into the air with a model of the form

$$\bar{z}_{vl} = -\frac{1}{4}gt^2 + \frac{1}{2}w_o t \tag{B.38}$$

where $\bar{z}_{vl}$ is the centroid height and w_o the initial upward velocity. The model applies only over the ballistic rise time w_o/g at which point the cloud stops rising. The upward velocity, currently modeled as nonzero only for buried charges, is given by

$$w_o = 9.9W^{1/6} \tag{B.39}$$

Following the ballistic rise, the centroid falls back to earth with

$$\bar{z}_{vl} = \frac{1}{4}\left(\frac{w_o^2}{g}\right) - w_{fall}\left(t - \frac{w_o}{g}\right) \tag{B.40}$$

where

$$w_{fall} = \min \frac{1}{4}g\left(t - \frac{w_o}{g}\right), 4.15 \tag{B.41}$$

where 4.15 m/s is half the terminal fall velocity of a 1050 μm particle. The bottom of the cloud remains at ground level while the top of the cloud initially rises at twice the centroid velocity. That is the reason for the one-half factors in the equations. The vertical radius of the ballistic region equals the centroid height above ground level. The horizontal radius depends on the various cases. For charges above the surface, the centroid height, which is discussed below, is set equal to the surface cloud vertical radius. The horizontal radius also matches the surface cloud. The ballistic cloud immediately begins to fall with the velocity in equation B.42 (w_o is zero). For charges below the surface, however, the horizontal cloud expands with the vertical cloud rise. The horizontal radius up until the end of ballistic rise is

$$R_{hvl} = \bar{z}_{vl} \bullet \ \mathrm{MAX} \begin{cases} 1.192 - 20.5\left(\frac{D_b}{W^{1/3}}\right) - 1) \\ .577 \end{cases} \tag{B.42}$$

following the ballistic rise time limit, the horizontal radius remains fixed. This corresponds to the observed fallback of large dust particles but does not model the actual ballistic ejecta of rocks.

The fraction of energy appearing as heat for thermal rise is taken to be the remainder of total energy not coupled into the ground, including the case fragments:

$$F_h = (0.53 - 0.504F_b)(1 - F_s) \tag{B.43}$$

Use of this "hydro-yield fraction" gives a total thermal energy of

$$Q = 1100CF_hW \tag{B.44}$$

where C converts pounds to grams, and 1100 cal/g are provided by the explosive. Q provides the thermal energy for buoyant rise.

Both the crater volume scaling factor S_{ac} and the hydro-yield fraction F_h may be input by the user on the MUNT record to override the built-in models. The data for crater volumes from field tests [Kennedy, 1980] shows that a variation in crater volume up to a factor of two is observed even in the same type of soil and for the same charge yield. The model provides good agreement within this spread, which can partly be attributed to the difficulty in measuring the precise boundaries of the crater. Subsurface soil variations are probably also a factor.

Thus, there are five dust subclouds, a buoyant fireball of small mode particles, a surface cloud of small mode particles, a connecting stem of small mode particles, a stem of large particles that have 0.92 m/s fallout, and an initial ballistic cloud of large particles that rapidly return to earth.

Forty percent of the available carbon from TNT (approximately, 0.3 pounds of carbon per pound of TNT yield) is by default divided in equal amounts among the fireball and cloud stem regions. The user may override this value by input on the SUBA record if the carbon yield is different for the type of explosive considered.

Half the total thermal energy Q is assigned to the large particle and half to the small particle buoyant clouds. The vertical rise of each region is computed with the equations for Gaussian puffs given in the section on the boundary layer model. Figure B.6 illustrates some of the forces that determines vertical rise. The large particle region has a height computed by subtracting the total distance fallen over time, t, following the explosion from the height the region would have had if there were no fall velocity. The windspeed for horizontal advection is taken to be that which is appropriate to the fall velocity's adjusted height. The stem cloud centroid position is computed as the average between the small particle buoyant region and the ground level position that the region would have had if it were nonbuoyant. The increase in windspeed with height implies that the nonbuoyant position will lag behind the buoyant position. This shearing effect rotates or "cants" the stem through an angle whose tangent is the difference in downwind distance of the buoyant and nonbuoyant positions divided by the height of the buoyant region. The stem is an oversimplified model of the region of dust that trails the buoyant puff in real world dust clouds. For convenience, since mass profiles are not produced and stored for Gaussian puffs, no "bleeding" of dust from the buoyant region into the stem is modeled. The storage locations used to hold the mass production profiles as a function of time

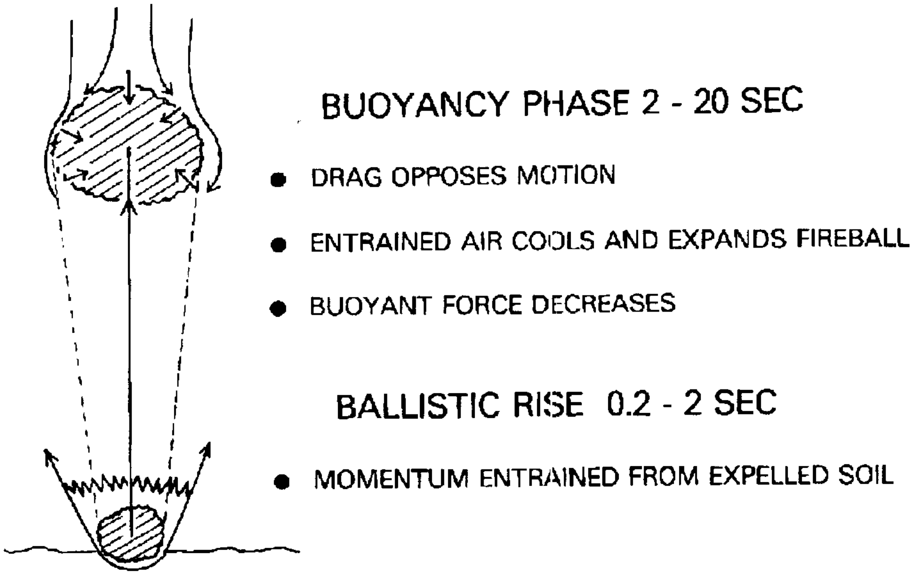

Figure B.6: Forces effecting rise of explosive dust.

for continuous Gaussian plumes are used to hold the cant angles as a function of downwind distance for Gaussian puffs.

In addition to the buoyant cloud regions, a nonbuoyant base cloud or "skirt," is also modeled. The base cloud originates in part from the dust ejected near the edge of the crater and in part from shock and fragment-raised dust outside the crater.

The basic size for the initial clouds is determined from the largest of the following:

a. The buoyancy radius

$$R_o = 1.9 \left[\frac{3q}{8\pi \rho_a C_p t_a} \right]^{1/3} \tag{B.45}$$

b. The radius of a volume equal to that of the crater

$$R_{ac} = \left[\frac{3V_{ac}}{4\pi} \right]^{1/3} \tag{B.46}$$

c. The volume at which the dust density equals the air density

$$R_d = \left[\frac{3M_a}{4\pi \rho_a} \right]^{1/3} \tag{B.47}$$

These results are then adjusted for the observed cloud shape that depends on burst depth. Buried charges produce higher clouds, while airbursts produce lower, wider clouds. The horizontal-to-vertical-radius ratio is taken to be a minimum of one and a maximum of four, with intermediate values between these limits given by

$$S_h = 2.25N_s^{1/3} - \frac{10.4D_b}{W^{1/3}} \tag{B.48}$$

The source sigmas are then specified in terms of the basic values

$$\sigma_z = \frac{R}{2.15S_h^{1/3}} \tag{B.49}$$

and

$$\sigma_x = \sigma_y = S_h\sigma_z \tag{B.50}$$

The sigmas for the buoyant small particle region and buoyant large particle region are, therefore, initially equal to the basic values. The base cloud has the values

$$\sigma_{0z} = 1.8\sigma_z \tag{B.51}$$

$$\sigma_{0x} = \sigma_{0y} = 1.5\sigma_x \tag{B.52}$$

and the cloud stem

$$\sigma_{0z} = 1.25\sigma_z \tag{B.53}$$

$$\sigma_{0x} = \sigma_{0y} = 1.25\sigma_x \tag{B.54}$$

For the barrage approximation, the dust production model is similar to that for WP smoke. Two continuous Gaussian clouds are produced. One has the vertical rise trajectory of a single, small-particle, buoyant region for an individual munition. The other is nonbuoyant. The mass production is assumed to be uniform over the barrage period. The buoyant cloud is given the total mass of the small-particle buoyant clouds, stem, and 5 percent of the mass of the large-particle region. It is assumed to have zero fall velocity. It is also given 83 percent of the carbon. The nonbuoyant cloud is given the mass of the base cloud plus 5 percent of the mass of the large-particle region and 17 percent of the carbon. The clouds are both assumed to be small-particle mode. The large-particle mode has only 10 percent of the mass extinction of the small mode; therefore, the 5 percent rather than 50 percent mass fractions are partitioned to represent the large particles. The barrage source sigmas are computed as in the case for smoke.

Table B.2 gives the mass extinction coefficients for the small-particle and large-particle modes. The small-mode mass extinction values are based on field tests [Duncan, 1981; Bowman *et al.*, 1979; Ground, 1978b], [Maddix *et al.*, 1982; Nelson and Farmer, 1981] The large-mode values are based on Mie calculations. They should not be taken out of the context of the COMBIC dust model. As mentioned at the beginning of this section, mass extinction for large particles is not in fact a constant when applied to a size distribution of finite width that varies in both space and time in real-world clouds. The carbon mass extinction values are those of the DRTRAN model [Duncan, 1981] and represent small particles of mean radius of about 0.2 μm. The millimeter wave values are based on a study by Alexander, Brown, and Mott [1984]. The appropriate scaling to the ballistic sizes has also been performed using Mie calculations.

Vehicular dust is modeled as a nonbuoyant, continuous Gaussian plume. The source terms are those of the DRTRAN vehicular dust model [Duncan, 1981; Dyck and Stukel, 1976]. DRTRAN, is an earlier EOSAEL dust model on which some of COMBIC is based and is no longer used. The production rate of dust is determined by

$$\dot{M}(t) = aNS_nM_vu_v^2 \tag{B.55}$$

where $\dot{M}$ is the constant dust production rate in grams per second; N is the arbitrary dimensionless scale factor that may be input by the user but normally has a default value of one; S_n is the percentage silt, M_v is the vehicle weight in tons, and u_v is the vehicle speed in m/s. The scale factor was derived for that model based on the analysis of SMOKE WEEK II vehicle dust trials [Ground, 1978a].

$$a = \begin{cases} 0.00345 & \text{for wheeled vehicles} \\ 0.00460 & \text{for tracked vehicles} \end{cases} \tag{B.56}$$

The source sigmas are taken as

$$\sigma_{0x} = 0 \tag{B.57}$$

$$\sigma_{0y} = 0.233W_v(1 + u_v/20) \tag{B.58}$$

and

$$\sigma_{0z} = 0.15W_v \tag{B.59}$$

where W_v is the vehicle width in meters. The height of the source is assumed to be at 25 percent of its width.

Scaling laws for changing the total obscurant mass and for accounting for locally warm, buoyant regions in the clouds were discussed in the earlier sections. However, a special set of scaling laws is applied to the clouds produced by moving sources. The cloud produced by a moving source has an apparent direction that is different from that produced by a source at rest and is the vector difference of the wind and source velocities, figure B.7. The downwind transport and diffusion, however, are dependent on the distance over which the cloud has traveled in relation to the position at which that portion of the cloud was generated. Note that it is not dependent on the present position of the vehicle or source but rather on its earlier position. This fact is used to allow the cloud history computed for a stationary source in Phase I to be used in Phase II for sources moving at any constant speed and direction. The model assumes that the cloud extends from the current source position to a leading edge along a straight line. The leading edge position is determined by the current time and the position of the source at ignition time, that is, the starting time and position when production began. The assumption that the effective plume lies along a straight line is not quite accurate since changing windspeed with height moves the leading edge downwind at a different speed than portions of the cloud near the source. But for the nonbuoyant or slightly buoyant source, the resulting curvature of the plume centerline is small.

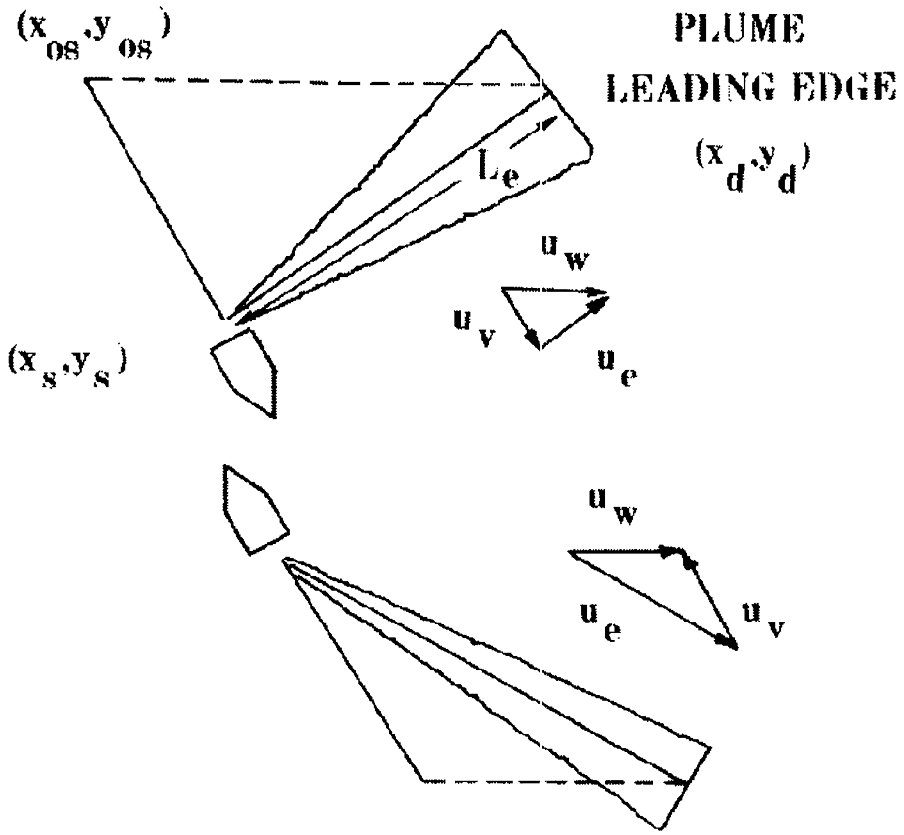

Figure B.7: Vehicular source dependence on vehicle speed and windspeed.

All table lookup and LOS intersections for the continuous plume produced by a moving source are computed in the rotated frame in which the centerline of the plume is the x-axis. This computation is accomplished by the relations,

$$C_x = (x_d - x_{os} - x_s + x_{os})/L_e \tag{B.60}$$

$$C_y = -(y_s + y_{os})/L_e \tag{B.61}$$

$$L_e = \left[(x_d - x_s)^2 + (y_{os} - y_s)^2)\right]^{1/2} \tag{B.62}$$

$$x_e = C_x x_w + C_y y_w \tag{B.63}$$

$$y_e = -C_y x_w + C_x y_w \tag{B.64}$$

that transform any coordinates in the Phase II wind-rotated system into the effective plume system. L_e is the length of the effective plume; x_{os}, y_{os} are the coordinates of the source at ignition time, that is, its starting position in the original wind-rotated system; x_s, y_s are the current source coordinates in the wind-rotated system, and x_d, y_d are the current downwind coordinates of the leading edge of the plume in the wind-rotated system.

A linear scaling of distances along the effective plume is used to provide values for table lookup. A correction factor is

$$S_t = \frac{x_d - x_{os}}{x_{de} - x_{se}} = \frac{x_d - x_{os}}{L_e} \tag{B.65}$$

where $x_d - x_{os}$ is the distance between the leading edge and the initial source position in the wind-rotated frame, and $x_{de} - x_{se}$ is the distance of the leading edge from the current source position in the effective plume coordinate system, L_e. Thus, to look up the cloud dimensions at 15 m down the axis of the effective plume in relation to the moving source, one simply uses 15 S_t in the stored cloud tables. Similarly, when one finds the average mass per unit downwind concentration equation, the average mass per unit distance in the effective plume is simply that value multiplied by S_t.

Vehicular dust sources are scaled in Phase II if the vehicle speed differs from that of Phase I. The scaling follows the assumed model for dust production; that is,

$$\dot{M}(t)_{II} = \frac{v_{II}^2}{v_I^2}\dot{M}(t)_I \tag{B.66}$$

where v_I and $\dot{M}_I$ are the vehicle speed and dust production rates input in Phase I, and v_{II} and $\dot{M}_{II}$ are the Phase II inputs.

Appendix C. Munitions Default Parameters

This appendix contains the defaults parameters for the 33 munitions modeled by COMBIC. It is included to aid the user in creating new smoke munitions and new HE. Extinction values are not listed, but are listed in the previous appendices. Yield factors are listed in the following tables for a relative humidity of 90 %. The initial cloud temperature in the following tables are for an ambient temperature of 27°. The initial cloud temperature is determined from how much air is entrained into the cloud with a volume defined by the initial obscurant radii.

Table C.1: Defaults for 155-mm HC M1 Canister.

Source No.	Obscurant Agent	
1	155-mm HC M1 Canister	
	Fill Weight (lbs)	5.4
	Obscurant Type Code	3.0
	Efficiency (%)	70.0
	Yield Factor	5.725
	No. of Submunitions	1.0
	Burn Duration (sec)	100.0
	Burn Rate Coefficients:	
	B1	0.5370
	B2	0.4760
	B3	4.779
	B4	-5.472
	B5	0.0
	B6	0.0
	Smoldering Time (s)	0.0
	Smoldering Coefficient	0.0

Subcloud No.	1	2	3	4	5
Mass Fraction	1.0				
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0				
Plume Flag (1=Puff, 2=Plume)	2.0				
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	1.0				
Extinction Coefficient Code	3.0				
Ballistic Flag (1=Yes, 0=No)	0.0				
Initial Obscurant Radii (m):					
Downwind	3.1				
Crosswind	3.1				
Vertical	3.7				
Buoyancy Radius (m)	2.29				
Initial Cloud Temperature (deg K)	312.07				
Thermal Production Coeff (cal/g)	3307.09				
Upward Velocity (m/s)	0.94				
Height Of Burst (m)	0.0				
Fall Velocity (m/s)	0.0				
Evaporation/Deposition:					
F_δ *(Long-Term)*	1.0				
Delta (s^{-1})	0.0				
Reflection Coefficient	0.55				
Momentum Radius (m)	0.0				
Horizontal Velocity (m/s)	0.85				

Table C.2: Defaults for 155-mm HC M2 Canister.

Source No.	Obscurant Agent	
2	155-mm HC M2 Canister	
	Fill Weight (lbs)	2.8
	Obscurant Type Code	3.0
	Efficiency (%)	70.0
	Yield Factor	5.725
	No. of Submunitions	1.0
	Burn Duration (s)	70.0
	Burn Rate Coefficients:	
	B1	0.631
	B2	-.4985
	B3	6.745
	B4	-6.52
	B5	0.0
	B6	0.0
	Smoldering Time (s)	0.0
	Smoldering Coefficient	0.0

Subcloud No.	1	2	3	4	5
Mass Fraction	1.0				
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0				
Plume Flag (1=Puff, 2=Plume)	2.0				
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	1.0				
Extinction Coefficient Code	3.0				
Ballistic Flag (1=Yes, 0=No)	0.0				
Initial Obscurant Radii (m):					
Downwind	2.8				
Crosswind	2.8				
Vertical	3.4				
Buoyancy Radius (m)	2.07				
Initial Cloud Temperature (deg K)	311.66				
Thermal Production Coeff (cal/g)	340.08				
Upward Velocity (m/s)	0.91				
Height Of Burst (m)	0.0				
Fall Velocity (m/s)	0.0				
Evaporation/Deposition:					
F_δ (Long-Term)	1.0				
Delta (s^{-1})	0.0				
Reflection Coefficient	0.55				
Momentum Radius (m)	0.0				
Horizontal Velocity (m/s)	0.83				

Table C.3: Defaults for 105-mm HC Canister.

Source No.	Obscurant Agent	
3	105-mm HC Canister	
	Fill Weight (lbs)	1.52
	Obscurant Type Code	3.0
	Efficiency (%)	70.0
	Yield Factor	5.725
	No. of Submunitions	1.0
	Burn Duration (s)	120.0
	Burn Rate Coefficients:	
	B1	0.2218
	B2	3.915
	B3	-1.7368
	B4	-2.3995
	B5	0.0
	B6	0.0
	Smoldering Time (s)	0.0
	Smoldering Coefficient	0.0

Subcloud No.	1	2	3	4	5
Mass Fraction	1.0				
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0				
Plume Flag (1=Puff, 2=Plume)	2.0				
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	1.0				
Extinction Coefficient Code	3.0				
Ballistic Flag (1=Yes, 0=No)	0.0				
Initial Obscurant Radii (m):					
Downwind	2.1				
Crosswind	2.1				
Vertical	2.5				
Buoyancy Radius (m)	1.55				
Initial Cloud Temperature (deg K)	307.32				
Thermal Production Coeff (cal/g)	3240.43				
Upward Velocity (m/s)	0.80				
Height Of Burst (m)	0.0				
Fall Velocity (m/s)	0.0				
Evaporation/Deposition:					
F_δ *(Long-Term)*	1.0				
Delta (s^{-1} *)*	0.0				
Reflection Coefficient	0.55				
Momentum Radius (m)	0.0				
Horizontal Velocity (m/s)	0.73				

Table C.4: Defaults for 155-mm HC M116B1 Projectile.

Source No.	Obscurant Agent
4	155-mm M116B1 Projectile

	Fill Weight (lbs)	19.0
	Obscurant Type Code	3.0
	Efficiency (%)	70.0
	Yield Factor	5.725
	No. of Submunitions	4.0
	Burn Duration (s)	100.0
	Burn Rate Coefficients:	
	B1	0.537
	B2	0.476
	B3	4.779
	B4	-5.472
	B5	0.0
	B6	0.0
	Smoldering Time (s)	0.0
	Smoldering Coefficient	0.0

Subcloud No.	1	2	3	4	5
Mass Fraction	1.0				
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0				
Plume Flag (1=Puff, 2=Plume)	2.0				
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	1.0				
Extinction Coefficient Code	3.0				
Ballistic Flag (1=Yes, 0=No)	0.0				
Initial Obscurant Radii (m):					
Downwind	3.0				
Crosswind	30.0				
Vertical	3.6				
Buoyancy Radius (m)	4.74				
Initial Cloud Temperature (deg K)	302.63				
Thermal Production Coeff (cal/g)	3307.09				
Upward Velocity (m/s)	0.93				
Height Of Burst (m)	0.0				
Fall Velocity (m/s)	0.0				
Evaporation/Deposition:					
F_δ *(Long-Term)*	1.0				
Delta (s^{-1})	0.0				
Reflection Coefficient	0.55				
Momentum Radius (m)	0.0				
Horizontal Velocity (m/s)	0.84				

Table C.5: Defaults for 105-mm HC M84A1 Projectile.

Source No.	Obscurant Agent	
5	105-mm HC M84A1 Projectile	
	Fill Weight (lbs)	4.73
	Obscurant Type Code	3.0
	Efficiency (%)	70.0
	Yield Factor	5.725
	No. of Submunitions	3.0
	Burn Duration (s)	120.0
	Burn Rate Coefficients:	
	B1	0.2218
	B2	3.915
	B3	-1.7368
	B4	-2.3995
	B5	0.0
	B6	0.0
	Smoldering Time (s)	0.0
	Smoldering Coefficient	0.0

Subcloud No.	1	2	3	4	5
Mass Fraction	1.0				
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0				
Plume Flag (1=Puff, 2=Plume)	2.0				
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	1.0				
Extinction Coefficient Code	3.0				
Ballistic Flag (1=Yes, 0=No)	0.0				
Initial Obscurant Radii (m):					
Downwind	2.1				
Crosswind	30.0				
Vertical	2.5				
Buoyancy Radius (m)	2.7				
Initial Cloud Temperature (deg K)	302.63				
Thermal Production Coeff (cal/g)	3240.43				
Upward Velocity (m/s)	0.80				
Height Of Burst (m)	0.0				
Fall Velocity (m/s)	0.0				
Evaporation/Deposition:					
F_δ (Long-Term)	1.0				
Delta (s^{-1})	0.0				
Reflection Coefficient	0.55				
Momentum Radius (m)	0.0				
Horizontal Velocity (m/s)	0.73				

Table C.6: Defaults for Smoke pot, HC M5.

Source No.	Obscurant Agent	
6	Smoke pot, HC M5	
	Fill Weight (lbs)	31.0
	Obscurant Type Code	3.0
	Efficiency (%)	70.0
	Yield Factor	5.725
	No. of Submunitions	1.0
	Burn Duration (s)	900.0
	Burn Rate Coefficients:	
	B1	1.0
	B2	0.0
	B3	0.0
	B4	0.0
	B5	0.0
	B6	0.0
	Smoldering Time (s)	0.0
	Smoldering Coefficient	0.0

Subcloud No.	1	2	3	4	5
Mass Fraction	1.0				
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0				
Plume Flag (1=Puff, 2=Plume)	2.0				
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	1.0				
Extinction Coefficient Code	3.0				
Ballistic Flag (1=Yes, 0=No)	0.0				
Initial Obscurant Radii (m):					
Downwind	2.6				
Crosswind	2.6				
Vertical	3.2				
Buoyancy Radius (m)	1.92				
Initial Cloud Temperature (deg K)	309.39				
Thermal Production Coeff (cal/g)	3140.39				
Upward Velocity (m/s)	0.89				
Height Of Burst (m)	0.0				
Fall Velocity (m/s)	0.0				
Evaporation/Deposition:					
F_δ *(Long-Term)*	1.0				
Delta (s^{-1})	0.0				
Reflection Coefficient	0.55				
Momentum Radius (m)	0.0				
Horizontal Velocity (m/s)	0.81				

Table C.7: Defaults for Smoke Pot, HC M4A2.

Source No.	Obscurant Agent	
7	Smoke Pot, HC M4A2	
	Fill Weight (lbs)	27.0
	Obscurant Type Code	3.0
	Efficiency (%)	70.0
	Yield Factor	5.725
	No. of Submunitions	1.0
	Burn Duration (s)	750.0
	Burn Rate Coefficients:	
	B1	1.0
	B2	0.0
	B3	0.0
	B4	0.0
	B5	0.0
	B6	0.0
	Smoldering Time (s)	0.0
	Smoldering Coefficient	0.0

Subcloud No.	1	2	3	4	5
Mass Fraction	1.0				
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0				
Plume Flag (1=Puff, 2=Plume)	2.0				
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	1.0				
Extinction Coefficient Code	3.0				
Ballistic Flag (1=Yes, 0=No)	0.0				
Initial Obscurant Radii (m):					
Downwind	2.7				
Crosswind	2.7				
Vertical	3.3				
Buoyancy Radius (m)	2.0				
Initial Cloud Temperature (deg K)	308.99				
Thermal Production Coeff (cal/g)	3140.39				
Upward Velocity (m/s)	0.90				
Height Of Burst (m)	0.0				
Fall Velocity (m/s)	0.0				
Evaporation/Deposition:					
F_δ (Long-Term)	1.0				
Delta (s^{-1})	0.0				
Reflection Coefficient	0.55				
Momentum Radius (m)	0.0				
Horizontal Velocity (m/s)	0.82				

Table C.8: Defaults for 60-mm WP M302A1 Cartridge.

Source No.	Obscurant Agent	
8	60-mm WP M302A1 Cartridge	
	Fill Weight (lbs)	0.76
	Obscurant Type Code	1.0
	Efficiency (%)	100.0
	Yield Factor	7.847
	No. of Submunitions	1.0
	Burn Duration (s)	45.0
	Burn Rate Coefficients:	
	B1	0.6
	B2	-0.6
	B3	0.0
	B4	0.0
	B5	1.0
	B6	0.2
	Smoldering Time (s)	0.0
	Smoldering Coefficient	0.0

Subcloud No.	1	2	3	4	5
Mass Fraction	0.23	0.51	0.26		
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0	0.0	0.0		
Plume Flag (1=Puff, 2=Plume)	2.0	1.0	1.0		
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	1.0	1.0	12.0		
Extinction Coefficient Code	1.0	1.0	1.0		
Ballistic Flag (1=Yes, 0=No)	0.0	0.0	0.0		
Initial Obscurant Radii (m):					
Downwind	15.1	7.1	11.1		
Crosswind	15.1	7.1	11.1		
Vertical	3.0	2.4	2.7		
Buoyancy Radius (m)	3.95	2.48	0.0		
Initial Cloud Temperature (deg K)	302.62	432.56	0.0		
Thermal Production Coeff (cal/g)	9318.31	9318.31	9318.31		
Upward Velocity (m/s)	0.99	1.62	0.0		
Height Of Burst (m)	1.0	1.0	1.0		
Fall Velocity (m/s)	0.0	0.0	0.0		
Evaporation/Deposition:					
F_δ *(Long-Term)*	1.0	1.0	1.0		
Delta (s^{-1})	0.0	0.0	0.0		
Reflection Coefficient	0.55	0.55	0.55		
Momentum Radius (m)	0.0	0.0	0.0		
Horizontal Velocity (m/s)	0.90	0.85	0.0		

Table C.9: Defaults for 81-mm WP M375A2 Cartridge.

Source No.	Obscurant Agent	
9	81-mm WP M375A2 Cartridge	
	Fill Weight (lbs)	1.6
	Obscurant Type Code	1.0
	Efficiency (%)	100.0
	Yield Factor	7.847
	No. of Submunitions	1.0
	Burn Duration (s)	45.0
	Burn Rate Coefficients:	
	B1	0.6
	B2	-0.6
	B3	0.0
	B4	0.0
	B5	1.0
	B6	0.2
	Smoldering Time (s)	0.0
	Smoldering Coefficient	0.0

Subcloud No.	1	2	3	4	5
Mass Fraction	0.23	0.51	0.26		
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0	0.0	0.0		
Plume Flag (1=Puff, 2=Plume)	2.0	1.0	1.0		
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	1.0	1.0	12.0		
Extinction Coefficient Code	1.0	1.0	1.0		
Ballistic Flag (1=Yes, 0=No)	0.0	0.0	0.0		
Initial Obscurant Radii (m):					
Downwind	18.9	8.9	13.9		
Crosswind	18.9	8.9	13.9		
Vertical	3.0	3.0	3.0		
Buoyancy Radius (m)	5.71	3.18	0.0		
Initial Cloud Temperature (deg K)	302.62	432.56	0.0		
Thermal Production Coeff (cal/g)	9318.31	9318.31	9318.31		
Upward Velocity (m/s)	0.99	1.62	0.0		
Height Of Burst (m)	1.0	1.0	1.0		
Fall Velocity (m/s)	0.0	0.0	0.0		
Evaporation/Deposition:					
F_δ *(Long-Term)*	1.0	1.0	1.0		
Delta (s^{-1})	0.0	0.0	0.0		
Reflection Coefficient	0.55	0.55	0.55		
Momentum Radius (m)	0.0	0.0	0.0		
Horizontal Velocity (m/s)	0.90	0.90	0.0		

Table C.10: Defaults for 4.2-in WP M328A1 Cartridge.

Source No.	Obscurant Agent	
10	4.2-in WP M328A1 Cartridge	
	Fill Weight (lbs)	8.14
	Obscurant Type Code	1.0
	Efficiency (%)	100.0
	Yield Factor	7.847
	No. of Submunitions	1.0
	Burn Duration (s)	45.0
	Burn Rate Coefficients:	
	B1	0.6
	B2	-0.6
	B3	0.0
	B4	0.0
	B5	1.0
	B6	0.2
	Smoldering Time (s)	0.0
	Smoldering Coefficient	0.0

Subcloud No.	1	2	3	4	5
Mass Fraction	0.23	0.51	0.26		
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0	0.0	0.0		
Plume Flag (1=Puff, 2=Plume)	2.0	1.0	1.0		
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	1.0	1.0	12.0		
Extinction Coefficient Code	1.0	1.0	1.0		
Ballistic Flag (1=Yes, 0=No)	0.0	0.0	0.0		
Initial Obscurant Radii (m):					
Downwind	30.8	14.5	22.7		
Crosswind	30.8	14.5	22.7		
Vertical	3.0	4.8	3.9		
Buoyancy Radius (m)	12.87	5.47	0.0		
Initial Cloud Temperature (deg K)	302.62	432.55	0.0		
Thermal Production Coeff (cal/g)	9318.31	9318.31	9318.31		
Upward Velocity (m/s)	0.99	1.62	0.0		
Height Of Burst (m)	1.0	1.0	1.0		
Fall Velocity (m/s)	0.0	0.0	0.0		
Evaporation/Deposition:					
F_δ *(Long-Term)*	1.0	1.0	1.0		
Delta (s^{-1})	0.0	0.0	0.0		
Reflection Coefficient	0.55	0.55	0.55		
Momentum Radius (m)	0.0	0.0	0.0		
Horizontal Velocity (m/s)	0.90	1.01	0.0		

Table C.11: Defaults for 2.75-in WP M156 Rocket.

Source No.	Obscurant Agent	
11	2.75-in WP M156 Rocket	
	Fill Weight (lbs)	2.12
	Obscurant Type Code	1.0
	Efficiency (%)	100.0
	Yield Factor	7.847
	No. of Submunitions	1.0
	Burn Duration (s)	45.0
	Burn Rate Coefficients:	
	B1	0.6
	B2	-0.6
	B3	0.0
	B4	0.0
	B5	1.0
	B6	0.2
	Smoldering Time (s)	0.0
	Smoldering Coefficient	0.0

Subcloud No.	1	2	3	4	5
Mass Fraction	0.23	0.51	0.26		
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0	0.0	0.0		
Plume Flag (1=Puff, 2=Plume)	2.0	1.0	1.0		
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	1.0	1.0	12.0		
Extinction Coefficient Code	1.0	1.0	1.0		
Ballistic Flag (1=Yes, 0=No)	0.0	0.0	0.0		
Initial Obscurant Radii (m):					
Downwind	20.5	9.7	15.1		
Crosswind	20.5	9.7	15.1		
Vertical	3.0	3.2	3.1		
Buoyancy Radius (m)	6.57	3.5	0.0		
Initial Cloud Temperature (deg K)	302.62	432.56	0.0		
Thermal Production Coeff (cal/g)	9318.31	9318.31	9318.31		
Upward Velocity (m/s)	0.99	1.62	0.0		
Height Of Burst (m)	1.0	1.0	1.0		
Fall Velocity (m/s)	0.0	0.0	0.0		
Evaporation/Deposition:					
F_δ *(Long-Term)*	1.0	1.0	1.0		
Delta (s^{-1})	0.0	0.0	0.0		
Reflection Coefficient	0.55	0.55	0.55		
Momentum Radius (m)	0.0	0.0	0.0		
Horizontal Velocity (m/s)	0.90	0.91	0.0		

Table C.12: Defaults for 155-mm WP M110E2 Projectile.

Source No.	Obscurant Agent	
12	155-mm WP M110E2 Projectile	
	Fill Weight (lbs)	15.6
	Obscurant Type Code	1.0
	Efficiency (%)	100.0
	Yield Factor	7.847
	No. of Submunitions	1.0
	Burn Duration (s)	240.0
	Burn Rate Coefficients:	
	B1	0.2
	B2	-0.2
	B3	0.0
	B4	0.0
	B5	1.0
	B6	0.6
	Smoldering Time (sec)	8.0
	Smoldering Coefficient	3.0

Subcloud No.	1	2	3	4	5
Mass Fraction	0.66	0.23	0.11		
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0	0.0	0.0		
Plume Flag (1=Puff, 2=Plume)	2.0	1.0	1.0		
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	1.0	1.0	12.0		
Extinction Coefficient Code	1.0	1.0	1.0		
Ballistic Flag (1=Yes, 0=No)	0.0	0.0	0.0		
Initial Obscurant Radii (m):					
Downwind	37.4	17.7	27.6		
Crosswind	37.4	17.7	27.6		
Vertical	3.0	5.9	4.5		
Buoyancy Radius (m)	23.99	5.21	0.0		
Initial Cloud Temperature (deg K)	302.62	432.55	0.0		
Thermal Production Coeff (cal/g)	9318.31	9318.31	9318.31		
Upward Velocity (m/s)	0.99	1.62	0.0		
Height Of Burst (m)	1.0	1.0	1.0		
Fall Velocity (m/s)	0.0	0.0	0.0		
Evaporation/Deposition:					
F_δ *(Long-Term)*	1.0	1.0	1.0		
Delta (s^{-1})	0.0	0.0	0.0		
Reflection Coefficient	0.55	0.55	0.55		
Momentum Radius (m)	0.0	0.0	0.0		
Horizontal Velocity (m/s)	0.90	1.06	0.0		

Table C.13: Defaults for 105-mm WP M60A2 Cartridge.

Source No.	Obscurant Agent	
13	105-mm WP M60A2 Cartridge	
	Fill Weight (lbs)	3.83
	Obscurant Type Code	1.0
	Efficiency (%)	100.0
	Yield Factor	7.847
	No. of Submunitions	1.0
	Burn Duration (s)	75.0
	Burn Rate Coefficients:	
	B1	0.6
	B2	-0.6
	B3	0.0
	B4	0.0
	B5	1.0
	B6	0.2
	Smoldering Time (sec)	8.0
	Smoldering Coefficient	3.0

Subcloud No.	1	2	3	4	5
Mass Fraction	0.23	0.51	0.26		
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0	0.0	0.0		
Plume Flag (1=Puff, 2=Plume)	2.0	1.0	1.0		
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	1.0	1.0	12.0		
Extinction Coefficient Code	1.0	1.0	1.0		
Ballistic Flag (1=Yes, 0=No)	0.0	0.0	0.0		
Initial Obscurant Radii (m):					
Downwind	24.5	11.6	18.0		
Crosswind	24.5	11.6	18.0		
Vertical	3.0	3.9	3.5		
Buoyancy Radius (m)	7.05	4.26	0.0		
Initial Cloud Temperature (deg K)	302.62	432.56	0.0		
Thermal Production Coeff (cal/g)	9318.31	9318.31	9318.31		
Upward Velocity (m/s)	0.99	1.62	0.0		
Height Of Burst (m)	1.0	1.0	1.0		
Fall Velocity (m/s)	0.0	0.0	0.0		
Evaporation/Deposition:					
F_δ (Long-Term)	1.0	1.0	1.0		
Delta (s^{-1})	0.0	0.0	0.0		
Reflection Coefficient	0.55	0.55	0.55		
Momentum Radius (m)	0.0	0.0	0.0		
Horizontal Velocity (m/s)	0.90	0.96	0.0		

Table C.14: Defaults for 4.2-in PWP M328A1.

Source No.	Obscurant Agent	
14	4.2-in PWP M328A1	
	Fill Weight (lbs)	8.14
	Obscurant Type Code	2.0
	Efficiency (%)	60.0
	Yield Factor	7.847
	No. of Submunitions	1.0
	Burn Duration (s)	180.0
	Burn Rate Coefficients:	
	B1	0.6
	B2	-0.4
	B3	0.0
	B4	0.0
	B5	0.15
	B6	0.3
	Smoldering Time (sec)	8.0
	Smoldering Coefficient	3.0

Subcloud No.	1	2	3	4	5
Mass Fraction	0.925	0.075			
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0	0.0			
Plume Flag (1=Puff, 2=Plume)	2.0	1.0			
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	1.0	1.0			
Extinction Coefficient Code	2.0	2.0			
Ballistic Flag (1=Yes, 0=No)	0.0	0.0			
Initial Obscurant Radii (m):					
Downwind	35.0	6.7			
Crosswind	35.0	6.7			
Vertical	3.0	5.0			
Buoyancy Radius (m)	11.91	2.44			
Initial Cloud Temperature (deg K)	302.62	432.55			
Thermal Production Coeff (cal/g)	9318.31	9318.31			
Upward Velocity (m/s)	0.99	1.62			
Height Of Burst (m)	1.0	1.0			
Fall Velocity (m/s)	0.0	0.0			
Evaporation/Deposition:					
F_δ *(Long-Term)*	1.0	1.0			
Delta (s^{-1})	0.0	0.0			
Reflection Coefficient	0.55	0.55			
Momentum Radius (m)	0.0	0.0			
Horizontal Velocity (m/s)	0.90	1.02			

Table C.15: Defaults for 5-in PWP Zuni MK4.

Source No.	Obscurant Agent	
15	5-in PWP Zuni MK4	
	Fill Weight (lbs)	13.52
	Obscurant Type Code	2.0
	Efficiency (%)	60.0
	Yield Factor	7.847
	No. of Submunitions	1.0
	Burn Duration (s)	180.0
	Burn Rate Coefficients:	
	B1	0.6
	B2	-0.4
	B3	0.0
	B4	0.0
	B5	0.15
	B6	0.3
	Smoldering Time (sec)	8.0
	Smoldering Coefficient	3.0

Subcloud No.	1	2	3	4	5
Mass Fraction	0.925	0.075			
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0	0.0			
Plume Flag (1=Puff, 2=Plume)	2.0	1.0			
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	1.0	1.0			
Extinction Coefficient Code	2.0	2.0			
Ballistic Flag (1=Yes, 0=No)	0.0	0.0			
Initial Obscurant Radii (m):					
Downwind	41.0	7.8			
Crosswind	41.0	7.8			
Vertical	3.0	5.9			
Buoyancy Radius (m)	15.34	2.89			
Initial Cloud Temperature (deg K)	302.62	432.55			
Thermal Production Coeff (cal/g)	9318.31	9318.31			
Upward Velocity (m/s)	0.99	1.62			
Height Of Burst (m)	1.0	1.0			
Fall Velocity (m/s)	0.0	0.0			
Evaporation/Deposition:					
F_δ (Long-Term)	1.0	1.0			
Delta (s^{-1})	0.0	0.0			
Reflection Coefficient	0.55	0.55			
Momentum Radius (m)	0.0	0.0			
Horizontal Velocity (m/s)	0.90	1.06			

Table C.16: Defaults for 2.75 WP Wedge.

Source No.	Obscurant Agent	
16	2.75 WP Wedge	
	Fill Weight (lbs)	0.463
	Obscurant Type Code	2.0
	Efficiency (%)	66.0
	Yield Factor	7.847
	No. of Submunitions	1.0
	Burn Duration (s)	240.0
	Burn Rate Coefficients:	
	B1	0.521
	B2	2.106
	B3	-1.110
	B4	-0.748
	B5	0.0
	B6	0.0
	Smoldering Time (sec)	8.0
	Smoldering Coefficient	3.0

Subcloud No.	1	2	3	4	5
Mass Fraction	0.925	0.075			
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0	0.0			
Plume Flag (1=Puff, 2=Plume)	2.0	1.0			
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	1.0	1.0			
Extinction Coefficient Code	2.0	2.0			
Ballistic Flag (1=Yes, 0=No)	0.0	0.0			
Initial Obscurant Radii (m):					
Downwind	3.8	2.8			
Crosswind	3.8	2.8			
Vertical	3.0	2.0			
Buoyancy Radius (m)	1.76	0.97			
Initial Cloud Temperature (deg K)	302.62	432.56			
Thermal Production Coeff (cal/g)	9318.31	9318.31			
Upward Velocity (m/s)	0.99	1.62			
Height Of Burst (m)	1.0	1.0			
Fall Velocity (m/s)	0.0	0.0			
Evaporation/Deposition:					
F_δ *(Long-Term)*	1.0	1.0			
Delta (s^{-1})	0.0	0.0			
Reflection Coefficient	0.55	0.55			
Momentum Radius (m)	0.0	0.0			
Horizontal Velocity (m/s)	0.90	0.82			

Table C.17: Defaults for 2.75 WP M259 Rocket.

Source No.	Obscurant Agent	
17	2.75 WP M259 Rocket	
	Fill Weight (lbs)	4.63
	Obscurant Type Code	2.0
	Efficiency (%)	66.0
	Yield Factor	7.847
	No. of Submunitions	1.0
	Burn Duration (s)	240.0
	Burn Rate Coefficients:	
	B1	0.521
	B2	2.106
	B3	-1.110
	B4	-0.748
	B5	0.0
	B6	0.0
	Smoldering Time (sec)	8.0
	Smoldering Coefficient	3.0

Subcloud No.	1	2	3	4	5
Mass Fraction	0.925	0.075			
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0	0.0			
Plume Flag (1=Puff, 2=Plume)	2.0	1.0			
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	1.0	1.0			
Extinction Coefficient Code	2.0	2.0			
Ballistic Flag (1=Yes, 0=No)	0.0	0.0			
Initial Obscurant Radii (m):					
Downwind	34.0	5.6			
Crosswind	34.0	5.6			
Vertical	3.0	4.3			
Buoyancy Radius (m)	1.76	0.97			
Initial Cloud Temperature (deg K)	302.62	432.55			
Thermal Production Coeff (cal/g)	9318.31	9318.31			
Upward Velocity (m/s)	0.99	1.62			
Height Of Burst (m)	1.0	1.0			
Fall Velocity (m/s)	0.0	0.0			
Evaporation/Deposition:					
F_δ *(Long-Term)*	1.0	1.0			
Delta (s^{-1})	0.0	0.0			
Reflection Coefficient	0.55	0.55			
Momentum Radius (m)	0.0	0.0			
Horizontal Velocity (m/s)	0.90	0.98			

Table C.18: Defaults for 3-in WP Wick.

Source No.	Obscurant Agent	
18	3-in WP Wick	
	Fill Weight (lbs)	0.139
	Obscurant Type Code	2.0
	Efficiency (%)	71.0
	Yield Factor	7.847
	No. of Submunitions	1.0
	Burn Duration (s)	470.0
	Burn Rate Coefficients:	
	B1	1.631
	B2	0.678
	B3	-5.907
	B4	4.012
	B5	0.0
	B6	0.0
	Smoldering Time (sec)	0.0
	Smoldering Coefficient	0.0

Subcloud No.	1	2	3	4	5
Mass Fraction	0.925	0.075			
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0	0.0			
Plume Flag (1=Puff, 2=Plume)	2.0	1.0			
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	1.0	1.0			
Extinction Coefficient Code	2.0	2.0			
Ballistic Flag (1=Yes, 0=No)	0.0	0.0			
Initial Obscurant Radii (m):					
Downwind	2.6	2.0			
Crosswind	2.6	2.0			
Vertical	3.0	1.6			
Buoyancy Radius (m)	0.72	0.66			
Initial Cloud Temperature (deg K)	302.62	432.57			
Thermal Production Coeff (cal/g)	9318.31	9318.31			
Upward Velocity (m/s)	0.99	1.62			
Height Of Burst (m)	1.0	1.0			
Fall Velocity (m/s)	0.0	0.0			
Evaporation/Deposition:					
F_δ *(Long-Term)*	1.0	1.0			
Delta (s^{-1})	0.0	1.0			
Reflection Coefficient	0.55	0.55			
Momentum Radius (m)	0.0	0.0			
Horizontal Velocity (m/s)	0.90	0.79			

Table C.19: Defaults for 6-in WP Wick.

Source No.	Obscurant Agent	
19	6-in WP Wick	
	Fill Weight (lbs)	0.234
	Obscurant Type Code	2.0
	Efficiency (%)	67.0
	Yield Factor	7.847
	No. of Submunitions	1.0
	Burn Duration (s)	390.0
	Burn Rate Coefficients:	
	B1	1.808
	B2	-2.556
	B3	2.883
	B4	2.008
	B5	0.0
	B6	0.0
	Smoldering Time (sec)	8.0
	Smoldering Coefficient	3.0

Subcloud No.	1	2	3	4	5
Mass Fraction	0.925	0.075			
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0	0.0			
Plume Flag (1=Puff, 2=Plume)	2.0	1.0			
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	1.0	1.0			
Extinction Coefficient Code	2.0	2.0			
Ballistic Flag (1=Yes, 0=No)	0.0	0.0			
Initial Obscurant Radii (m):					
Downwind	3.1	2.3			
Crosswind	3.1	2.3			
Vertical	3.0	1.8			
Buoyancy Radius (m)	1.0	0.78			
Initial Cloud Temperature (deg K)	302.62	432.57			
Thermal Production Coeff (cal/g)	9318.31	9318.31			
Upward Velocity (m/s)	0.99	1.62			
Height Of Burst (m)	1.0	1.0			
Fall Velocity (m/s)	0.0	0.0			
Evaporation/Deposition:					
F_δ *(Long-Term)*	1.0	1.0			
Delta (s^{-1})	0.0	0.0			
Reflection Coefficient	0.55	0.55			
Momentum Radius (m)	0.0	0.0			
Horizontal Velocity (m/s)	0.90	0.81			

Table C.20: Defaults for 155-mm WP M825 Projectile.

Source No.	Obscurant Agent	
20	155-mm WP M825 Projectile	
	Fill Weight (lbs)	16.43
	Obscurant Type Code	2.0
	Efficiency (%)	74.0
	Yield Factor	7.847
	No. of Submunitions	116.0
	Burn Duration (s)	780.0
	Burn Rate Coefficients:	
	B1	3.3236
	B2	-9.4664
	B3	9.5994
	B4	-3.1612
	B5	0.0
	B6	0.0
	Smoldering Time (sec)	8.0
	Smoldering Coefficient	3.0

Subcloud No.	1	2	3	4	5
Mass Fraction	1.0				
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0				
Plume Flag (1=Puff, 2=Plume)	2.0				
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	1.0				
Extinction Coefficient Code	2.0				
Ballistic Flag (1=Yes, 0=No)	0.0				
Initial Obscurant Radii (m):					
Downwind	37.0				
Crosswind	37.0				
Vertical	3.0				
Buoyancy Radius (m)	0.61				
Initial Cloud Temperature (deg K)	302.62				
Thermal Production Coeff (cal/g)	9318.31				
Upward Velocity (m/s)	0.99				
Height Of Burst (m)	1.0				
Fall Velocity (m/s)	0.0				
Evaporation/Deposition:					
F_δ *(Long-Term)*	1.0				
Delta (s^{-1})	0.0				
Reflection Coefficient	0.55				
Momentum Radius (m)	0.0				
Horizontal Velocity (m/s)	0.90				

Table C.21: Defaults for 81-mm RP Wedge.

Source No.	Obscurant Agent	
21	81-mm RP Wedge	
	Fill Weight (lbs)	0.128
	Obscurant Type Code	5.0
	Efficiency (%)	53.0
	Yield Factor	7.847
	No. of Submunitions	1.0
	Burn Duration (s)	260.0
	Burn Rate Coefficients:	
	B1	0.653
	B2	-3.136
	B3	15.309
	B4	-12.872
	B5	0.0
	B6	0.0
	Smoldering Time (sec)	8.0
	Smoldering Coefficient	3.0

Subcloud No.	1	2	3	4	5
Mass Fraction	0.925	0.075			
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0	0.0			
Plume Flag (1=Puff, 2=Plume)	2.0	1.0			
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	1.0	1.0			
Extinction Coefficient Code	5.0	5.0			
Ballistic Flag (1=Yes, 0=No)	0.0	0.0			
Initial Obscurant Radii (m):					
Downwind	4.2	1.9			
Crosswind	4.2	1.9			
Vertical	3.0	0.6			
Buoyancy Radius (m)	0.82	0.59			
Initial Cloud Temperature (deg K)	302.62	432.57			
Thermal Production Coeff (cal/g)	9318.31	9318.31			
Upward Velocity (m/s)	0.99	1.62			
Height Of Burst (m)	1.0	1.0			
Fall Velocity (m/s)	0.0	0.0			
Evaporation/Deposition:					
F_δ *(Long-Term)*	10	1.0			
Delta (s^{-1})	0.0	0.0			
Reflection Coefficient	0.55	0.55			
Momentum Radius (m)	0.0	0.0			
Horizontal Velocity (m/s)	0.90	0.75			

Table C.22: Defaults for I81-mm RP XM819 Cartridge.

Source No.	Obscurant Agent	
22	I81-mm RP XM819 Cartridge	
	Fill Weight (gal)	2.834
	Obscurant Type Code	5.0
	Efficiency (%)	48.0
	Yield Factor	7.847
	No. of Submunitions	28.0
	Burn Duration (s)	600.0
	Burn Rate Coefficients:	
	B1	5.088
	B2	-20.268
	B3	25.938
	B4	-10.400
	B5	0.0
	B6	0.0
	Smoldering Time (sec)	8.0
	Smoldering Coefficient	3.0

Subcloud No.	1	2	3	4	5
Mass Fraction	0.925	0.075			
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0	0.0			
Plume Flag (1=Puff, 2=Plume)	2.0	1.0			
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	1.0	1.0			
Extinction Coefficient Code	5.0	5.0			
Ballistic Flag (1=Yes, 0=No)	0.0	0.0			
Initial Obscurant Radii (m):					
Downwind	17.0	4.9			
Crosswind	17.0	4.9			
Vertical	3.0	1.6			
Buoyancy Radius (m)	0.45	0.52			
Initial Cloud Temperature (deg K)	302.62	432.57			
Thermal Production Coeff (cal/g)	9318.31	9318.31			
Upward Velocity (m/s)	0.99	1.62			
Height Of Burst (m)	1.0	1.0			
Fall Velocity (m/s)	0.0	0.0			
Evaporation/Deposition:					
F_δ *(Long-Term)*	1.0	1.0			
Delta (s^{-1})	0.0	0.0			
Reflection Coefficient	0.55	0.55			
Momentum Radius (m)	0.0	0.0			
Horizontal Velocity (m/s)	0.90	0.79			

Table C.23: Defaults for Generator, ABC M3A3.

Source No.	Obscurant Agent	
23	Generator, ABC M3A3	
	Fill Weight (gal)	10.0
	Obscurant Type Code	4.0
	Efficiency (%)	100.0
	Yield Factor	1.0
	No. of Submunitions	1.0
	Burn Duration (s)	900.0
	Burn Rate Coefficients:	
	B1	1.0
	B2	0.0
	B3	0.0
	B4	0.0
	B5	0.0
	B6	0.0
	Smoldering Time (sec)	8.0
	Smoldering Coefficient	3.0

Subcloud No.	1	2	3	4	5
Mass Fraction	1.0				
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0				
Plume Flag (1=Puff, 2=Plume)	2.0				
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	1.0				
Extinction Coefficient Code	4.0				
Ballistic Flag (1=Yes, 0=No)	0.0				
Initial Obscurant Radii (m):					
Downwind	0.2				
Crosswind	0.2				
Vertical	0.2				
Buoyancy Radius (m)	0.04				
Initial Cloud Temperature (deg K)	640.0				
Thermal Production Coeff (cal/g)	523.95				
Upward Velocity (m/s)	31.89				
Height Of Burst (m)	1.0				
Fall Velocity (m/s)	0.0				
Evaporation/Deposition:					
F_δ (Long-Term)	0.65				
Delta (s^{-1})	0.000333				
Reflection Coefficient	0.55				
Momentum Radius (m)	0.03				
Horizontal Velocity (m/s)	55.24				

Table C.24: Defaults for Generator, VEESS.

Source No.	Obscurant Agent	
24	Generator, VEESS	
	Fill Weight (gal)	11.0
	Obscurant Type Code	8.0
	Efficiency (%)	100.0
	Yield Factor	1.0
	No. of Submunitions	1.0
	Burn Duration (s)	900.0
	Burn Rate Coefficients:	
	B1	1.0
	B2	0.0
	B3	0.0
	B4	0.0
	B5	0.0
	B6	0.0
	Smoldering Time (sec)	8.0
	Smoldering Coefficient	3.0

Subcloud No.	1	2	3	4	5
Mass Fraction	1.0				
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0				
Plume Flag (1=Puff, 2=Plume)	2.0				
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	1.0				
Extinction Coefficient Code	8.0				
Ballistic Flag (1=Yes, 0=No)	0.0				
Initial Obscurant Radii (m):					
Downwind	0.2				
Crosswind	0.2				
Vertical	0.2				
Buoyancy Radius (m)	0.06				
Initial Cloud Temperature (deg K)	540.0				
Thermal Production Coeff (cal/g)	695.82				
Upward Velocity (m/s)	17.82				
Height Of Burst (m)	1.0				
Fall Velocity (m/s)	0.0				
Evaporation/Deposition:					
F_δ *(Long-Term)*	0.1				
Delta (s^{-1})	0.00185				
Reflection Coefficient	0.55				
Momentum Radius (m)	0.06				
Horizontal Velocity (m/s)	30.86				

Table C.25: Defaults for Smoke Pot, Fogoil M7A1.

Source No.	Obscurant Agent	
25	Smoke Pot, Fogoil M7A1	
	Fill Weight (lbs)	1.7
	Obscurant Type Code	4.0
	Efficiency (%)	100.0
	Yield Factor	1.0
	No. of Submunitions	1.0
	Burn Time (sec)	600.0
	Burn Rate Coefficients:	
	B1	1.0
	B2	0.0
	B3	0.0
	B4	0.0
	B5	0.0
	B6	0.0
	Smoldering Time (sec)	0.0
	Smoldering Coefficient	0.0

Subcloud No.	1	2	3	4	5
Mass Fraction	1.0				
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0				
Flag (1=Puff, 2=Plume)	2.0				
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	1.0				
Extinction Coefficient Code	4.0				
Ballistic Flag (1=Yes, 0=No)	0.0				
Initial Obscurant Radii (m):					
Downwind	0.2				
Crosswind	0.2				
Vertical	0.2				
Buoyancy Radius (m)	0.02				
Initial Cloud Temp (deg K)	640.0				
Thermal Prod Coeff (cal/g)	532.95				
Upward Velocity (m/s)	31.89				
Height Of Burst (m)	1.0				
Fall Velocity (m/s)	0.0				
Evaporation/Deposition:					
F_δ *(Long-Term)*	0.65				
Delta (s^{-1})	0.000333				
Reflection Coefficient	0.0				
Momentum Radius (m)	0.02				
Horizontal Velocity (m/s)	55.24				

Table C.26: Defaults for 155-mm HE (dust).

Source No.	Obscurant Agent
26	155-mm HE (dust)

	Fill Weight (lbs)	14.9
	Obscurant Type Code	10.0
	Efficiency (%)	31.2
	Yield Factor	0.027
	No. of Submunitions	1.0
	Depth Of Burst (m)	-0.06
	Munition Delivery:	
	(1=Uncased Charge, 2=Static, 3=Live	3.0
	Casing Length (m)	0.61
	Casing Diam. (m)	0.178
	Impact Angle (deg.)	10.0

Subcloud No.	1	2	3	4	5
Mass Fraction	0.03555	0.5842	0.005075	0.021725	0.35345
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0	0.003	1.784	0.092	0.006
Flag (1=Puff, 2=Plume)	1.0	1.0	1.0	1.0	1.0
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	2.0	2.0	1.0	13.0	13.0
Extinction Coefficient Code	10.0	13.0	10.0	10.0	11.0
Ballistic Flag (1=Yes, 0=No)	0.0	1.0	1.0	0.0	0.0
Initial Obscurant Radii (m):					
Downwind	11.37	9.48	7.58	9.48	9.48
Crosswind	11.37	9.48	7.58	9.48	9.48
Vertical	5.45	5.45	3.03	4.24	4.24
Buoyancy Radius (m)	0.0	0.0	2.59	0.0	0.0
Initial Cloud Temp (deg K)	0.0	0.0	432.57	0.0	0.0
Thermal Prod Coeff (cal/g)	0.0	0.0	173399.0	5063.29	311.22
Upward Velocity (m/s)	0.0	0.0	1.62	0.0	0.0
Height Of Burst (m)	0.0	0.05	0.1	0.0	0.0
Fall Velocity (m/s)	0.003	4.15	0.003	0.003	0.92
Evaporation/Deposition:					
F_δ *(Long-Term)*	1.0	1.0	1.0	1.0	1.0
Delta (s^{-1})	0.0	0.0	0.0	0.0	0.0
Reflection Coefficient	0.1	0.1	0.1	0.1	0.1
Momentum Radius (m)	0.0	0.0	0.0	0.0	0.0
Horizontal Velocity (m/s)	0.0	0.0	0.79	0.0	0.0

Table C.27: Defaults for 105-mm HE (dust).

Source No.	Obscurant Agent	
27	105-mm HE (dust)	
	Fill Weight (lbs)	6.04
	Obscurant Type Code	10.0
	Efficiency (%)	31.5
	Yield Factor	0.029
	No. of Submunitions	1.0
	Depth of Burst (m)	-.06
	Munition Delivery:	
	(1=Uncased Charge, 2=Static, 3=Live	3.0
	Casing Length (m)	0.406
	Casing Diam. (m)	0.102
	Impact Angle (deg.)	10.0

Subcloud No.	1	2	3	4	5
Mass Fraction	0.03555	0.5842	0.005075	0.021725	0.35345
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0	0.003	1.797	0.093	0.006
Flag (1=Puff, 2=Plume)	1.0	1.0	1.0	1.0	1.0
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	2.0	2.0	1.0	13.0	13.0
Extinction Coefficient Code	10.0	13.0	10.0	10.0	11.0
Ballistic Flag (1=Yes, 0=No)	0.0	1.0	1.0	0.0	0.0
Initial Obscurant Radii (m):					
Downwind	8.7	7.25	5.8	7.25	7.25
Crosswind	8.7	7.25	5.8	7.25	7.25
Vertical	4.03	4.03	2.24	3.13	3.13
Buoyancy Radius (m)	0.0	0.0	1.92	0.0	0.0
Initial Cloud Temp (deg K)	0.0	0.0	432.57	0.0	0.0
Thermal Prod Coeff (cal/g)	0.0	0.0	173399.0	5063.29	311.22
Upward Velocity (m/s)	0.0	0.0	1.62	0.0	0.0
Height Of Burst (m)	0.0	0.0	0.1	0.0	0.0
Fall Velocity (m/s)	0.003	4.15	0.003	0.003	0.92
Evaporation/Deposition:					
F_δ *(Long-Term)*	1.0	1.0	1.0	1.0	1.0
Delta (s^{-1})	0.0	0.0	0.0	0.0	0.0
Reflection Coefficient	0.1	0.1	0.1	0.1	0.1
Momentum Radius (m)	0.0	0.0	0.0	0.0	0.0
Horizontal Velocity (m/s)	0.0	0.0	0.70	0.0	0.0

Table C.28: Defaults for 4.2inch HE (dust).

Source No.	Obscurant Agent	
28	4.2inch HE (dust)	
	Fill Weight (gal)	7.45
	Obscurant Type Code	10.0
	Efficiency (%)	31.4
	Yield Factor	0.039
	No. of Submunitions	1.0
	Depth Of Burst (m)	-.6
	Munition Delivery: (1=Uncased Charge, 2=Static, 3=Live	3.0
	Casing Length (m)	0.46
	Casing Diam. (m)	0.102
	Impact Angle (deg.)	60.0

Subcloud No.	1	2	3	4	5
Mass Fraction	0.03555	0.5842	0.005075	0.021725	0.35345
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0	0.003	1.321	0.068	0.004
Plume Flag (1=Puff, 2=Plume)	1.0	1.0	1.0	1.0	1.0
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	2.0	2.0	1.0	13.0	13.0
Extinction Coefficient Code	10.0	13.0	10.0	10.0	11.0
Ballistic Flag (1=Yes, 0=No)	0.0	1.0	1.0	0.0	0.0
Initial Obscurant Radii (m):					
Downwind	10.24	8.54	6.83	8.54	8.54
Crosswind	10.24	8.54	6.83	8.54	8.54
Vertical	4.78	4.78	2.66	3.72	3.72
Buoyancy Radius (m)	0.0	0.0	2.06	0.0	0.0
Initial Cloud Temperature (deg K)	0.0	0.0	432.57	0.0	0.0
Thermal Production Coeff (cal/g)	0.0	0.0	173399.0	5063.29	311.22
Upward Velocity (m/s)	0.0	0.0	1.62	0.0	0.0
Height Of Burst (m)	0.0	0.0	0.1	0.0	0.0
Fall Velocity (m/s)	0.003	4.15	0.003	0.003	0.92
Evaporation/Deposition:					
F_δ *(Long-Term)*	1.0	1.0	1.0	1.0	1.0
Delta (s^{-1})	0.0	0.0	0.0	0.0	0.0
Reflection Coefficient	0.1	0.1	0.1	0.1	0.1
Momentum Radius (m)	0.0	0.0	0.0	0.0	0.0
Horizontal Velocity (m/s)	0.0	0.0	0.75	0.0	0.0

Table C.29: Defaults for 10 lb C4 HE (dust).

Source No.	Obscurant Agent	
29	10 lb C4 HE (dust)	
	Fill Weight (gal)	13.4
	Obscurant Type Code	10.0
	Efficiency (%)	49.9
	Yield Factor	0.015
	No. of Submunitions	1.0
	Depth Of Burst (m)	-.06
	Munition Delivery:	
	(1=Uncased Charge, 2=Static, 3=Live	1.0
	Casing Length (m)	0.606
	Casing Diam. (m)	0.178
	Impact Angle (deg.)	0.0

Subcloud No.	1	2	3	4	5
Mass Fraction	0.03555	0.5842	0.005075	0.021725	0.35345
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0	0.006	3.256	0.168	0.01
Plume Flag (1=Puff, 2=Plume)	1.0	1.0	1.0	1.0	1.0
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	2.0	2.0	1.0	13.0	13.0
Extinction Coefficient Code	10.0	13.0	10.0	10.0	11.0
Ballistic Flag (1=Yes, 0=No)	0.0	1.0	1.0	0.0	0.0
Initial Obscurant Radii (m):					
Downwind	11.02	9.18	7.35	9.18	9.18
Crosswind	11.02	9.18	7.35	9.18	9.18
Vertical	5.26	5.26	2.92	4.09.	4.09
Buoyancy Radius (m)	0.0	0.0	2.92	0.0	0.0
Initial Cloud Temperature (deg K)	0.0	0.0	432.57	0.0	0.0
Thermal Production Coeff (cal/g)	0.0	0.0	173399.0	5063.29	311.22
Upward Velocity (m/s)	0.0	0.0	1.62	0.0	0.0
Height Of Burst (m)	0.0	0.0	0.1	0.0	0.0
Fall Velocity (m/s)	0.003	4.15	0.003	0.003	0.92
Evaporation/Deposition:					
F_δ *(Long-Term)*	1.0	1.0	1.0	1.0	1.0
Delta (s^{-1})	0.0	0.0	0.0	0.0	0.0
Reflection Coefficient	0.1	0.1	0.1	0.1	0.1
Momentum Radius (m)	0.0	0.0	0.0	0.0	0.0
Horizontal Velocity (m/s)	0.0	0.0	0.78	0.0	0.0

Table C.30: Defaults for Diesel Fuel/Oil/Rubber Fire.

Source No.	Obscurant Agent	
30	Diesel Fuel/Oil/Rubber Fire	
	Fill Weight (lbs)	150.0
	Obscurant Type Code	14.0
	Efficiency (%)	26.0
	Yield Factor	1.0
	No. of Subclouds	1.0
	Burn Duration (s)	1800.0
	Burn Rate Coefficients:	
	B1	1.0
	B2	0.0
	B3	0.0
	B4	0.0
	B5	0.0
	B6	0.0
	Smoldering Time (s)	0.0
	Smoldering Coefficient	0.0

Subcloud No.	1	2	3	4	5
Mass Fraction	1.0				
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0				
Plume Flag (1=Puff, 2=Plume)	2.0				
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	1.0				
Extinction Coefficient Code	14.0				
Ballistic Flag (1=Yes, 0=No)	.0				
Initial Obscurant Radii (m):					
Downwind	3.09				
Crosswind	3.09				
Vertical	1.03				
Buoyancy Radius (m)	2.96				
Initial Cloud Temperature (deg K)	349.59				
Thermal Production Coeff (cal/g)	7185.0				
Upward Velocity (m/s)	1.48				
Height Of Burst (m)	.0				
Fall Velocity (m/s)	.0				
Evaporation/Deposition:					
F_δ *(Long-Term)*	.1				
Delta (s^{-1})	0.0				
Reflection Coefficient	.55				
Momentum Radius (m)	.0				
Horizontal Velocity (m/s)	.44				

Table C.31: Defaults for Muzzle blast smoke.

Source No.	Obscurant Agent	
31	Muzzle Blast Smoke	
	Fill Weight (lbs)	2.0
	Obscurant Type Code	10.0
	Efficiency (%)	5.0
	Yield Factor	0.01
	No. of Subclouds	1.0
	Depth Of Burst (m)	-.06
	Munition Delivery:	
	(1=Uncased Charge, 2=Static, 3=Live	1.0
	Casing Length (m)	0.606
	Casing Diam. (m)	0.178
	Impact Angle (deg.)	0.0

Subcloud No.	1	2	3	4	5
Mass Fraction	1.0				
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0				
Plume Flag (1=Puff, 2=Plume)	1.0				
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	2.0				
Extinction Coefficient Code	10.0				
Ballistic Flag (1=Yes, 0=No)	0.0				
Initial Obscurant Radii (m):					
Downwind	15.0				
Crosswind	10.0				
Vertical	7.0				
Buoyancy Radius (m)	0.0				
Initial Cloud Temperature (deg K)	0.0				
Thermal Production Coeff (cal/g)	0.0				
Upward Velocity (m/s)	0.0				
Height Of Burst (m)	0.0				
Fall Velocity (m/s)	0.0				
Evaporation/Deposition:					
F_δ *(Long-Term)*	1.0				
Delta (s^{-1})	0.0				
Reflection Coefficient	0.0				
Momentum Radius (m)	1.0				
Horizontal Velocity (m/s)	0.0				

Table C.32: Defaults for M76 IR Grenade.

Source No.	Obscurant Agent	
32	M76 IR Grenade	
	Fill Weight (lbs)	2.98
	Obscurant Type Code	20.0
	Efficiency (%)	60.0
	Yield Factor	1.0
	No. of Subclouds	1.0
	Burn Duration (s)	
	Burn Rate Coefficients:	1.0
	B1	1.0
	B2	0.0
	B3	0.0
	B4	0.0
	B5	0.0
	B6	0.0
	Smoldering Time (s)	0.0
	Smoldering Coefficient	0.0

Subcloud No.	1	2	3	4	5
Mass Fraction	1.0				
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0				
Plume Flag (1=Puff, 2=Plume)	1.0				
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	2				
Extinction Coefficient Code	20.0				
Ballistic Flag (1=Yes, 0=No)	0.0				
Initial Obscurant Radii (m):					
Downwind	10.8				
Crosswind	10.8				
Vertical	16.8				
Buoyancy Radius (m)	.0				
Initial Cloud Temperature (deg K)	.0				
Thermal Production Coeff (cal/g)	.0				
Upward Velocity (m/s)	.0				
Height Of Burst (m)	10.0				
Fall Velocity (m/s)	0.0				
Evaporation/Deposition:					
F_δ *(Long-Term)*	1.0				
Delta (s^{-1})	0.0				
Reflection Coefficient	1.0				
Momentum Radius (m)	0.0				
Horizontal Velocity (m/s)	0.0				

Table C.33: Defaults for L8A1/L8A3 RP Grenade.

Source No.	Obscurant Agent	
33	L8A3/L8A1 RP Grenades	
	Fill Weight (lbs)	0.794
	Obscurant Type Code	5.0
	Efficiency (%)	95.0
	Yield Factor	7.847
	No. of Subclouds	1.0
	Burn Duration (s)	658.0
	Burn Rate Coefficients:	0.0
	B1	0.0
	B2	0.0
	B3	0.0
	B4	0.0
	B5	120.0
	B6	0.0083
	Smoldering Time (s)	0.0
	Smoldering Coefficient	0.0

Subcloud No.	1	2	3	4	5
Mass Fraction	0.925	0.05	0.025		
Debris Carbon $\frac{g\ Carbon}{g\ obsc}$	0.0	0.0	0.0		
Plume Flag (1=Puff, 2=Plume)	2.0	1.0	1.0		
Rise Flag (1=Rise, 2=No Rise, >3=Stem)	1.0	1.0	12.0		
Extinction Coefficient Code	5.0	5.0	5.0		
Ballistic Flag (1=Yes, 0=No)	0.0	0.0	0.0		
Initial Obscurant Radii (m):					
Downwind	17.54	3.32	3.32		
Crosswind	17.54	3.32	3.32		
Vertical	3.0	2.4	2.49		
Buoyancy Radius (m)	2.09	1.14	0.0		
Initial Cloud Temperature (deg K)	302.63	432.41	0.0		
Thermal Production Coeff (cal/g)	9318.31	9318.31	0.0		
Upward Velocity (m/s)	.86	1.62	0.0		
Height Of Burst (m)	0.0	.0	0.0		
Fall Velocity (m/s)	0.0	0.0	0.0		
Evaporation/Deposition:					
F_δ (Long-Term)	1.0	1.0	1.0		
Delta (s^{-1})	0.0	0.0	0.0		
Reflection Coefficient	1.0	1.0	1.0		
Momentum Radius (m)	0.0	0.0	0.0		
Horizontal Velocity (m/s)	0.78	1.56	0.0		

Appendix D. Pasquill Decision Tree

This appendix contains a flow chart (Figure D.1) that allows determination of the pasquill stability given windspeed, cloud cover and time of day.

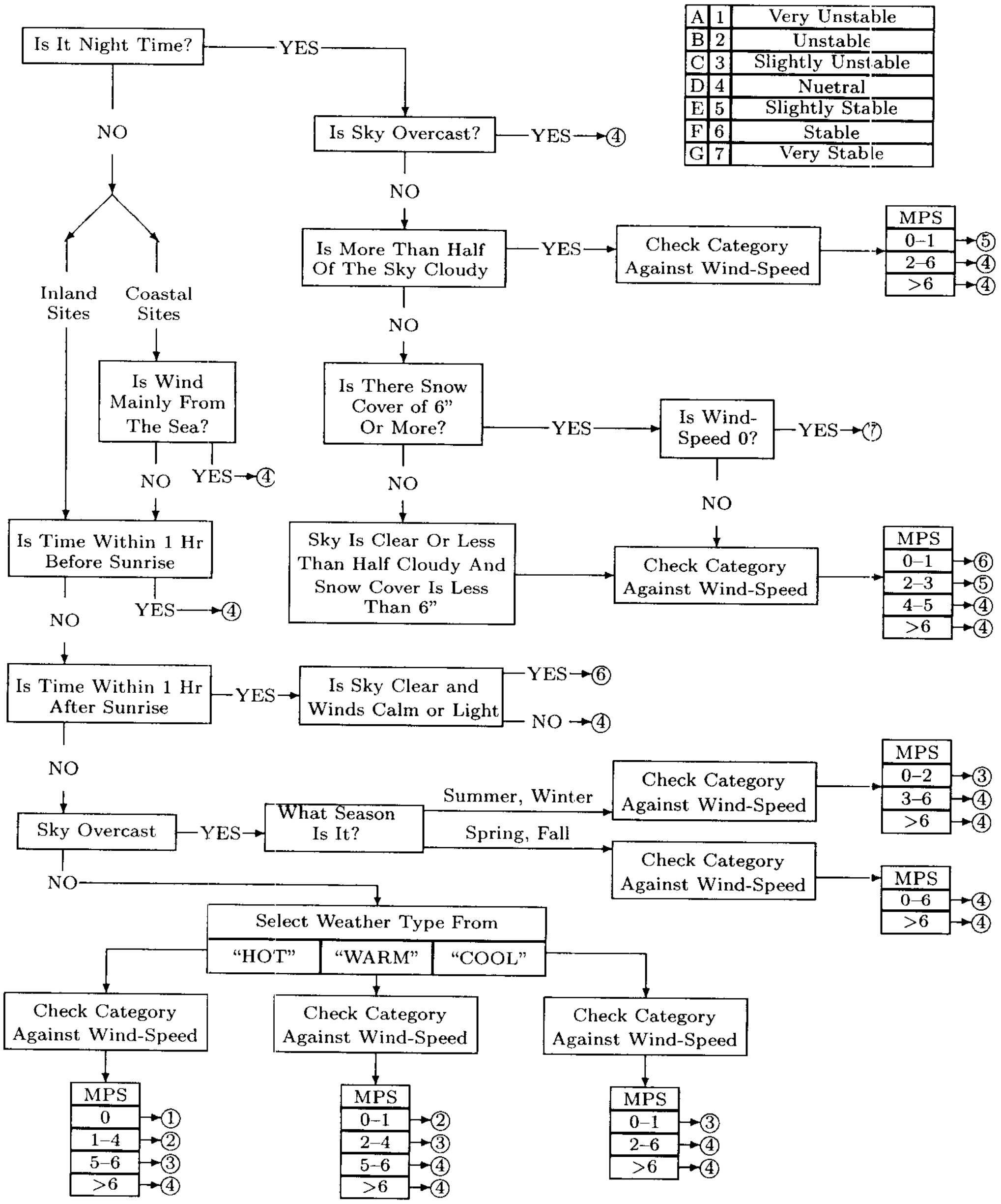

Figure D.1: Flowchart to determine Pasquill Stability.

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EOSAEL Modules

AGAUS	(vol 1)	Mie Scattering Code
BITS	(vol 2)	Broad-band Integrated Transmittances
CLIMAT	(vol 3)	Climatology
COMBIC	(vol 4)	Obscuration Model for Multiple Battlefield-Induced Contaminants
COPTER	(vol 5)	Obscuration due to Helicopter-Lofted Snow and Dust
FASCAT	(vol 6)	Fast Algorithm for Atmospheric Scattering Calculations
FITTE	(vol 7)	Fire-Induced Transmission and Turbulence Effects
GRNADE	(vol 8)	Smoke Munitions Self-Screening Applications
ILUMA	(vol 9)	Natural Illumination under Realistic Weather Conditions
KWIK	(vol 10)	Transmission Threshold Smoke Munitions Expenditures Model
LASS	(vol 11)	Large Area Screening Systems Application
LOWTRN	(vol 12)	Atmospheric Transmittance and Radiance for Broadband Applications
LZTRAN	(vol 13)	Laser Transmittance–Gaseous Absorption Algorithm
MPLUME	(vol 14)	Missile Smoke Plume Obscuration
NBSCAT	(vol 15)	Narrow Beam Multiple Scattering
NMMW	(vol 16)	Near Millimeter Wave, Gaseous Absorption
NOVAE	(vol 17)	Nonlinear Aerosol Vaporization and Breakdown Effects, High Energy Lasers
OVRCST	(vol 18)	Contrast Transmission
PFNDAT	(vol 19)	Aerosol Phase Function Data Base
RADAR	(vol 20)	Millimeter Wave System Performance
REFRAC	(vol 21)	Optical Path Bending Code for Near Earth Paths
TARGAC	(vol 22)	Target Acquisition
UVTRAN	(vol 23)	Ultraviolet Transmission and Lidar Simulation
XSCALE	(vol 24)	Natural Aerosol Extinction

Attachment Q

National Nuclear Security Administration
Nevada Site Office

DEFENSE THREAT REDUCTION AGENCY PROPOSED EXPLOSIVE EXPERIMENT AT THE NEVADA TEST SITE

Response to the Bureau of Air Pollution Control's request for the inclusion of the 12-month rolling average for hazardous air pollutant (HAP) emissions and for SO2 emissions

Emissions of HAPs and sulfur dioxide (SO2) from Divine Strake were estimated using the POLU4WN Model and amounted to 10.79 tons per year and 0.4 tons, respectively. The HAPs included a combination of eight chlorine compounds, six cyanide compounds, formaldehyde and hydrazine.

A summary page from the most recent NTS Quarterly Report shows the actual HAP emissions from all permitted sources from the previous three quarters plus the first quarter of 2006 (see Table 1). The total HAP emissions were .066 tons.

The May, 2005 NTS emissions inventory indicates that the potential to emit for sulfur dioxide, a criteria pollutant, is 6.91 tons/year.

The combined total HAPs for Divine Strake plus the NTS permitted sources is an estimated 10.86 tons, which is well below the NTS Air Permit limit of 23.300 tons per 12-month rolling average. Similarly, the combined SO2 emissions for Divine Strake plus the potential to emit is 7.31 tons, which is considerably less than the 100 ton/yr threshold for each of the criteria pollutants.

NTS PERMIT AP9711-0549.01
HAPS EMISSIONS
QUARTERLY REPORT

Hazardous Air Pollutant Emissions Summary - Tons/Yr

	2nd Quarter 2005	3rd Quarter 2005	4th Quarter 2005	1st Quarter 2006	Total HAPs Emissions (Ton/Yr)
Aggregate Processing Equipment	5.09E-06	5.16E-06	3.70E-06	5.17E-06	1.91E-05
Combustion Equipment	1.49E-03	3.86E-03	5.54E-04	3.03E-04	6.21E-03
Boilers	2.76E-04	6.21E-05	6.67E-04	8.04E-04	1.81E-03
Chemical Releases	1.79E-03	5.23E-02	1.79E-03	1.65E-03	5.75E-02
			TOTAL		**6.56E-02**

NTS PERMIT AP9711-0549.01
HAPS EMISSIONS
QUARTERLY REPORT

Hazardous Air Pollutant Emissions - Tons/Yr

2nd Quarter 2005 /3rd Quarter 2005 4th Quarter 2005 / 1st Quarter 2006					Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	TOTAL HAPS
					3.75E-02	0.00E+00	1.30E-02	2.94E-06	1.71E-03	1.11E-03	1.36E-03	2.85E-03	4.50E-07	9.00E-07	3.15E-06	5.75E-02
emission source #	Equipment	process rate (ton/hr) or *heat rate (MMBtu/hr)*	operating hours (hr/yr)	control (%)	Carbon Tetrachloride (ton/yr)	Diethanol-amine (ton/yr)	Methanol (ton/yr)	Nitric Acid (ton/yr)	HF (ton/yr)	HNO3 (ton/yr)	H2SO4 (ton/yr)	HCl (ton/yr)	Formaldehyde (ton/yr)	Hydrazine (ton/yr)	Cyanide Compounds (HCN)(ton/yr)	
CHEMICAL RELEASES/FUME HOODS - 2nd QUARTER, 2005																
Area 4 - BEEF Detonations																
F1.001	There were no detonations that resulted in the release of HAPs during the 2nd Quarter, 2005															
AREA 5 - NPTEC Chemical Releases																
5.008	There were no chemical releases that resulted in the release of HAPs during the 2nd Quarter, 2005															
Area 23 Fume Hoods																
23.50	Building 652 Hoods		1300					7.50E-07	4.35E-04	2.84E-04	3.47E-04	7.27E-04				1.79E-03
														2nd Quarter Total		***1.79E-03***
CHEMICAL RELEASES/FUME HOODS - 3RD QUARTER, 2005																
Area 4 - BEEF Detonations																
F1.001	There were no detonations that resulted in the release of HAPs during the 3rd Quarter, 2005															
AREA 5 - NPTEC Chemical Releases																
5.008	Chemical releases				3.75E-02		1.30E-02									5.05E-02
Area 23 Fume Hoods																
23.50	Building 652 Hoods		1300					7.50E-07	4.35E-04	2.84E-04	3.47E-04	7.27E-04				1.79E-03
														3rd Quarter Total		***5.23E-02***
CHEMICAL RELEASES/FUME HOODS - 4TH QUARTER, 2005																
Area 4 - BEEF Detonations																
F1.001	There were no detonations that resulted in the release of HAPs during the 4th Quarter, 2005															
AREA 5 - NPTEC Chemical Releases																
5.008	There were no chemical releases that resulted in the release of HAPs during the 4th Quarter, 2005															
Area 23 Fume Hoods																
23.50	Building 652 Hoods		1300					7.50E-07	4.35E-04	2.84E-04	3.47E-04	7.27E-04				1.79E-03
														4th Quarter Total		***1.79E-03***
CHEMICAL RELEASES/FUME HOODS - 1ST QUARTER, 2006																
Area 4 - BEEF Detonations																
F1.001													4.5E-07	9E-07	3.15E-06	4.50E-06
AREA 5 - NPTEC Chemical Releases																
5.008	There were no chemical releases that resulted in the release of HAPs during the 1st Quarter, 2006															
Area 23 Fume Hoods																
23.50	Building 652 Hoods		1200					6.90E-07	4.00E-04	2.61E-04	3.19E-04	6.69E-04				1.65E-03
														1st Quarter Total		***1.65E-03***

NTS PERMIT AP9711-0549.01
HAPS EMISSIONS
QUARTERLY REPORT

Hazardous Air Pollutant Emissions - Tons/Yr												
2nd Quarter 2005 /3rd Quarter 2005				Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	TOTAL HAPS
4th Quarter 2005 / 1st Quarter 2006				1.71E-07	4.27E-09	1.92E-08	1.57E-07	1.02E-07	1.71E-05	1.56E-06	0.00E+00	1.91E-05
emission source no.	Equipment	operating hours (hr/yr)	control (%)	As (ton/yr)	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Phosphorous (P) (ton/yr)	
This report includes the Permitted and Insignificant Emissions Sources that are regulated under a site-wide emissions cap for HAPS												
Note: All of the aggregate processing equipment is permitted												
AGGREGATE PROCESSING EQUIPMENT - 2ND QUARTER, 2005												
Area 1 Concrete Batch Plant				3.528E-08	3.759E-10	4.914E-09	5.292E-09	1.5456E-08	0.000004242	3.696E-07	0	4.67E-06
1.46	Baghouse 04			3.528E-08	3.759E-10	4.914E-09	5.292E-09	1.5456E-08	0.000004242	3.696E-07	0	
46A	loading overhead bin	42	99	1.764E-08	1.8795E-10	2.457E-09	2.646E-09	7.728E-09	0.000002121	1.848E-07	0	
46B	loading weigh hopper	42	99	1.764E-08	1.8795E-10	2.457E-09	2.646E-09	7.728E-09	0.000002121	1.848E-07	0	
Area 6 Cementing Equipment				8.59E-09	6.41E-10	1.21E-10	3.37E-08	1.05E-08	3.21E-07	3.98E-08	0.00E+00	4.15E-07
123A	Baghouse 07/back-up											
123B	waste silo		99									
6.004	Baghouse 10			8.589E-09	6.405E-10	1.2075E-10	3.3653E-08	1.0505E-08	3.213E-07	3.98475E-08	0	
4A	Load blending tank	10.5	99	6.09E-10	0	3.0975E-11	3.7275E-09	1.0028E-09	1.6065E-07	8.61E-09	0	
4B	Blending tank discharge	10.5	99	7.98E-09	6.405E-10	8.9775E-11	2.9925E-08	9.5025E-09	1.6065E-07	3.12375E-08	0	
6.006	Bin Vent #3											
567C	Silo #3		90									
										2nd Quarter Total		***5.09E-06***
AGGREGATE PROCESSING EQUIPMENT - 3RD QUARTER, 2005												
Area 1 Concrete Batch Plant				3.612E-08	3.8485E-10	5.031E-09	5.418E-09	1.5824E-08	0.000004343	3.784E-07	0	4.78E-06
1.46	Baghouse 04			3.612E-08	3.8485E-10	5.031E-09	5.418E-09	1.5824E-08	0.000004343	3.784E-07	0	
46A	loading overhead bin	43	99	1.806E-08	1.9243E-10	2.5155E-09	2.709E-09	7.912E-09	2.1715E-06	1.892E-07	0	
46B	loading weigh hopper	43	99	1.806E-08	1.9243E-10	2.5155E-09	2.709E-09	7.912E-09	2.1715E-06	1.892E-07	0	
Area 6 Cementing Equipment				1.25E-08	1.01E-09	1.41E-10	4.70E-08	1.49E-08	2.52E-07	4.91E-08	0.00E+00	3.77E-07
123A	Baghouse 07/back-up											
123B	waste silo		99									
6.004	Baghouse 10			1.3497E-08	1.0065E-09	1.8975E-10	5.2883E-08	1.6508E-08	5.049E-07	6.26175E-08	0	
4A	Load blending tank	16.5	99	9.57E-10	0	4.8675E-11	5.8575E-09	1.5758E-09	2.5245E-07	1.353E-08	0	
4B	Blending tank discharge	16.5	99	1.254E-08	1.0065E-09	1.4108E-10	4.7025E-08	1.4933E-08	2.5245E-07	4.90875E-08	0	
6.006	Bin Vent #3											
567C	Silo #3		90									
										3nd Quarter Total		***5.16E-06***
AGGREGATE PROCESSING EQUIPMENT - 4TH QUARTER, 2005												
Area 1 Concrete Batch Plant				2.646E-08	2.8193E-10	3.6855E-09	3.969E-09	1.1592E-08	3.1815E-06	2.772E-07	0	3.50E-06
1.46	Baghouse 04			2.646E-08	2.8193E-10	3.6855E-09	3.969E-09	1.1592E-08	3.1815E-06	2.772E-07	0	
46A	loading overhead bin	31.5	99	1.323E-08	1.4096E-10	1.8428E-09	1.9845E-09	5.796E-09	1.59075E-06	1.386E-07	0	
46B	loading weigh hopper	31.5	99	1.323E-08	1.4096E-10	1.8428E-09	1.9845E-09	5.796E-09	1.59075E-06	1.386E-07	0	
Area 6 Cementing Equipment				6.46E-09	5.19E-10	7.27E-11	2.42E-08	7.69E-09	1.30E-07	2.53E-08	0.00E+00	1.94E-07
123A	Baghouse 07/back-up											

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Hazardous Air Pollutant Emissions - Tons/Yr													
2nd Quarter 2005 /3rd Quarter 2005					Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	TOTAL HAPS
4th Quarter 2005 / 1st Quarter 2006					1.71E-07	4.27E-09	1.92E-08	1.57E-07	1.02E-07	1.71E-05	1.56E-06	0.00E+00	1.91E-05
emission source no.	Equipment		operating hours (hr/yr)	control (%)	As (ton/yr)	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Phosphorous (P) (ton/yr)	
123B	waste silo			99									
6.004	Baghouse 10				6.953E-09	5.185E-10	9.775E-11	2.7243E-08	8.5043E-09	2.601E-07	3.22575E-08	0	
4A	Load blending tank		8.5	99	4.93E-10	0	2.5075E-11	3.0175E-09	8.1175E-10	1.3005E-07	6.97E-09	0	
4B	Blending tank discharge		8.5	99	6.46E-09	5.185E-10	7.2675E-11	2.4225E-08	7.6925E-09	1.3005E-07	2.52875E-08	0	
6.006	Bin Vent #3												
567C	Silo #3			90									
											4th Quarter Total		***3.70E-06***
AGGREGATE PROCESSING EQUIPMENT - 1ST QUARTER, 2006													
Area 1 Concrete Batch Plant					3.7128E-08	3.9559E-10	5.1714E-09	5.5692E-09	1.6266E-08	4.4642E-06	3.8896E-07	0	4.92E-06
1.46	Baghouse 04				3.7128E-08	3.9559E-10	5.1714E-09	5.5692E-09	1.6266E-08	4.4642E-06	3.8896E-07	0	
46A	loading overhead bin		44.2	99	1.8564E-08	1.978E-10	2.5857E-09	2.7846E-09	8.1328E-09	2.2321E-06	1.9448E-07	0	
46B	loading weigh hopper		44.2	99	1.8564E-08	1.978E-10	2.5857E-09	2.7846E-09	8.1328E-09	2.2321E-06	1.9448E-07	0	
Area 6 Cementing Equipment					8.36E-09	6.71E-10	9.41E-11	3.14E-08	9.96E-09	1.68E-07	3.27E-08	0.00E+00	2.51E-07
123A	Baghouse 07/back-up												
123B	waste silo			99									
6.004	Baghouse 10				8.998E-09	6.71E-10	1.265E-10	3.5255E-08	1.1006E-08	3.366E-07	4.1745E-08	0	
4A	Load blending tank		11	99	6.38E-10	0	3.245E-11	3.905E-09	1.0505E-09	1.683E-07	9.02E-09	0	
4B	Blending tank discharge		11	99	8.36E-09	6.71E-10	9.405E-11	3.135E-08	9.955E-09	1.683E-07	3.2725E-08	0	
6.006	Bin Vent #3												
567C	Silo #3			90									
											1st Quarter Total		***5.17E-06***

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Hazardous Air Pollutant Emissions - Tons/Yr														
2nd Quarter 2005 /3rd Quarter 2005					Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	TOTAL HAPS
4th Quarter 2005 / 1st Quarter 2006					9.092E-04	3.988E-04	2.777E-04	2.514E-03	3.810E-05	1.150E-03	7.475E-04	9.014E-05	8.264E-05	6.208E-03
emission source #	Equipment	operating hours (hr/yr)	gallons of fuel used	Current Status	Be (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldahyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	
Note: the Combustion Equipment listed below includes permitted as well as insignificant sources; operating hours and fuel usage														
	are also included													
DIESEL GENERATORS/COMPRESSORS - 2ND QTR 2005														
Area 5 Checkpoint Pass					3.649E-06	1.600E-06	1.115E-06	1.009E-05	1.529E-07	4.615E-06	3.000E-06	3.618E-07	3.317E-07	2.492E-05
5.001	generator/Checkpoint Pa	28	137	IN	2.6751E-06	1.173E-06	8.172E-07	7.397E-06	1.121E-07	3.3833E-06	2.1991E-06	2.652E-07	2.43139E-07	
5.002	generator/WEF	18	40	IN	9.74052E-07	4.27E-07	2.975E-07	2.694E-06	4.082E-08	1.2319E-06	8.0075E-07	9.657E-08	8.85312E-08	
Area 6 - Const. Equipment Yard					1.302E-04	5.708E-05	3.976E-05	3.589E-04	5.455E-06	1.646E-04	1.070E-04	1.290E-05	1.183E-05	8.887E-04
6.052	diesel generator	53	119	IN	3.39612E-05	1.489E-05	1.037E-05	9.391E-05	1.423E-06	4.2952E-05	2.7919E-05	3.367E-06	3.08672E-06	
6.081	generator	5	42	IN	7.96082E-07	3.49E-07	2.432E-07	2.201E-06	3.336E-08	1.0068E-06	6.5444E-07	7.893E-08	7.23556E-08	
6.082	generator/CP-43	76	368	IN	7.26098E-06	3.183E-06	2.218E-06	2.008E-05	3.043E-07	9.1832E-06	5.9691E-06	7.199E-07	6.59948E-07	
S2.105	generator 947 hp	9	266	PER	1.76337E-05	7.73E-06	5.387E-06	4.876E-05	7.39E-07	2.2302E-05	1.4496E-05	1.748E-06	1.60272E-06	
S2.107	generator DAF	13	580	PER	3.39612E-05	1.489E-05	1.037E-05	9.391E-05	1.423E-06	4.2952E-05	2.7919E-05	3.367E-06	3.08672E-06	
S2.108	generator DAF	13	580	PER	3.39612E-05	1.489E-05	1.037E-05	9.391E-05	1.423E-06	4.2952E-05	2.7919E-05	3.367E-06	3.08672E-06	
6.030	diesel air compressor	10	16	IN	9.7172E-07	4.26E-07	2.968E-07	2.687E-06	4.072E-08	1.229E-06	7.9883E-07	9.634E-08	8.83192E-08	
6.039	diesel air compressor	17	25	IN	1.61624E-06	7.085E-07	4.937E-07	4.469E-06	6.773E-08	2.0441E-06	1.3287E-06	1.602E-07	1.46899E-07	
Area 23 - Mercury					6.336E-05	2.779E-05	1.936E-05	1.753E-04	2.656E-06	8.016E-05	5.211E-05	6.284E-06	5.781E-06	4.328E-04
23.01	generator/B1000	50	70	IN	1.3062E-07	5.726E-08	3.99E-08	3.612E-07	5.474E-09	1.652E-07	1.0738E-07	1.295E-08	1.1872E-08	
23.02	generator/B1010	31	230	IN	4.93571E-06	2.164E-06	1.508E-06	1.365E-05	2.068E-07	6.2424E-06	4.0575E-06	4.893E-07	4.48605E-07	
23.06	generator	47	91	IN	1.49751E-06	6.565E-07	4.574E-07	4.141E-06	6.276E-08	1.894E-06	1.2311E-06	1.485E-07	1.36108E-07	
S2.111	generator/B650	27	681	PER	5.29011E-05	2.319E-05	1.616E-05	0.0001463	2.217E-06	6.6906E-05	4.3489E-05	5.245E-06	4.80816E-06	
S2.112	generator/B725	2	46	PER	3.9186E-06	1.718E-06	1.197E-06	1.084E-05	1.642E-07	4.956E-06	3.2214E-06	3.885E-07	3.5616E-07	
Area 27					2.090E-05	9.162E-06	6.384E-06	5.779E-05	8.758E-07	2.643E-05	1.718E-05	2.072E-06	1.900E-06	1.427E-04
S2.100	generator	8	313	PER	2.08992E-05	9.162E-06	6.384E-06	5.779E-05	8.758E-07	2.6432E-05	1.7181E-05	2.072E-06	1.89952E-06	
														.
												2nd Quarter Total		**1.489E-03**

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Hazardous Air Pollutant Emissions - Tons/Yr 2nd Quarter 2005 /3rd Quarter 2005					Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	TOTAL HAPS
4th Quarter 2005 / 1st Quarter 2006					9.092E-04	3.986E-04	2.777E-04	2.514E-03	3.810E-05	1.150E-03	7.475E-04	9.014E-05	8.264E-05	6.208E-03
emission source #	Equipment	operating hours (hr/yr)	gallons of fuel used	Current Status	Be (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldahyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	
DIESEL GENERATORS/COMPRESSORS - 3RD QTR 2005														
Area 6 - Const. Equipment Yard					2.695E-05	1.181E-05	8.233E-06	7.453E-05	1.129E-06	3.409E-05	2.216E-05	2.672E-06	2.450E-06	1.840E-04
S2.109	generator/CP-1	11	260	PER	2.15523E-05	9.448E-06	6.584E-06	5.96E-05	9.032E-07	2.7258E-05	1.7718E-05	2.137E-06	1.95888E-06	
6.082	generator/CP-43	26	120	IN	2.48402E-06	1.089E-06	7.588E-07	6.869E-06	1.041E-07	3.1416E-06	2.0421E-06	2.463E-07	2.25772E-07	
6.030	diesel air compressor	30	88	IN	2.91516E-06	1.278E-06	8.905E-07	8.061E-06	1.222E-07	3.6869E-06	2.3965E-06	2.89E-07	2.64958E-07	
Area 23 - Mercury					4.188E-04	1.836E-04	1.279E-04	1.158E-03	1.755E-05	5.297E-04	3.443E-04	4.152E-05	3.807E-05	2.860E-03
23.01	generator/B1000	5	8	IN	1.07762E-05	4.724E-06	3.292E-06	2.98E-05	4.516E-07	1.3629E-05	8.8589E-06	1.068E-06	9.7944E-07	
23.02	generator/B1010	15	110	IN	2.38825E-06	1.047E-06	7.295E-07	6.604E-06	1.001E-07	3.0205E-06	1.9633E-06	2.368E-07	2.17067E-07	
23.06	generator	3	5	IN	9.55859E-08	4.19E-08	2.92E-08	2.643E-07	4.006E-09	1.2089E-07	7.8579E-08	9.477E-09	8.68776E-09	
S2.111	generator/B650	12	290	PER	2.35116E-05	1.031E-05	7.182E-06	6.502E-05	9.853E-07	2.9736E-05	1.9328E-05	2.331E-06	2.13696E-06	
S2.112	generator/B725	195	2535	PER	0.000382064	0.0001675	0.0001167	0.0010565	1.601E-05	0.00048321	0.00031409	3.788E-05	3.47256E-05	
Area 25 - Skull Mtn					2.39E-06	1.05E-06	7.30E-07	6.60E-06	1.00E-07	3.02E-06	1.96E-06	2.37E-07	2.17E-07	1.63E-05
25.03	generator/ Skull Mtn.	25	107.0	IN	2.39E-06	1.05E-06	7.30E-07	6.60E-06	1.00E-07	3.02E-06	1.96E-06	2.37E-07	2.17E-07	
Area 27					1.176E-04	5.153E-05	3.591E-05	3.251E-04	4.927E-06	1.487E-04	9.664E-05	1.166E-05	1.068E-05	8.027E-04
S2.100	generator	35	1365	PER	0.000091434	4.008E-05	2.793E-05	0.0002528	3.832E-06	0.00011564	7.5166E-05	9.065E-06	8.3104E-06	
S2.101	generator	10	390	PER	0.000026124	1.145E-05	7.98E-06	7.224E-05	1.095E-06	0.00003304	2.1476E-05	2.59E-06	2.3744E-06	
												3rd Quarter Total		***3.863E-03***
DIESEL GENERATORS/COMPRESSORS - 4TH QTR 2005														
Area 1 - U1G					3.13E-05	1.37E-05	9.58E-06	8.67E-05	1.31E-06	3.96E-05	2.58E-05	3.11E-06	2.85E-06	2.140E-04
1.78	emergency generator	16	220	IN	3.13488E-05	1.374E-05	9.576E-06	8.669E-05	1.314E-06	3.9648E-05	2.5771E-05	3.108E-06	2.84928E-06	
Area 5 Checkpoint Pass					2.866E-07	1.256E-07	8.755E-08	7.926E-07	1.201E-08	3.625E-07	2.356E-07	2.842E-08	2.605E-08	1.957E-06
5.001	generator/Checkpoint Pa	3	15	IN	2.86618E-07	1.256E-07	8.755E-08	7.926E-07	1.201E-08	3.625E-07	2.3562E-07	2.842E-08	2.60506E-08	
Area 6 - Const. Equipment Yard					9.236E-06	4.049E-06	2.821E-06	2.554E-05	3.871E-07	1.168E-05	7.593E-06	9.157E-07	8.395E-07	6.306E-05
S2.109	generator/CP-1	1	81	PER	1.9593E-06	8.589E-07	5.985E-07	5.418E-06	8.211E-08	2.478E-06	1.6107E-06	1.943E-07	1.7808E-07	
6.054	generator	3	15	IN	2.86618E-07	1.256E-07	8.755E-08	7.926E-07	1.201E-08	3.625E-07	2.3562E-07	2.842E-08	2.60506E-08	
6.080	generator/CP-18	19	92	IN	2.26906E-06	9.947E-07	6.931E-07	6.275E-06	9.509E-08	2.8698E-06	1.8653E-06	2.25E-07	2.06234E-07	
6.081	generator/CP-40	2	42	IN	3.18433E-07	1.396E-07	9.727E-08	8.806E-07	1.334E-08	4.0273E-07	2.6178E-07	3.157E-08	2.89422E-08	
6.082	generator/CP-43	23	110	IN	2.1974E-06	9.633E-07	6.712E-07	6.076E-06	9.209E-08	2.7791E-06	1.8064E-06	2.179E-07	1.99721E-07	
6.030	diesel air compressor	9	24	IN	8.74548E-07	3.834E-07	2.671E-07	2.418E-06	3.665E-08	1.1061E-06	7.1895E-07	8.67E-08	7.94873E-08	
6.040	diesel air compressor	14	20	IN	1.33102E-06	5.835E-07	4.066E-07	3.681E-06	5.578E-08	1.6834E-06	1.0942E-06	1.32E-07	1.20976E-07	
Area 19					8.625E-06	3.781E-06	2.635E-06	2.385E-05	3.615E-07	1.091E-05	7.091E-06	8.551E-07	7.840E-07	5.889E-05
S2.680	generator/Echo Peak	3	12	IN	2.86618E-07	1.256E-07	8.755E-08	7.926E-07	1.201E-08	3.625E-07	2.3562E-07	2.842E-08	2.60506E-08	
Area 23 - Mercury					7.108E-06	3.116E-06	2.171E-06	1.966E-05	2.979E-07	8.990E-06	5.844E-06	7.047E-07	6.461E-07	4.853E-05
23.01	generator/B1000	330	55	IN	1.63275E-07	7.158E-08	4.988E-08	4.515E-07	6.843E-09	2.065E-07	1.3423E-07	1.619E-08	1.484E-08	

Hazardous Air Pollutant Emissions - Tons/Yr

2nd Quarter 2005 /3rd Quarter 2005					Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	TOTAL HAPS
4th Quarter 2005 / 1st Quarter 2006					9.092E-04	3.986E-04	2.777E-04	2.514E-03	3.810E-05	1.150E-03	7.475E-04	9.014E-05	8.264E-05	6.208E-03
emission source #	Equipment	operating hours (hr/yr)	gallons of fuel used	Current Status	Be (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldahyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	
23.02	generator/B1010	2	15	IN	3.18433E-07	1.396E-07	9.727E-08	8.806E-07	1.334E-08	4.0273E-07	2.6178E-07	3.157E-08	2.89422E-08	
23.06	generator	3	5	IN	9.55859E-08	4.19E-08	2.92E-08	2.643E-07	4.006E-09	1.2089E-07	7.8579E-08	9.477E-09	8.68776E-09	
23.08	generator/Angel Peak	7	19	IN	6.531E-07	2.863E-07	1.995E-07	1.806E-06	2.737E-08	8.26E-07	5.369E-07	6.475E-08	5.936E-08	
S2.111	generator/B650	3	73	PER	5.8779E-06	2.577E-06	1.796E-06	1.625E-05	2.463E-07	7.434E-06	4.8321E-06	5.828E-07	5.3424E-07	
Area 25 - Skull Mtn					9.55E-07	4.19E-07	2.92E-07	2.64E-06	4.00E-08	1.21E-06	7.85E-07	9.47E-08	8.68E-08	6.52E-06
25.03	generator/ Skull Mtn.	10	43.0	IN	9.55E-07	4.19E-07	2.92E-07	2.64E-06	4.00E-08	1.21E-06	7.85E-07	9.47E-08	8.68E-08	
Area 27					2.351E-05	1.031E-05	7.182E-06	6.502E-05	9.853E-07	2.974E-05	1.933E-05	2.331E-06	2.137E-06	1.605E-04
S2.131	generator	9	335	PER	2.35116E-05	1.031E-05	7.182E-06	6.502E-05	9.853E-07	2.9736E-05	1.9328E-05	2.331E-06	2.13696E-06	
												4th Quarter Total		***5.536E-04***
DIESEL GENERATORS/COMPRESSORS - 1ST QTR 2006														
Area 1 - U1G					2.61E-06	1.15E-06	7.98E-07	7.22E-06	1.09E-07	3.30E-06	2.15E-06	2.59E-07	2.37E-07	1.784E-05
1.76	generator/U1A	8	107	IN	2.6124E-06	1.145E-06	7.98E-07	7.224E-06	1.095E-07	3.304E-06	2.1476E-06	2.59E-07	2.3744E-07	
Area 5 Checkpoint Pass					1.911E-07	8.376E-08	5.837E-08	5.284E-07	8.008E-09	2.417E-07	1.571E-07	1.894E-08	1.737E-08	1.305E-06
5.001	generator/Checkpoint Pa	2	10	IN	1.91078E-07	8.376E-08	5.837E-08	5.284E-07	8.008E-09	2.4166E-07	1.5708E-07	1.894E-08	1.7367E-08	
Area 6 - Const. Equipment Yard					2.825E-05	1.238E-05	8.630E-06	7.812E-05	1.184E-06	3.573E-05	2.323E-05	2.801E-06	2.568E-06	1.929E-04
6.052	generator	1	3	IN	4.665E-08	2.045E-08	1.425E-08	1.29E-07	1.955E-09	5.9E-08	3.835E-08	4.625E-09	4.24E-09	
6.054	generator	3	15	IN	2.86618E-07	1.256E-07	8.755E-08	7.926E-07	1.201E-08	3.625E-07	2.3562E-07	2.842E-08	2.60506E-08	
6.080	generator/CP-18	8	39	IN	1.27373E-06	5.584E-07	3.891E-07	3.522E-06	5.338E-08	1.6109E-06	1.0471E-06	1.263E-07	1.15769E-07	
6.081	generator/CP-40	2	42	IN	1.27373E-06	5.584E-07	3.891E-07	3.522E-06	5.338E-08	1.6109E-06	1.0471E-06	1.263E-07	1.15769E-07	
6.082	generator/CP-43	1	2	IN	9.55392E-08	4.188E-08	2.918E-08	2.642E-07	4.004E-09	1.2083E-07	7.8541E-08	9.472E-09	8.68352E-09	
6.083	generator/CP-70	5	1	IN	9.95045E-07	4.362E-07	3.04E-07	2.752E-06	4.17E-08	1.2585E-06	8.1801E-07	9.865E-08	9.04392E-08	
6.087	generator/DAF	9	405	PER	2.35116E-05	1.031E-05	7.182E-06	6.502E-05	9.853E-07	2.9736E-05	1.9328E-05	2.331E-06	2.13696E-06	
6.030	diesel air compressor	4	10	IN	3.88688E-07	1.704E-07	1.187E-07	1.075E-06	1.629E-08	4.9159E-07	3.1953E-07	3.854E-08	3.53277E-08	
6.040	diesel air compressor	4	6	IN	3.80291E-07	1.667E-07	1.162E-07	1.052E-06	1.594E-08	4.8097E-07	3.1263E-07	3.77E-08	3.45645E-08	
Area 19					3.449E-06	1.512E-06	1.054E-06	9.538E-06	1.445E-07	4.362E-06	2.835E-06	3.420E-07	3.135E-07	2.355E-05
S2.680	generator/Echo Peak	3	12	IN	2.86618E-07	1.256E-07	8.755E-08	7.926E-07	1.201E-08	3.625E-07	2.3562E-07	2.842E-08	2.60506E-08	
Area 23 - Mercury					2.561E-06	1.123E-06	7.823E-07	7.082E-06	1.073E-07	3.239E-06	2.105E-06	2.539E-07	2.328E-07	1.749E-05
23.01	generator/B1000	4	1	IN	1.3062E-07	5.726E-08	3.99E-08	3.612E-07	5.474E-09	1.652E-07	1.0738E-07	1.295E-08	1.1872E-08	
23.02	generator/B1010	1	7	IN	1.59216E-07	6.98E-08	4.864E-08	4.403E-07	6.672E-09	2.0137E-07	1.3089E-07	1.579E-08	1.44711E-08	
23.06	generator/Bldg 425	1	2	IN	3.1862E-08	1.397E-08	9.733E-09	8.811E-08	1.335E-09	4.0297E-08	2.6193E-08	3.159E-09	2.89592E-09	
23.08	generator/Angel Peak	3	8	IN	2.799E-07	1.227E-07	8.55E-08	7.74E-07	1.173E-08	3.54E-07	2.301E-07	2.775E-08	2.544E-08	
23.09	generator/B650	1	25	PER	1.9593E-06	8.589E-07	5.985E-07	5.418E-06	8.211E-08	2.478E-06	1.6107E-06	1.943E-07	1.7808E-07	
Area 25 - Skull Mtn					7.26E-06	3.18E-06	2.22E-06	2.01E-05	3.04E-07	9.18E-06	5.97E-06	7.20E-07	6.60E-07	4.96E-05
25.03	generator/ Skull Mtn.	76	326.0	IN	7.26E-06	3.18E-06	2.22E-06	2.01E-05	3.04E-07	9.18E-06	5.97E-06	7.20E-07	6.60E-07	

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HAPS EMISSIONS
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Hazardous Air Pollutant Emissions - Tons/Yr														
2nd Quarter 2005 /3rd Quarter 2005					Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	TOTAL HAPS
4th Quarter 2005 / 1st Quarter 2006					9.092E-04	3.968E-04	2.777E-04	2.514E-03	3.610E-05	1.160E-03	7.475E-04	9.014E-05	8.264E-05	6.208E-03
emission source #	Equipment	operating hours (hr/yr)	gallons of fuel used	Current Status	Be (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldahyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	
												1st Quarter Total		***3.027E-04***

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Hazardous Air Pollutant Emissions - Tons/Yr

2nd Quarter 2005 /3rd Quarter 2005				**Totals**	**Totals**	**Totals**	**Totals**	**Totals**	**Totals**	**Totals**	**Totals**	**Totals**	**Totals**	**Totals**	**Totals**	**Totals**	**Totals**	**Totals**	**TOTAL HAPS**
4th Quarter 2005 / 1st Quarter 2006				7.61E-05	5.70E-05	5.70E-05	5.70E-05	1.71E-04	5.70E-05	1.14E-04	5.70E-05	2.85E-04	2.93E-05	8.48E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.81E-03
emission source #	**Equipment Location**	**operating hours**	**gallons of fuel used**	**As** *(ton/yr)*	**Be** (ton/yr)	**Cd** (ton/yr)	**Cr** (ton/yr)	**Pb** (ton/yr)	**Hg** (ton/yr)	**Mn** (ton/yr)	**Ni** (ton/yr)	**Se** (ton/yr)	**Benzene** (ton/yr)	**Toluene** (ton/yr)	**Formaldahyde** (ton/yr)	**Napthalene** (ton/yr)	**Ethyl Benzene** (ton/yr)	**o-Xylene** (ton/yr)	
BOILERS - 2ND QTR 2005																			
AREA 6				**4.27E-07**	**3.20E-07**	**3.20E-07**	**3.20E-07**	**9.60E-07**	**3.20E-07**	**6.40E-07**	**3.20E-07**	**1.60E-06**	**1.64E-07**	**4.76E-06**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	1.02E-05
6.08	CP-9	253.6	1470.9	4.24E-07	3.18E-07	3.18E-07	3.18E-07	9.54E-07	3.18E-07	6.36E-07	3.18E-07	1.59E-06	1.63E-07	4.73E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
6.076	CP-1	0.8	7.3	2.68E-09	2.01E-09	2.01E-09	2.01E-09	6.02E-09	2.01E-09	4.01E-09	2.01E-09	1.00E-08	1.03E-09	2.98E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
AREA 23				**1.12E-05**	**8.39E-06**	**8.39E-06**	**8.39E-06**	**2.52E-05**	**8.39E-06**	**1.68E-05**	**8.39E-06**	**4.19E-05**	**4.30E-06**	**1.25E-04**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	2.66E-04
23.03	B111	238.8	429.6	8.74E-08	6.56E-08	6.56E-08	6.56E-08	1.97E-07	6.56E-08	1.31E-07	6.56E-08	3.28E-07	3.36E-08	9.75E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
23.04	B128	211.8	1302.6	3.54E-07	2.66E-07	2.66E-07	2.66E-07	7.97E-07	2.66E-07	5.31E-07	2.66E-07	1.33E-06	1.36E-07	3.95E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
23.05	B156	254.5	788.9	1.70E-07	1.28E-07	1.28E-07	1.28E-07	3.83E-07	1.28E-07	2.55E-07	1.28E-07	6.38E-07	6.55E-08	1.90E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
23.07	B536	44.5	445	1.58E-07	1.18E-07	1.18E-07	1.18E-07	3.54E-07	1.18E-07	2.36E-07	1.18E-07	5.91E-07	6.06E-08	1.76E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
23.11	B754 HW	463	8889.6	2.96E-06	2.22E-06	2.22E-06	2.22E-06	6.67E-06	2.22E-06	4.44E-06	2.22E-06	1.11E-05	1.14E-06	3.30E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
23.12	B753	186.3	2161.1	2.40E-06	1.80E-06	1.80E-06	1.80E-06	5.40E-06	1.80E-06	3.60E-06	1.80E-06	9.00E-06	9.24E-07	2.68E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
2.12	B753	186.3	2161.1	2.40E-06	1.80E-06	1.80E-06	1.80E-06	5.40E-06	1.80E-06	3.60E-06	1.80E-06	9.00E-06	9.24E-07	2.68E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
23.57	B754 Steam	414.5	4310.8	2.65E-06	1.99E-06	1.99E-06	1.99E-06	5.97E-06	1.99E-06	3.98E-06	1.99E-06	9.95E-06	1.02E-06	2.96E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
																	2nd Quarter Total		***2.76E-04***
BOILERS - 3RD QTR 2005																			
AREA 23				**2.61E-06**	**1.96E-06**	**1.96E-06**	**1.96E-06**	**5.88E-06**	**1.96E-06**	**3.92E-06**	**1.96E-06**	**9.80E-06**	**1.01E-06**	**2.91E-05**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	6.21E-05
23.57	B754 Steam	408.2	4245.3	2.61E-06	1.96E-06	1.96E-06	1.96E-06	5.88E-06	1.96E-06	3.92E-06	1.96E-06	9.80E-06	1.01E-06	2.91E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
																	3rd Quarter Total		***6.21E-05***

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Hazardous Air Pollutant Emissions - Tons/Yr

2nd Quarter 2005 /3rd Quarter 2005				Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	TOTAL HAPS
4th Quarter 2005 / 1st Quarter 2006				7.61E-05	5.70E-05	5.70E-05	5.70E-05	1.71E-04	5.70E-05	1.14E-04	5.70E-05	2.85E-04	2.93E-05	8.48E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.81E-03
emission source #	**Equipment Location**	**operating hours**	**gallons of fuel used**	**As (ton/yr)**	**Be (ton/yr)**	**Cd (ton/yr)**	**Cr (ton/yr)**	**Pb (ton/yr)**	**Hg (ton/yr)**	**Mn (ton/yr)**	**Ni (ton/yr)**	**Se (ton/yr)**	**Benzene (ton/yr)**	**Toluene (ton/yr)**	**Formaldahyde (ton/yr)**	**Napthalene (ton/yr)**	**Ethyl Benzene (ton/yr)**	**o-Xylene (ton/yr)**	
BOILERS - 4TH QTR 2005																			
AREA 6				**9.40E-06**	**7.05E-06**	**7.05E-06**	**7.05E-06**	**2.11E-05**	**7.05E-06**	**1.41E-05**	**7.05E-06**	**3.52E-05**	**3.62E-06**	**1.05E-04**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	2.24E-04
6.08	CP-9	417.6	2422.1	6.98E-07	5.24E-07	5.24E-07	5.24E-07	1.57E-06	5.24E-07	1.05E-06	5.24E-07	2.62E-06	2.69E-07	7.79E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
6.075	CP-1	36.3	330.3	8.70E-06	6.52E-06	6.52E-06	6.52E-06	1.96E-05	6.52E-06	1.30E-05	6.52E-06	3.26E-05	3.35E-06	9.70E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
6.076	CP-1	207.9	1891.9	2.68E-09	2.01E-09	2.01E-09	2.01E-09	6.02E-09	2.01E-09	4.01E-09	2.01E-09	1.00E-08	1.03E-09	2.98E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
AREA 23				**1.86E-05**	**1.40E-05**	**1.40E-05**	**1.40E-05**	**4.19E-05**	**1.40E-05**	**2.80E-05**	**1.40E-05**	**6.99E-05**	**7.17E-06**	**2.08E-04**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	4.43E-04
23.03	B111	238.8	1098.5	2.24E-07	1.68E-07	1.68E-07	1.68E-07	5.03E-07	1.68E-07	3.35E-07	1.68E-07	8.38E-07	8.60E-08	2.49E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
23.04	B128	299.7	1843.2	5.01E-07	3.76E-07	3.76E-07	3.76E-07	1.13E-06	3.76E-07	7.52E-07	3.76E-07	1.88E-06	1.93E-07	5.59E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
23.05	B156	437.8	1357.2	2.93E-07	2.20E-07	2.20E-07	2.20E-07	6.59E-07	2.20E-07	4.39E-07	2.20E-07	1.10E-06	1.13E-07	3.27E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
23.07	B536	563.9	5639	2.00E-06	1.50E-06	1.50E-06	1.50E-06	4.49E-06	1.50E-06	2.99E-06	1.50E-06	7.49E-06	7.68E-07	2.23E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
23.11	B754 HW	1010.9	19409.3	6.47E-06	4.85E-06	4.85E-06	4.85E-06	1.46E-05	4.85E-06	9.70E-06	4.85E-06	2.43E-05	2.49E-06	7.21E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
23.12	B753	576.2	6683.9	7.42E-06	5.57E-06	5.57E-06	5.57E-06	1.67E-05	5.57E-06	1.11E-05	5.57E-06	2.78E-05	2.86E-06	8.28E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
23.57	B754 Steam	270.7	2815.3	1.73E-06	1.30E-06	1.30E-06	1.30E-06	3.90E-06	1.30E-06	2.60E-06	1.30E-06	6.50E-06	6.67E-07	1.93E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
																	4th Quarter Total		***6.67E-04***
BOILERS - 1ST QTR 2006																			
AREA 6				**3.09E-06**	**2.32E-06**	**2.32E-06**	**2.32E-06**	**6.96E-06**	**2.32E-06**	**4.64E-06**	**2.32E-06**	**1.16E-05**	**1.19E-06**	**3.45E-05**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	7.35E-05
6.08	CP-9	676	3920.8	1.13E-06	8.48E-07	8.48E-07	8.48E-07	2.54E-06	8.48E-07	1.70E-06	8.48E-07	4.24E-06	4.35E-07	1.26E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
6.075	CP-1	217.5	1979.3	7.27E-07	5.46E-07	5.46E-07	5.46E-07	1.64E-06	5.46E-07	1.09E-06	5.46E-07	2.73E-06	2.80E-07	8.11E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
6.076	CP-1	368.8	3356.1	1.23E-06	9.25E-07	9.25E-07	9.25E-07	2.78E-06	9.25E-07	1.85E-06	9.25E-07	4.63E-06	4.75E-07	1.38E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
AREA 23				**3.07E-05**	**2.30E-05**	**2.30E-05**	**2.30E-05**	**6.91E-05**	**2.30E-05**	**4.61E-05**	**2.30E-05**	**1.15E-04**	**1.18E-05**	**3.42E-04**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	7.30E-04
23.03	B111	423.8	1949.5	3.97E-07	2.98E-07	2.98E-07	2.98E-07	8.93E-07	2.98E-07	5.95E-07	2.98E-07	1.49E-06	1.53E-07	4.42E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
23.04	B128	631.7	3885	1.06E-06	7.92E-07	7.92E-07	7.92E-07	2.38E-06	7.92E-07	1.58E-06	7.92E-07	3.96E-06	4.07E-07	1.18E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
23.05	B156	785.1	2433.8	5.25E-07	3.94E-07	3.94E-07	3.94E-07	1.18E-06	3.94E-07	7.88E-07	3.94E-07	1.97E-06	2.02E-07	5.86E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
23.07	B536	1015.2	10152	2.00E-06	1.50E-06	1.50E-06	1.50E-06	4.49E-06	1.50E-06	2.99E-06	1.50E-06	7.49E-06	7.68E-07	2.23E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
23.11	B754 HW	1211.3	23257	7.75E-06	5.81E-06	5.81E-06	5.81E-06	1.74E-05	5.81E-06	1.16E-05	5.81E-06	2.91E-05	2.98E-06	8.64E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
23.12	B753	1327	15395.5	1.71E-05	1.28E-05	1.28E-05	1.28E-05	3.85E-05	1.28E-05	2.56E-05	1.28E-05	6.41E-05	6.58E-06	1.91E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
23.57	B754 Steam	293.9	3056.6	1.88E-06	1.41E-06	1.41E-06	1.41E-06	4.23E-06	1.41E-06	2.82E-06	1.41E-06	7.05E-06	7.24E-07	2.10E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
																	1st Quarter Total		***8.04E-04***

Nevada Test Site Emission Inventory

LBS/HR

Hazardous Air Pollutant Emissions

AGGREGATE PROCESSING EQUIPMENT

emission source #	old permit #	Equipment	process rate (ton/hr) or heat rate (MMBtu/hr)	operating hours (hr/yr)	control (%)	As (lb/hr)	Be (lb/hr)	Cd (lb/hr)	Cr (lb/hr)	Pb (lb/hr)	Hg (lb/hr)	Mn (lb/hr)	Ni (lb/hr)	Se (lb/hr)	Benzene (lb/hr)	Toluene (lb/hr)	Xylenes (lb/hr)	Propylene (lb/hr)	1,3-Butadiene (lb/hr)	Formaldehyde (lb/hr)	Acetaldehyde (lb/hr)	Acrolein (lb/hr)	Napthalene (lb/hr)	Ethylbenzene (lb/hr)	o-Xylene (lb/hr)	Phosphorous (P) (lb/hr)
					Totals	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0.0004746	[illegible]	[illegible]	[illegible]	[illegible]	0.008457	0.206728	[illegible]	0.0152788	0.0142606	#VALUE!	2.478E-06	#VALUE!
Area 1 Shaker Plant						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
1.14		Baghouse 02				#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
14A	1.016	C-7 to Rotary	100	250	99	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
14B	2.023	Rotary Dryer	100	250	99	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
Area 1 Concrete Batch Plant						[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0.0019381	0.0001654	0	0	0	0	0	0	0	0	0	0	0	0	[illegible]
1.46		Baghouse 04				0.00001176	1.253E-07	0.000001638	0.000001764	0.000005152	0	0.001414	0.0001232	0	0	0	0	0	0	0	0	0	0	0	0	0.0000826
46A	2.026	loading overhe	50	42	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46B	1.057	loading weigh h	50	42	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46C		loading temp. h	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46D		discharge temp	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46E		loading temp. h	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46F		discharge temp	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46G		loading temp. h	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46H		discharge temp	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46I	2.111	loading Silo #3	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46J	2.112	discharge Silo	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46K	2.113	loading Silo #4	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46L	2.114	discharge Silo	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46M	2.115	loading Silo #5	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46N	2.116	discharge Silo	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
1.47		Baghouse 06				3.8992E-06	3.759E-08	5.1028E-07	2.8012E-06	2.1568E-06	0	0.0005221	4.221E-05	0	0	0	0	0	0	0	0	0	0	0	0	0
47A	2.026	C-2 to funnel	160	1920	99	0.000002688	2.864E-08	3.744E-07	4.032E-07	1.1776E-06	0	0.0003232	2.816E-05	0	0	0	0	0	0	0	0	0	0	0	0	1.888E-05
47B	2.027	weigh hopper 2	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
47C	2.029	truck loading	160	1920	99	3.712E-07	0	1.888E-08	0.000002272	6.112E-07	0	9.792E-05	5.248E-06	0	0	0	0	0	0	0	0	0	0	0	0	3.232E-05
Area 6 Cementing Equipment						[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0.0146032	0.0013672	1.31E-06	0	0	0	0	0	0	0	0	0	0	0	[illegible]
6.001	2.032	Scale #1	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
6.002	2.033	Scale #2	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
6.003	2.034	Scale #3	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
123A		Baghouse 07/back-up				0.000002688	2.864E-08	3.744E-07	4.032E-07	1.1776E-06	0	0.0003232	2.816E-05	0	0	0	0	0	0	0	0	0	0	0	0	1.888E-05
123B		waste silo	10	1920	99	0.000000168	1.79E-09	2.34E-08	2.52E-08	7.36E-08	0	0.0000202	1.76E-06	0	0	0	0	0	0	0	0	0	0	0	0	1.18E-06
6.004		Baghouse 15				0.000001636	0.000000122	0.000000023	0.00000641	0.000002001	0	0.0000612	7.59E-06	1.31E-06	0	0	0	0	0	0	0	0	0	0	0	0.0000293
4A	2.035	Load blending	50	8.5	99	0.000000116	0	5.9E-09	0.00000071	0.000000191	0	0.0000306	1.64E-06	0	0	0	0	0	0	0	0	0	0	0	0	0.0000101
4B	2.036	Blending tank	50	8.5	99	0.00000152	0.000000122	1.71E-08	0.0000057	0.00000181	0	0.0000306	5.95E-06	1.31E-06	0	0	0	0	0	0	0	0	0	0	0	0.0000192
6.005		Bin Vent #1				0.000014	1.49167E-07	0.00000195	0.0000021	6.13333E-06	0	0.0016833	0.0001467	0	0	0	0	0	0	0	0	0	0	0	0	9.833E-05
6.006		Bin Vent #3				0.000014	1.49167E-07	0.00000195	0.0000021	6.13333E-06	0	0.0016833	0.0001467	0	0	0	0	0	0	0	0	0	0	0	0	9.833E-05
6.007		Bin Vent #4				0.000014	1.49167E-07	0.00000195	0.0000021	6.13333E-06	0	0.0016833	0.0001467	0	0	0	0	0	0	0	0	0	0	0	0	9.833E-05
967A	2.037	Silo #1	50	1920	90	0.0000084	8.95E-08	0.00000117	0.00000126	0.00000368	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
967B	2.038	Silo #2	50	1920	90	0.0000084	8.95E-08	0.00000117	0.00000126	0.00000368	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
967C	2.039	Silo #3	50	1920	90	0.0000084	8.95E-08	0.00000117	0.00000126	0.00000368	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
967D	2.040	Silo #4	50	1920	90	0.0000084	8.95E-08	0.00000117	0.00000126	0.00000368	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
967E	2.041	Silo #5	50	1920	90	0.0000084	8.95E-08	0.00000117	0.00000126	0.00000368	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
6.008		Bin Vent #6				0.0000168	0.000000179	0.00000234	0.00000252	0.00000736	0	0.00202	0.000176	0	0	0	0	0	0	0	0	0	0	0	0	0.000118
8A	2.042	Silo #7	50	1920	90	0.0000084	8.95E-08	0.00000117	0.00000126	0.00000368	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
8B	2.043	Silo #8	50	1920	90	0.0000084	8.95E-08	0.00000117	0.00000126	0.00000368	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
6.009	2.044	Silo #15	50	1920	90	0.0000084	8.95E-08	0.00000117	0.00000126	0.00000368	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
6.010	2.045	Silo #16	50	1920	90	0.0000084	8.95E-08	0.00000117	0.00000126	0.00000368	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
6.011		Bin Vent #18				0.0000126	1.3425E-07	0.000001755	0.00000189	0.00000552	0	0.001515	0.000132	0	0	0	0	0	0	0	0	0	0	0	0	0.0000885
6.012		Bin Vent #19				0.0000126	1.3425E-07	0.000001755	0.00000189	0.00000552	0	0.001515	0.000132	0	0	0	0	0	0	0	0	0	0	0	0	0.0000885
1112A	2.046	Silo #17	50	1920	90	0.0000084	8.95E-08	0.00000117	0.00000126	0.00000368	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
1112B	2.047	Silo #18	50	1920	90	0.0000084	8.95E-08	0.00000117	0.00000126	0.00000368	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
1112C	2.048	Silo #19	50	1920	90	0.0000084	8.95E-08	0.00000117	0.00000126	0.00000368	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
6.013		Baghouse 08				0.00000924	9.845E-08	0.000001287	0.000001386	0.000004048	0	0.001111	0.0000968	0	0	0	0	0	0	0	0	0	0	0	0	0.0000649
13A	2.049	Silo #9	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13B	2.050	Silo #10	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13C	2.051	Silo #11	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13D	2.052	Silo #12	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13E	2.053	Silo #13	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13F	2.054	Silo #14	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13G	2.055	Silo #27	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13H	2.056	Silo #28	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13I	2.057	Silo #29	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13J	2.058	Silo #30	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13K	2.059	Silo #31	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
6.014		Baghouse 09				0.00000672	7.16E-08	0.000000936	0.000001008	0.000002944	0	0.000808	0.0000704	0	0	0	0	0	0	0	0	0	0	0	0	0.0000472
14A	2.060	Silo #21	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14B	2.061	Silo #22	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14C	2.062	Silo #23	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14D	2.063	Silo #24	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14E	2.064	Silo #25	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14F	2.065	Silo #26	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14G	2.066	Silo #32	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14H	2.067	Silo #33	50	1920	99	0.00000084	8.95E-09	0.000000117	0.000000126	0.000000368	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
Area 6 Construction storage yard						0	[illegible]	0	0	0	0	0	0	0	0	0.02045	0.01425	0.129	0.001955	0.058	0.03835	0.004625	0.00424	0	0	0

6.111		Baghouse 11					0.04665	0	0	0	0	0	0	0	0	0.02045	0.01425	0.129	0.001955	0.059	0.03835	0.004625	0.00424	0	0	0
6.110	2.119	misc portable	50	1920	99	0	0.04665	0	0	0	0	0	0	0	0	0.02045	0.01425	0.129	0.001955	0.059	0.03835	0.004625	0.00424	0	0	0
Area 12 Batch Plant						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.01	1.067	loading hopper	50	504	75.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.02	1.068	discharge hopp	50	504	50.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.03		Baghouse 11				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3A	2.073	loading silo #1	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3B	2.074	loading silo #2	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.04		Baghouse 13				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4A		weigh hoppers	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4B	2.075	conveyor to	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.05	2.076	loadout	50	504	50.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 12 Portable Cement Silos						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.06		Baghouse 14				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6A		Mutiple portable	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6B		Mutiple portable	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6C	2.125	surge #1 loadin	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6D	2.126	surge #1 disch	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6E	2.127	surge #2 loadin	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6F	2.128	surge #2 disch	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
USTA						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.111		Baghouse 11				.0000008.4	0	0	0	0	#REF!	0	0	0.0003511	3.60317E-05	0	0	0	0	0	0	0	0	1.071E-05	1.835E-05	0
6.093	2.119	portable silo	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.094	2.121	portable silo	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.095	2.123	portable silo	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

COMBUSTION EQUIPMENT

Area 1 U1A						0	0.0013062	0	0	0	0	0	0	0	0	0.0005726	0.000399	0.003612	5.474E-05	0.001652	0.0010738	0.0001295	0.0001187	0	0	0
1.75	2.521	diesel air comp	0.70	75	0	0	0.0006531	0	0	0	0	0	0	0	0	0.0002863	0.0001995	0.001806	2.737E-05	0.000826	0.0005369	6.475E-05	5.936E-05	0	0	0
1.76		diesel generato	0.70	65	0	0	0.0006531	0	0	0	0	0	0	0	0	0.0002863	0.0001995	0.001806	2.737E-05	0.000826	0.0005369	6.475E-05	5.936E-05	0	0	0
Area 1 U1G						0	0.004109678	0	0	0	0	0	0	0	0	0.0018016	0.0012554	0.0113644	0.0001722	0.0051977	0.0033785	0.0004074	0.0003736	0	0	0
1.77	2.679	diesel generato	0.20	65	0	0	0.000191078	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0005284	8.008E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	0
1.78	2.161	emergency gen	4.20	65	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
Area 1 Drilling Storage Yard						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0	0	0.0011452	0.000798	0.0072224	0.0001095	0.003304	0.0021476	0.000259	0.0002374	0	0	0
1.79	2.804	fluid pump	1.40	50	0	0	0.0013062	0	0	0	0	0	0	0	0	0.0005726	0.000399	0.003612	5.474E-05	0.001652	0.0010738	0.0001295	0.0001187	0	0	0
1.80	2.806	mud pump	1.40	300	0	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0	0	0.0005726	0.000399	0.003612	5.474E-05	0.001652	0.0010738	0.0001295	0.0001187	0	0	0
Area 5 Check Point Plaza						0	0.000191078	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0005284	8.008E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0		
5.001	2.677	diesel gen.(60)	0.2048	28			0.000191078							.0	0	8.376E-05	5.837E-05	0.0005284	8.008E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	0
Area 5 WEF						0	0.000108228	0	0	0	0	0	0	0	0	4.744E-05	3.306E-05	0.0002993	4.536E-06	0.0001369	8.897E-05	1.073E-05	9.837E-06	0		
5.002	2.658	diesel gen.(34)	0.116	18			0.000108228							0	0	4.744E-05	3.306E-05	0.0002993	4.536E-06	0.0001369	8.897E-05	1.073E-05	9.837E-06	0	0	0
Area 5 NPTEC						0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0		
5.007	2.165	diesel generato	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
Area 6 Heavy Equipment Yard																										
6.028	2.500	diesel air comp	0.7004	75	0	0	0.000653473	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.029	2.507	diesel air comp	0.2083	75	0	0	0.000194344	0	0	0	0	0	0	0	0	8.519E-05	5.937E-05	0.0005374	8.145E-06	0.0002458	0.0001598	1.927E-05	1.766E-05	0	0	0
6.030	2.508	diesel air comp	0.2083	10	0	0	0.000194344	0	0	0	0	0	0	0	0	8.519E-05	5.937E-05	0.0005374	8.145E-06	0.0002458	0.0001598	1.927E-05	1.766E-05	0	0	0
6.031	2.528	diesel air comp	0.7004	75	0	0	0.000653473	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.032	2.530	diesel air comp	0.7004	75	0	0	0.000653473	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.033	2.531	diesel air comp	0.7004	75	0	0	0.000653473	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.034	2.532	diesel air comp	0.7004	75	0	0	0.000653473	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.035	2.533	diesel air comp	0.7004	75	0	0	0.000653473	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.036	2.534	diesel air comp	0.7004	75	0	0	0.000653473	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.037	2.551	diesel air comp	0.2038	75	0	0	0.000190145	0	0	0	0	0	0	0	0	8.335E-05	5.808E-05	0.0005258	7.969E-06	0.0002405	0.0001563	1.885E-05	1.728E-05	0	0	0
6.038	2.552	diesel air comp	0.2038	75	0	0	0.000190145	0	0	0	0	0	0	0	0	8.335E-05	5.808E-05	0.0005258	7.969E-06	0.0002405	0.0001563	1.885E-05	1.728E-05	0	0	0
6.039	2.553	diesel air comp	0.2038	17	0	0	0.000190145	0	0	0	0	0	0	0	0	8.335E-05	5.808E-05	0.0005258	7.969E-06	0.0002405	0.0001563	1.885E-05	1.728E-05	0	0	0
6.040		diesel air comp	0.2	75	0	0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
6.041	2.141	diesel air comp	1.8822	180	0	0	0.001756093	0	0	0	0	0	0	0	0	0.0007698	0.0005364	0.0048561	7.359E-05	0.002221	0.0014436	0.0001741	0.0001596	0	0	0
6.042		diesel generato	0.3413	65		0	0.000318433	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.043		diesel generato	0.3413	65		0	0.000318433	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.044	2.132	diesel generato	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.045	2.133	diesel generato	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.046	2.134	diesel generato	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.047	2.139	diesel generato	4.2	9	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.048	2.611	diesel generato	0.3413	65	0	0	0.000318433	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.049	2.628	diesel generato	0.07	65		0	0.00006531	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.050	2.647	diesel generato	0.07	65		0	0.00006531	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.051	2.648	diesel generato	0.07	65		0	0.00006531	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.052	2.656	diesel generato	0.1	9		0	0.0000933	0	0	0	0	0	0	0	0	0.0000409	0.0000285	0.000258	3.91E-06	0.000118	0.0000767	9.25E-06	8.48E-06	0	0	0
6.053	2.657	diesel generato	0.1024	65	0	0	9.55392E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
6.054	2.681	diesel generato	0.2048	63	0	0	0.000191078	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0005284	8.008E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	0
6.055	2.605	diesel generato	0.3413	65	0	0	0.000318433	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.056	2.606	diesel generato	0.3413	65	0	0	0.000318433	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.057		diesel generato	0.3413	65		0	0.000318433	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.058		diesel generato	0.3413	65		0	0.000318433	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.059		diesel generato	0.3413	65		0	0.000318433	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.060		diesel generato	0.3413	65		0	0.000318433	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.061		gas generator	0.07	75		0	0.00006531	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.062		gas generator	0.07	75		0	0.00006531	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.063		gas generator	0.07	75		0	0.00006531	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.064		gas generator	0.07	75		0	0.00006531	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.065		gas generator	0.07	75		0	0.00006531	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.066		gas generator	0.07	75		0	0.00006531	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.067		gas generator	0.07	75		0	0.00006531	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.068		trash pump	0.026	50		0	0.000024256	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
6.069		diesel cable	0.026	50		0	0.000024256	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0

6.070		diesel cable re	0.026	50		0	0.000024258	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
6.071		diesel cable re	0.026	50		0	0.000024258	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
6.072		diesel cable re	0.026	50		0	0.000024258	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
6.073		diesel cable re	0.026	50		0	0.000024258	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
6.074		diesel cable re	0.026	50		0	0.000024258	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
Area 6 CP-1						1.33764E-05	0.004597315	1.00338E-05	1.00338E-05	3.01014E-05	1.003E-05	2.007E-05	1.003E-05	5.017E-05	5.14924E-06	0.0021661	0.0014013	0.0126851	0.0001922	0.00727	0.0037711	0.0004548	0.0004441	1.53E-06	2.623E-06	0
6.075	2.404	Boiler	1.6723	2600	0	6.6892E-06	5.0169E-06	5.0169E-06	5.0169E-06	1.50507E-05	5.017E-06	1.003E-05	5.017E-06	2.508E-05	2.57462E-06	7.459E-05	0	0	0	0.0007341	0	0	1.359E-05	7.652E-07	1.311E-06	0
6.076	2.405	Boiler	1.6723	0.8	0	6.6892E-06	5.0169E-06	5.0169E-06	5.0169E-06	1.50507E-05	5.017E-06	1.003E-05	5.017E-06	2.508E-05	2.57462E-06	7.459E-05	0	0	0	0.0007341	0	0	1.359E-05	7.652E-07	1.311E-06	0
6.077	2.158	emerg. generat	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.078		diesel generato	0.3413	65	0	0	0.000318433	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.079	2.614	diesel generato	0.3754	65	0	0	0.000350248	0	0	0	0	0	0	0	0	0.0001535	0.000107	0.0009685	1.468E-05	0.000443	0.0002879	3.472E-05	3.183E-05	0	0	0
Area 6 CP-18						0	0.000238848	0	0	0	0	0	0	0	0	0.0001047	7.296E-05	0.0006605	1.001E-05	0.0003021	0.0001964	2.368E-05	2.171E-05	0	0	0
6.080	2.690	diesel generato	0.256	65	0	0	0.000238848	0	0	0	0	0	0	0	0	0.0001047	7.296E-05	0.0006605	1.001E-05	0.0003021	0.0001964	2.368E-05	2.171E-05	0	0	0
Area 6 CP-40						0	0.000318433	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.081	2.603	diesel generato	0.3413	5	0	0	0.000318433	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
Area 6 CP-43						0	0.000191078	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0005284	8.008E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	0
6.082	2.673	diesel generato	0.2048	76	0	0	0.000191078	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0005284	8.008E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	0
Area 6 CP-70						0	0.000398018	0	0	0	0	0	0	0	0	0.0001745	0.0001216	0.0011006	1.666E-05	0.0005034	0.0003272	3.946E-05	3.618E-05	0	0	0
6.083	2.618	diesel generato	0.4266	35	0	0	0.000398018	0	0	0	0	0	0	0	0	0.0001745	0.0001216	0.0011006	1.666E-05	0.0005034	0.0003272	3.946E-05	3.618E-05	0	0	0
Area 6 CP-8						3.3444E-06	0.007839708	2.5083E-06	2.5083E-06	7.5249E-06	2.508E-06	5.017E-06	2.508E-06	1.254E-05	1.28723E-06	0.0034729	0.002394	0.021672	0.0003284	0.010279	0.0064428	0.000777	0.0007181	3.826E-07	6.556E-07	0
6.084	2.403	Boiler	0.8361	253.6	0	3.3444E-06	2.5083E-06	2.5083E-06	2.5083E-06	7.5249E-06	2.508E-06	5.017E-06	2.508E-06	1.254E-05	1.28723E-06	3.729E-05	0	0	0	0.000367	0	0	6.797E-06	3.826E-07	6.556E-07	0
6.085	2.156	emerg. generat	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.086	2.163	emerg. generat	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
Area 6 DAF						0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	0	0	0
6.087	2.160	emerg. generat	5.6	13	0	0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	0	0	0
6.088	2.159	emerg. generat	5.6	13	0	0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	0	0	0
6.089	2.407	Boiler	2.3412	2600	0	9.3648E-06	7.0236E-06	7.0236E-06	7.0236E-06	2.10708E-05	7.024E-06	1.405E-05	7.024E-06	3.512E-05	3.60444E-06	0.0001044	0	0	0	0.0010278	0	0	1.903E-05	1.071E-06	1.836E-06	0
6.090	2.408	Boiler	2.3412	2600	0	9.3648E-06	7.0236E-06	7.0236E-06	7.0236E-06	2.10708E-05	7.024E-06	1.405E-05	7.024E-06	3.512E-05	3.60444E-06	0.0001044	0	0	0	0.0010278	0	0	1.903E-05	1.071E-06	1.836E-06	0
Area 6 Decon						0.00002072	0.00001554	0.00001554	0.00001554	0.00004662	1.554E-05	3.108E-05	1.554E-05	0.0000777	7.97496E-06	0.0002311	0	0	0	0.002274	0	0	4.211E-05	2.37E-06	4.062E-06	0
6.091	2.068	Boiler	5.18	1000	0	0.00002072	0.00001554	0.00001554	0.00001554	0.00004662	1.554E-05	3.108E-05	1.554E-05	0.0000777	7.97496E-06	0.0002311	0	0	0	0.002274	0	0	4.211E-05	2.37E-06	4.062E-06	0
Area 6 Iron Workers Yard						0	0.000125955	0	0	0	0	0	0	0	0	5.522E-05	3.848E-05	0.0003483	5.279E-06	0.0001593	0.0001035	1.249E-05	1.145E-05	0	0	0
6.092		diesel cable re	0.135	50		0	0.000125955	0	0	0	0	0	0	0	0	5.522E-05	3.848E-05	0.0003483	5.279E-06	0.0001593	0.0001035	1.249E-05	1.145E-05	0	0	0
Area 6 Well 3 Yard						0	0.00126888	0	0	0	0	0	0	0	0	0.0005562	0.0003876	0.0035088	5.316E-05	0.0016048	0.0010431	0.0001258	0.0001153	0	0	0
6.096	2.097	bin	80	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.097		diesel generato	0.34	65		0	0.00031722	0	0	0	0	0	0	0	0	0.0001391	0.0000969	0.0008772	1.329E-05	0.0004012	0.0002608	3.145E-05	2.883E-05	0	0	0
6.098		diesel generato	0.34	65		0	0.00031722	0	0	0	0	0	0	0	0	0.0001391	0.0000969	0.0008772	1.329E-05	0.0004012	0.0002608	3.145E-05	2.883E-05	0	0	0
6.099		diesel generato	0.34	65		0	0.00031722	0	0	0	0	0	0	0	0	0.0001391	0.0000969	0.0008772	1.329E-05	0.0004012	0.0002608	3.145E-05	2.883E-05	0	0	0
6.100		diesel generato	0.34	65		0	0.00031722	0	0	0	0	0	0	0	0	0.0001391	0.0000969	0.0008772	1.329E-05	0.0004012	0.0002608	3.145E-05	2.883E-05	0	0	0
Area 6 Wet/Wild						0	0.010514817	0	0	0	0	0	0	0	0	0.0046064	0.0032119	0.0290763	0.0004407	0.0132995	0.0086444	0.0010428	0.0009557	0	0	0
6.101	2.542	diesel air comp	1.9739	150	0	0	0.001841649	0	0	0	0	0	0	0	0	0.0008073	0.0005626	0.0050927	7.718E-05	0.0023292	0.001514	0.0001826	0.0001674	0	0	0
6.102	2.543	diesel air comp	0.7004	75	0	0	0.000653473	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.103	2.544	diesel air comp	1.9739	150	0	0	0.001841649	0	0	0	0	0	0	0	0	0.0008073	0.0005626	0.0050927	7.718E-05	0.0023292	0.001514	0.0001826	0.0001674	0	0	0
6.104	2.545	diesel air comp	1.9739	150	0	0	0.001841649	0	0	0	0	0	0	0	0	0.0008073	0.0005626	0.0050927	7.718E-05	0.0023292	0.001514	0.0001826	0.0001674	0	0	0
6.105		diesel air comp	1.9739	150		0	0.001841649	0	0	0	0	0	0	0	0	0.0008073	0.0005626	0.0050927	7.718E-05	0.0023292	0.001514	0.0001826	0.0001674	0	0	0
6.106		conveyor	250	100		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.107		pump	0.7	50		0	0.0006531	0	0	0	0	0	0	0	0	0.0002863	0.0001995	0.001806	2.737E-05	0.000826	0.0005369	6.475E-05	5.936E-05	0	0	0
6.108		diesel air comp	1.9739	150	0	0	0.001841649	0	0	0	0	0	0	0	0	0.0008073	0.0005626	0.0050927	7.718E-05	0.0023292	0.001514	0.0001826	0.0001674	0	0	0
Area 6 Other misc. equipment						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.109		abrasive blaster		50		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 12 Cafeteria						2.14904E-05	1.61178E-05	1.61178E-05	1.61178E-05	4.83534E-05	1.612E-05	3.224E-05	1.612E-05	8.059E-05	8.27148E-06	0.0002396	0	0	0	0.0023586	0	0	4.368E-05	2.458E-06	4.213E-06	0
12.07	2.402	boiler	1.7726	2600	0.0	7.0904E-06	5.3178E-06	5.3178E-06	5.3178E-06	1.59534E-05	5.318E-06	1.064E-05	5.318E-06	2.659E-05	2.72904E-06	7.907E-05	0	0	0	0.0007782	0	0	1.441E-05	8.111E-07	1.39E-06	0
12.08	2.072	boiler	3.6	2600	0.0	0.0000144	0.0000108	0.0000108	0.0000108	0.0000324	0.0000108	0.0000216	0.0000108	0.000054	5.54245E-06	0.0001606	0	0	0	0.0015804	0	0	2.927E-05	1.647E-06	2.823E-06	0
Area 12 G-Tunnel						0.000001092	0.000637592	0.000000819	0.000000819	0.000002457	8.19E-07	1.638E-06	8.19E-07	4.095E-06	4.20302E-07	0.0002913	0.0001945	0.0017609	2.669E-05	0.0009253	0.0005235	6.313E-05	6.01E-05	1.249E-07	2.141E-07	0
12.09		diesel generato	0.1365	65	0.0	0	0.000127355	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	0	0	0
12.10		diesel generato	0.1365	65	0.0	0	0.000127355	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	0	0	0
12.11		diesel generato	0.1365	65	0.0	0	0.000127355	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	0	0	0
12.12		diesel generato	0.1365	65	0.0	0	0.000127355	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	0	0	0
12.13		diesel generato	0.1365	65	0.0	0	0.000127355	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	0	0	0
12.14		industrial heate	0.1365	65	0.0	0.000000546	4.095E-07	4.095E-07	4.095E-07	1.2285E-06	4.095E-07	8.19E-07	4.095E-07	2.048E-06	2.10151E-07	6.088E-06	0	0	0	5.992E-05	0	0	1.11E-06	6.246E-08	1.07E-07	0
12.15		steam cleaner	0.1365	65	0.0	0.000000546	4.095E-07	4.095E-07	4.095E-07	1.2285E-06	4.095E-07	8.19E-07	4.095E-07	2.048E-06	2.10151E-07	6.088E-06	0	0	0	5.992E-05	0	0	1.11E-06	6.246E-08	1.07E-07	0
Area 12 N-Tunnel						0	0.0104496	0	0	0	0	0	0	0	0	0.0045808	0.003192	0.028896	0.0004379	0.013216	0.0085904	0.001036	0.0009498	0	0	0
12.16	2.154	diesel generato	5.6	65	0.0	0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	0	0	0
12.17	2.155	diesel generato	5.6	65	0.0	0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	0	0	0
Area 12 P-Tunnel																										
12.18		diesel compres	0.2	75		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.19		diesel air dryer	0.2	75		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.20	2.701	gasoline gener	0.0683	75	0.0	0	6.37239E-05	0	0	0	0	0	0	0	0	2.793E-05	1.947E-05	0.0001762	2.671E-06	8.059E-05	5.239E-05	6.318E-06	5.792E-06	0	0	0
Area 12 T-Tunnel						0	0.0054114	0	0	0	0	0	0	0	0	0.0023722	0.001653	0.014964	0.0002268	0.006844	0.0044486	0.0005365	0.0004918	0	0	0
12.21		diesel generato	0.2	120		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.22	2.153	diesel generato	5.6	65	0.0	0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	0	0	0
Area 12 U-Tunnel						0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.23		diesel generato	0.2	65		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
Area 12 Yard						0	0.003689211	0	0	0	0	0	0	0	0	0.0017531	0.0012216	0.0110589	0.0001676	0.005058	0.0032877	0.0003966	0.0003635	0	0	0
12.24		diesel generato	0.512	65		0	0.000477696	0	0	0	0	0	0	0	0	0.0002094	0.0001459	0.001321	2.002E-05	0.0006042	0.0003927	4.736E-05	4.342E-05	0	0	0
12.25		diesel generato	0.512	65		0	0.000477696	0	0	0	0	0	0	0	0	0.0002094	0.0001459	0.001321	2.002E-05	0.0006042	0.0003927	4.736E-05	4.342E-05	0	0	0
12.26		diesel generato	0.512	65		0	0.000477696	0	0	0	0	0	0	0	0	0.0002094	0.0001459	0.001321	2.002E-05	0.0006042	0.0003927	4.736E-05	4.342E-05	0	0	0
12.27		diesel generato	0.512	65		0	0.000477696	0	0	0	0	0	0	0	0	0.0002094	0.0001459	0.001321	2.002E-05	0.0006042	0.0003927	4.736E-05	4.342E-05	0	0	0
12.28		diesel generato	0.512	65		0	0.000477696	0	0	0	0	0	0	0	0	0.0002094	0.0001459	0.001321	2.002E-05	0.0006042	0.0003927	4.736E-05	4.342E-05	0	0	0
12.29		diesel generato	0.2	65		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.30		diesel generato	0.2	65		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.31		diesel generato	0.2	65		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.32		diesel generato	0.1024	65		0	9.55392E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.33		diesel generato	0.1024	65		0	9.55392E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.34		diesel generato	0.1024	65		0	9.55392E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.35		diesel generato	0.1024	65		0	9.55392E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.36		diesel generato	0.1024	65		0	9.55392E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.37		diesel generato	0.1024	65		0	9.55392E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.38		diesel generato	0.1024	65		0	9.55392E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0

12.39		diesel generato	0.1024	65		0	9.55392E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.40		diesel generato	0.1024	65		0	9.55392E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.41		diesel generato	0.1024	65		0	9.55392E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.42		diesel generato	0.1024	65		0	9.55392E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
Area 23 (Mercury)								3.9195E-05	3.9195E-05	0.000117485	3.9155E-05	7.831E-05	3.9155E-05	0.00019577	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.9718E-06	1.0235E-05	0
23.01	2.444	generator/B10	0.07	4		0	0.00006531	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
23.02	2.604	generator/B10	0.3413	31		0	0.000318433	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0006806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
23.03	2.400	boiler/B111	0.468	93.4		0.000001872	0.000001404	0.000001404	0.000001404	0.000004212	1.404E-06	2.808E-06	1.404E-06	7.02E-06	7.20518E-07	2.087E-05	0	0	0	0.0002055	0	0	3.805E-06	2.141E-07	3.67E-07	0
23.04	2.401	boiler/B128	0.836	211.8		0.000003344	0.000002508	0.000002508	0.000002508	0.000007524	2.508E-06	5.016E-06	2.508E-06	1.254E-05	1.28708E-06	3.729E-05	0	0	0	0.000367	0	0	6.796E-06	3.825E-07	6.556E-07	0
23.05	2.409	boiler/B196	0.3345	254.5		0.000001338	1.0035E-06	1.0035E-06	1.0035E-06	3.0105E-06	1.004E-06	2.007E-06	1.004E-06	5.018E-06	5.14986E-07	1.492E-05	0	0	0	0.0001468	0	0	2.719E-06	1.531E-07	2.623E-07	0
23.06	2.601	emergency ge	0.0683	47		0	6.37239E-05	0	0	0	0	0	0	0	0	2.793E-05	1.947E-05	0.0001762	2.671E-06	8.059E-05	5.239E-05	6.318E-06	5.792E-06	0	0	0
23.07	2.411	boiler/B536	1.77	44.5		0.00000708	0.00000531	0.00000531	0.00000531	0.00001593	5.31E-06	1.062E-05	5.31E-06	2.655E-05	2.72504E-06	7.895E-05	0	0	0	0.000777	0	0	1.439E-05	8.099E-07	1.388E-06	0
23.08		diesel generat	0.2	120		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
23.09	2.157	emergency ga	4.2	27		0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
23.10	2.164	emergency ga	4.2	2		0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
23.11	2.070	boiler/B754 C	3.2	463		0.0000128	0.0000096	0.0000096	0.0000096	0.0000288	0.0000096	0.0000192	0.0000096	0.000048	4.92662E-06	0.0001427	0	0	0	0.0014048	0	0	2.601E-05	1.464E-06	2.509E-06	0
23.12	2.071	boiler/B753	6.44	188.3		0.00002576	0.00001932	0.00001932	0.00001932	0.00005796	1.932E-05	3.864E-05	1.932E-05	0.0000966	9.91482E-06	0.0002873	0	0	0	0.0028272	0	0	5.235E-05	2.947E-06	5.05E-06	0
23.13	2.152	incinerator	0.315	872	99.0	1.26E-08	9.45E-09	9.45E-09	9.45E-09	2.835E-08	9.45E-09	1.89E-08	9.45E-09	4.725E-08	4.84964E-09	1.405E-07	0	0	0	1.383E-06	0	0	2.561E-08	1.441E-09	2.47E-09	0
23.14		generator/RSH	0.2	120		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
23.15		generator/RSH	0.2	120		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
23.57	2.070	boiler/B754 C	3.2	414.5		0.0000128	0.0000096	0.0000096	0.0000096	0.0000288	0.0000096	0.0000192	0.0000096	0.000048	4.92662E-06	0.0001427	0	0	0	0.0014048	0	0	2.601E-05	1.464E-06	2.509E-06	0
Area 25								[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	#VALUE!	[illegible]	#VALUE!
25.01	2.410	5	2.6757	2600		1.07028E-05	8.0271E-06	8.0271E-06	8.0271E-06	2.40813E-05	8.027E-06	1.605E-05	8.027E-06	4.014E-05	4.11942E-06	0.0001193	0	0	0	0.0011746	0	0	2.175E-05	1.224E-06	2.098E-06	#VALUE!
25.02	2.406	5	0.8361	2600		3.3444E-06	2.5083E-06	2.5083E-06	2.5083E-06	7.5249E-06	2.508E-06	5.017E-06	2.508E-06	1.254E-05	1.28723E-06	3.729E-05	0	0	0	0.000367	0	0	6.797E-06	3.826E-07	6.556E-07	#VALUE!
25.03	2.683	Skull Mtn.	0.2048	22		0	0.000191078	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0005284	8.006E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	#VALUE!
25.04	2.529	tunnel	0.7	75		0	0.0006531	0	0	0	0	0	0	0	0	0.0002863	0.0001995	0.001806	2.737E-05	0.000826	0.0005369	6.475E-05	5.936E-05	0	0	#VALUE!
Area 27								0	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	#VALUE!	0	0
27.01	2.131	emergency ge	5.6	8		0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006606	0.0042952	0.000518	0.0004749	#VALUE!	0	0
27.02	2.130	emergency ge	5.6	300		0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006606	0.0042952	0.000518	0.0004749	#VALUE!	0	0
27.03	2.619	diesel generat	0.0512	65		0	4.77696E-05	0	0	0	0	0	0	0	0	2.094E-05	1.459E-05	0.0001321	2.002E-06	6.042E-05	3.927E-05	4.736E-06	4.342E-06	#VALUE!	0	0
27.04	2.669	diesel generat	0.1365	65		0	0.000127355	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	#VALUE!	0	0
Area 29								0	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0
29.01	2.602	diesel generat	0.3413	65		0	0.000318433	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0006806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	#VALUE!	0	0

Nevada Test Site Emission Inventory

TONS/YR

Hazardous Air Pollutant Emissions

						Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals
						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0.0002	1.7E-05	0.0231	0.0158	0.143	0.002	0.07	0.042	0.0061	0.005	#REF!	#REF!	#REF!
emission source #	old permit #	Equipment	process rate (ton/hr) or *heat rate (MMBtu/hr)*	operating hours (hr/yr)	control (%)	As *(ton/yr)*	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
AGGREGATE PROCESSING EQUIPMENT																										
Area 1 Shaker Plant						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.14		Baghouse 02				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14A	1.016	C-7 to Rotary dryer	100	250	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14B	2.023	Rotary Dryer	100	250	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 1 Concrete Batch Plant						1.346E-05	1.39566E-07	2E-06	4E-06	6E-06	0	0.002	1E-04	0	0	0	0	0	0	0	0	0	0	0	0	1E-04
1.46		Baghouse 04				3.528E-08	3.759E-10	5E-09	5E-09	2E-08	0	4E-06	4E-07	0	0	0	0	0	0	0	0	0	0	0	0	2E-07
46A	2.026	loading overhead bin	50	42	99	1.764E-08	1.8795E-10	2E-09	3E-09	8E-09	0	2E-06	2E-07	0	0	0	0	0	0	0	0	0	0	0	0	1E-07
46B	1.057	loading weigh hopper	50	42	99	1.764E-08	1.8795E-10	2E-09	3E-09	8E-09	0	2E-06	2E-07	0	0	0	0	0	0	0	0	0	0	0	0	1E-07
46C		loading temp. bin A	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46D		discharge temp bin A	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46E		loading temp. bin B	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46F		discharge temp bin B	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46G		loading temp. bin C	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46H		discharge temp bin C	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46I	2.111	loading Silo #3	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46J	2.112	discharge Silo #3	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46K	2.113	loading Silo #4	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46L	2.114	discharge Silo #4	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46M	2.115	loading Silo #5	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46N	2.116	discharge Silo #5	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
1.47		Baghouse 06				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47A	2.028	C-2 to funnel	160	1920	99	2.58E-06	2.74944E-08	4E-07	4E-07	1E-06	0	3E-04	3E-05	0	0	0	0	0	0	0	0	0	0	0	0	2E-05
47B	2.027	weigh hopper 2 to funnel	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
47C	2.029	truck loading	160	1920	99	3.564E-07	0	2E-08	2E-08	6E-07	0	9E-05	5E-06	0	0	0	0	0	0	0	0	0	0	0	0	3E-05
Area 6 Cementing Equipment						0.0001145	1.15197E-06	2E-05	2E-05	5E-05	0	0.013	0.001	7E-09	0	0	0	0	0	0	0	0	0	0	0	8E-04
6.001	2.032	Scale #1	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
6.002	2.033	Scale #2	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
6.003	2.034	Scale #3	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
123A		Baghouse 07/back-up				2.58E-06	2.74944E-08	4E-07	4E-07	1E-06	0	3E-04	3E-05	0	0	0	0	0	0	0	0	0	0	0	0	2E-05
123B		waste silo	10	1920	99	1.613E-07	1.7184E-09	2E-08	2E-08	7E-08	0	2E-05	2E-06	0	0	0	0	0	0	0	0	0	0	0	0	1E-06
6.004		Baghouse 10				8.569E-09	6.405E-10	1E-10	3E-08	1E-08	0	3E-07	4E-08	7E-09	0	0	0	0	0	0	0	0	0	0	0	2E-07
4A	2.035	Load blending tank	50	10.5	99	6.09E-10	0	3E-11	4E-09	1E-09	0	2E-07	9E-09	0	0	0	0	0	0	0	0	0	0	0	0	5E-08
4B	2.036	Blending tank discharge	50	10.5	99	7.98E-09	6.405E-10	9E-11	3E-08	1E-08	0	2E-07	3E-08	7E-09	0	0	0	0	0	0	0	0	0	0	0	1E-07
6.005		Bin Vent #1				1.344E-05	1.432E-07	2E-06	2E-06	6E-06	0	0.002	1E-04	0	0	0	0	0	0	0	0	0	0	0	0	9E-05
6.006		Bin Vent #3				1.344E-05	1.432E-07	2E-06	2E-06	6E-06	0	0.002	1E-04	0	0	0	0	0	0	0	0	0	0	0	0	9E-05
6.007		Bin Vent #4				1.344E-05	1.432E-07	2E-06	2E-06	6E-06	0	0.002	1E-04	0	0	0	0	0	0	0	0	0	0	0	0	9E-05
567A	2.037	Silo #1	50	1920	90	8.064E-06	8.592E-08	1E-06	1E-06	4E-06	0	1E-03	8E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
567B	2.038	Silo #2	50	1920	90	8.064E-06	8.592E-08	1E-06	1E-06	4E-06	0	1E-03	8E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
567C	2.039	Silo #3	50	1920	90	8.064E-06	8.592E-08	1E-06	1E-06	4E-06	0	1E-03	8E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
567D	2.040	Silo #4	50	1920	90	8.064E-06	8.592E-08	1E-06	1E-06	4E-06	0	1E-03	8E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
567E	2.041	Silo #5	50	1920	90	8.064E-06	8.592E-08	1E-06	1E-06	4E-06	0	1E-03	8E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
6.008		Bin Vent #8				1.613E-05	1.7184E-07	2E-06	2E-06	7E-06	0	0.002	2E-04	0	0	0	0	0	0	0	0	0	0	0	0	1E-04
8A	2.042	Silo #7	50	1920	90	8.064E-06	8.592E-08	1E-06	1E-06	4E-06	0	1E-03	8E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
8B	2.043	Silo #8	50	1920	90	8.064E-06	8.592E-08	1E-06	1E-06	4E-06	0	1E-03	8E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
6.009	2.044	Silo #15	50	1920	90	8.064E-06	8.592E-08	1E-06	1E-06	4E-06	0	1E-03	8E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
6.010	2.045	Silo #16	50	1920	90	8.064E-06	8.592E-08	1E-06	1E-06	4E-06	0	1E-03	8E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
6.011		Bin Vent #18				1.21E-05	1.2888E-07	2E-06	2E-06	5E-06	0	0.001	1E-04	0	0	0	0	0	0	0	0	0	0	0	0	8E-05
6.012		Bin Vent #19				1.21E-05	1.2888E-07	2E-06	2E-06	5E-06	0	0.001	1E-04	0	0	0	0	0	0	0	0	0	0	0	0	8E-05
1112A	2.046	Silo #17	50	1920	90	8.064E-06	8.592E-08	1E-06	1E-06	4E-06	0	1E-03	8E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
1112B	2.047	Silo #18	50	1920	90	8.064E-06	8.592E-08	1E-06	1E-06	4E-06	0	1E-03	8E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
1112C	2.048	Silo #19	50	1920	90	8.064E-06	8.592E-08	1E-06	1E-06	4E-06	0	1E-03	8E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
6.013		Baghouse 08				8.87E-06	9.4512E-08	1E-06	1E-06	4E-06	0	0.001	9E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
13A	2.049	Silo #9	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13B	2.050	Silo #10	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13C	2.051	Silo #11	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13D	2.052	Silo #12	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13E	2.053	Silo #13	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13F	2.054	Silo #14	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13G	2.055	Silo #27	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13H	2.056	Silo #28	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13I	2.057	Silo #29	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13J	2.058	Silo #30	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13K	2.059	Silo #31	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
6.014		Baghouse 09				6.451E-06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14A	2.060	Silo #21	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14B	2.061	Silo #22	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14C	2.062	Silo #23	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14D	2.063	Silo #24	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14E	2.064	Silo #25	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14F	2.065	Silo #26	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14G	2.066	Silo #32	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14H	2.067	Silo #33	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06

Nevada Test Site Emission Inventory

TONS/YR

Hazardous Air Pollutant Emissions

emission source #	old permit #	Equipment	process rate (ton/hr) or heat rate (*MMBtu/hr*)	operating hours (hr/yr)	control (%)	As (ton/yr)	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
						Totals #REF!	Totals #REF!	Totals #REF!	Totals #REF!	Totals #REF!	Totals #REF!	Totals #REF!	Totals #REF!	Totals 0.0002	Totals 1.7E-05	Totals 0.0231	Totals 0.0158	Totals 0.143	Totals 0.002	Totals 0.07	Totals 0.042	Totals 0.0051	Totals 0.006	Totals #REF!	Totals #REF!	Totals #REF!
Area 6 Construction storage yard						0	0.044784	0	0	0	0	0	0	0	0	0.0196	0.0137	0.124	0.002	0.057	0.037	0.0044	0.004	0	0	0
6.111		Baghouse 11					0.044784	0	0	0	0	0	0	0	0	0.0196	0.0137	0.124	0.002	0.057	0.037	0.0044	0.004	0	0	0
6.110	2.119	misc portable silos (7)	50	1920	99	0	0.044784	0	0	0	0	0	0	0	0	0.0196	0.0137	0.124	0.002	0.057	0.037	0.0044	0.004	0	0	0
Area 12 Batch Plant						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.01	1.067	loading hopper	50	504	75.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.02	1.068	discharge hopper	50	504	50.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.03		Baghouse 11				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3A	2.073	loading silo #1	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3B	2.074	loading silo #2	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.04		Baghouse 13				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4A		weigh hopper/scale	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4B	2.075	conveyor to loadout	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.05	2.076	loadout	50	504	50.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 12 Portable Cement Bins						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.06		Baghouse 14				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6A		Mutiple portable bins	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6B		Mutiple portable bins	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6C	2.125	surge #1 loading	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6D	2.126	surge #1 discharge	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6E	2.127	surge #2 loading	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6F	2.128	surge #2 discharge	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Portable Baghouse/Silos (Previously UGTA)						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.111		Baghouse 11				.0000008.0€	.0000008.06	.00000(	.000000	.000000	.00000(	.00000ı	.00000ı	.00000(	.000000€	.00000(	.000000	.00000(	.00000ı	.00000	.00000ı	.00000(	.00000ı	.0000008.(	.00000(	.0000008.06
6.093	2.119	portable silo	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.094	2.121	portable silo	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.095	2.123	portable silo	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

COMBUSTION EQUIPMENT

emission source #	old permit #	Equipment	process rate (ton/hr) or heat rate (*MMBtu/hr*)	operating hours (hr/yr)	control (%)	As (ton/yr)	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
Area 1 U1A						0	0.000045717	0	0	0	0	0	0	0	0	2E-05	1E-05	1E-04	2E-06	6E-05	4E-05	5E-06	4E-06	0	0	0
1.75	2.521	diesel air compressor	0.70	75	0	0	2.44913E-05	0	0	0	0	0	0	0	0	1E-05	7E-06	7E-05	1E-06	3E-05	2E-05	2E-06	2E-06	0	0	0
1.76		diesel generator	0.70	65	0	0	2.12258E-05	0	0	0	0	0	0	0	0	9E-06	6E-06	6E-05	9E-07	3E-05	2E-05	2E-06	2E-06	0	0	0
Area 1 U1G						0	0.000133565	0	0	0	0	0	0	0	0	6E-05	4E-05	4E-04	5E-06	2E-04	1E-04	1E-05	1E-05	0	0	0
1.77	2.679	diesel generator	0.20	65	0	0	6.21005E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	8E-06	5E-06	6E-07	6E-07	0	0	0
1.78	2.161	emergency generator	4.20	65	0	0	0.000127355	0	0	0	0	0	0	0	0	6E-05	4E-05	4E-04	5E-06	2E-04	1E-04	1E-05	1E-05	0	0	0
Area 1 Drilling Storage Yard						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0	0	0.0001	7E-05	6E-04	1E-05	3E-04	2E-04	2E-05	2E-05	#REF!	#REF!	#REF!
1.79	2.804	fluid pump	1.40	50	0	#REF!	0.000032655	0	0	0	0	0	0	0	0	1E-05	1E-05	9E-05	1E-06	4E-05	3E-05	3E-06	3E-06	#REF!	#REF!	#REF!
1.80	2.808	mud pump	1.40	300	0	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0	0	9E-05	6E-05	5E-04	8E-06	2E-04	2E-04	2E-05	2E-05	#REF!	#REF!	#REF!
Area 5 Check Point Pass						0	2.6751E-06	0	0	0	0	0	0	0	0	1E-06	8E-07	7E-06	1E-07	3E-06	2E-06	3E-07	2E-07	0		
5.001	2.677	diesel gen.(60 KW)	0.2	26	0	0	2.6751E-06	0	0	0	0	0	0	0	0	1E-06	8E-07	7E-06	1E-07	3E-06	2E-06	3E-07	2E-07	0	0	0
Area 5 WEF						0	9.74052E-07	0	0	0	0	0	0	0	0	4E-07	3E-07	3E-06	4E-08	1E-06	8E-07	1E-07	9E-08	0		
5.002	2.658	diesel gen.(34 KW)	0.12	18	0	0	9.74052E-07	0	0	0	0	0	0	0	0	4E-07	3E-07	3E-06	4E-08	1E-06	8E-07	1E-07	9E-08	0	0	0
Area 5 NPTEC																										
5.007	2.165	diesel generator	4.2	300	0	0	0.00058779	0	0	0	0	0	0	0	0	0.0003	0.0002	0.002	2E-05	7E-04	5E-04	6E-05	5E-05	0	0	0
Area 6 Heavy Equipment Storage Yard						0	0.002245524	0	0	0	0	0	0	0	0	0.001	0.0007	0.008	9E-05	0.003	0.002	0.0002	2E-04	0	0	0
6.028	2.500	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1E-05	7E-06	7E-05	1E-06	3E-05	2E-05	2E-06	2E-06	0	0	0
6.029	2.507	diesel air compressor	0.21	75	0	0	7.2879E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	9E-06	6E-06	7E-07	7E-07	0	0	0
6.030	2.508	diesel air compressor	0.21	10	0	0	9.7172E-07	0	0	0	0	0	0	0	0	4E-07	3E-07	3E-06	4E-08	1E-06	8E-07	1E-07	9E-08	0	0	0
6.031	2.528	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1E-05	7E-06	7E-05	1E-06	3E-05	2E-05	2E-06	2E-06	0	0	0
6.032	2.530	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1E-05	7E-06	7E-05	1E-06	3E-05	2E-05	2E-06	2E-06	0	0	0
6.033	2.531	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1E-05	7E-06	7E-05	1E-06	3E-05	2E-05	2E-06	2E-06	0	0	0
6.034	2.532	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1E-05	7E-06	7E-05	1E-06	3E-05	2E-05	2E-06	2E-06	0	0	0
6.035	2.533	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1E-05	7E-06	7E-05	1E-06	3E-05	2E-05	2E-06	2E-06	0	0	0
6.036	2.534	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1E-05	7E-06	7E-05	1E-06	3E-05	2E-05	2E-06	2E-06	0	0	0
6.037	2.551	diesel air compressor	0.2	75	0	0	7.13045E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	9E-06	6E-06	7E-07	6E-07	0	0	0
6.038	2.552	diesel air compressor	0.2	75	0	0	7.13045E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	9E-06	6E-06	7E-07	6E-07	0	0	0
6.039	2.553	diesel air compressor	0.2	17	0	0	1.61624E-06	0	0	0	0	0	0	0	0	7E-07	5E-07	4E-06	7E-08	2E-06	1E-06	2E-07	1E-07	0	0	0
6.040		diesel air compressor	0.2	75	0	0	6.9975E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	9E-06	6E-06	7E-07	6E-07	0	0	0
6.041	2.141	diesel air compressor	1.88	150	0	0	0.000131707	0	0	0	0	0	0	0	0	6E-05	4E-05	4E-04	6E-06	2E-04	1E-04	1E-05	1E-05	0	0	0
6.042		diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	9E-06	1E-06	9E-07	0	0	0
6.043		diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	9E-06	1E-06	9E-07	0	0	0
6.044	2.132	diesel generator	4.2	300	0	0	0.00058779	0	0	0	0	0	0	0	0	0.0003	0.0002	0.002	2E-05	7E-04	5E-04	6E-05	5E-05	0	0	0
6.045	2.133	diesel generator	4.2	300	0	0	0.00058779	0	0	0	0	0	0	0	0	0.0003	0.0002	0.002	2E-05	7E-04	5E-04	6E-05	5E-05	0	0	0
6.046	2.134	diesel generator	4.2	300	0	0	0.00058779	0	0	0	0	0	0	0	0	0.0003	0.0002	0.002	2E-05	7E-04	5E-04	6E-05	5E-05	0	0	0
6.047	2.139	diesel generator	4.2	9	0	0	1.76337E-05	0	0	0	0	0	0	0	0	8E-06	5E-06	5E-05	7E-07	2E-05	1E-05	2E-06	2E-06	0	0	0
6.048	2.611	diesel generator	0.34	65	0	0	1.03491E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	9E-06	1E-06	9E-07	0	0	0
6.049	2.628	diesel generator	0.07	65		0	2.12258E-06	0	0	0	0	0	0	0	0	9E-07	6E-07	6E-06	9E-08	3E-06	2E-06	2E-07	2E-07	0	0	0
6.050	2.647	diesel generator	0.07	65		0	2.12258E-06	0	0	0	0	0	0	0	0	9E-07	6E-07	6E-06	9E-08	3E-06	2E-06	2E-07	2E-07	0	0	0
6.051	2.648	diesel generator	0.07	65		0	2.12258E-06	0	0	0	0	0	0	0	0	9E-07	6E-07	6E-06	9E-08	3E-06	2E-06	2E-07	2E-07	0	0	0
6.052	2.656	diesel generator	0.1	9		0	4.1985E-07	0	0	0	0	0	0	0	0	2E-07	1E-07	1E-06	2E-08	5E-07	3E-07	4E-08	4E-08	0	0	0
6.053	2.657	diesel generator	0.1	65	0	0	3.10502E-06	0	0	0	0	0	0	0	0	1E-06	9E-07	9E-06	1E-07	4E-06	3E-06	3E-07	3E-07	0	0	0
6.054	2.681	diesel generator	0.2	63	0	0	6.01897E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	8E-06	5E-06	6E-07	5E-07	0	0	0
6.055	2.605	diesel generator	0.34	65	0	0	1.03491E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	9E-06	1E-06	9E-07	0	0	0
6.056	2.606	diesel generator	0.34	65	0	0	1.03491E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	9E-06	1E-06	9E-07	0	0	0
6.057		diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	9E-06	1E-06	9E-07	0	0	0

Nevada Test Site Emission Inventory

TONS/YR

Hazardous Air Pollutant Emissions

emission source #	old permit #	Equipment	process rate (ton/hr) or *heat rate (MMBtu/hr)*	operating hours (hr/yr)	control (%)	As (ton/yr)	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
						Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals
						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0.0002	1.7E-05	0.0231	0.0158	0.143	0.002	0.07	0.042	0.0051	0.005	#REF!	#REF!	#REF!
6.058		diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	9E-06	1E-06	9E-07	0	0	0
6.059		diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	9E-06	1E-06	9E-07	0	0	0
6.060		diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	9E-06	1E-06	9E-07	0	0	0
6.061		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1E-06	7E-07	7E-06	1E-07	3E-06	2E-06	2E-07	2E-07	0	0	0
6.062		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1E-06	7E-07	7E-06	1E-07	3E-06	2E-06	2E-07	2E-07	0	0	0
6.063		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1E-06	7E-07	7E-06	1E-07	3E-06	2E-06	2E-07	2E-07	0	0	0
6.064		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1E-06	7E-07	7E-06	1E-07	3E-06	2E-06	2E-07	2E-07	0	0	0
6.065		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1E-06	7E-07	7E-06	1E-07	3E-06	2E-06	2E-07	2E-07	0	0	0
6.066		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1E-06	7E-07	7E-06	1E-07	3E-06	2E-06	2E-07	2E-07	0	0	0
6.067		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1E-06	7E-07	7E-06	1E-07	3E-06	2E-06	2E-07	2E-07	0	0	0
6.068		trash pump	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	3E-07	2E-07	2E-06	3E-08	8E-07	5E-07	6E-08	6E-08	0	0	0
6.069		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	3E-07	2E-07	2E-06	3E-08	8E-07	5E-07	6E-08	6E-08	0	0	0
6.070		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	3E-07	2E-07	2E-06	3E-08	8E-07	5E-07	6E-08	6E-08	0	0	0
6.071		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	3E-07	2E-07	2E-06	3E-08	8E-07	5E-07	6E-08	6E-08	0	0	0
6.072		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	3E-07	2E-07	2E-06	3E-08	8E-07	5E-07	6E-08	6E-08	0	0	0
6.073		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	3E-07	2E-07	2E-06	3E-08	8E-07	5E-07	6E-08	6E-08	0	0	0
6.074		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	3E-07	2E-07	2E-06	3E-08	8E-07	5E-07	6E-08	6E-08	0	0	0
Area 6 CP-1						8.696E-06	0.000616048	7E-06	7E-06	2E-05	7E-06	1E-05	7E-06	3E-05	3.3E-06	0.0004	0.0002	0.002	3E-05	0.002	5E-04	6E-05	7E-05	9.95E-07	2E-06	0
6.075	2.404	Boiler	1.67	2600	0	8.696E-06	6.52197E-06	7E-06	7E-06	2E-05	7E-06	1E-05	7E-06	3E-05	3.3E-06	1E-04	0	0	0	1E-03	0	0	2E-05	9.95E-07	2E-06	0
6.076	2.405	Boiler	1.67	0.8	0	2.676E-09	2.00676E-09	2E-09	2E-09	6E-09	2E-09	4E-09	2E-09	1E-08	1E-09	3E-08	0	0	0	3E-07	0	0	5E-09	3.06E-10	5E-10	0
6.077	2.158	emerg. generator	4.2	300	0	0	0.00058779	0	0	0	0	0	0	0	0	0.0003	0.0002	0.002	2E-05	7E-04	5E-04	6E-05	5E-05	0	0	0
6.078		diesel generator	0.34	65	0	0	1.03491E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	9E-06	1E-06	9E-07	0	0	0
6.079	2.614	diesel generator	0.38	65	0	0	1.13831E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	5E-07	1E-05	9E-06	1E-06	1E-06	0	0	0
Area 6 CP-18						0	7.76256E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	1E-05	6E-06	8E-07	7E-07	0	0	0
6.080	2.690	diesel generator	0.26	65	0	0	7.76256E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	1E-05	6E-06	8E-07	7E-07	0	0	0
Area 6 CP-40						0	7.96062E-07	0	0	0	0	0	0	0	0	3E-07	2E-07	2E-06	3E-08	1E-06	7E-07	8E-08	7E-08	0	0	0
6.081	2.603	diesel generator	0.34	5	0	0	7.96062E-07	0	0	0	0	0	0	0	0	3E-07	2E-07	2E-06	3E-08	1E-06	7E-07	8E-08	7E-08	0	0	0
Area 6 CP-43						0	7.26098E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	9E-06	6E-06	7E-07	7E-07	0	0	0
6.082	2.673	diesel generator	0.2	76	0	0	7.26098E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	9E-06	6E-06	7E-07	7E-07	0	0	0
Area 6 CP-70						0	6.96531E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	9E-06	6E-06	7E-07	6E-07	0	0	0
6.083	2.618	diesel generator	0.43	35	0	0	6.96531E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	9E-06	6E-06	7E-07	6E-07	0	0	0
Area 6 CP-6						4.241E-07	0.001175898	3E-07	3E-07	1E-06	3E-07	6E-07	3E-07	2E-06	1.6E-07	0.0006	0.0004	0.003	5E-05	0.002	1E-03	0.0001	1E-04	4.85E-08	8E-08	0
6.084	2.403	Boiler	0.84	254	0	4.241E-07	3.18052E-07	3E-07	3E-07	1E-06	3E-07	6E-07	3E-07	2E-06	1.6E-07	5E-06	0	0	0	5E-05	0	0	9E-07	4.85E-08	8E-08	0
6.085	2.156	emerg. generator	4.2	300	0	0	0.00058779	0	0	0	0	0	0	0	0	0.0003	0.0002	0.002	2E-05	7E-04	5E-04	6E-05	5E-05	0	0	0
6.086	2.163	emerg. generator	4.2	300	0	0	0.00058779	0	0	0	0	0	0	0	0	0.0003	0.0002	0.002	2E-05	7E-04	5E-04	6E-05	5E-05	0	0	0
Area 6 DAF						0	3.39612E-05	0	0	0	0	0	0	0	0	1E-05	1E-05	9E-05	1E-06	4E-05	3E-05	3E-06	3E-06	0	0	0
6.087	2.160	emerg. generator	5.6	13	0	0	3.39612E-05	0	0	0	0	0	0	0	0	1E-05	1E-05	9E-05	1E-06	4E-05	3E-05	3E-06	3E-06	0	0	0
6.088	2.159	emerg. generator	5.6	13	0	0	3.39612E-05	0	0	0	0	0	0	0	0	1E-05	1E-05	9E-05	1E-06	4E-05	3E-05	3E-06	3E-06	0	0	0
6.089	2.407	Boiler	2.34	2600	0	1.217E-05	9.13068E-06	9E-06	9E-06	3E-05	9E-06	2E-05	9E-06	5E-05	4.7E-06	0.0001	0	0	0	0.001	0	0	2E-05	1.39E-06	2E-06	0
6.090	2.406	Boiler	2.34	2600	0	1.217E-05	9.13068E-06	9E-06	9E-06	3E-05	9E-06	2E-05	9E-06	5E-05	4.7E-06	0.0001	0	0	0	0.001	0	0	2E-05	1.39E-06	2E-06	0
Area 6 Decon						1.036E-05	0.00000777	8E-06	8E-06	2E-05	8E-06	2E-05	8E-06	4E-05	4E-06	0.0001	0	0	0	0.001	0	0	2E-05	1.19E-06	2E-06	0
6.091	2.068	Boiler	5.18	1000	0	1.036E-05	0.00000777	8E-06	8E-06	2E-05	8E-06	2E-05	8E-06	4E-05	4E-06	0.0001	0	0	0	0.001	0	0	2E-05	1.19E-06	2E-06	0
Area 6 Iron Workers Yard						0	3.14888E-06	0	0	0	0	0	0	0	0	1E-06	1E-06	9E-06	1E-07	4E-06	3E-06	3E-07	3E-07	0	0	0
6.092		diesel cable reeler	0.14	50		0	3.14888E-06	0	0	0	0	0	0	0	0	1E-06	1E-06	9E-06	1E-07	4E-06	3E-06	3E-07	3E-07	0	0	0
Area 6 Well 3 Yard						0	4.12385E-05	0	0	0	0	0	0	0	0	2E-05	1E-05	1E-04	2E-06	5E-05	3E-05	4E-06	4E-06	0	0	0
6.096	2.097	bin	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.097		diesel generator	0.34	65		0	1.03097E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	8E-06	1E-06	9E-07	0	0	0
6.098		diesel generator	0.34	65		0	1.03097E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	8E-06	1E-06	9E-07	0	0	0
6.099		diesel generator	0.34	65		0	1.03097E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	8E-06	1E-06	9E-07	0	0	0
6.100		diesel generator	0.34	65		0	1.03097E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	8E-06	1E-06	9E-07	0	0	0
Area 6 Wet/Wild						0	0.000731451	0	0	0	0	0	0	0	0	0.0003	0.0002	0.002	3E-05	9E-04	6E-04	7E-05	7E-05	0	0	0
6.101	2.542	diesel air compressor	1.97	150	0	0	0.000138124	0	0	0	0	0	0	0	0	6E-05	4E-05	4E-04	6E-06	2E-04	1E-04	1E-05	1E-05	0	0	0
6.102	2.543	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1E-05	7E-06	7E-05	1E-06	3E-05	2E-05	2E-06	2E-06	0	0	0
6.103	2.544	diesel air compressor	1.97	150	0	0	0.000138124	0	0	0	0	0	0	0	0	6E-05	4E-05	4E-04	6E-06	2E-04	1E-04	1E-05	1E-05	0	0	0
6.104	2.545	diesel air compressor	1.97	150	0	0	0.000138124	0	0	0	0	0	0	0	0	6E-05	4E-05	4E-04	6E-06	2E-04	1E-04	1E-05	1E-05	0	0	0
6.105		diesel air compressor	1.97	150		0	0.000138124	0	0	0	0	0	0	0	0	6E-05	4E-05	4E-04	6E-06	2E-04	1E-04	1E-05	1E-05	0	0	0
6.106		conveyor	250	100		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.107		pump	0.7	50		0	1.63275E-05	0	0	0	0	0	0	0	0	7E-06	5E-06	5E-05	7E-07	2E-05	1E-05	2E-06	1E-06	0	0	0
6.108		diesel air compressor	1.97	150	0	0	0.000138124	0	0	0	0	0	0	0	0	6E-05	4E-05	4E-04	6E-06	2E-04	1E-04	1E-05	1E-05	0	0	0
Area 6 Other misc. equipment						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.109		abrasive blaster		50		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 12 Cafeteria						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.07	2.402	boiler	1.77	2600	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.08	2.072	boiler	3.6	2600	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 12G-Tunnel						3.549E-08	2.07217E-05	3E-08	3E-08	8E-08	3E-08	5E-08	3E-08	1E-07	1.4E-08	9E-06	6E-06	6E-05	9E-07	3E-05	2E-05	2E-06	2E-06	4.06E-09	7E-09	0
12.09		diesel generator	0.14	65	0.0	0	4.13902E-06	0	0	0	0	0	0	0	0	2E-06	1E-06	1E-05	2E-07	5E-06	3E-06	4E-07	4E-07	0	0	0
12.10		diesel generator	0.14	65	0.0	0	4.13902E-06	0	0	0	0	0	0	0	0	2E-06	1E-06	1E-05	2E-07	5E-06	3E-06	4E-07	4E-07	0	0	0
12.11		diesel generator	0.14	65	0.0	0	4.13902E-06	0	0	0	0	0	0	0	0	2E-06	1E-06	1E-05	2E-07	5E-06	3E-06	4E-07	4E-07	0	0	0
12.12		diesel generator/welder	0.14	65	0.0	0	4.13902E-06	0	0	0	0	0	0	0	0	2E-06	1E-06	1E-05	2E-07	5E-06	3E-06	4E-07	4E-07	0	0	0
12.13		diesel generator	0.14	65	0.0	0	4.13902E-06	0	0	0	0	0	0	0	0	2E-06	1E-06	1E-05	2E-07	5E-06	3E-06	4E-07	4E-07	0	0	0
12.14		industrial heater	0.14	65	0.0	1.775E-08	1.33068E-08	1E-08	1E-08	4E-08	1E-08	3E-08	1E-08	7E-08	6.8E-09	2E-07	0	0	0	2E-06	0	0	4E-08	2.03E-09	3E-09	0
12.15		steam cleaner	0.14	65	0.0	1.775E-08	1.33068E-08	1E-08	1E-08	4E-08	1E-08	3E-08	1E-08	7E-08	6.8E-09	2E-07	0	0	0	2E-06	0	0	4E-08	2.03E-09	3E-09	0
Area 12N-Tunnel						0	0.000339612	0	0	0	0	0	0	0	0	0.0001	0.0001	9E-04	1E-05	4E-04	3E-04	3E-05	3E-05	0	0	0
12.16	2.154	diesel generator	5.6	65	0.0	0	0.000169806	0	0	0	0	0	0	0	0	7E-05	5E-05	5E-04	7E-06	2E-04	1E-04	2E-05	2E-05	0	0	0
12.17	2.155	diesel generator	5.6	65	0.0	0	0.000169806	0	0	0	0	0	0	0	0	7E-05	5E-05	5E-04	7E-06	2E-04	1E-04	2E-05	2E-05	0	0	0
Area 12 P-Tunnel						0	1.63846E-05	0	0	0	0	0	0	0	0	7E-06	5E-06	5E-05	7E-07	2E-05	1E-05	2E-06	1E-06	0	0	0

Nevada Test Site Emission Inventory

TONS/YR

Hazardous Air Pollutant Emissions

emission source #	old permit #	Equipment	process rate (ton/hr) or heat rate (MMBtu/hr)	operating hours (hr/yr)	control (%)	As (ton/yr)	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
						Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals
						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0.0002	1.7E-06	0.0231	0.0166	0.143	0.002	0.07	0.042	0.0061	0.005	#REF!	#REF!	#REF!
12.18		diesel compressor	0.2	75		0	6.9975E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	9E-06	6E-06	7E-07	6E-07	0	0	0
12.19		diesel air dryer	0.2	75		0	6.9975E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	9E-06	6E-06	7E-07	6E-07	0	0	0
12.20	2.701	gasoline generator	0.07	75	0.0	0	2.38985E-06	0	0	0	0	0	0	0	0	1E-06	7E-07	7E-06	1E-07	3E-06	2E-06	2E-07	2E-07	0	0	0
Area 12 T-Tunnel						0	0.000181002	0	0	0	0	0	0	0	0	8E-05	6E-05	6E-04	8E-06	2E-04	1E-04	2E-05	2E-05	0	0	0
12.21		diesel generator	0.2	120		0	0.000011196	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	5E-07	1E-05	9E-06	1E-06	1E-06	0	0	0
12.22	2.153	diesel generator	5.6	65	0.0	0	0.000169806	0	0	0	0	0	0	0	0	7E-05	5E-05	5E-04	7E-06	2E-04	1E-04	2E-05	2E-05	0	0	0
Area 12 U-Tunnel						0	6.0645E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	8E-06	5E-06	6E-07	6E-07	0	0	0
12.23		diesel generator	0.2	65		0	6.0645E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	8E-06	5E-06	6E-07	6E-07	0	0	0
Area 12 Yard						0	0.000129774	0	0	0	0	0	0	0	0	6E-05	4E-05	4E-04	6E-06	2E-04	1E-04	1E-05	1E-05	0	0	0
12.24		diesel generator	0.51	65		0	1.55251E-05	0	0	0	0	0	0	0	0	7E-06	5E-06	4E-05	7E-07	2E-05	1E-05	2E-06	1E-06	0	0	0
12.25		diesel generator	0.51	65		0	1.55251E-05	0	0	0	0	0	0	0	0	7E-06	5E-06	4E-05	7E-07	2E-05	1E-05	2E-06	1E-06	0	0	0
12.26		diesel generator	0.51	65		0	1.55251E-05	0	0	0	0	0	0	0	0	7E-06	5E-06	4E-05	7E-07	2E-05	1E-05	2E-06	1E-06	0	0	0
12.27		diesel generator	0.51	65		0	1.55251E-05	0	0	0	0	0	0	0	0	7E-06	5E-06	4E-05	7E-07	2E-05	1E-05	2E-06	1E-06	0	0	0
12.28		diesel generator	0.51	65		0	1.55251E-05	0	0	0	0	0	0	0	0	7E-06	5E-06	4E-05	7E-07	2E-05	1E-05	2E-06	1E-06	0	0	0
12.29		diesel generator	0.2	65		0	6.0645E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	8E-06	5E-06	6E-07	6E-07	0	0	0
12.30		diesel generator	0.2	65		0	6.0645E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	8E-06	5E-06	6E-07	6E-07	0	0	0
12.31	2.667	diesel generator	0.2	65		0	6.0645E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	8E-06	5E-06	6E-07	6E-07	0	0	0
12.32		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1E-06	9E-07	9E-06	1E-07	4E-06	3E-06	3E-07	3E-07	0	0	0
12.33		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1E-06	9E-07	9E-06	1E-07	4E-06	3E-06	3E-07	3E-07	0	0	0
12.34		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1E-06	9E-07	9E-06	1E-07	4E-06	3E-06	3E-07	3E-07	0	0	0
12.35		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1E-06	9E-07	9E-06	1E-07	4E-06	3E-06	3E-07	3E-07	0	0	0
12.36		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1E-06	9E-07	9E-06	1E-07	4E-06	3E-06	3E-07	3E-07	0	0	0
12.37		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1E-06	9E-07	9E-06	1E-07	4E-06	3E-06	3E-07	3E-07	0	0	0
12.38		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1E-06	9E-07	9E-06	1E-07	4E-06	3E-06	3E-07	3E-07	0	0	0
12.39		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1E-06	9E-07	9E-06	1E-07	4E-06	3E-06	3E-07	3E-07	0	0	0
12.40		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1E-06	9E-07	9E-06	1E-07	4E-06	3E-06	3E-07	3E-07	0	0	0
12.41		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1E-06	9E-07	9E-06	1E-07	4E-06	3E-06	3E-07	3E-07	0	0	0
12.42		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1E-06	9E-07	9E-06	1E-07	4E-06	3E-06	3E-07	3E-07	0	0	0
Area 23 (Mercury)						6.138E-06	0.000101575	5E-06	5E-06	1E-05	5E-06	9E-06	5E-06	2E-05	2.4E-06	0.0001	3E-05	3E-04	4E-06	8E-04	8E-05	1E-05	2E-05	7.02E-07	1E-06	
23.01	2.464	generator/B1000	0.07	4		0	1.3062E-07	0	0	0	0	0	0	0	0	6E-08	4E-08	4E-07	5E-09	2E-07	1E-07	1E-08	1E-08	0	0	
23.02	2.604	generator/B1010	0.34	31		0	4.93571E-06	0	0	0	0	0	0	0	0	2E-06	2E-06	1E-05	2E-07	6E-06	4E-06	5E-07	4E-07	0	0	
23.03	2.400	boiler/B111	0.47	93.4		8.742E-08	6.55868E-08	7E-08	7E-08	2E-07	7E-08	1E-07	7E-08	3E-07	3.4E-08	1E-06	0	0	0	1E-05	0	0	2E-07	1E-08	2E-08	
23.04	2.401	boiler/B128	0.84	212		3.541E-07	2.65597E-07	3E-07	3E-07	8E-07	3E-07	5E-07	3E-07	1E-06	1.4E-07	4E-06	0	0	0	4E-05	0	0	7E-07	4.05E-08	7E-08	
23.05	2.409	boiler/B156	0.33	255		1.703E-07	1.27695E-07	1E-07	1E-07	4E-07	1E-07	3E-07	1E-07	6E-07	6.6E-08	2E-06	0	0	0	2E-05	0	0	3E-07	1.95E-08	3E-08	
23.06	2.601	emergency generator	0.07	47		0	1.49751E-06	0	0	0	0	0	0	0	0	7E-07	5E-07	4E-06	6E-08	2E-06	1E-06	1E-07	1E-07	0	0	
23.07	2.411	boiler/B538	1.77	44.5		1.575E-07	1.18148E-07	1E-07	1E-07	4E-07	1E-07	2E-07	1E-07	6E-07	6.1E-08	2E-06	0	0	0	2E-05	0	0	3E-07	1.8E-08	3E-08	
23.08		diesel generator	0.2	120		0	0.000011196	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	5E-07	1E-05	9E-06	1E-06	1E-06	0	0	
23.09	2.157	emergency generator	4.2	27		0	5.29011E-05	0	0	0	0	0	0	0	0	2E-05	2E-05	1E-04	2E-06	7E-05	4E-05	5E-06	5E-06	0	0	
23.10	2.164	emergency generator	4.2	2		0	3.9186E-06	0	0	0	0	0	0	0	0	2E-06	1E-06	1E-05	2E-07	5E-06	3E-06	4E-07	4E-07	0	0	
23.11	2.070	boiler/B754 Café	3.2	463		2.963E-06	2.2224E-06	2E-06	2E-06	7E-06	2E-06	4E-06	2E-06	1E-05	1.1E-06	3E-05	0	0	0	3E-04	0	0	6E-06	3.39E-07	6E-07	
23.12	2.071	boiler/B753	6.44	186		2.4E-06	1.79966E-06	2E-06	2E-06	5E-06	2E-06	4E-06	2E-06	9E-06	9.2E-07	3E-05	0	0	0	3E-04	0	0	5E-06	2.74E-07	5E-07	
23.13	2.152	incinerator	0.32	872	99.0	5.494E-09	4.1202E-09	4E-09	4E-09	1E-08	4E-09	8E-09	4E-09	2E-08	2.1E-09	6E-08	0	0	0	6E-07	0	0	1E-08	6.28E-10	1E-09	
23.14		generator/RSN MAT	0.2	120		0	0.000011196	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	5E-07	1E-05	9E-06	1E-06	1E-06	0	0	
23.15		generator/RSN MAT	0.2	120		0	0.000011196	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	5E-07	1E-05	9E-06	1E-06	1E-06	0	0	
23.57	2.070	boiler/B754 Café	3.2	415		2.653E-06	1.9898E-06	2E-06	2E-06	6E-06	2E-06	4E-06	2E-06	1E-05	1E-06	3E-05	0	0	0	3E-04	0	0	5E-06	3.03E-07	5E-07	
Area 25						1.826E-05	1.3696E-05	1E-05	1E-05	4E-05	1E-05	3E-05	1E-05	7E-05	7E-06	0.0002	0	0	0	0.002	0	0	4E-05	2.09E-06	4E-06	
25.01	2.410	boiler/B4015	2.68	2600		1.391E-05	1.04352E-05	1E-05	1E-05	3E-05	1E-05	2E-05	1E-05	5E-05	5.4E-06	0.0002	0	0	0	0.002	0	0	3E-05	1.59E-06	3E-06	
25.02	2.406	boiler/B4215	0.84	2600		4.348E-06	3.26079E-06	3E-06	3E-06	1E-05	3E-06	7E-06	3E-06	2E-05	1.7E-06	5E-05	0	0	0	5E-04	0	0	9E-06	4.97E-07	9E-07	
25.03	2.683	generator/ Skull Mtn.	0.2	25		0	2.38848E-06	0	0	0	0	0	0	0	0	1E-06	7E-07	7E-06	1E-07	3E-06	2E-06	2E-07	2E-07	0	0	
25.04	2.529	air comp./ X-tunnel	0.7	75		0	2.44913E-05	0	0	0	0	0	0	0	0	1E-05	7E-06	7E-05	1E-06	3E-05	2E-05	2E-06	2E-06	0	0	
Area 27						0	0.000804619	0	0	0	0	0	0	0	0	0.0004	0.0002	0.002	3E-05	0.001	7E-04	8E-05	7E-05	#VALUE!	0	
27.01	2.131	emergency generator	5.6	8		0	2.08992E-05	0	0	0	0	0	0	0	0	9E-06	6E-06	6E-05	9E-07	3E-05	2E-05	2E-06	2E-06	#VALUE!	0	
27.02	2.130	emergency generator	5.6	300		0	0.00078372	0	0	0	0	0	0	0	0	0.0003	0.0002	0.002	3E-05	1E-03	6E-04	8E-05	7E-05	#VALUE!	0	
27.03	2.619	diesel generator	0.05	65		0	1.55251E-06	0	0	0	0	0	0	0	0	7E-07	5E-07	4E-06	7E-08	2E-06	1E-06	2E-07	1E-07	#VALUE!	0	
27.04	2.669	diesel generator	0.14	65		0	4.13902E-06	0	0	0	0	0	0	0	0	2E-06	1E-06	1E-05	2E-07	5E-06	3E-06	4E-07	4E-07	#VALUE!	0	
Area 29						0	1.03491E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	9E-06	1E-06	9E-07	#VALUE!	0	
29.01	2.602	diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	9E-06	1E-06	9E-07	#VALUE!	0	

Nevada Test Site Emission Inventory

TONS/YR

Hazardous Air Pollutant Emissions

emission source #	old permit #	Equipment	process rate (ton/hr) or *heat rate (MMBtu/hr)*	operating hours (hr/yr)	control (%)	As (ton/yr)	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
					Totals	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0.0002	1.7E-05	0.0231	0.0158	0.143	0.002	0.07	0.042	0.0051	0.005	#REF!	#REF!	#REF!
CHEMICAL RELEASES/FUME HOODS																										
AREA 5																										
HSC																										
HSC Chemical Releases																										
5.008		Chemical releases																								

Nevada Test Site Emission Inventory

LBS/HR

Hazardous Air Pollutant Emissions

emission source #	old permit #	Equipment	process rate (ton/hr) or heat rate (MMBtu/hr)	operating hours (hr/yr)	control (%)	As (lb/hr)	Be (lb/hr)	Cd (lb/hr)	Cr (lb/hr)	Pb (lb/hr)	Hg (lb/hr)	Mn (lb/hr)	Ni (lb/hr)	Se (lb/hr)	Benzene (lb/hr)	Toluene (lb/hr)	Xylenes (lb/hr)	Propylene (lb/hr)	1,3-Butadiene (lb/hr)	Formaldehyde (lb/hr)	Acetaldehyde (lb/hr)	Acrolein (lb/hr)	Napthalene (lb/hr)	Ethylbenzene (lb/hr)	o-Xylene (lb/hr)	Phosphorous (P) (lb/hr)
						Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals
						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0.0004749	4.866E-05	0.028951	0.0470863	0.4280646	0.006457	0.206725	0.1269635	0.0152706	0.0142805	#VALUE!	2.478E-05	#VALUE!
AGGREGATE PROCESSING EQUIPMENT																										
Area 1 Shaker Plant						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
1.14		Baghouse 02				#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
14A	1.016	C-7 to Rotary d	100	250	99	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
14B	2.023	Rotary Dryer	100	250	99	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
Area 1 Concrete Batch Plant						1.569E-05	1.629E-07	2.148E-06	4.566E-06	7.388E-06	0	0.0018281	0.0001664	0	0	0	0	0	0	0	0	0	0	0	0	0.0000826
1.46		Baghouse 04				1.176E-05	1.253E-07	1.638E-06	1.764E-06	5.152E-06	0	0.001414	0.0001232	0	0	0	0	0	0	0	0	0	0	0	0	0.0000826
46A	2.026	loading overhe	50	31.5	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46B	1.057	loading weigh h	50	31.5	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46C		loading temp. b	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46D		discharge temp	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46E		loading temp. b	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46F		discharge temp	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46G		loading temp. b	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46H		discharge temp	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46I	2.111	loading Silo #3	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46J	2.112	discharge Silo	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46K	2.113	loading Silo #4	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46L	2.114	discharge Silo	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46M	2.115	loading Silo #5	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46N	2.116	discharge Silo	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
1.47		Baghouse 06				3.899E-06	3.759E-08	5.103E-07	2.801E-06	2.157E-06	0	0.0005221	4.221E-05	0	0	0	0	0	0	0	0	0	0	0	0	0
47A	2.028	C-2 to funnel	160	1920	99	2.688E-06	2.864E-08	3.744E-07	4.032E-07	1.178E-06	0	0.0003232	2.816E-05	0	0	0	0	0	0	0	0	0	0	0	0	1.888E-05
47B	2.027	weigh hopper 2	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
47C	2.029	truck loading	160	1920	99	3.712E-07	0	1.888E-08	2.272E-06	6.112E-07	0	9.792E-05	5.248E-06	0	0	0	0	0	0	0	0	0	0	0	0	3.232E-05
Area 6 Concreting Equipment						0.0001209	1.383E-06	[illegible]	2.43E-05	[illegible]	0	0.0164832	0.0013672	1.31E-06	0	0	0	0	0	0	0	0	0	0	0	0.0008671
6.801	2.032	Scale #1	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
6.802	2.033	Scale #2	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
6.803	2.034	Scale #3	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
123A		Baghouse 07/back-up				2.688E-06	2.864E-08	3.744E-07	4.032E-07	1.178E-06	0	0.0003232	2.816E-05	0	0	0	0	0	0	0	0	0	0	0	0	1.888E-05
123B		waste silo	10	1920	99	1.68E-07	1.79E-09	2.34E-08	2.52E-08	7.36E-08	0	0.0000202	1.76E-06	0	0	0	0	0	0	0	0	0	0	0	0	1.18E-06
6.004		Baghouse 10				1.636E-06	1.22E-07	2.3E-08	6.41E-06	2.001E-06	0	0.0000612	7.59E-06	1.31E-06	0	0	0	0	0	0	0	0	0	0	0	0.0000293
4A	2.035	Load blending t	50	8.5	99	1.16E-07	0	5.9E-09	7.1E-07	1.91E-07	0	0.0000306	1.64E-06	0	0	0	0	0	0	0	0	0	0	0	0	0.0000101
4B	2.036	Blending tank s	50	8.5	99	1.52E-06	1.22E-07	1.71E-08	0.0000057	1.81E-06	0	0.0000306	5.95E-06	1.31E-06	0	0	0	0	0	0	0	0	0	0	0	0.0000192
6.805		Bin Vent #1				0.000014	1.492E-07	1.95E-06	0.0000021	6.133E-06	0	0.0016833	0.0001467	0	0	0	0	0	0	0	0	0	0	0	0	9.833E-05
6.806		Bin Vent #3				0.000014	1.492E-07	1.95E-06	0.0000021	6.133E-06	0	0.0016833	0.0001467	0	0	0	0	0	0	0	0	0	0	0	0	9.833E-05
6.807		Bin Vent #4				0.000014	1.492E-07	1.95E-06	0.0000021	6.133E-06	0	0.0016833	0.0001467	0	0	0	0	0	0	0	0	0	0	0	0	9.833E-05
867A	2.037	Silo #1	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
867B	2.038	Silo #2	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
867C	2.039	Silo #3	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
867D	2.040	Silo #4	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
867E	2.041	Silo #5	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
6.808		Bin Vent #8				0.0000168	1.79E-07	2.34E-06	2.52E-06	7.36E-06	0	0.00202	0.000176	0	0	0	0	0	0	0	0	0	0	0	0	0.000118
8A	2.042	Silo #7	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
8B	2.043	Silo #8	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
6.809	2.044	Silo #15	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
6.810	2.045	Silo #16	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
6.811		Bin Vent #18				0.0000126	1.343E-07	1.755E-06	1.89E-06	5.52E-06	0	0.001515	0.000132	0	0	0	0	0	0	0	0	0	0	0	0	0.0000885
6.812		Bin Vent #19				0.0000126	1.343E-07	1.755E-06	1.89E-06	5.52E-06	0	0.001515	0.000132	0	0	0	0	0	0	0	0	0	0	0	0	0.0000885
1112A	2.046	Silo #17	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
1112B	2.047	Silo #18	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
1112C	2.048	Silo #19	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
6.813		Baghouse 08				9.24E-06	9.845E-08	1.287E-06	1.386E-06	4.048E-06	0	0.001111	0.0000968	0	0	0	0	0	0	0	0	0	0	0	0	0.0000649
13A	2.049	Silo #9	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13B	2.050	Silo #10	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13C	2.051	Silo #11	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13D	2.052	Silo #12	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13E	2.053	Silo #13	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13F	2.054	Silo #14	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13G	2.055	Silo #27	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13H	2.056	Silo #28	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13I	2.057	Silo #29	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13J	2.058	Silo #30	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13K	2.059	Silo #31	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
6.814		Baghouse 09				6.72E-06	7.16E-08	9.36E-07	1.008E-06	2.944E-06	0	0.000808	0.0000704	0	0	0	0	0	0	0	0	0	0	0	0	0.0000472
14A	2.060	Silo #21	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14B	2.061	Silo #22	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14C	2.062	Silo #23	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14D	2.063	Silo #24	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14E	2.064	Silo #25	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14F	2.065	Silo #26	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14G	2.066	Silo #32	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14H	2.067	Silo #33	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
Area 6 Construction storage yard						0	0.0083	0	0	0	0	0	0	0	0	0.02045	0.01425	0.129	0.001958	0.059	0.03835	0.004625	0.00424	0	0	0

6.111		Baghouse 11					0.04665	0	0	0	0	0	0	0	0	0.02045	0.01425	0.129	0.001955	0.059	0.03835	0.004625	0.00424	0	0	0
6.110	2.119	misc portable s	50	1920	99	0	0.04665	0	0	0	0	0	0	0	0	0.02045	0.01425	0.129	0.001955	0.059	0.03835	0.004625	0.00424	0	0	0
Area 12 Batch Plant						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.01	1.067	loading hopper	50	504	75.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.02	1.068	discharge hopp	50	504	50.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.03		Baghouse 11				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3A	2.073	loading silo #1	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3B	2.074	loading silo #2	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.04		Baghouse 13				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4A		weigh hopper/s	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4B	2.075	conveyor to loa	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.05	2.076	loadout	50	504	50.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 12 Portable Cement Silos						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.06		Baghouse 14				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6A		Mutiple portabl	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6B		Mutiple portabl	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6C	2.125	surge #1 loadin	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6D	2.126	surge #1 disch	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6E	2.127	surge #2 loadin	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6F	2.128	surge #2 disch	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UGTA						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.111		Baghouse 11				.0000008.4	0	0	0	0	#REFI	0	0	0.0003511	3.603E-05	0	0	0	0	0	0	0	0	1.071E-05	1.835E-05	0
6.093	2.119	portable silo	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.094	2.121	portable silo	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.095	2.123	portable silo	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

COMBUSTION EQUIPMENT

Area 1 U1A						0	0.0013062	0	0	0	0	0	0	0	0	0.0005726	0.000399	0.003612	5.474E-05	0.001652	0.0010738	0.0001295	0.0001187	0	0	0
1.75	2.521	diesel air compr	0.70	75	0	0	0.0006531	0	0	0	0	0	0	0	0	0.0002863	0.0001995	0.001806	2.737E-05	0.000626	0.0005369	6.475E-05	5.936E-05	0	0	0
1.76		diesel generato	0.70	65	0	0	0.0006531	0	0	0	0	0	0	0	0	0.0002863	0.0001995	0.001806	2.737E-05	0.000626	0.0005369	6.475E-05	5.936E-05	0	0	0
Area 1 U1G						0	0.0041097	0	0	0	0	0	0	0	0	0.0018016	0.0012554	0.0114644	0.0001722	0.0051977	0.0033785	0.0004074	0.0003736	0	0	0
1.77	2.679	diesel generato	0.20	65	0	0	0.0001911	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0006284	8.006E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	0
1.78	2.161	emergency gen	4.20	65	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
Area 1 Drilling Storage Yard						#REFI	#REFI	#REFI	#REFI	#REFI	#REFI	#REFI	#REFI	0	0	0.0011452	0.000798	0.007224	0.0001095	0.003304	0.0021476	0.000259	0.0002374	0	0	0
1.79	2.804	fluid pump	1.40	50	0	0	0.0013062	0	0	0	0	0	0	0	0	0.0005726	0.000399	0.003612	5.474E-05	0.001652	0.0010738	0.0001295	0.0001187	0	0	0
1.80	2.806	mud pump	1.40	300	0	#REFI	#REFI	#REFI	#REFI	#REFI	#REFI	#REFI	#REFI	0	0	0.0005726	0.000399	0.003612	5.474E-05	0.001652	0.0010738	0.0001295	0.0001187	0	0	0
Area 5 Check Point Pass						0	0.0001911	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0006284	8.006E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0		
5.001	2.677	diesel gen.(60 k	0.2048	28			0.0001911							0	0	8.376E-05	5.837E-05	0.0006284	8.006E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	0
Area 5 WEF						0	0.0001082	0	0	0	0	0	0	0	0	4.744E-05	3.306E-05	0.0002993	4.536E-06	0.0001369	8.897E-05	1.073E-05	9.837E-06	0		
5.002	2.656	diesel gen.(34 k	0.116	16			0.0001082							0	0	4.744E-05	3.306E-05	0.0002993	4.536E-06	0.0001369	8.897E-05	1.073E-05	9.837E-06	0	0	0
Area 5 NPTEC						0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0		
5.007	2.165	diesel generato	4.2	360	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
Area 6 Heavy Equipment Yard																										
6.828	2.500	diesel air compr	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.829	2.507	diesel air compr	0.2083	75	0	0	0.0001943	0	0	0	0	0	0	0	0	8.519E-05	5.937E-05	0.0005374	8.145E-06	0.0002458	0.0001596	1.927E-05	1.766E-05	0	0	0
6.830	2.506	diesel air compr	0.2083	30	0	0	0.0001943	0	0	0	0	0	0	0	0	8.519E-05	5.937E-05	0.0005374	8.145E-06	0.0002458	0.0001596	1.927E-05	1.766E-05	0	0	0
6.831	2.528	diesel air compr	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.832	2.530	diesel air compr	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.833	2.531	diesel air compr	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.834	2.532	diesel air compr	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.835	2.533	diesel air compr	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.836	2.534	diesel air compr	0.7004	75	0	0	0.0006536	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.837	2.551	diesel air compr	0.2038	75	0	0	0.0001901	0	0	0	0	0	0	0	0	8.335E-05	5.808E-05	0.0005258	7.969E-06	0.0002405	0.0001563	1.885E-05	1.728E-05	0	0	0
6.838	2.552	diesel air compr	0.2038	75	0	0	0.0001901	0	0	0	0	0	0	0	0	8.335E-05	5.808E-05	0.0005258	7.969E-06	0.0002405	0.0001563	1.885E-05	1.728E-05	0	0	0
6.839	2.553	diesel air compr	0.2038	17	0	0	0.0001901	0	0	0	0	0	0	0	0	8.335E-05	5.808E-05	0.0005258	7.969E-06	0.0002405	0.0001563	1.885E-05	1.728E-05	0	0	0
6.840		diesel air compr	0.2	75	0	0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
6.841	2.141	diesel air compr	1.8822	150	0	0	0.0017561	0	0	0	0	0	0	0	0	0.0007698	0.0005364	0.0048561	7.359E-05	0.002221	0.0014436	0.0001741	0.0001596	0	0	0
6.842		diesel generato	0.3413	65		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.843		diesel generato	0.3413	65		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.844	2.132	diesel generato	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.845	2.133	diesel generato	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.846	2.134	diesel generato	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.847	2.139	diesel generato	4.2	9	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.848	2.611	diesel generato	0.3413	65	0	0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.849	2.628	diesel generato	0.07	65		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.850	2.647	diesel generato	0.07	65		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.851	2.648	diesel generato	0.07	65		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.852	2.656	diesel generato	0.1	9		0	0.0000933	0	0	0	0	0	0	0	0	0.0000409	0.0000285	0.000258	3.91E-06	0.000118	0.0000767	9.25E-06	8.48E-06	0	0	0
6.853	2.657	diesel generato	0.1024	65	0	0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001206	7.854E-05	9.472E-06	8.684E-06	0	0	0
6.854	2.681	diesel generato	0.2048	3	0	0	0.0001911	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0005284	8.006E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	0
6.855	2.605	diesel generato	0.3413	65	0	0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.856	2.606	diesel generato	0.3413	65	0	0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.857		diesel generato	0.3413	65		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.858		diesel generato	0.3413	65		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.859		diesel generato	0.3413	65		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.860		diesel generato	0.3413	65		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.861		gas generator	0.07	75		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.862		gas generator	0.07	75		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.863		gas generator	0.07	75		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.864		gas generator	0.07	75		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.865		gas generator	0.07	75		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.866		gas generator	0.07	75		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.867		gas generator	0.07	75		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.868		trash pump	0.026	50		0	2.426E-05	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.706E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
6.869		diesel cable re	0.026	50		0	2.426E-05	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.706E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0

6.070		diesel cable ree	0.026	50		0	2.426E-05	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
6.071		diesel cable ree	0.026	50		0	2.426E-05	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
6.072		diesel cable ree	0.026	50		0	2.426E-05	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
6.073		diesel cable ree	0.026	50		0	2.426E-05	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
6.074		diesel cable ree	0.026	50		0	2.426E-05	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
Area 6 CP-1						1.339E-05	0.0045973	1.003E-05	1.003E-05	3.01E-05	1.003E-05	2.007E-05	1.003E-05	5.017E-05	5.149E-06	0.0021601	0.0014013	0.0126851	0.0001922	0.00727	0.0037711	0.0004546	0.0004441	1.53E-06	2.623E-06	0
6.075	2.404	Boiler	1.6723	36.3	0	6.689E-06	5.017E-06	5.017E-06	5.017E-06	1.505E-05	5.017E-06	1.003E-05	5.017E-06	2.508E-05	2.575E-06	7.459E-05	0	0	0	0.0007341	0	0	1.359E-05	7.652E-07	1.311E-06	0
6.076	2.405	Boiler	1.6723	207.9	0	6.689E-06	5.017E-06	5.017E-06	5.017E-06	1.505E-05	5.017E-06	1.003E-05	5.017E-06	2.508E-05	2.575E-06	7.459E-05	0	0	0	0.0007341	0	0	1.359E-05	7.652E-07	1.311E-06	0
6.077	2.158	emerg. generat	4.2	11	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.078		diesel generato	0.3413	65	0	0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.079	2.614	diesel generato	0.3754	65	0	0	0.0003502	0	0	0	0	0	0	0	0	0.0001535	0.000107	0.0009685	1.468E-05	0.000443	0.0002879	3.472E-05	3.183E-05	0	0	0
Area 6 CP-18						0	0.0002388	0	0	0	0	0	0	0	0	0.0001047	7.296E-05	0.0006605	1.001E-05	0.0003021	0.0001964	2.368E-05	2.171E-05	0	0	0
6.080	2.690	diesel generato	0.256	65	0	0	0.0002388	0	0	0	0	0	0	0	0	0.0001047	7.296E-05	0.0006605	1.001E-05	0.0003021	0.0001964	2.368E-05	2.171E-05	0	0	0
Area 6 CP-40						0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.081	2.603	diesel generato	0.3413	5	0	0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
Area 6 CP-43						0	0.0001911	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0005284	8.008E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	0
6.082	2.673	diesel generato	0.2048	26	0	0	0.0001911	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0005284	8.008E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	0
Area 6 CP-78						0	0.000398	0	0	0	0	0	0	0	0	0.0001745	0.0001216	0.0011006	1.668E-05	0.0005034	0.0003272	3.946E-05	3.618E-05	0	0	0
6.083	2.618	diesel generato	0.4266	35	0	0	0.000398	0	0	0	0	0	0	0	0	0.0001745	0.0001216	0.0011006	1.668E-05	0.0005034	0.0003272	3.946E-05	3.618E-05	0	0	0
Area 6 CP-8						3.344E-06	0.0078397	2.508E-06	2.508E-06	7.525E-06	2.508E-06	5.017E-06	2.508E-06	1.254E-05	1.287E-06	0.0034729	0.002394	0.021672	0.0003284	0.010279	0.0064428	0.000777	0.0007191	3.826E-07	6.556E-07	0
6.084	2.403	Boiler	0.8361	417.6	0	3.344E-06	2.508E-06	2.508E-06	2.508E-06	7.525E-06	2.508E-06	5.017E-06	2.508E-06	1.254E-05	1.287E-06	3.729E-05	0	0	0	0.000367	0	0	6.797E-06	3.826E-07	6.556E-07	0
6.085	2.156	emerg. generat	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.086	2.163	emerg. generat	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
Area 6 DAF						0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	0	0	0
6.087	2.160	emerg. generat	5.6	13	0	0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	0	0	0
6.088	2.159	emerg. generat	5.6	13	0	0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	0	0	0
6.089	2.407	Boiler	2.3412	2600	0	9.365E-06	7.024E-06	7.024E-06	7.024E-06	2.107E-05	7.024E-06	1.405E-05	7.024E-06	3.512E-05	3.604E-06	0.0001044	0	0	0	0.0010278	0	0	1.903E-05	1.071E-06	1.836E-06	0
6.090	2.408	Boiler	2.3412	2600	0	9.365E-06	7.024E-06	7.024E-06	7.024E-06	2.107E-05	7.024E-06	1.405E-05	7.024E-06	3.512E-05	3.604E-06	0.0001044	0	0	0	0.0010278	0	0	1.903E-05	1.071E-06	1.836E-06	0
Area 6 Decon						2.072E-05	1.554E-05	1.554E-05	1.554E-05	4.662E-05	1.554E-05	3.108E-05	1.554E-05	0.0000777	7.975E-06	0.0002311	0	0	0	0.002274	0	0	4.211E-05	2.37E-06	4.062E-06	0
6.091	2.068	Boiler	5.18	1000	0	2.072E-05	1.554E-05	1.554E-05	1.554E-05	4.662E-05	1.554E-05	3.108E-05	1.554E-05	0.0000777	7.975E-06	0.0002311	0	0	0	0.002274	0	0	4.211E-05	2.37E-06	4.062E-06	0
Area 6 Iron Workers Yard						0	0.000126	0	0	0	0	0	0	0	0	5.522E-05	3.848E-05	0.0003483	5.279E-06	0.0001593	0.0001035	1.249E-05	1.145E-05	0	0	0
6.092		diesel cable ree	0.135	50		0	0.000126	0	0	0	0	0	0	0	0	5.522E-05	3.848E-05	0.0003483	5.279E-06	0.0001593	0.0001035	1.249E-05	1.145E-05	0	0	0
Area 6 Well 3 Yard						0	0.0012689	0	0	0	0	0	0	0	0	0.0005564	0.0003876	0.0035088	5.316E-05	0.0016048	0.0010431	0.0001258	0.0001153	0	0	0
6.096	2.097	bin	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.097		diesel generato	0.34	65		0	0.0003172	0	0	0	0	0	0	0	0	0.0001391	0.0000969	0.0008772	1.329E-05	0.0004012	0.0002608	3.145E-05	2.883E-05	0	0	0
6.098		diesel generato	0.34	65		0	0.0003172	0	0	0	0	0	0	0	0	0.0001391	0.0000969	0.0008772	1.329E-05	0.0004012	0.0002608	3.145E-05	2.883E-05	0	0	0
6.099		diesel generato	0.34	65		0	0.0003172	0	0	0	0	0	0	0	0	0.0001391	0.0000969	0.0008772	1.329E-05	0.0004012	0.0002608	3.145E-05	2.883E-05	0	0	0
6.100		diesel generato	0.34	65		0	0.0003172	0	0	0	0	0	0	0	0	0.0001391	0.0000969	0.0008772	1.329E-05	0.0004012	0.0002608	3.145E-05	2.883E-05	0	0	0
Area 6 WetWild						0	0.0105146	0	0	0	0	0	0	0	0	0.0046094	0.0032119	0.0290763	0.0004407	0.0132865	0.008644	0.0010425	0.0009557	0	0	0
6.101	2.542	diesel air comp	1.9739	150	0	0	0.0018416	0	0	0	0	0	0	0	0	0.0008073	0.0005626	0.0050927	7.718E-05	0.0023292	0.001514	0.0001826	0.0001674	0	0	0
6.102	2.543	diesel air comp	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.103	2.544	diesel air comp	1.9739	150	0	0	0.0018416	0	0	0	0	0	0	0	0	0.0008073	0.0005626	0.0050927	7.718E-05	0.0023292	0.001514	0.0001826	0.0001674	0	0	0
6.104	2.545	diesel air comp	1.9739	150	0	0	0.0018416	0	0	0	0	0	0	0	0	0.0008073	0.0005626	0.0050927	7.718E-05	0.0023292	0.001514	0.0001826	0.0001674	0	0	0
6.105		diesel air comp	1.9739	150		0	0.0018416	0	0	0	0	0	0	0	0	0.0008073	0.0005626	0.0050927	7.718E-05	0.0023292	0.001514	0.0001826	0.0001674	0	0	0
6.106		conveyor	250	100		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.107		pump	0.7	50		0	0.0006531	0	0	0	0	0	0	0	0	0.0002863	0.0001995	0.001806	2.737E-05	0.000826	0.0005369	6.475E-05	5.936E-05	0	0	0
6.108		diesel air comp	1.9739	150	0	0	0.0018416	0	0	0	0	0	0	0	0	0.0008073	0.0005626	0.0050927	7.718E-05	0.0023292	0.001514	0.0001826	0.0001674	0	0	0
Area 6 Other misc. equipment						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.109		abrasive blaster		50		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 12 Cafeteria						2.149E-05	1.612E-05	1.612E-05	1.612E-05	4.835E-05	1.612E-05	3.224E-05	1.612E-05	8.059E-05	8.271E-06	0.0002396	0	0	0	0.0023586	0	0	4.368E-05	2.458E-06	4.213E-06	0
12.07	2.402	boiler	1.7726	2600	0.0	7.09E-06	5.318E-06	5.318E-06	5.318E-06	1.595E-05	5.318E-06	1.064E-05	5.318E-06	2.659E-05	2.729E-06	7.907E-05	0	0	0	0.0007782	0	0	1.441E-05	8.111E-07	1.39E-06	0
12.08	2.072	boiler	3.6	2600	0.0	0.0000144	0.0000108	0.0000108	0.0000108	0.0000324	0.0000108	0.0000216	0.0000108	0.000054	5.542E-06	0.0001606	0	0	0	0.0015604	0	0	2.927E-05	1.647E-06	2.823E-06	0
Area 12 G-Tunnel						1.092E-06	0.0006376	8.19E-07	8.19E-07	2.457E-06	8.19E-07	1.638E-06	8.19E-07	4.095E-06	4.203E-07	0.0002913	0.0001945	0.0017609	2.669E-05	0.0009252	0.0005235	6.313E-05	6.01E-05	1.249E-07	2.141E-07	0
12.09		diesel generato	0.1365	65	0.0	0	0.0001274	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	0	0	0
12.10		diesel generato	0.1365	65	0.0	0	0.0001274	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	0	0	0
12.11		diesel generato	0.1365	65	0.0	0	0.0001274	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	0	0	0
12.12		diesel generato	0.1365	65	0.0	0	0.0001274	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	0	0	0
12.13		diesel generato	0.1365	65	0.0	0	0.0001274	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	0	0	0
12.14		industrial heat	0.1365	65	0.0	5.46E-07	4.095E-07	4.095E-07	4.095E-07	1.229E-06	4.095E-07	8.19E-07	4.095E-07	2.048E-06	2.102E-07	6.088E-06	0	0	0	5.992E-05	0	0	1.11E-06	6.246E-08	1.07E-07	0
12.15		steam cleaner	0.1365	65	0.0	5.46E-07	4.095E-07	4.095E-07	4.095E-07	1.229E-06	4.095E-07	8.19E-07	4.095E-07	2.048E-06	2.102E-07	6.088E-06	0	0	0	5.992E-05	0	0	1.11E-06	6.246E-08	1.07E-07	0
Area 12 N-Tunnel						0	0.0104496	0	0	0	0	0	0	0	0	0.0045808	0.003192	0.028896	0.0004379	0.013216	0.0085904	0.001036	0.0009498	0	0	0
12.16	2.154	diesel generato	5.6	65	0.0	0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	0	0	0
12.17	2.155	diesel generato	5.6	65	0.0	0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	0	0	0
Area 12 P-Tunnel																										
12.18		diesel compres	0.2	75		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.19		diesel air dryer	0.2	75		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.20	2.701	gasoline gener	0.0683	75	0.0	0	6.372E-05	0	0	0	0	0	0	0	0	2.793E-05	1.947E-05	0.0001762	2.671E-06	8.059E-05	5.239E-05	6.318E-06	5.792E-06	0	0	0
Area 12 T-Tunnel						0	0.0054114	0	0	0	0	0	0	0	0	0.0023722	0.001653	0.014964	0.0002268	0.006844	0.0044486	0.0005365	0.0004918	0	0	0
12.21		diesel generato	0.2	120		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.22	2.153	diesel generato	5.6	65	0.0	0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	0	0	0
Area 12 U-Tunnel						0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.23		diesel generato	0.2	65		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
Area 12 Yard						0	0.0039882	0	0	0	0	0	0	0	0	0.0017531	0.0012216	0.0110589	0.0001676	0.005058	0.0032877	0.0003965	0.0003635	0	0	0
12.24		diesel generato	0.512	65		0	0.0004777	0	0	0	0	0	0	0	0	0.0002094	0.0001459	0.001321	2.002E-05	0.0006042	0.0003927	4.736E-05	4.342E-05	0	0	0
12.25		diesel generato	0.512	65		0	0.0004777	0	0	0	0	0	0	0	0	0.0002094	0.0001459	0.001321	2.002E-05	0.0006042	0.0003927	4.736E-05	4.342E-05	0	0	0
12.26		diesel generato	0.512	65		0	0.0004777	0	0	0	0	0	0	0	0	0.0002094	0.0001459	0.001321	2.002E-05	0.0006042	0.0003927	4.736E-05	4.342E-05	0	0	0
12.27		diesel generato	0.512	65		0	0.0004777	0	0	0	0	0	0	0	0	0.0002094	0.0001459	0.001321	2.002E-05	0.0006042	0.0003927	4.736E-05	4.342E-05	0	0	0
12.28		diesel generato	0.512	65		0	0.0004777	0	0	0	0	0	0	0	0	0.0002094	0.0001459	0.001321	2.002E-05	0.0006042	0.0003927	4.736E-05	4.342E-05	0	0	0
12.29		diesel generato	0.2	65		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.30		diesel generato	0.2	65		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.31		diesel generato	0.2	65		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.32		diesel generato	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.33		diesel generato	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.34		diesel generato	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.35		diesel generato	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.36		diesel generato	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.37		diesel generato	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.38		diesel generato	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0

12.39		diesel generat	0.1024	65		0	9.564E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.40		diesel generat	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.41		diesel generat	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.42		diesel generat	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
Area 23 (Mercury)								[illegible]	[illegible]	[illegible]	[illegible]	7.831E-06	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0
23.01	2.464	generator/B10	0.07	5		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
23.02	2.604	generator/B10	0.3413	15		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
23.03	2.400	boiler/B111	0.468	238.8		1.672E-06	1.404E-06	1.404E-06	1.404E-06	4.212E-06	1.404E-06	2.808E-06	1.404E-06	7.02E-06	7.205E-07	2.087E-05	0	0	0	0.0002055	0	0	3.806E-06	2.141E-07	3.67E-07	0
23.04	2.401	boiler/B126	0.836	290.7		3.344E-06	2.508E-06	2.508E-06	2.508E-06	7.524E-06	2.508E-06	5.016E-06	2.508E-06	1.254E-05	1.287E-06	3.729E-05	0	0	0	0.000367	0	0	6.796E-06	3.825E-07	6.556E-07	0
23.05	2.409	boiler/B156	0.3345	437.8		1.338E-06	1.004E-06	1.004E-06	1.004E-06	3.011E-06	1.004E-06	2.007E-06	1.004E-06	5.018E-06	5.15E-07	1.492E-05	0	0	0	0.0001468	0	0	2.719E-06	1.531E-07	2.623E-07	0
23.06	2.801	emergency gen	0.0683	3		0	6.372E-05	0	0	0	0	0	0	0	0	2.793E-05	1.947E-05	0.0001762	2.671E-06	8.059E-05	5.239E-05	6.318E-06	5.792E-06	0	0	0
23.07	2.411	boiler/B536	1.77	583.9		7.08E-06	5.31E-06	5.31E-06	5.31E-06	1.593E-05	5.31E-06	1.062E-05	5.31E-06	2.655E-05	2.725E-06	7.895E-05	0	0	0	0.000777	0	0	1.439E-05	8.099E-07	1.388E-06	0
23.08		diesel generat	0.2	120		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
23.09	2.157	emergency gen	4.2	12		0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
23.10	2.164	emergency gen	4.2	195		0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
23.11	2.070	boiler/B754 C	3.2	1010.9		0.0000128	0.0000096	0.0000096	0.0000096	0.0000288	0.0000096	0.0000192	0.0000096	0.000048	4.927E-06	0.0001427	0	0	0	0.0014048	0	0	2.601E-05	1.464E-06	2.509E-06	0
23.12	2.071	boiler/B753	6.44	576.2		2.576E-05	1.932E-05	1.932E-05	1.932E-05	5.796E-05	1.932E-05	3.864E-05	1.932E-05	0.0000966	9.915E-06	0.0002873	0	0	0	0.0028272	0	0	5.235E-05	2.947E-06	5.05E-06	0
23.13	2.152	incinerator	0.315	872	99.0	1.26E-08	9.45E-09	9.45E-09	9.45E-09	2.835E-08	9.45E-09	1.89E-08	9.45E-09	4.725E-08	4.86E-09	1.405E-07	0	0	0	1.383E-06	0	0	2.561E-08	1.441E-09	2.47E-09	0
23.14		generator/RSH	0.2	120		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
23.15		generator/RSH	0.2	120		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
23.57	2.070	boiler/B754 C	3.2	270.7		0.0000128	0.0000096	0.0000096	0.0000096	0.0000288	0.0000096	0.0000192	0.0000096	0.000048	4.927E-06	0.0001427	0	0	0	0.0014048	0	0	2.601E-05	1.464E-06	2.509E-06	0
Area 25								[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	#VALUE!	[illegible]	#VALUE!
25.01	2.410	5	2.6757	2600		1.07E-05	8.027E-06	8.027E-06	8.027E-06	2.408E-05	8.027E-06	1.605E-05	8.027E-06	4.014E-05	4.119E-06	0.0001193	0	0	0	0.0011746	0	0	2.175E-05	1.224E-06	2.098E-06	#VALUE!
25.02	2.406	5	0.8361	2600		3.344E-06	2.508E-06	2.508E-06	2.508E-06	7.525E-06	2.508E-06	5.017E-06	2.508E-06	1.254E-05	1.287E-06	3.729E-05	0	0	0	0.000367	0	0	6.797E-06	3.826E-07	6.556E-07	#VALUE!
25.03	2.683	Skull Mtn.	0.2048	25		0	0.0001911	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0005284	8.008E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	#VALUE!
25.04	2.529	tunnel	0.7	75		0	0.0006531	0	0	0	0	0	0	0	0	0.0002863	0.0001995	0.001806	2.737E-05	0.000826	0.0005369	6.475E-05	5.936E-05	0	0	#VALUE!
Area 27								0	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	#VALUE!	0	0
27.01	2.131	emergency ge	5.6	36		0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	#VALUE!	0	0
27.02	2.130	emergency ge	5.6	10		0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	#VALUE!	0	0
27.03	2.619	diesel generat	0.0512	65		0	4.777E-05	0	0	0	0	0	0	0	0	2.094E-05	1.459E-05	0.0001321	2.002E-06	6.042E-05	3.927E-05	4.736E-06	4.342E-06	#VALUE!	0	0
27.04	2.669	diesel generat	0.1365	65		0	0.0001274	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	#VALUE!	0	0
Area 29								0	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	#VALUE!	0	0
29.01	2.602	diesel generat	0.3413	65		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	#VALUE!	0	0

Nevada Test Site Emission Inventory

TONS/YR

Hazardous Air Pollutant Emissions

						Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals
						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0.0002	1.7E-05	0.0231	0.0158	0.143	0.002	0.07	0.042	0.0051	0.005	#REF!	#REF!	#REF!
emission source #	old permit #	Equipment	process rate (ton/hr) or *heat rate (MMBtu/hr)*	operating hours (hr/yr)	control (%)	As *(ton/yr)*	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
AGGREGATE PROCESSING EQUIPMENT																										
Area 1 Shaker Plant						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.14		Baghouse 02				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14A	1.016	C-7 to Rotary dryer	100	250	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14B	2.023	Rotary Dryer	100	250	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 1 Concrete Batch Plant						1.346E-05	1.39586E-07	2E-06	4E-06	6E-06	0	0.002	1E-04	0	0	0	0	0	0	0	0	0	0	0	0	1E-04
1.46		Baghouse 04				3.528E-08	3.759E-10	5E-09	5E-09	2E-08	0	4E-06	4E-07	0	0	0	0	0	0	0	0	0	0	0	0	2E-07
46A	2.026	loading overhead bin	50	42	99	1.764E-08	1.8795E-10	2E-09	3E-09	8E-09	0	2E-06	2E-07	0	0	0	0	0	0	0	0	0	0	0	0	1E-07
46B	1.057	loading weigh hopper	50	42	99	1.764E-08	1.8795E-10	2E-09	3E-09	8E-09	0	2E-06	2E-07	0	0	0	0	0	0	0	0	0	0	0	0	1E-07
46C		loading temp. bin A	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46D		discharge temp bin A	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46E		loading temp. bin B	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46F		discharge temp bin B	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46G		loading temp. bin C	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46H		discharge temp bin C	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46I	2.111	loading Silo #3	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46J	2.112	discharge Silo #3	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46K	2.113	loading Silo #4	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46L	2.114	discharge Silo #4	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46M	2.115	loading Silo #5	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46N	2.116	discharge Silo #5	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
1.47		Baghouse 06				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47A	2.028	C-2 to funnel	160	1920	99	2.58E-06	2.74944E-08	4E-07	4E-07	1E-06	0	3E-04	3E-05	0	0	0	0	0	0	0	0	0	0	0	0	2E-05
47B	2.027	weigh hopper 2 to funnel	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
47C	2.029	truck loading	160	1920	99	3.564E-07	0	2E-08	2E-06	6E-07	0	9E-05	5E-06	0	0	0	0	0	0	0	0	0	0	0	0	3E-05
Area 6 Cementing Equipment						0.0001145	1.15197E-06	2E-05	2E-05	5E-05	0	0.013	0.001	7E-09	0	0	0	0	0	0	0	0	0	0	0	6E-04
6.001	2.032	Scale #1	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
6.002	2.033	Scale #2	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
6.003	2.034	Scale #3	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
123A		Baghouse 07/back-up				2.58E-06	2.74944E-08	4E-07	4E-07	1E-06	0	3E-04	3E-05	0	0	0	0	0	0	0	0	0	0	0	0	2E-05
123B		waste silo	10	1920	99	1.613E-07	1.7184E-09	2E-08	2E-08	7E-08	0	2E-05	2E-06	0	0	0	0	0	0	0	0	0	0	0	0	1E-06
6.004		Baghouse 10				8.589E-09	6.405E-10	1E-10	3E-08	1E-08	0	3E-07	4E-08	7E-09	0	0	0	0	0	0	0	0	0	0	0	2E-07
4A	2.035	Load blending tank	50	10.5	99	6.09E-10	0	3E-11	4E-09	1E-09	0	2E-07	9E-09	0	0	0	0	0	0	0	0	0	0	0	0	5E-08
4B	2.036	Blending tank discharge	50	10.5	99	7.98E-09	6.405E-10	9E-11	3E-08	1E-08	0	2E-07	3E-08	7E-09	0	0	0	0	0	0	0	0	0	0	0	1E-07
6.005		Bin Vent #1				1.344E-05	1.432E-07	2E-06	2E-06	6E-06	0	0.002	1E-04	0	0	0	0	0	0	0	0	0	0	0	0	9E-05
6.006		Bin Vent #3				1.344E-05	1.432E-07	2E-06	2E-06	6E-06	0	0.002	1E-04	0	0	0	0	0	0	0	0	0	0	0	0	9E-05
6.007		Bin Vent #4				1.344E-05	1.432E-07	2E-06	2E-06	6E-06	0	0.002	1E-04	0	0	0	0	0	0	0	0	0	0	0	0	9E-05
567A	2.037	Silo #1	50	1920	90	8.064E-06	8.592E-08	1E-06	1E-06	4E-06	0	1E-03	8E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
567B	2.038	Silo #2	50	1920	90	8.064E-06	8.592E-08	1E-06	1E-06	4E-06	0	1E-03	8E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
567C	2.039	Silo #3	50	1920	90	8.064E-06	8.592E-08	1E-06	1E-06	4E-06	0	1E-03	8E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
567D	2.040	Silo #4	50	1920	90	8.064E-06	8.592E-08	1E-06	1E-06	4E-06	0	1E-03	8E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
567E	2.041	Silo #5	50	1920	90	8.064E-06	8.592E-08	1E-06	1E-06	4E-06	0	1E-03	8E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
6.008		Bin Vent #8				1.613E-05	1.7184E-07	2E-06	2E-06	7E-06	0	0.002	2E-04	0	0	0	0	0	0	0	0	0	0	0	0	1E-04
8A	2.042	Silo #7	50	1920	90	8.064E-06	8.592E-08	1E-06	1E-06	4E-06	0	1E-03	8E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
8B	2.043	Silo #8	50	1920	90	8.064E-06	8.592E-08	1E-06	1E-06	4E-06	0	1E-03	8E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
6.009	2.044	Silo #15	50	1920	90	8.064E-06	8.592E-08	1E-06	1E-06	4E-06	0	1E-03	8E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
6.010	2.045	Silo #16	50	1920	90	8.064E-06	8.592E-08	1E-06	1E-06	4E-06	0	1E-03	8E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
6.011		Bin Vent #18				1.21E-05	1.2888E-07	2E-06	2E-06	5E-06	0	0.001	1E-04	0	0	0	0	0	0	0	0	0	0	0	0	8E-05
6.012		Bin Vent #19				1.21E-05	1.2888E-07	2E-06	2E-06	5E-06	0	0.001	1E-04	0	0	0	0	0	0	0	0	0	0	0	0	8E-05
1112A	2.046	Silo #17	50	1920	90	8.064E-06	8.592E-08	1E-06	1E-06	4E-06	0	1E-03	8E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
1112B	2.047	Silo #18	50	1920	90	8.064E-06	8.592E-08	1E-06	1E-06	4E-06	0	1E-03	8E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
1112C	2.048	Silo #19	50	1920	90	8.064E-06	8.592E-08	1E-06	1E-06	4E-06	0	1E-03	8E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
6.013		Baghouse 08				8.87E-06	9.4512E-08	1E-06	1E-06	4E-06	0	0.001	9E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
13A	2.049	Silo #9	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13B	2.050	Silo #10	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13C	2.051	Silo #11	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13D	2.052	Silo #12	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13E	2.053	Silo #13	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13F	2.054	Silo #14	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13G	2.055	Silo #27	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13H	2.056	Silo #28	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13I	2.057	Silo #29	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13J	2.058	Silo #30	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13K	2.059	Silo #31	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
6.014		Baghouse 09				6.451E-06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14A	2.060	Silo #21	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14B	2.061	Silo #22	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14C	2.062	Silo #23	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14D	2.063	Silo #24	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14E	2.064	Silo #25	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14F	2.065	Silo #26	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14G	2.066	Silo #32	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14H	2.067	Silo #33	50	1920	99	8.064E-07	8.592E-09	1E-07	1E-07	4E-07	0	1E-04	8E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06

Nevada Test Site Emission Inventory

TONS/YR

Hazardous Air Pollutant Emissions

						Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals
						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0.0002	1.7E-05	0.0231	0.0158	0.143	0.002	0.07	0.042	0.0051	0.005	#REF!	#REF!	#REF!
emission source #	old permit #	Equipment	process rate (ton/hr) or heat rate (MMBtu/hr)	operating hours (hr/yr)	control (%)	As (ton/yr)	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
Area 6 Construction storage yard						0	0.044784	0	0	0	0	0	0	0	0	0.0196	0.0137	0.124	0.002	0.057	0.037	0.0044	0.004	0	0	0
6.111		Baghouse 11					0.044784	0	0	0	0	0	0	0	0	0.0196	0.0137	0.124	0.002	0.057	0.037	0.0044	0.004	0	0	0
6.110	2.119	misc portable silos (7)	50	1920	99	0	0.044784	0	0	0	0	0	0	0	0	0.0196	0.0137	0.124	0.002	0.057	0.037	0.0044	0.004	0	0	0
Area 12 Batch Plant						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.01	1.067	loading hopper	50	504	75.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.02	1.068	discharge hopper	50	504	50.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.03		Baghouse 11				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3A	2.073	loading silo #1	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3B	2.074	loading silo #2	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.04		Baghouse 13				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4A		weigh hopper/scale	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4B	2.075	conveyor to loadout	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.05	2.076	loadout	50	504	50.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 12 Portable Cement Bins						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.06		Baghouse 14				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6A		Mutiple portable bins	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6B		Mutiple portable bins	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6C	2.125	surge #1 loading	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6D	2.126	surge #1 discharge	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6E	2.127	surge #2 loading	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6F	2.128	surge #2 discharge	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Portable Baghouse/Silos (Previously UGTA)						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.111		Baghouse 11				.0000008.0(	.0000008.06	.00000(	.000000	.000000	.00000(	.00000	.00000	.00000(	.000000	.00000(	.000000	.00000(	.00000(	.00000	.00000	.00000(	.00000	.0000008.(	.00000(	.0000008.06
6.083	2.119	portable silo	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.084	2.121	portable silo	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.085	2.123	portable silo	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

COMBUSTION EQUIPMENT

Area 1 U1A						0	0.000045717	0	0	0	0	0	0	0	0	2E-05	1E-05	1E-04	2E-06	6E-05	4E-05	5E-06	4E-06	0	0	0
1.75	2.521	diesel air compressor	0.70	75	0	0	2.44913E-05	0	0	0	0	0	0	0	0	1E-05	7E-06	7E-05	1E-06	3E-05	2E-05	2E-06	2E-06	0	0	0
1.76		diesel generator	0.70	65	0	0	2.12258E-05	0	0	0	0	0	0	0	0	9E-06	6E-06	6E-05	9E-07	3E-05	2E-05	2E-06	2E-06	0	0	0
Area 1 U1G						0	0.000133565	0	0	0	0	0	0	0	0	6E-05	4E-05	4E-04	6E-06	2E-04	1E-04	1E-05	1E-05	0	0	0
1.77	2.679	diesel generator	0.20	65	0	0	6.21005E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	8E-06	5E-06	6E-07	6E-07	0	0	0
1.78	2.161	emergency generator	4.20	65	0	0	0.000127355	0	0	0	0	0	0	0	0	6E-05	4E-05	4E-04	5E-06	2E-04	1E-04	1E-05	1E-05	0	0	0
Area 1 Drilling Storage Yard						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0	0	0.0001	7E-05	6E-04	1E-05	3E-04	2E-04	2E-05	2E-05	#REF!	#REF!	#REF!
1.79	2.804	fluid pump	1.40	50	0	#REF!	0.000032655	0	0	0	0	0	0	0	0	1E-05	1E-05	9E-05	1E-06	4E-05	3E-05	3E-06	3E-06	#REF!	#REF!	#REF!
1.80	2.806	mud pump	1.40	300	0	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0	0	9E-05	6E-05	5E-04	8E-06	2E-04	2E-04	2E-05	2E-05	#REF!	#REF!	#REF!
Area 5 Check Point Pass						0	2.6751E-06	0	0	0	0	0	0	0	0	1E-06	8E-07	7E-06	1E-07	3E-06	2E-06	3E-07	2E-07	0		
5.001	2.677	diesel gen.(60 KW)	0.2	28	0	0	2.6751E-06	0	0	0	0	0	0	0	0	1E-06	8E-07	7E-06	1E-07	3E-06	2E-06	3E-07	2E-07	0	0	0
Area 5 BREF						0	9.74052E-07	0	0	0	0	0	0	0	0	4E-07	3E-07	3E-06	4E-08	1E-06	8E-07	1E-07	9E-08	0		
5.002	2.658	diesel gen.(34 KW)	0.12	18	0	0	9.74052E-07	0	0	0	0	0	0	0	0	4E-07	3E-07	3E-06	4E-08	1E-06	8E-07	1E-07	9E-08	0	0	0
Area 5 NPTEC																										
5.007	2.165	diesel generator	4.2	300	0	0	0.00058779	0	0	0	0	0	0	0	0	0.0003	0.0002	0.002	2E-05	7E-04	5E-04	6E-05	5E-05	0	0	0
Area 6 Heavy Equipment Storage Yard						0	0.002245624	0	0	0	0	0	0	0	0	0.001	0.0007	0.008	9E-06	0.003	0.002	0.0002	2E-04	0	0	0
6.028	2.500	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1E-05	7E-06	7E-05	1E-06	3E-05	2E-05	2E-06	2E-06	0	0	0
6.029	2.507	diesel air compressor	0.21	75	0	0	7.2879E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	9E-06	6E-06	7E-07	7E-07	0	0	0
6.030	2.508	diesel air compressor	0.21	10	0	0	9.7172E-07	0	0	0	0	0	0	0	0	4E-07	3E-07	3E-06	4E-08	1E-06	8E-07	1E-07	9E-08	0	0	0
6.031	2.528	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1E-05	7E-06	7E-05	1E-06	3E-05	2E-05	2E-06	2E-06	0	0	0
6.032	2.530	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1E-05	7E-06	7E-05	1E-06	3E-05	2E-05	2E-06	2E-06	0	0	0
6.033	2.531	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1E-05	7E-06	7E-05	1E-06	3E-05	2E-05	2E-06	2E-06	0	0	0
6.034	2.532	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1E-05	7E-06	7E-05	1E-06	3E-05	2E-05	2E-06	2E-06	0	0	0
6.035	2.533	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1E-05	7E-06	7E-05	1E-06	3E-05	2E-05	2E-06	2E-06	0	0	0
6.036	2.534	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1E-05	7E-06	7E-05	1E-06	3E-05	2E-05	2E-06	2E-06	0	0	0
6.037	2.551	diesel air compressor	0.2	75	0	0	7.13045E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	9E-06	6E-06	7E-07	6E-07	0	0	0
6.038	2.552	diesel air compressor	0.2	75	0	0	7.13045E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	9E-06	6E-06	7E-07	6E-07	0	0	0
6.039	2.553	diesel air compressor	0.2	17	0	0	1.61624E-06	0	0	0	0	0	0	0	0	7E-07	5E-07	4E-06	7E-08	2E-06	1E-06	2E-07	1E-07	0	0	0
6.040		diesel air compressor	0.2	75	0	0	6.9975E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	9E-06	6E-06	7E-07	6E-07	0	0	0
6.041	2.141	diesel air compressor	1.88	150	0	0	0.000131707	0	0	0	0	0	0	0	0	6E-05	4E-05	4E-04	6E-06	2E-04	1E-04	1E-05	1E-05	0	0	0
6.042		diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	9E-06	1E-06	9E-07	0	0	0
6.043		diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	9E-06	1E-06	9E-07	0	0	0
6.044	2.132	diesel generator	4.2	300	0	0	0.00058779	0	0	0	0	0	0	0	0	0.0003	0.0002	0.002	2E-05	7E-04	5E-04	6E-05	5E-05	0	0	0
6.045	2.133	diesel generator	4.2	300	0	0	0.00058779	0	0	0	0	0	0	0	0	0.0003	0.0002	0.002	2E-05	7E-04	5E-04	6E-05	5E-05	0	0	0
6.046	2.134	diesel generator	4.2	300	0	0	0.00058779	0	0	0	0	0	0	0	0	0.0003	0.0002	0.002	2E-05	7E-04	5E-04	6E-05	5E-05	0	0	0
6.047	2.139	diesel generator	4.2	9	0	0	1.76337E-05	0	0	0	0	0	0	0	0	8E-06	5E-06	5E-05	7E-07	2E-05	1E-05	2E-06	2E-06	0	0	0
6.048	2.611	diesel generator	0.34	65	0	0	1.03491E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	9E-06	1E-06	9E-07	0	0	0
6.049	2.626	diesel generator	0.07	65		0	2.12258E-06	0	0	0	0	0	0	0	0	9E-07	6E-07	6E-06	9E-08	3E-06	2E-06	2E-07	2E-07	0	0	0
6.050	2.647	diesel generator	0.07	65		0	2.12258E-06	0	0	0	0	0	0	0	0	9E-07	6E-07	6E-06	9E-08	3E-06	2E-06	2E-07	2E-07	0	0	0
6.051	2.648	diesel generator	0.07	65		0	2.12258E-06	0	0	0	0	0	0	0	0	9E-07	6E-07	6E-06	9E-08	3E-06	2E-06	2E-07	2E-07	0	0	0
6.052	2.656	diesel generator	0.1	9		0	4.1985E-07	0	0	0	0	0	0	0	0	2E-07	1E-07	1E-06	2E-08	5E-07	3E-07	4E-08	4E-08	0	0	0
6.053	2.657	diesel generator	0.1	65	0	0	3.10502E-06	0	0	0	0	0	0	0	0	1E-06	9E-07	9E-06	1E-07	4E-06	3E-06	3E-07	3E-07	0	0	0
6.054	2.681	diesel generator	0.2	63	0	0	6.01897E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	8E-06	5E-06	6E-07	5E-07	0	0	0
6.055	2.605	diesel generator	0.34	65	0	0	1.03491E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	9E-06	1E-06	9E-07	0	0	0
6.056	2.606	diesel generator	0.34	65	0	0	1.03491E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	9E-06	1E-06	9E-07	0	0	0
6.057		diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	9E-06	1E-06	9E-07	0	0	0

Nevada Test Site Emission Inventory

TONS/YR

Hazardous Air Pollutant Emissions

emission source #	old permit #	Equipment	process rate (ton/hr) or heat rate (MMBtu/hr)	operating hours (hr/yr)	control (%)	As (ton/yr)	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
						Totals #REF!	Totals #REF!	Totals #REF!	Totals #REF!	Totals #REF!	Totals #REF!	Totals #REF!	Totals #REF!	Totals 0.0002	Totals 1.7E-05	Totals 0.0231	Totals 0.0158	Totals 0.143	Totals 0.002	Totals 0.07	Totals 0.042	Totals 0.0061	Totals 0.005	Totals #REF!	Totals #REF!	Totals #REF!
6.058		diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	9E-06	1E-06	9E-07	0	0	0
6.059		diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	9E-06	1E-06	9E-07	0	0	0
6.060		diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	9E-06	1E-06	9E-07	0	0	0
6.061		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1E-06	7E-07	7E-06	1E-07	3E-06	2E-06	2E-07	2E-07	0	0	0
6.062		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1E-06	7E-07	7E-06	1E-07	3E-06	2E-06	2E-07	2E-07	0	0	0
6.063		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1E-06	7E-07	7E-06	1E-07	3E-06	2E-06	2E-07	2E-07	0	0	0
6.064		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1E-06	7E-07	7E-06	1E-07	3E-06	2E-06	2E-07	2E-07	0	0	0
6.065		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1E-06	7E-07	7E-06	1E-07	3E-06	2E-06	2E-07	2E-07	0	0	0
6.066		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1E-06	7E-07	7E-06	1E-07	3E-06	2E-06	2E-07	2E-07	0	0	0
6.067		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1E-06	7E-07	7E-06	1E-07	3E-06	2E-06	2E-07	2E-07	0	0	0
6.068		trash pump	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	3E-07	2E-07	2E-06	3E-08	8E-07	5E-07	6E-08	6E-08	0	0	0
6.069		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	3E-07	2E-07	2E-06	3E-08	8E-07	5E-07	6E-08	6E-08	0	0	0
6.070		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	3E-07	2E-07	2E-06	3E-08	8E-07	5E-07	6E-08	6E-08	0	0	0
6.071		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	3E-07	2E-07	2E-06	3E-08	8E-07	5E-07	6E-08	6E-08	0	0	0
6.072		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	3E-07	2E-07	2E-06	3E-08	8E-07	5E-07	6E-08	6E-08	0	0	0
6.073		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	3E-07	2E-07	2E-06	3E-08	8E-07	5E-07	6E-08	6E-08	0	0	0
6.074		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	3E-07	2E-07	2E-06	3E-08	8E-07	5E-07	6E-08	6E-08	0	0	0
Area 6 CP-1						8.699E-06	0.000616048	7E-06	7E-06	2E-05	7E-06	1E-05	7E-06	3E-05	3.3E-06	0.0004	0.0002	0.002	3E-05	0.002	5E-04	6E-05	7E-05	9.95E-07	2E-06	0
6.075	2.404	Boiler	1.67	2600	0	8.696E-06	6.52197E-06	7E-06	7E-06	2E-05	7E-06	1E-05	7E-06	3E-05	3.3E-06	1E-04	0	0	0	1E-03	0	0	2E-05	9.95E-07	2E-06	0
6.076	2.405	Boiler	1.67	0.8	0	2.676E-09	2.00876E-09	2E-09	2E-09	6E-09	2E-09	4E-09	2E-09	1E-08	1E-09	3E-08	0	0	0	3E-07	0	0	5E-09	3.06E-10	5E-10	0
6.077	2.158	emerg. generator	4.2	300	0	0	0.00058779	0	0	0	0	0	0	0	0	0.0003	0.0002	0.002	2E-05	7E-04	5E-04	6E-05	5E-05	0	0	0
6.078		diesel generator	0.34	65	0	0	1.03491E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	9E-06	1E-06	9E-07	0	0	0
6.079	2.614	diesel generator	0.38	65	0	0	1.13831E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	5E-07	1E-05	9E-06	1E-06	1E-06	0	0	0
Area 6 CP-18						0	7.76256E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	1E-05	6E-06	8E-07	7E-07	0	0	0
6.080	2.690	diesel generator	0.26	65	0	0	7.76256E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	1E-05	6E-06	8E-07	7E-07	0	0	0
Area 6 CP-40						0	7.98082E-07	0	0	0	0	0	0	0	0	3E-07	2E-07	2E-06	3E-08	1E-06	7E-07	8E-08	7E-08	0	0	0
6.081	2.603	diesel generator	0.34	5	0	0	7.98082E-07	0	0	0	0	0	0	0	0	3E-07	2E-07	2E-06	3E-08	1E-06	7E-07	8E-08	7E-08	0	0	0
Area 6 CP-43						0	7.26096E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	9E-06	6E-06	7E-07	7E-07	0	0	0
6.082	2.673	diesel generator	0.2	76	0	0	7.26096E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	9E-06	6E-06	7E-07	7E-07	0	0	0
Area 6 CP-70						0	6.96531E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	9E-06	6E-06	7E-07	6E-07	0	0	0
6.083	2.618	diesel generator	0.43	35	0	0	6.96531E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	9E-06	6E-06	7E-07	6E-07	0	0	0
Area 6 CP-9						4.241E-07	0.001175898	3E-07	3E-07	1E-06	3E-07	6E-07	3E-07	2E-06	1.6E-07	0.0005	0.0004	0.003	5E-05	0.002	1E-03	0.0001	1E-04	4.85E-06	8E-08	0
6.084	2.403	Boiler	0.84	254	0	4.241E-07	3.18052E-07	3E-07	3E-07	1E-06	3E-07	6E-07	3E-07	2E-06	1.6E-07	5E-06	0	0	0	5E-05	0	0	9E-07	4.85E-06	8E-08	0
6.085	2.156	emerg. generator	4.2	300	0	0	0.00058779	0	0	0	0	0	0	0	0	0.0003	0.0002	0.002	2E-05	7E-04	5E-04	6E-05	5E-05	0	0	0
6.086	2.163	emerg. generator	4.2	300	0	0	0.00058779	0	0	0	0	0	0	0	0	0.0003	0.0002	0.002	2E-05	7E-04	5E-04	6E-05	5E-05	0	0	0
Area 6 DAF						0	3.39612E-05	0	0	0	0	0	0	0	0	1E-05	1E-05	9E-05	1E-06	4E-05	3E-05	3E-06	3E-06	0	0	0
6.087	2.160	emerg. generator	5.6	13	0	0	3.39612E-05	0	0	0	0	0	0	0	0	1E-05	1E-05	9E-05	1E-06	4E-05	3E-05	3E-06	3E-06	0	0	0
6.088	2.159	emerg. generator	5.6	13	0	0	3.39612E-05	0	0	0	0	0	0	0	0	1E-05	1E-05	9E-05	1E-06	4E-05	3E-05	3E-06	3E-06	0	0	0
6.089	2.407	Boiler	2.34	2600	0	1.217E-05	9.13068E-06	9E-06	9E-06	3E-05	9E-06	2E-05	9E-06	5E-05	4.7E-06	0.0001	0	0	0	0.001	0	0	2E-05	1.39E-06	2E-06	0
6.090	2.408	Boiler	2.34	2600	0	1.217E-05	9.13068E-06	9E-06	9E-06	3E-05	9E-06	2E-05	9E-06	5E-05	4.7E-06	0.0001	0	0	0	0.001	0	0	2E-05	1.39E-06	2E-06	0
Area 6 Decon						1.036E-05	0.00000777	8E-06	8E-06	2E-05	8E-06	2E-05	8E-06	4E-05	4E-06	0.0001	0	0	0	0.001	0	0	2E-05	1.19E-06	2E-06	0
6.091	2.068	Boiler	5.18	1000	0	1.036E-05	0.00000777	8E-06	8E-06	2E-05	8E-06	2E-05	8E-06	4E-05	4E-06	0.0001	0	0	0	0.001	0	0	2E-05	1.19E-06	2E-06	0
Area 6 Iron Workers Yard						0	3.14888E-06	0	0	0	0	0	0	0	0	1E-06	1E-06	9E-06	1E-07	4E-06	3E-06	3E-07	3E-07	0	0	0
6.092		diesel cable reeler	0.14	50		0	3.14888E-06	0	0	0	0	0	0	0	0	1E-06	1E-06	9E-06	1E-07	4E-06	3E-06	3E-07	3E-07	0	0	0
Area 6 Well 3 Yard						0	4.12388E-05	0	0	0	0	0	0	0	0	2E-05	1E-05	1E-04	2E-06	5E-05	3E-05	4E-06	4E-06	0	0	0
6.096	2.097	bin	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.097		diesel generator	0.34	65		0	1.03097E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	8E-06	1E-06	9E-07	0	0	0
6.098		diesel generator	0.34	65		0	1.03097E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	8E-06	1E-06	9E-07	0	0	0
6.099		diesel generator	0.34	65		0	1.03097E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	8E-06	1E-06	9E-07	0	0	0
6.100		diesel generator	0.34	65		0	1.03097E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	8E-06	1E-06	9E-07	0	0	0
Area 6 Wet/Wild						0	0.000731451	0	0	0	0	0	0	0	0	0.0003	0.0002	0.002	3E-05	9E-04	6E-04	7E-05	7E-05	0	0	0
6.101	2.542	diesel air compressor	1.97	150	0	0	0.000138124	0	0	0	0	0	0	0	0	6E-05	4E-05	4E-04	6E-06	2E-04	1E-04	1E-05	1E-05	0	0	0
6.102	2.543	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1E-05	7E-06	7E-05	1E-06	3E-05	2E-05	2E-06	2E-06	0	0	0
6.103	2.544	diesel air compressor	1.97	150	0	0	0.000138124	0	0	0	0	0	0	0	0	6E-05	4E-05	4E-04	6E-06	2E-04	1E-04	1E-05	1E-05	0	0	0
6.104	2.545	diesel air compressor	1.97	150	0	0	0.000138124	0	0	0	0	0	0	0	0	6E-05	4E-05	4E-04	6E-06	2E-04	1E-04	1E-05	1E-05	0	0	0
6.105		diesel air compressor	1.97	150		0	0.000138124	0	0	0	0	0	0	0	0	6E-05	4E-05	4E-04	6E-06	2E-04	1E-04	1E-05	1E-05	0	0	0
6.106		conveyor	250	100		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.107		pump	0.7	50		0	1.63275E-05	0	0	0	0	0	0	0	0	7E-06	5E-06	5E-05	7E-07	2E-05	1E-05	2E-06	1E-06	0	0	0
6.108		diesel air compressor	1.97	150	0	0	0.000138124	0	0	0	0	0	0	0	0	6E-05	4E-05	4E-04	6E-06	2E-04	1E-04	1E-05	1E-05	0	0	0
Area 6 Other misc. equipment						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.109		abrasive blaster		50		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 12 Cafeteria						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.07	2.402	boiler	1.77	2600	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.08	2.072	boiler	3.6	2600	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 12G-Tunnel						3.549E-08	2.07217E-05	3E-08	3E-08	8E-08	3E-08	6E-08	3E-08	1E-07	1.4E-08	9E-06	6E-06	6E-05	9E-07	3E-05	2E-05	2E-06	2E-06	4.06E-09	7E-09	0
12.09		diesel generator	0.14	65	0.0	0	4.13902E-06	0	0	0	0	0	0	0	0	2E-06	1E-06	1E-05	2E-07	5E-06	3E-06	4E-07	4E-07	0	0	0
12.10		diesel generator	0.14	65	0.0	0	4.13902E-06	0	0	0	0	0	0	0	0	2E-06	1E-06	1E-05	2E-07	5E-06	3E-06	4E-07	4E-07	0	0	0
12.11		diesel generator	0.14	65	0.0	0	4.13902E-06	0	0	0	0	0	0	0	0	2E-06	1E-06	1E-05	2E-07	5E-06	3E-06	4E-07	4E-07	0	0	0
12.12		diesel generator/welder	0.14	65	0.0	0	4.13902E-06	0	0	0	0	0	0	0	0	2E-06	1E-06	1E-05	2E-07	5E-06	3E-06	4E-07	4E-07	0	0	0
12.13		diesel generator	0.14	65	0.0	0	4.13902E-06	0	0	0	0	0	0	0	0	2E-06	1E-06	1E-05	2E-07	5E-06	3E-06	4E-07	4E-07	0	0	0
12.14		industrial heater	0.14	65	0.0	1.775E-08	1.33088E-08	1E-08	1E-08	4E-08	1E-08	3E-08	1E-08	7E-08	6.8E-09	2E-07	0	0	0	2E-06	0	0	4E-08	2.03E-09	3E-09	0
12.15		steam cleaner	0.14	65	0.0	1.775E-08	1.33088E-08	1E-08	1E-08	4E-08	1E-08	3E-08	1E-08	7E-08	6.8E-09	2E-07	0	0	0	2E-06	0	0	4E-08	2.03E-09	3E-09	0
Area 12N-Tunnel						0	0.000339612	0	0	0	0	0	0	0	0	0.0001	0.0001	9E-04	1E-05	4E-04	3E-04	3E-05	3E-05	0	0	0
12.16	2.154	diesel generator	5.6	65	0.0	0	0.000169806	0	0	0	0	0	0	0	0	7E-05	5E-05	5E-04	7E-06	2E-04	1E-04	2E-05	2E-05	0	0	0
12.17	2.155	diesel generator	5.6	65	0.0	0	0.000169806	0	0	0	0	0	0	0	0	7E-05	5E-05	5E-04	7E-06	2E-04	1E-04	2E-05	2E-05	0	0	0
Area 12 P-Tunnel						0	1.63646E-05	0	0	0	0	0	0	0	0	7E-06	5E-06	5E-05	7E-07	2E-05	1E-05	2E-06	1E-06	0	0	0

Nevada Test Site Emission Inventory

TONS/YR

Hazardous Air Pollutant Emissions

emission source #	old permit #	Equipment	process rate (ton/hr) or *heat rate (MMBtu/hr)*	operating hours (hr/yr)	control (%)	As (ton/yr)	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
						Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals
						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0.0002	1.7E-05	0.0231	0.0158	0.143	0.002	0.07	0.042	0.0061	0.005	#REF!	#REF!	#REF!
12.18		diesel compressor	0.2	75		0	6.9975E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	9E-06	6E-06	7E-07	6E-07	0	0	0
12.19		diesel air dryer	0.2	75		0	6.9975E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	9E-06	6E-06	7E-07	6E-07	0	0	0
12.20	2.701	gasoline generator	0.07	75	0.0	0	2.36965E-06	0	0	0	0	0	0	0	0	1E-06	7E-07	7E-06	1E-07	3E-06	2E-06	2E-07	2E-07	0	0	0
Area 12 T-Tunnel						0	0.000181002	0	0	0	0	0	0	0	0	8E-05	5E-05	5E-04	8E-06	2E-04	1E-04	2E-05	2E-05	0	0	0
12.21		diesel generator	0.2	120		0	0.000011196	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	5E-07	1E-05	9E-06	1E-06	1E-06	0	0	0
12.22	2.153	diesel generator	5.6	65	0.0	0	0.000169806	0	0	0	0	0	0	0	0	7E-05	5E-05	5E-04	7E-06	2E-04	1E-04	2E-05	2E-05	0	0	0
Area 12 U-Tunnel						0	6.0645E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	8E-06	5E-06	6E-07	6E-07	0	0	0
12.23		diesel generator	0.2	65		0	6.0645E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	8E-06	5E-06	6E-07	6E-07	0	0	0
Area 12 Yard						0	0.000129974	0	0	0	0	0	0	0	0	6E-05	4E-05	4E-04	5E-06	2E-04	1E-04	1E-05	1E-05	0	0	0
12.24		diesel generator	0.51	65		0	1.55251E-05	0	0	0	0	0	0	0	0	7E-06	5E-06	4E-05	7E-07	2E-05	1E-05	2E-06	1E-06	0	0	0
12.25		diesel generator	0.51	65		0	1.55251E-05	0	0	0	0	0	0	0	0	7E-06	5E-06	4E-05	7E-07	2E-05	1E-05	2E-06	1E-06	0	0	0
12.26		diesel generator	0.51	65		0	1.55251E-05	0	0	0	0	0	0	0	0	7E-06	5E-06	4E-05	7E-07	2E-05	1E-05	2E-06	1E-06	0	0	0
12.27		diesel generator	0.51	65		0	1.55251E-05	0	0	0	0	0	0	0	0	7E-06	5E-06	4E-05	7E-07	2E-05	1E-05	2E-06	1E-06	0	0	0
12.28		diesel generator	0.51	65		0	1.55251E-05	0	0	0	0	0	0	0	0	7E-06	5E-06	4E-05	7E-07	2E-05	1E-05	2E-06	1E-06	0	0	0
12.29		diesel generator	0.2	65		0	6.0645E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	8E-06	5E-06	6E-07	6E-07	0	0	0
12.30		diesel generator	0.2	65		0	6.0645E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	8E-06	5E-06	6E-07	6E-07	0	0	0
12.31	2.687	diesel generator	0.2	65		0	6.0645E-06	0	0	0	0	0	0	0	0	3E-06	2E-06	2E-05	3E-07	8E-06	5E-06	6E-07	6E-07	0	0	0
12.32		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1E-06	9E-07	9E-06	1E-07	4E-06	3E-06	3E-07	3E-07	0	0	0
12.33		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1E-06	9E-07	9E-06	1E-07	4E-06	3E-06	3E-07	3E-07	0	0	0
12.34		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1E-06	9E-07	9E-06	1E-07	4E-06	3E-06	3E-07	3E-07	0	0	0
12.35		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1E-06	9E-07	9E-06	1E-07	4E-06	3E-06	3E-07	3E-07	0	0	0
12.36		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1E-06	9E-07	9E-06	1E-07	4E-06	3E-06	3E-07	3E-07	0	0	0
12.37		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1E-06	9E-07	9E-06	1E-07	4E-06	3E-06	3E-07	3E-07	0	0	0
12.38		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1E-06	9E-07	9E-06	1E-07	4E-06	3E-06	3E-07	3E-07	0	0	0
12.39		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1E-06	9E-07	9E-06	1E-07	4E-06	3E-06	3E-07	3E-07	0	0	0
12.40		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1E-06	9E-07	9E-06	1E-07	4E-06	3E-06	3E-07	3E-07	0	0	0
12.41		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1E-06	9E-07	9E-06	1E-07	4E-06	3E-06	3E-07	3E-07	0	0	0
12.42		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1E-06	9E-07	9E-06	1E-07	4E-06	3E-06	3E-07	3E-07	0	0	0
Area 23 (Mercury)						6.136E-06	0.000191575	5E-06	5E-06	1E-05	6E-06	9E-06	5E-06	2E-05	2.4E-06	0.0001	3E-05	3E-04	4E-06	8E-04	8E-05	1E-05	2E-05	7.02E-07	1E-06	
23.01	2.464	generator/B1000	0.07	4		0	1.3062E-07	0	0	0	0	0	0	0	0	6E-08	4E-08	4E-07	5E-09	2E-07	1E-07	1E-08	1E-08	0	0	
23.02	2.604	generator/B1010	0.34	31		0	4.93571E-06	0	0	0	0	0	0	0	0	2E-06	2E-06	1E-05	2E-07	6E-06	4E-06	5E-07	4E-07	0	0	
23.03	2.400	boiler/B111	0.47	93.4		8.742E-08	6.55668E-08	7E-08	7E-08	2E-07	7E-08	1E-07	7E-08	3E-07	3.4E-08	1E-06	0	0	0	1E-05	0	0	2E-07	1E-08	2E-08	
23.04	2.401	boiler/B126	0.84	212		3.541E-07	2.65597E-07	3E-07	3E-07	8E-07	3E-07	5E-07	3E-07	1E-06	1.4E-07	4E-06	0	0	0	4E-05	0	0	7E-07	4.05E-08	7E-08	
23.05	2.409	boiler/B156	0.33	255		1.703E-07	1.27695E-07	1E-07	1E-07	4E-07	1E-07	3E-07	1E-07	6E-07	6.6E-08	2E-06	0	0	0	2E-05	0	0	3E-07	1.95E-08	3E-08	
23.06	2.601	emergency generator	0.07	47		0	1.49751E-06	0	0	0	0	0	0	0	0	7E-07	5E-07	4E-06	6E-08	2E-06	1E-06	1E-07	1E-07	0	0	
23.07	2.411	boiler/B538	1.77	44.5		1.575E-07	1.18148E-07	1E-07	1E-07	4E-07	1E-07	2E-07	1E-07	6E-07	6.1E-08	2E-06	0	0	0	2E-05	0	0	3E-07	1.8E-08	3E-08	
23.08		diesel generator	0.2	120		0	0.000011196	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	5E-07	1E-05	9E-06	1E-06	1E-06	0	0	
23.09	2.157	emergency generator	4.2	27		0	5.29011E-05	0	0	0	0	0	0	0	0	2E-05	2E-05	1E-04	2E-06	7E-05	4E-05	5E-06	5E-06	0	0	
23.10	2.164	emergency generator	4.2	2		0	3.9186E-06	0	0	0	0	0	0	0	0	2E-06	1E-06	1E-05	2E-07	5E-06	3E-06	4E-07	4E-07	0	0	
23.11	2.070	boiler/B754 Café	3.2	463		2.963E-06	2.2224E-06	2E-06	2E-06	7E-06	2E-06	4E-06	2E-06	1E-05	1.1E-06	3E-05	0	0	0	3E-04	0	0	6E-06	3.39E-07	6E-07	
23.12	2.071	boiler/B753	6.44	186		2.4E-06	1.79986E-06	2E-06	2E-06	5E-06	2E-06	4E-06	2E-06	9E-06	9.2E-07	3E-05	0	0	0	3E-04	0	0	5E-06	2.74E-07	5E-07	
23.13	2.152	incinerator	0.32	872	99.0	5.494E-09	4.1202E-09	4E-09	4E-09	1E-08	4E-09	8E-09	4E-09	2E-08	2.1E-09	6E-08	0	0	0	6E-07	0	0	1E-08	6.28E-10	1E-09	
23.14		generator/RSN MAT	0.2	120		0	0.000011196	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	5E-07	1E-05	9E-06	1E-06	1E-06	0	0	
23.15		generator/RSN MAT	0.2	120		0	0.000011196	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	5E-07	1E-05	9E-06	1E-06	1E-06	0	0	
23.57	2.070	boiler/B754 Café	3.2	415		2.653E-06	1.9896E-06	2E-06	2E-06	6E-06	2E-06	4E-06	2E-06	1E-05	1E-06	3E-05	0	0	0	3E-04	0	0	5E-06	3.03E-07	5E-07	
Area 25						1.826E-05	1.3696E-05	1E-05	1E-05	4E-05	1E-05	3E-05	1E-05	7E-05	7E-06	0.0002	0	0	0	0.002	0	0	4E-05	2.09E-06	4E-06	
25.01	2.410	boiler/B4015	2.68	2600		1.391E-05	1.04352E-05	1E-05	1E-05	3E-05	1E-05	2E-05	1E-05	5E-05	5.4E-06	0.0002	0	0	0	0.002	0	0	3E-05	1.59E-06	3E-06	
25.02	2.406	boiler/B4215	0.84	2600		4.348E-06	3.26079E-06	3E-06	3E-06	1E-05	3E-06	7E-06	3E-06	2E-05	1.7E-06	5E-05	0	0	0	5E-04	0	0	9E-06	4.97E-07	9E-07	
25.03	2.683	generator/ Skull Mtn.	0.2	25		0	2.38848E-06	0	0	0	0	0	0	0	0	1E-06	7E-07	7E-06	1E-07	3E-06	2E-06	2E-07	2E-07	0	0	
25.04	2.529	air comp./ X-tunnel	0.7	75		0	2.44913E-05	0	0	0	0	0	0	0	0	1E-05	7E-06	7E-05	1E-06	3E-05	2E-05	2E-06	2E-06	0	0	
Area 27						0	0.000810311	0	0	0	0	0	0	0	0	0.0004	0.0002	0.002	3E-05	0.001	7E-04	8E-05	7E-05	#VALUE!	0	
27.01	2.131	emergency generator	5.6	8		0	2.08992E-05	0	0	0	0	0	0	0	0	9E-06	6E-06	6E-05	9E-07	3E-05	2E-05	2E-06	2E-06	#VALUE!	0	
27.02	2.130	emergency generator	5.6	300		0	0.00078372	0	0	0	0	0	0	0	0	0.0003	0.0002	0.002	3E-05	1E-03	6E-04	8E-05	7E-05	#VALUE!	0	
27.03	2.619	diesel generator	0.05	65		0	1.55251E-06	0	0	0	0	0	0	0	0	7E-07	5E-07	4E-06	7E-08	2E-06	1E-06	2E-07	1E-07	#VALUE!	0	
27.04	2.669	diesel generator	0.14	65		0	4.13902E-06	0	0	0	0	0	0	0	0	2E-06	1E-06	1E-05	2E-07	5E-06	3E-06	4E-07	4E-07	#VALUE!	0	
Area 29						0	1.03491E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	9E-06	1E-06	9E-07	#VALUE!	0	
29.01	2.602	diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	5E-06	3E-06	3E-05	4E-07	1E-05	9E-06	1E-06	9E-07	#VALUE!	0	

Nevada Test Site Emission Inventory

TONS/YR

Hazardous Air Pollutant Emissions

emission source #	old permit #	Equipment	process rate (ton/hr) or *heat rate (MMBtu/hr)*	operating hours (hr/yr)	control (%)	As (ton/yr)	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
						Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals
						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0.0002	1.7E-05	0.0231	0.0156	0.143	0.002	0.07	0.042	0.0061	0.006	#REF!	#REF!	#REF!
CHEMICAL RELEASES/FUME HOODS																										
AREA 5																										
HSC																										
HSC Chemical Releases																										
5.008		Chemical releases																								

Nevada Test Site Emission Inventory

LBS/HR

Hazardous Air Pollutant Emissions

						Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals
						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0.0004748	4.85E-05	0.068851	0.0470863	0.4280548	0.008457	0.206736	0.1288636	0.0182768	0.0142806	#VALUE!	2.479E-05	#VALUE!
emission source #	old permit #	Equipment	process rate (ton/hr) or heat rate (MMBtu/hr)	operating hours (hr/yr)	control (%)	As (lb/hr)	Be (lb/hr)	Cd (lb/hr)	Cr (lb/hr)	Pb (lb/hr)	Hg (lb/hr)	Mn (lb/hr)	Ni (lb/hr)	Se (lb/hr)	Benzene (lb/hr)	Toluene (lb/hr)	Xylenes (lb/hr)	Propylene (lb/hr)	1,3-Butadiene (lb/hr)	Formaldehyde (lb/hr)	Acetaldehyde (lb/hr)	Acrolein (lb/hr)	Napthalene (lb/hr)	Ethylbenzene (lb/hr)	o-Xylene (lb/hr)	Phosphorous (P) (lb/hr)
AGGREGATE PROCESSING EQUIPMENT																										
Area 1 Shaker Plant						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
1.14		Baghouse 02				#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
14A	1.016	C-7 to Rotary	100	250	99	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
14B	2.023	Rotary Dryer	100	250	99	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
Area 1 Concrete Batch Plant						1.586E-05	1.029E-07	2.148E-06	4.888E-06	7.308E-06	0	0.0016061	0.0001864	0	0	0	0	0	0	0	0	0	0	0	0	[illegible]
1.46		Baghouse 04				1.176E-05	1.253E-07	1.638E-06	1.764E-06	5.152E-06	0	0.001414	0.0001232	0	0	0	0	0	0	0	0	0	0	0	0	0.0000826
46A	2.026	loading over	50	31.5	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46B	1.057	loading weigh	50	31.5	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46C		loading temp.	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46D		discharge temp	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46E		loading temp.	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46F		discharge temp	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46G		loading temp.	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46H		discharge temp	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46I	2.111	loading Silo	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46J	2.112	discharge Silo	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46K	2.113	loading Silo	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46L	2.114	discharge Silo	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46M	2.115	loading Silo	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46N	2.116	discharge Silo	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
1.47		Baghouse 06				3.899E-06	3.759E-08	5.103E-07	2.801E-06	2.157E-06	0	0.0005221	4.221E-05	0	0	0	0	0	0	0	0	0	0	0	0	0
47A	2.028	C-2 to funnel	160	1920	99	2.688E-06	2.864E-08	3.744E-07	4.032E-07	1.178E-06	0	0.0003232	2.816E-05	0	0	0	0	0	0	0	0	0	0	0	0	1.888E-05
47B	2.027	weigh hopper 2	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
47C	2.029	truck loading	160	1920	99	3.712E-07	0	1.888E-08	2.272E-06	6.112E-07	0	9.792E-05	5.248E-06	0	0	0	0	0	0	0	0	0	0	0	0	3.232E-05
Area 6 Conveying Equipment						0.0001209	1.383E-06	1.084E-05	2.43E-05	8.436E-05	0	0.0144062	0.0012872	1.31E-06	0	0	0	0	0	0	0	0	0	0	0	[illegible]
6.001	2.032	Scale #1	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
6.002	2.033	Scale #2	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
6.003	2.034	Scale #3	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
123A		Baghouse 07/back-up				2.688E-06	2.864E-08	3.744E-07	4.032E-07	1.178E-06	0	0.0003232	2.816E-05	0	0	0	0	0	0	0	0	0	0	0	0	1.888E-05
123B		waste silo	10	1920	99	1.68E-07	1.79E-09	2.34E-08	2.52E-08	7.36E-08	0	0.0000202	1.76E-06	0	0	0	0	0	0	0	0	0	0	0	0	1.18E-06
6.004		Baghouse 10				1.636E-06	1.22E-07	2.3E-08	6.41E-06	2.001E-06	0	0.0000612	7.59E-06	1.31E-06	0	0	0	0	0	0	0	0	0	0	0	0.0000293
4A	2.035	Load blending	50	8.5	99	1.16E-07	0	5.9E-09	7.1E-07	1.91E-07	0	0.0000306	1.64E-06	0	0	0	0	0	0	0	0	0	0	0	0	0.0000101
4B	2.036	Blending tank	50	8.5	99	1.52E-06	1.22E-07	1.71E-08	0.0000057	1.81E-06	0	0.0000306	5.95E-06	1.31E-06	0	0	0	0	0	0	0	0	0	0	0	0.0000192
6.005		Bin Vent #1				0.000014	1.492E-07	1.95E-06	0.0000021	6.133E-06	0	0.0016833	0.0001467	0	0	0	0	0	0	0	0	0	0	0	0	9.833E-05
6.006		Bin Vent #3				0.000014	1.492E-07	1.95E-06	0.0000021	6.133E-06	0	0.0016833	0.0001467	0	0	0	0	0	0	0	0	0	0	0	0	9.833E-05
6.007		Bin Vent #4				0.000014	1.492E-07	1.95E-06	0.0000021	6.133E-06	0	0.0016833	0.0001467	0	0	0	0	0	0	0	0	0	0	0	0	9.833E-05
867A	2.037	Silo #1	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
867B	2.038	Silo #2	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
867C	2.039	Silo #3	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
867D	2.040	Silo #4	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
867E	2.041	Silo #5	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
6.008		Bin Vent #8				0.0000168	1.79E-07	2.34E-06	2.52E-06	7.36E-06	0	0.00202	0.000176	0	0	0	0	0	0	0	0	0	0	0	0	0.000118
8A	2.042	Silo #7	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
8B	2.043	Silo #8	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
6.009	2.044	Silo #15	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
6.010	2.045	Silo #16	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
6.011		Bin Vent #1				0.0000126	1.343E-07	1.755E-06	1.89E-06	5.52E-06	0	0.001515	0.000132	0	0	0	0	0	0	0	0	0	0	0	0	0.0000885
6.012		Bin Vent #1				0.0000126	1.343E-07	1.755E-06	1.89E-06	5.52E-06	0	0.001515	0.000132	0	0	0	0	0	0	0	0	0	0	0	0	0.0000885
1112A	2.046	Silo #17	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
1112B	2.047	Silo #18	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
1112C	2.048	Silo #19	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
6.013		Baghouse 0				9.24E-06	9.845E-08	1.287E-06	1.386E-06	4.048E-06	0	0.001111	0.0000968	0	0	0	0	0	0	0	0	0	0	0	0	0.0000649
13A	2.049	Silo #9	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13B	2.050	Silo #10	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13C	2.051	Silo #11	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13D	2.052	Silo #12	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13E	2.053	Silo #13	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13F	2.054	Silo #14	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13G	2.055	Silo #27	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13H	2.056	Silo #28	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13I	2.057	Silo #29	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13J	2.058	Silo #30	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13K	2.059	Silo #31	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
6.014		Baghouse 0				6.72E-06	7.16E-08	9.36E-07	1.008E-06	2.944E-06	0	0.000808	0.0000704	0	0	0	0	0	0	0	0	0	0	0	0	0.0000472
14A	2.060	Silo #21	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14B	2.061	Silo #22	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14C	2.062	Silo #23	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14D	2.063	Silo #24	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14E	2.064	Silo #25	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14F	2.065	Silo #26	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14G	2.066	Silo #32	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14H	2.067	Silo #33	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
Area 6 Construction storage yard						0	0.0663	0	0	0	0	0	0	0	0	0.02045	0.01425	0.129	0.001955	0.059	0.03635	0.004825	0.00424	0	0	0

6.111		Baghouse 11					0.04665	0	0	0	0	0	0	0	0	0.02045	0.01425	0.129	0.001955	0.059	0.03835	0.004625	0.00424	0	0	0
6.110	2.119	misc portable s	50	1920	99	0	0.04665	0	0	0	0	0	0	0	0	0.02045	0.01425	0.129	0.001955	0.059	0.03835	0.004625	0.00424	0	0	0
Area 12 Batch Plant						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.01	1.067	loading hoppe	50	504	75.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.02	1.068	discharge hopp	50	504	50.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.03		Baghouse 11				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3A	2.073	loading silo #1	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3B	2.074	loading silo #2	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.04		Baghouse 13				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4A		weigh hopper	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4B	2.075	conveyor to	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.05	2.076	loadout	50	504	50.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 12 Portable Cement Silos						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.06		Baghouse 14				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6A		Multiple portab	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6B		Multiple portab	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6C	2.125	surge #1 loadin	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6D	2.126	surge #1 disch	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6E	2.127	surge #2 loadin	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6F	2.128	surge #2 disch	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MSTA						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.111		Baghouse 11				.0000008.4	0	0	0	0	#REF!	0	0	0.0003511	3.603E-05	0	0	0	0	0	0	0	0	1.071E-05	1.835E-05	0
6.893	2.119	portable silo	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.894	2.121	portable silo	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.895	2.123	portable silo	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

COMBUSTION EQUIPMENT

Area 1 U1A						0	0.0013062	0	0	0	0	0	0	0	0	0.0005726	0.000399	0.003612	5.474E-05	0.001652	0.0010738	0.0001295	0.0001187	0	0	0
1.75	2.521	diesel air comp	0.70	75	0	0	0.0006531	0	0	0	0	0	0	0	0	0.0002863	0.0001995	0.001806	2.737E-05	0.000826	0.0005369	6.475E-05	5.936E-05	0	0	0
1.76		diesel generato	0.70	65	0	0	0.0006531	0	0	0	0	0	0	0	0	0.0002863	0.0001995	0.001806	2.737E-05	0.000826	0.0005369	6.475E-05	5.936E-05	0	0	0
Area 1 U1G						0	0.0041097	0	0	0	0	0	0	0	0	0.0018016	0.0012554	0.0113644	0.0001722	0.0051977	0.0033785	0.0004074	0.0003736	0	0	0
1.77	2.679	diesel generato	0.20	65	0	0	0.0001911	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0005284	8.006E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	0
1.78	2.161	emergency gen	4.20	65	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
Area 1 Drilling Storage Yard						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0	0	0.0011452	0.000798	0.007224	0.0001095	0.003304	0.0021476	0.000259	0.0002374	0	0	0
1.79	2.804	fluid pump	1.40	50	0	0	0.0013062	0	0	0	0	0	0	0	0	0.0005726	0.000399	0.003612	5.474E-05	0.001652	0.0010738	0.0001295	0.0001187	0	0	0
1.80	2.806	mud pump	1.40	300	0	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0	0	0.0005726	0.000399	0.003612	5.474E-05	0.001652	0.0010738	0.0001295	0.0001187	0	0	0
Area 5 Check Point Pass						0	0.0001911	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0005284	8.006E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0		
5.001	2.677	diesel gen.(68	0.2048	28			0.0001911							0	0	8.376E-05	5.837E-05	0.0005284	8.006E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	0
Area 5 NEF						0	0.0001062	0	0	0	0	0	0	0	0	4.744E-05	3.306E-05	0.0002993	4.536E-06	0.0001369	8.897E-05	1.073E-05	9.837E-06	0		
5.002	2.658	diesel gen.(34	0.116	18			0.0001062							0	0	4.744E-05	3.306E-05	0.0002993	4.536E-06	0.0001369	8.897E-05	1.073E-05	9.837E-06	0	0	0
Area 5 NPTEC						0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0		
5.007	2.165	diesel generato	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
Area 6 Heavy Equipment Yard																										
6.028	2.500	diesel air comp	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.029	2.507	diesel air comp	0.2063	75	0	0	0.0001943	0	0	0	0	0	0	0	0	8.519E-05	5.937E-05	0.0005374	8.145E-06	0.0002458	0.0001598	1.927E-05	1.766E-05	0	0	0
6.030	2.506	diesel air comp	0.2063	30	0	0	0.0001943	0	0	0	0	0	0	0	0	8.519E-05	5.937E-05	0.0005374	8.145E-06	0.0002458	0.0001598	1.927E-05	1.766E-05	0	0	0
6.031	2.528	diesel air comp	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.032	2.530	diesel air comp	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.033	2.531	diesel air comp	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.034	2.532	diesel air comp	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.035	2.533	diesel air comp	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.036	2.534	diesel air comp	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.037	2.551	diesel air comp	0.2038	75	0	0	0.0001901	0	0	0	0	0	0	0	0	8.335E-05	5.808E-05	0.0005258	7.969E-06	0.0002405	0.0001563	1.885E-05	1.728E-05	0	0	0
6.038	2.552	diesel air comp	0.2038	75	0	0	0.0001901	0	0	0	0	0	0	0	0	8.335E-05	5.808E-05	0.0005258	7.969E-06	0.0002405	0.0001563	1.885E-05	1.728E-05	0	0	0
6.039	2.553	diesel air comp	0.2038	17	0	0	0.0001901	0	0	0	0	0	0	0	0	8.335E-05	5.808E-05	0.0005258	7.969E-06	0.0002405	0.0001563	1.885E-05	1.728E-05	0	0	0
6.040		diesel air comp	0.2	75	0	0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
6.041	2.141	diesel air comp	1.8822	150	0	0	0.0017561	0	0	0	0	0	0	0	0	0.0007698	0.0005364	0.0048561	7.359E-05	0.002221	0.0014436	0.0001741	0.0001596	0	0	0
6.042		diesel generato	0.3413	65		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.043		diesel generato	0.3413	65		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.044	2.132	diesel generato	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.045	2.133	diesel generato	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.046	2.134	diesel generato	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.047	2.139	diesel generato	4.2	9	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.048	2.611	diesel generato	0.3413	65	0	0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.049	2.628	diesel generato	0.07	65		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.050	2.647	diesel generato	0.07	65		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.051	2.648	diesel generato	0.07	65		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.052	2.656	diesel generato	0.1	9		0	0.0000933	0	0	0	0	0	0	0	0	0.0000409	0.0000285	0.000258	3.91E-06	0.000118	0.0000767	9.25E-06	8.48E-06	0	0	0
6.053	2.657	diesel generato	0.1024	65	0	0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
6.054	2.681	diesel generato	0.2048	3	0	0	0.0001911	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0005284	8.006E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	0
6.055	2.605	diesel generato	0.3413	65	0	0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.056	2.606	diesel generato	0.3413	65	0	0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.057		diesel generato	0.3413	65		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.058		diesel generato	0.3413	65		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.059		diesel generato	0.3413	65		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.060		diesel generato	0.3413	65		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.061		gas generator	0.07	75		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.062		gas generator	0.07	75		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.063		gas generator	0.07	75		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.064		gas generator	0.07	75		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.065		gas generator	0.07	75		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.066		gas generator	0.07	75		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.067		gas generator	0.07	75		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.068		trash pump	0.026	50		0	2.426E-05	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
6.069		diesel cable	0.026	50		0	2.426E-05	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0

6.070		diesel cable re	0.026	50		0	2.426E-05	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
6.071		diesel cable re	0.026	50		0	2.426E-05	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
6.072		diesel cable re	0.026	50		0	2.426E-05	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
6.073		diesel cable re	0.026	50		0	2.426E-05	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
6.074		diesel cable re	0.026	50		0	2.426E-05	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
Area 6 CP-1						1.338E-05	0.0045973	1.003E-05	1.003E-05	3.01E-05	1.003E-05	2.007E-05	1.003E-05	5.017E-05	5.149E-06	0.0021601	0.0014013	0.0126851	0.0001922	0.00727	0.0037711	0.0004548	0.0004441	1.53E-06	2.623E-06	0
6.075	2.404	Boiler	1.6723	36.3	0	6.689E-06	5.017E-06	5.017E-06	5.017E-06	1.505E-05	5.017E-06	1.003E-05	5.017E-06	2.508E-05	2.575E-06	7.459E-05	0	0	0	0.0007341	0	0	1.359E-05	7.652E-07	1.311E-06	0
6.076	2.405	Boiler	1.6723	207.9	0	6.689E-06	5.017E-06	5.017E-06	5.017E-06	1.505E-05	5.017E-06	1.003E-05	5.017E-06	2.508E-05	2.575E-06	7.459E-05	0	0	0	0.0007341	0	0	1.359E-05	7.652E-07	1.311E-06	0
6.077	2.158	emerg. generat	4.2	11	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.078		diesel generato	0.3413	65	0	0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.079	2.614	diesel generato	0.3754	65	0	0	0.0003502	0	0	0	0	0	0	0	0	0.0001535	0.000107	0.0009685	1.468E-05	0.000443	0.0002879	3.472E-05	3.183E-05	0	0	0
Area 6 CP-18						0	0.0002388	0	0	0	0	0	0	0	0	0.0001047	7.296E-05	0.0006605	1.001E-05	0.0003021	0.0001964	2.368E-05	2.171E-05	0	0	0
6.080	2.690	diesel generato	0.256	65	0	0	0.0002388	0	0	0	0	0	0	0	0	0.0001047	7.296E-05	0.0006605	1.001E-05	0.0003021	0.0001964	2.368E-05	2.171E-05	0	0	0
Area 6 CP-40						0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.081	2.603	diesel generato	0.3413	5	0	0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
Area 6 CP-43						0	0.0001911	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0005284	8.008E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	0
6.082	2.673	diesel generato	0.2048	26	0	0	0.0001911	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0005284	8.008E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	0
Area 6 CP-70						0	0.000398	0	0	0	0	0	0	0	0	0.0001745	0.0001216	0.0011006	1.668E-05	0.0005034	0.0003272	3.946E-05	3.618E-05	0	0	0
6.083	2.618	diesel generato	0.4266	35	0	0	0.000398	0	0	0	0	0	0	0	0	0.0001745	0.0001216	0.0011006	1.668E-05	0.0005034	0.0003272	3.946E-05	3.618E-05	0	0	0
Area 6 CP-8						3.344E-06	0.0078397	2.508E-06	2.508E-06	7.525E-06	2.508E-06	5.017E-06	2.508E-06	1.254E-05	1.287E-06	0.0034729	0.002394	0.021672	0.0003284	0.010279	0.0064428	0.000777	0.0007191	3.826E-07	6.556E-07	0
6.084	2.403	Boiler	0.8361	417.6	0	3.344E-06	2.508E-06	2.508E-06	2.508E-06	7.525E-06	2.508E-06	5.017E-06	2.508E-06	1.254E-05	1.287E-06	3.729E-05	0	0	0	0.000367	0	0	6.797E-06	3.826E-07	6.556E-07	0
6.085	2.156	emerg. generat	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.086	2.163	emerg. generat	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
Area 6 DAF						0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	0	0	0
6.087	2.160	emerg. generat	5.6	13	0	0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	0	0	0
6.088	2.159	emerg. generat	5.6	13	0	0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	0	0	0
6.089	2.407	Boiler	2.3412	2600	0	9.365E-06	7.024E-06	7.024E-06	7.024E-06	2.107E-05	7.024E-06	1.405E-05	7.024E-06	3.512E-05	3.604E-06	0.0001044	0	0	0	0.0010278	0	0	1.903E-05	1.071E-06	1.836E-06	0
6.090	2.408	Boiler	2.3412	2600	0	9.365E-06	7.024E-06	7.024E-06	7.024E-06	2.107E-05	7.024E-06	1.405E-05	7.024E-06	3.512E-05	3.604E-06	0.0001044	0	0	0	0.0010278	0	0	1.903E-05	1.071E-06	1.836E-06	0
Area 6 Decon						2.072E-05	1.554E-05	1.554E-05	1.554E-05	4.662E-05	1.554E-05	3.108E-05	1.554E-05	0.0000777	7.975E-06	0.0002311	0	0	0	0.002274	0	0	4.211E-05	2.37E-06	4.062E-06	0
6.091	2.068	Boiler	5.18	1000	0	2.072E-05	1.554E-05	1.554E-05	1.554E-05	4.662E-05	1.554E-05	3.108E-05	1.554E-05	0.0000777	7.975E-06	0.0002311	0	0	0	0.002274	0	0	4.211E-05	2.37E-06	4.062E-06	0
Area 6 Iron Workers Yard						0	0.000126	0	0	0	0	0	0	0	0	5.522E-05	3.848E-05	0.0003483	5.279E-06	0.0001593	0.0001035	1.249E-05	1.145E-05	0	0	0
6.092		diesel cable re	0.135	50		0	0.000126	0	0	0	0	0	0	0	0	5.522E-05	3.848E-05	0.0003483	5.279E-06	0.0001593	0.0001035	1.249E-05	1.145E-05	0	0	0
Area 6 Well 3 Yard						0	0.0012689	0	0	0	0	0	0	0	0	0.0005562	0.0003876	0.0035088	5.316E-05	0.0016048	0.0010431	0.0001258	0.0001153	0	0	0
6.096	2.097	bin	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.097		diesel generato	0.34	65		0	0.0003172	0	0	0	0	0	0	0	0	0.0001391	0.0000969	0.0008772	1.329E-05	0.0004012	0.0002608	3.145E-05	2.883E-05	0	0	0
6.098		diesel generato	0.34	65		0	0.0003172	0	0	0	0	0	0	0	0	0.0001391	0.0000969	0.0008772	1.329E-05	0.0004012	0.0002608	3.145E-05	2.883E-05	0	0	0
6.099		diesel generato	0.34	65		0	0.0003172	0	0	0	0	0	0	0	0	0.0001391	0.0000969	0.0008772	1.329E-05	0.0004012	0.0002608	3.145E-05	2.883E-05	0	0	0
6.100		diesel generato	0.34	65		0	0.0003172	0	0	0	0	0	0	0	0	0.0001391	0.0000969	0.0008772	1.329E-05	0.0004012	0.0002608	3.145E-05	2.883E-05	0	0	0
Area 6 Wet/Wild						0	0.0105146	0	0	0	0	0	0	0	0	0.0046094	0.0032119	0.0290763	0.0004407	0.0132985	0.008644	0.0010425	0.0009557	0	0	0
6.101	2.542	diesel air comp	1.9739	150	0	0	0.0018416	0	0	0	0	0	0	0	0	0.0008073	0.0005626	0.0050927	7.718E-05	0.0023292	0.001514	0.0001826	0.0001674	0	0	0
6.102	2.543	diesel air comp	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.103	2.544	diesel air comp	1.9739	150	0	0	0.0018416	0	0	0	0	0	0	0	0	0.0008073	0.0005626	0.0050927	7.718E-05	0.0023292	0.001514	0.0001826	0.0001674	0	0	0
6.104	2.545	diesel air comp	1.9739	150	0	0	0.0018416	0	0	0	0	0	0	0	0	0.0008073	0.0005626	0.0050927	7.718E-05	0.0023292	0.001514	0.0001826	0.0001674	0	0	0
6.105		diesel air comp	1.9739	150		0	0.0018416	0	0	0	0	0	0	0	0	0.0008073	0.0005626	0.0050927	7.718E-05	0.0023292	0.001514	0.0001826	0.0001674	0	0	0
6.106		conveyor	250	100		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.107		pump	0.7	50		0	0.0006531	0	0	0	0	0	0	0	0	0.0002863	0.0001995	0.001806	2.737E-05	0.000826	0.0005369	6.475E-05	5.936E-05	0	0	0
6.108		diesel air comp	1.9739	150	0	0	0.0018416	0	0	0	0	0	0	0	0	0.0008073	0.0005626	0.0050927	7.718E-05	0.0023292	0.001514	0.0001826	0.0001674	0	0	0
Area 6 Other misc. equipment						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.109		abrasive blaster		50		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 12 Cafeteria						2.149E-05	1.612E-05	1.612E-05	1.612E-05	4.835E-05	1.612E-05	3.224E-05	1.612E-05	8.059E-05	8.271E-06	0.0002396	0	0	0	0.0023586	0	0	4.368E-05	2.458E-06	4.213E-06	0
12.07	2.402	boiler	1.7726	2600	0.0	7.09E-06	5.318E-06	5.318E-06	5.318E-06	1.595E-05	5.318E-06	1.064E-05	5.318E-06	2.659E-05	2.729E-06	7.907E-05	0	0	0	0.0007782	0	0	1.441E-05	8.111E-07	1.39E-06	0
12.08	2.072	boiler	3.6	2600	0.0	0.0000144	0.0000108	0.0000108	0.0000108	0.0000324	0.0000108	0.0000216	0.0000108	0.000054	5.542E-06	0.0001606	0	0	0	0.0015804	0	0	2.927E-05	1.647E-06	2.823E-06	0
Area 12 G-Tunnel						1.092E-06	0.0006376	8.19E-07	8.19E-07	2.457E-06	8.19E-07	1.638E-06	8.19E-07	4.095E-06	4.203E-07	0.0002913	0.0001945	0.0017609	2.668E-05	0.0009252	0.0005235	6.313E-05	6.01E-05	1.249E-07	2.141E-07	0
12.09		diesel generato	0.1365	65	0.0	0	0.0001274	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	0	0	0
12.10		diesel generato	0.1365	65	0.0	0	0.0001274	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	0	0	0
12.11		diesel generato	0.1365	65	0.0	0	0.0001274	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	0	0	0
12.12		diesel generato	0.1365	65	0.0	0	0.0001274	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	0	0	0
12.13		diesel generato	0.1365	65	0.0	0	0.0001274	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	0	0	0
12.14		industrial hea	0.1365	65	0.0	5.46E-07	4.095E-07	4.095E-07	4.095E-07	1.229E-06	4.095E-07	8.19E-07	4.095E-07	2.048E-06	2.102E-07	6.088E-06	0	0	0	5.992E-05	0	0	1.11E-06	6.246E-08	1.07E-07	0
12.15		steam cleaner	0.1365	65	0.0	5.46E-07	4.095E-07	4.095E-07	4.095E-07	1.229E-06	4.095E-07	8.19E-07	4.095E-07	2.048E-06	2.102E-07	6.088E-06	0	0	0	5.992E-05	0	0	1.11E-06	6.246E-08	1.07E-07	0
Area 12 N-Tunnel						0	0.0104496	0	0	0	0	0	0	0	0	0.0045808	0.003192	0.028896	0.0004379	0.013216	0.0085904	0.001036	0.0009498	0	0	0
12.16	2.154	diesel generato	5.6	65	0.0	0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	0	0	0
12.17	2.155	diesel generato	5.6	65	0.0	0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	0	0	0
Area 12 P-Tunnel																										
12.18		diesel compre	0.2	75		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.19		diesel air dryer	0.2	75		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.20	2.701	gasoline gener	0.0683	75	0.0	0	6.372E-05	0	0	0	0	0	0	0	0	2.793E-05	1.947E-05	0.0001762	2.671E-06	8.059E-05	5.239E-05	6.318E-06	5.792E-06	0	0	0
Area 12 T-Tunnel						0	0.0054114	0	0	0	0	0	0	0	0	0.0023722	0.001653	0.014964	0.0002268	0.006844	0.0044486	0.0005365	0.0004918	0	0	0
12.21		diesel generato	0.2	120		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.22	2.153	diesel generato	5.6	65	0.0	0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	0	0	0
Area 12 U-Tunnel						0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.23		diesel generato	0.2	65		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
Area 12 Yard						0	0.0039662	0	0	0	0	0	0	0	0	0.0017631	0.0012218	0.0110589	0.0001676	0.005066	0.0032677	0.0003865	0.0003535	0	0	0
12.24		diesel generato	0.512	65		0	0.0004777	0	0	0	0	0	0	0	0	0.0002094	0.0001459	0.001321	2.002E-05	0.0006042	0.0003927	4.736E-05	4.342E-05	0	0	0
12.25		diesel generato	0.512	65		0	0.0004777	0	0	0	0	0	0	0	0	0.0002094	0.0001459	0.001321	2.002E-05	0.0006042	0.0003927	4.736E-05	4.342E-05	0	0	0
12.26		diesel generato	0.512	65		0	0.0004777	0	0	0	0	0	0	0	0	0.0002094	0.0001459	0.001321	2.002E-05	0.0006042	0.0003927	4.736E-05	4.342E-05	0	0	0
12.27		diesel generato	0.512	65		0	0.0004777	0	0	0	0	0	0	0	0	0.0002094	0.0001459	0.001321	2.002E-05	0.0006042	0.0003927	4.736E-05	4.342E-05	0	0	0
12.28		diesel generato	0.512	65		0	0.0004777	0	0	0	0	0	0	0	0	0.0002094	0.0001459	0.001321	2.002E-05	0.0006042	0.0003927	4.736E-05	4.342E-05	0	0	0
12.29		diesel generato	0.2	65		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.30		diesel generato	0.2	65		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.31		diesel generato	0.2	65		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.32		diesel generato	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.33		diesel generato	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.34		diesel generato	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.35		diesel generato	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.36		diesel generato	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.37		diesel generato	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.38		diesel generato	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0

12.39		diesel generat	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.40		diesel generat	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.41		diesel generat	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.42		diesel generat	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
Area 23 ([illegible])								[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0
23.01	2.464	generator/B1000	0.07	5		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
23.02	2.604	generator/B1010	0.3413	15		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0006806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
23.03	2.400	boiler/B111	0.468	238.8		1.872E-06	1.404E-06	1.404E-06	1.404E-06	4.212E-06	1.404E-06	2.808E-06	1.404E-06	7.02E-06	7.205E-07	2.087E-05	0	0	0	0.0002056	0	0	3.805E-06	2.141E-07	3.67E-07	0
23.04	2.401	boiler/B128	0.836	289.7		3.344E-06	2.508E-06	2.508E-06	2.508E-06	7.524E-06	2.508E-06	5.016E-06	2.508E-06	1.254E-05	1.287E-06	3.729E-05	0	0	0	0.000367	0	0	6.796E-06	3.825E-07	6.556E-07	0
23.05	2.408	boiler/B156	0.3345	437.8		1.338E-06	1.004E-06	1.004E-06	1.004E-06	3.011E-06	1.004E-06	2.007E-06	1.004E-06	5.018E-06	5.15E-07	1.492E-05	0	0	0	0.0001468	0	0	2.719E-06	1.531E-07	2.623E-07	0
23.06	2.801	emergency gene	0.0683	3		0	6.372E-05	0	0	0	0	0	0	0	0	2.793E-05	1.947E-05	0.0001762	2.671E-06	8.059E-05	5.239E-05	6.316E-06	5.792E-06	0	0	0
23.07	2.411	boiler/B536	1.77	583.9		7.08E-06	5.31E-06	5.31E-06	5.31E-06	1.593E-05	5.31E-06	1.062E-05	5.31E-06	2.655E-05	2.725E-06	7.895E-05	0	0	0	0.000777	0	0	1.439E-05	6.099E-07	1.386E-06	0
23.08		diesel generator	0.2	120		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
23.09	2.157	emergency gene	4.2	12		0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
23.10	2.164	emergency gene	4.2	185		0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
23.11	2.070	boiler/B754 Caf	3.2	1010.9		0.0000128	0.0000096	0.0000096	0.0000096	0.0000288	0.0000096	0.0000192	0.0000096	0.000048	4.927E-06	0.0001427	0	0	0	0.0014048	0	0	2.601E-05	1.464E-06	2.509E-06	0
23.12	2.071	boiler/B763	6.44	576.2		2.576E-05	1.932E-05	1.932E-05	1.932E-05	5.796E-05	1.932E-05	3.864E-05	1.932E-05	0.0000966	9.915E-06	0.0002873	0	0	0	0.0028272	0	0	5.235E-05	2.947E-06	5.05E-06	0
23.13	2.152	incinerator	0.315	872	99.0	1.26E-08	9.45E-09	9.45E-09	9.45E-09	2.835E-08	9.45E-09	1.89E-08	9.45E-09	4.725E-08	4.85E-09	1.405E-07	0	0	0	1.363E-06	0	0	2.561E-08	1.441E-09	2.47E-09	0
23.14		generator/RSM	0.2	120		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
23.15		generator/RSM	0.2	120		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
23.57	2.070	boiler/B754 Caf	3.2	270.7		0.0000128	0.0000096	0.0000096	0.0000096	0.0000288	0.0000096	0.0000192	0.0000096	0.000048	4.927E-06	0.0001427	0	0	0	0.0014048	0	0	2.601E-05	1.464E-06	2.509E-06	0
Area 25								[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	#VALUE!	[illegible]	#VALUE!
25.01	2.410	5	2.6757	2600		1.07E-05	8.027E-06	8.027E-06	8.027E-06	2.408E-05	8.027E-06	1.605E-05	8.027E-06	4.014E-05	4.119E-06	0.0001193	0	0	0	0.0011746	0	0	2.175E-05	1.224E-06	2.098E-06	#VALUE!
25.02	2.406	5	0.8361	2600		3.344E-06	2.508E-06	2.508E-06	2.508E-06	7.525E-06	2.508E-06	5.017E-06	2.508E-06	1.254E-05	1.287E-06	3.729E-05	0	0	0	0.000367	0	0	6.797E-06	3.826E-07	6.556E-07	#VALUE!
25.03	2.683	Skull Mtn.	0.2048	25		0	0.0001911	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0005284	8.006E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	#VALUE!
25.04	2.529	tunnel	0.7	75		0	0.0006531	0	0	0	0	0	0	0	0	0.0002863	0.0001995	0.001806	2.737E-05	0.000826	0.0005369	6.475E-05	5.936E-05	0	0	#VALUE!
Area 27								0	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	#VALUE!	0	0
27.01	2.131	emergency gen	5.6	35		0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	#VALUE!	0	0
27.02	2.130	emergency gen	5.6	10		0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	#VALUE!	0	0
27.03	2.619	diesel generat	0.0512	65		0	4.777E-05	0	0	0	0	0	0	0	0	2.094E-05	1.459E-05	0.0001321	2.002E-06	6.042E-05	3.927E-05	4.736E-06	4.342E-06	#VALUE!	0	0
27.04	2.689	diesel generat	0.1365	65		0	0.0001274	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	#VALUE!	0	0
Area 29								0	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	#VALUE!	0	0
29.01	2.602	diesel generat	0.3413	65		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0006806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	#VALUE!	0	0

Nevada Test Site Emission Inventory

LBS/HR

Hazardous Air Pollutant Emissions

AGGREGATE PROCESSING EQUIPMENT

emission source #	old permit #	Equipment	process rate (ton/hr) or heat rate (MMBtu/hr)	operating hours (hr/yr)	control (%)	As (lb/hr)	Be (lb/hr)	Cd (lb/hr)	Cr (lb/hr)	Pb (lb/hr)	Hg (lb/hr)	Mn (lb/hr)	Ni (lb/hr)	Se (lb/hr)	Benzene (lb/hr)	Toluene (lb/hr)	Xylenes (lb/hr)	Propylene (lb/hr)	1,3-Butadiene (lb/hr)	Formaldehyde (lb/hr)	Acetaldehyde (lb/hr)	Acrolein (lb/hr)	Napthalene (lb/hr)	Ethylbenzene (lb/hr)	o-Xylene (lb/hr)	Phosphorous (P) (lb/hr)
Totals						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0.0004748	4.86E-06	[illegible]	0.0470863	0.4260646	[illegible]	[illegible]	[illegible]	0.0162789	0.0142806	#VALUE!	2.478E-05	#VALUE!
Area 1 Shaker Plant						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
1.14		Baghouse 02				#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
14A	1.016	C-7 to Rotary dryer	100	250	99	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
14B	2.023	Rotary Dryer	100	250	99	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
Area 1 Concrete Batch Plant						[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	0.0001654	0	0	0	0	0	0	0	0	0	0	0	0	[illegible]
1.46		Baghouse 04				1.176E-05	1.253E-07	1.638E-06	1.764E-06	5.152E-06	0	0.001414	0.0001232	0	0	0	0	0	0	0	0	0	0	0	0	0.0000826
46A	2.026	loading overhead bin	50	31.5	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46B	1.057	loading weigh hopper	50	31.5	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46C		loading temp. bin A	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46D		discharge temp bin A	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46E		loading temp. bin B	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46F		discharge temp bin B	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46G		loading temp. bin C	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46H		discharge temp bin C	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46I	2.111	loading Silo #3	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46J	2.112	discharge Silo #3	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46K	2.113	loading Silo #4	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46L	2.114	discharge Silo #4	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46M	2.115	loading Silo #5	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46N	2.116	discharge Silo #5	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
1.47		Baghouse 06				3.899E-06	3.759E-08	5.103E-07	2.801E-06	2.157E-06	0	0.0005221	4.221E-05	0	0	0	0	0	0	0	0	0	0	0	0	0
47A	2.028	C-2 to funnel	160	1920	99	2.688E-06	2.864E-08	3.744E-07	4.032E-07	1.178E-06	0	0.0003232	2.816E-05	0	0	0	0	0	0	0	0	0	0	0	0	1.888E-05
47B	2.027	weigh hopper 2 to funnel	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
47C	2.029	truck loading	160	1920	99	3.712E-07	0	1.888E-08	2.272E-06	6.112E-07	0	9.792E-05	5.248E-06	0	0	0	0	0	0	0	0	0	0	0	0	3.232E-05
Area 6 Conveying Equipment						[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	1.31E-06	0	0	0	0	0	0	0	0	0	0	0	[illegible]
6.001	2.032	Scale #1	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
6.002	2.033	Scale #2	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
6.003	2.034	Scale #3	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
123A		Baghouse 07/back-up				2.688E-06	2.864E-08	3.744E-07	4.032E-07	1.178E-06	0	0.0003232	2.816E-05	0	0	0	0	0	0	0	0	0	0	0	0	1.888E-05
123B		waste silo	10	1920	99	1.68E-07	1.79E-09	2.34E-08	2.52E-08	7.36E-08	0	0.0000202	1.76E-06	0	0	0	0	0	0	0	0	0	0	0	0	1.18E-06
6.004		Baghouse 10				1.636E-06	1.22E-07	2.3E-08	6.41E-06	2.001E-06	0	0.0000612	7.59E-06	1.31E-06	0	0	0	0	0	0	0	0	0	0	0	0.0000293
4A	2.035	Load blending tank	50	8.5	99	1.16E-07	0	5.9E-09	7.1E-07	1.91E-07	0	0.0000306	1.64E-06	0	0	0	0	0	0	0	0	0	0	0	0	0.0000101
4B	2.036	Blending tank discharge	50	8.5	99	1.52E-06	1.22E-07	1.71E-06	0.0000057	1.81E-06	0	0.0000306	5.95E-06	1.31E-06	0	0	0	0	0	0	0	0	0	0	0	0.0000192
6.005		Bin Vent #1				0.000014	1.492E-07	1.95E-06	0.0000021	6.133E-06	0	0.0016833	0.0001467	0	0	0	0	0	0	0	0	0	0	0	0	9.833E-05
6.006		Bin Vent #3				0.000014	1.492E-07	1.95E-06	0.0000021	6.133E-06	0	0.0016833	0.0001467	0	0	0	0	0	0	0	0	0	0	0	0	9.833E-05
6.007		Bin Vent #4				0.000014	1.492E-07	1.95E-06	0.0000021	6.133E-06	0	0.0016833	0.0001467	0	0	0	0	0	0	0	0	0	0	0	0	9.833E-05
967A	2.037	Silo #1	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
967B	2.038	Silo #2	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
967C	2.039	Silo #3	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
967D	2.040	Silo #4	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
967E	2.041	Silo #5	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
6.008		Bin Vent #6				0.0000168	1.79E-07	2.34E-06	2.52E-06	7.36E-06	0	0.00202	0.000176	0	0	0	0	0	0	0	0	0	0	0	0	0.000118
8A	2.042	Silo #7	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
8B	2.043	Silo #8	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
6.009	2.044	Silo #15	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
6.010	2.045	Silo #16	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
6.011		Bin Vent #18				0.0000126	1.343E-07	1.755E-06	1.89E-06	5.52E-06	0	0.001515	0.000132	0	0	0	0	0	0	0	0	0	0	0	0	0.0000885
6.012		Bin Vent #19				0.0000126	1.343E-07	1.755E-06	1.89E-06	5.52E-06	0	0.001515	0.000132	0	0	0	0	0	0	0	0	0	0	0	0	0.0000885
1112A	2.046	Silo #17	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
1112B	2.047	Silo #18	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
1112C	2.048	Silo #19	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
6.013		Baghouse 08				9.24E-06	9.845E-08	1.287E-06	1.386E-06	4.048E-06	0	0.001111	0.0000968	0	0	0	0	0	0	0	0	0	0	0	0	0.0000649
13A	2.049	Silo #9	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13B	2.050	Silo #10	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13C	2.051	Silo #11	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13D	2.052	Silo #12	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13E	2.053	Silo #13	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13F	2.054	Silo #14	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13G	2.055	Silo #27	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13H	2.056	Silo #28	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13I	2.057	Silo #29	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13J	2.058	Silo #30	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13K	2.059	Silo #31	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
6.014		Baghouse 09				6.72E-06	7.16E-08	9.36E-07	1.008E-06	2.944E-06	0	0.000808	0.0000704	0	0	0	0	0	0	0	0	0	0	0	0	0.0000472
14A	2.060	Silo #21	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14B	2.061	Silo #22	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14C	2.062	Silo #23	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14D	2.063	Silo #24	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14E	2.064	Silo #25	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14F	2.065	Silo #26	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14G	2.066	Silo #32	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14H	2.067	Silo #33	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
Area 6 Construction storage yard						0	0.0033	0	0	0	0	0	0	0	0	0.02046	0.01425	0.129	0.001868	0.059	0.08636	0.004625	0.00424	0	0	0

6.111		Baghouse 11					0.04665	0	0	0	0	0	0	0	0	0.02045	0.01425	0.129	0.001955	0.059	0.03835	0.004625	0.00424	0	0	0
6.110	2.119	misc portable silos (7)	50	1920	99	0	0.04665	0	0	0	0	0	0	0	0	0.02045	0.01425	0.129	0.001955	0.059	0.03835	0.004625	0.00424	0	0	0
Area 12 Batch Plant						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.01	1.067	loading hopper	50	504	75.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.02	1.068	discharge hopper	50	504	50.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.03		Baghouse 11				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3A	2.073	loading silo #1	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3B	2.074	loading silo #2	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.04		Baghouse 13				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4A		weigh hopper/scale	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4B	2.075	conveyor to loadout	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.05	2.076	loadout	50	504	50.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 12 Portable Cement Silos						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.06		Baghouse 14				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6A		Mutiple portable bins	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6B		Mutiple portable bins	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6C	2.125	surge #1 loading	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6D	2.126	surge #1 discharge	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6E	2.127	surge #2 loading	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6F	2.128	surge #2 discharge	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UOTA						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.111		Baghouse 11				.0000008.4	0	0	0	0	#REFI	0	0	0.0003511	3.603E-05	0	0	0	0	0	0	0	0	1.071E-05	1.835E-05	0
6.093	2.119	portable silo	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.094	2.121	portable silo	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.095	2.123	portable silo	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

COMBUSTION EQUIPMENT

Area 1 U1A						0	0.0013062	0	0	0	0	0	0	0	0	0.0005726	0.000399	0.003612	5.474E-05	0.001652	0.0010738	0.0001295	0.0001187	0	0	0
1.75	2.521	diesel air compressor	0.70	75	0	0	0.0006531	0	0	0	0	0	0	0	0	0.0002863	0.0001995	0.001806	2.737E-05	0.000626	0.0005369	6.475E-05	5.936E-05	0	0	0
1.76		diesel generator	0.70	65	0	0	0.0006531	0	0	0	0	0	0	0	0	0.0002863	0.0001995	0.001806	2.737E-05	0.000626	0.0005369	6.475E-05	5.936E-05	0	0	0
Area 1 U1G						0	0.0041097	0	0	0	0	0	0	0	0	0.0018016	0.0012554	0.0113644	0.0001722	0.0051977	0.0033785	0.0004074	0.0003736	0	0	0
1.77	2.679	diesel generator	0.20	65	0	0	0.0001911	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0005284	8.008E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	0
1.78	2.161	emergency generator	4.20	16	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
Area 1 Drilling Storage Yard						#REFI	#REFI	#REFI	#REFI	#REFI	#REFI	#REFI	#REFI	0	0	0.0011452	0.000798	0.007224	0.0001095	0.003304	0.0021476	0.000259	0.0002374	0	0	0
1.79	2.804	fluid pump	1.40	50	0	0	0.0013062	0	0	0	0	0	0	0	0	0.0005726	0.000399	0.003612	5.474E-05	0.001652	0.0010738	0.0001295	0.0001187	0	0	0
1.80	2.806	mud pump	1.40	300	0	#REFI	#REFI	#REFI	#REFI	#REFI	#REFI	#REFI	#REFI	0	0	0.0005726	0.000399	0.003612	5.474E-05	0.001652	0.0010738	0.0001295	0.0001187	0	0	0
Area 5 Check Point Pass						0	0.0001911	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0005284	8.008E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0		
5.001	2.677	diesel gen.(60 KW)	0.2048	3			0.0001911							0	0	8.376E-05	5.837E-05	0.0005284	8.008E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	0
Area 5 WEF						0	0.0001062	0	0	0	0	0	0	0	0	4.744E-05	3.306E-05	0.0002993	4.536E-06	0.0001369	8.897E-05	1.073E-05	9.837E-06	0		
5.002	2.658	diesel gen.(34 KW)	0.116	18			0.0001062							0	0	4.744E-05	3.306E-05	0.0002993	4.536E-06	0.0001369	8.897E-05	1.073E-05	9.837E-06	0	0	0
Area 5 NPTEC						0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0		
5.007	2.165	diesel generator	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
Area 6 Heavy Equipment Yard																										
6.028	2.500	diesel air compressor	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.029	2.507	diesel air compressor	0.2063	75	0	0	0.0001943	0	0	0	0	0	0	0	0	8.519E-05	5.937E-05	0.0005374	8.145E-06	0.0002458	0.0001598	1.927E-05	1.766E-05	0	0	0
6.030	2.508	diesel air compressor	0.2063	9	0	0	0.0001943	0	0	0	0	0	0	0	0	8.519E-05	5.937E-05	0.0005374	8.145E-06	0.0002458	0.0001598	1.927E-05	1.766E-05	0	0	0
6.031	2.526	diesel air compressor	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.032	2.530	diesel air compressor	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.033	2.531	diesel air compressor	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.034	2.532	diesel air compressor	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.035	2.533	diesel air compressor	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.036	2.534	diesel air compressor	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.037	2.551	diesel air compressor	0.2038	75	0	0	0.0001901	0	0	0	0	0	0	0	0	8.335E-05	5.808E-05	0.0005258	7.989E-06	0.0002405	0.0001563	1.885E-05	1.728E-05	0	0	0
6.038	2.552	diesel air compressor	0.2038	75	0	0	0.0001901	0	0	0	0	0	0	0	0	8.335E-05	5.808E-05	0.0005258	7.989E-06	0.0002405	0.0001563	1.885E-05	1.728E-05	0	0	0
6.039	2.553	diesel air compressor	0.2038	14	0	0	0.0001901	0	0	0	0	0	0	0	0	8.335E-05	5.808E-05	0.0005258	7.989E-06	0.0002405	0.0001563	1.885E-05	1.728E-05	0	0	0
6.040		diesel air compressor	0.2	75	0	0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
6.041	2.141	diesel air compressor	1.8822	180	0	0	0.0017561	0	0	0	0	0	0	0	0	0.0007696	0.0005364	0.0048561	7.359E-05	0.002221	0.0014436	0.0001741	0.0001596	0	0	0
6.042		diesel generator	0.3413	65		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.043		diesel generator	0.3413	65		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.044	2.132	diesel generator	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.045	2.133	diesel generator	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.046	2.134	diesel generator	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.047	2.139	diesel generator	4.2	9	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.048	2.611	diesel generator	0.3413	65	0	0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.049	2.628	diesel generator	0.07	65		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.050	2.647	diesel generator	0.07	65		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.051	2.648	diesel generator	0.07	65		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.052	2.656	diesel generator	0.1	9		0	0.0000933	0	0	0	0	0	0	0	0	0.0000409	0.0000285	0.000258	3.91E-06	0.000118	0.0000767	9.25E-06	8.46E-06	0	0	0
6.053	2.657	diesel generator	0.1024	65	0	0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
6.054	2.681	diesel generator	0.2048	3	0	0	0.0001911	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0005284	8.008E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	0
6.055	2.605	diesel generator	0.3413	65	0	0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.056	2.606	diesel generator	0.3413	65	0	0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.057		diesel generator	0.3413	65		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.058		diesel generator	0.3413	65		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.059		diesel generator	0.3413	65		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.060		diesel generator	0.3413	65		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.061		gas generator	0.07	75		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.062		gas generator	0.07	75		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.063		gas generator	0.07	75		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.064		gas generator	0.07	75		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.065		gas generator	0.07	75		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.066		gas generator	0.07	75		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.067		gas generator	0.07	75		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.068		trash pump	0.026	80		0	2.426E-05	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
6.069		diesel cable reeler	0.026	80		0	2.426E-05	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0

6.070		diesel cable reeler	0.026	50		0	2.426E-05	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
6.071		diesel cable reeler	0.026	50		0	2.426E-05	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
6.072		diesel cable reeler	0.026	50		0	2.426E-05	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
6.073		diesel cable reeler	0.026	50		0	2.426E-05	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
6.074		diesel cable reeler	0.026	50		0	2.426E-05	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
Area 6 CP-1						1.338E-05	0.0045973	1.003E-05	1.003E-05	3.01E-05	1.003E-05	2.007E-05	1.003E-05	5.017E-05	5.149E-06	0.0021601	0.0014013	0.0126851	0.0001922	0.00727	0.0037711	0.0004548	0.0004441	1.53E-06	2.623E-06	0
6.075	2.404	Boiler	1.6723	36.3	0	6.689E-06	5.017E-06	5.017E-06	5.017E-06	1.505E-05	5.017E-06	1.003E-05	5.017E-06	2.508E-05	2.575E-06	7.459E-05	0	0	0	0.0007341	0	0	1.359E-05	7.652E-07	1.311E-06	0
6.076	2.405	Boiler	1.6723	207.9	0	6.689E-06	5.017E-06	5.017E-06	5.017E-06	1.505E-05	5.017E-06	1.003E-05	5.017E-06	2.508E-05	2.575E-06	7.459E-05	0	0	0	0.0007341	0	0	1.359E-05	7.652E-07	1.311E-06	0
6.077	2.158	emerg. generator	4.2	1	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.078		diesel generator	0.3413	65	0	0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.079	2.614	diesel generator	0.3754	65	0	0	0.0003502	0	0	0	0	0	0	0	0	0.0001535	0.000107	0.0009685	1.468E-05	0.000443	0.0002879	3.472E-05	3.183E-05	0	0	0
Area 6 CP-18						0	0.0002388	0	0	0	0	0	0	0	0	0.0001047	7.296E-05	0.0006605	1.001E-05	0.0003021	0.0001964	2.368E-05	2.171E-05	0	0	0
6.080	2.690	diesel generator	0.256	19	0	0	0.0002388	0	0	0	0	0	0	0	0	0.0001047	7.296E-05	0.0006605	1.001E-05	0.0003021	0.0001964	2.368E-05	2.171E-05	0	0	0
Area 6 CP-40						0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.081	2.603	diesel generator	0.3413	2	0	0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
Area 6 CP-43						0	0.0001911	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0005284	8.006E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	0
6.082	2.673	diesel generator	0.2048	23	0	0	0.0001911	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0005284	8.006E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	0
Area 6 CP-70						0	0.000398	0	0	0	0	0	0	0	0	0.0001745	0.0001216	0.0011006	1.668E-05	0.0005034	0.0003272	3.946E-05	3.618E-05	0	0	0
6.083	2.618	diesel generator	0.4266	35	0	0	0.000398	0	0	0	0	0	0	0	0	0.0001745	0.0001216	0.0011006	1.668E-05	0.0005034	0.0003272	3.946E-05	3.618E-05	0	0	0
Area 6 CP-4						3.344E-06	0.0078397	2.508E-06	2.508E-06	7.525E-06	2.508E-06	5.017E-06	2.508E-06	1.254E-05	1.287E-06	0.0034729	0.002394	0.021672	0.0003284	0.010279	0.0064428	0.000777	0.0007191	3.826E-07	6.556E-07	0
6.084	2.403	Boiler	0.8361	417.6	0	3.344E-06	2.508E-06	2.508E-06	2.508E-06	7.525E-06	2.508E-06	5.017E-06	2.508E-06	1.254E-05	1.287E-06	3.729E-05	0	0	0	0.000367	0	0	6.797E-06	3.826E-07	6.556E-07	0
6.085	2.156	emerg. generator	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.086	2.163	emerg. generator	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
Area 6 DAF						0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	0	0	0
6.087	2.160	emerg. generator	5.6	13	0	0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	0	0	0
6.088	2.159	emerg. generator	5.6	13	0	0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	0	0	0
6.089	2.407	Boiler	2.3412	2600	0	9.365E-06	7.024E-06	7.024E-06	7.024E-06	2.107E-05	7.024E-06	1.405E-05	7.024E-06	3.512E-05	3.604E-06	0.0001044	0	0	0	0.0010278	0	0	1.903E-05	1.071E-06	1.836E-06	0
6.090	2.408	Boiler	2.3412	2600	0	9.365E-06	7.024E-06	7.024E-06	7.024E-06	2.107E-05	7.024E-06	1.405E-05	7.024E-06	3.512E-05	3.604E-06	0.0001044	0	0	0	0.0010278	0	0	1.903E-05	1.071E-06	1.836E-06	0
Area 6 Decon						2.072E-05	1.554E-05	1.554E-05	1.554E-05	4.662E-05	1.554E-05	3.108E-05	1.554E-05	0.0000777	7.975E-06	0.0002311	0	0	0	0.002274	0	0	4.211E-05	2.37E-06	4.062E-06	0
6.091	2.068	Boiler	5.18	1000	0	2.072E-05	1.554E-05	1.554E-05	1.554E-05	4.662E-05	1.554E-05	3.108E-05	1.554E-05	0.0000777	7.975E-06	0.0002311	0	0	0	0.002274	0	0	4.211E-05	2.37E-06	4.062E-06	0
Area 6 Iron Workers Yard						0	0.000126	0	0	0	0	0	0	0	0	5.522E-05	3.848E-05	0.0003483	5.279E-06	0.0001593	0.0001035	1.249E-05	1.145E-05	0	0	0
6.092		diesel cable reeler	0.135	50		0	0.000126	0	0	0	0	0	0	0	0	5.522E-05	3.848E-05	0.0003483	5.279E-06	0.0001593	0.0001035	1.249E-05	1.145E-05	0	0	0
Area 6 Well 3 Yard						0	0.0012688	0	0	0	0	0	0	0	0	0.0005564	0.0003876	0.0035088	5.316E-05	0.0016048	0.0010432	0.0001258	0.0001153	0	0	0
6.096	2.097	bin	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.097		diesel generator	0.34	65		0	0.0003172	0	0	0	0	0	0	0	0	0.0001391	0.0000969	0.0008772	1.329E-05	0.0004012	0.0002608	3.145E-05	2.883E-05	0	0	0
6.098		diesel generator	0.34	65		0	0.0003172	0	0	0	0	0	0	0	0	0.0001391	0.0000969	0.0008772	1.329E-05	0.0004012	0.0002608	3.145E-05	2.883E-05	0	0	0
6.099		diesel generator	0.34	65		0	0.0003172	0	0	0	0	0	0	0	0	0.0001391	0.0000969	0.0008772	1.329E-05	0.0004012	0.0002608	3.145E-05	2.883E-05	0	0	0
6.100		diesel generator	0.34	65		0	0.0003172	0	0	0	0	0	0	0	0	0.0001391	0.0000969	0.0008772	1.329E-05	0.0004012	0.0002608	3.145E-05	2.883E-05	0	0	0
Area 6 Wet/Wild						0	0.0105146	0	0	0	0	0	0	0	0	0.0046094	0.0032119	0.0290763	0.0004407	0.0132985	0.008644	0.0010425	0.0009557	0	0	0
6.101	2.542	diesel air compressor	1.9739	150	0	0	0.0018416	0	0	0	0	0	0	0	0	0.0008073	0.0005626	0.0050927	7.718E-05	0.0023292	0.001514	0.0001826	0.0001674	0	0	0
6.102	2.543	diesel air compressor	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001996	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.103	2.544	diesel air compressor	1.9739	150	0	0	0.0018416	0	0	0	0	0	0	0	0	0.0008073	0.0005626	0.0050927	7.718E-05	0.0023292	0.001514	0.0001826	0.0001674	0	0	0
6.104	2.545	diesel air compressor	1.9739	150	0	0	0.0018416	0	0	0	0	0	0	0	0	0.0008073	0.0005626	0.0050927	7.718E-05	0.0023292	0.001514	0.0001826	0.0001674	0	0	0
6.105		diesel air compressor	1.9739	150		0	0.0018416	0	0	0	0	0	0	0	0	0.0008073	0.0005626	0.0050927	7.718E-05	0.0023292	0.001514	0.0001826	0.0001674	0	0	0
6.106		conveyor	250	100		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.107		pump	0.7	50		0	0.0006531	0	0	0	0	0	0	0	0	0.0002863	0.0001995	0.001806	2.737E-05	0.000826	0.0005369	6.475E-05	5.936E-05	0	0	0
6.108		diesel air compressor	1.9739	150	0	0	0.0018416	0	0	0	0	0	0	0	0	0.0008073	0.0005626	0.0050927	7.718E-05	0.0023292	0.001514	0.0001826	0.0001674	0	0	0
Area 6 Other misc. equipment						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.109		abrasive blaster		50		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 12 Cafeteria						2.149E-05	1.612E-05	1.612E-05	1.612E-05	4.835E-05	1.612E-05	3.224E-05	1.612E-05	8.059E-05	8.271E-06	0.0002396	0	0	0	0.0023586	0	0	4.368E-05	2.458E-06	4.213E-06	0
12.07	2.402	boiler	1.7726	2600	0.0	7.09E-06	5.318E-06	5.318E-06	5.318E-06	1.595E-05	5.318E-06	1.064E-05	5.318E-06	2.659E-05	2.729E-06	7.907E-05	0	0	0	0.0007782	0	0	1.441E-05	8.111E-07	1.39E-06	0
12.08	2.072	boiler	3.6	2600	0.0	0.0000144	0.0000108	0.0000108	0.0000108	0.0000324	0.0000108	0.0000216	0.0000108	0.000054	5.542E-06	0.0001606	0	0	0	0.0015804	0	0	2.927E-05	1.647E-06	2.823E-06	0
Area 12 G-Tunnel						1.092E-06	0.0006378	8.19E-07	8.19E-07	2.457E-06	8.19E-07	1.638E-06	8.19E-07	4.095E-06	4.203E-07	0.0002913	0.0001945	0.0017609	2.669E-05	0.0009253	0.0005236	6.315E-05	6.012E-05	1.249E-07	2.141E-07	0
12.09		diesel generator	0.1365	65	0.0	0	0.0001274	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	0	0	0
12.10		diesel generator	0.1365	65	0.0	0	0.0001274	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	0	0	0
12.11		diesel generator	0.1365	65	0.0	0	0.0001274	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	0	0	0
12.12		diesel generator/welder	0.1365	65	0.0	0	0.0001274	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	0	0	0
12.13		diesel generator	0.1365	65	0.0	0	0.0001274	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	0	0	0
12.14		industrial heater	0.1365	65	0.0	5.46E-07	4.095E-07	4.095E-07	4.095E-07	1.229E-06	4.095E-07	8.19E-07	4.095E-07	2.048E-06	2.102E-07	6.088E-06	0	0	0	5.992E-05	0	0	1.11E-06	6.246E-08	1.07E-07	0
12.15		steam cleaner	0.1365	65	0.0	5.46E-07	4.095E-07	4.095E-07	4.095E-07	1.229E-06	4.095E-07	8.19E-07	4.095E-07	2.048E-06	2.102E-07	6.088E-06	0	0	0	5.992E-05	0	0	1.11E-06	6.246E-08	1.07E-07	0
Area 12 N-Tunnel						0	0.0104496	0	0	0	0	0	0	0	0	0.0045808	0.003192	0.028896	0.000438	0.013216	0.0085904	0.001036	0.0009498	0	0	0
12.16	2.154	diesel generator	5.6	65	0.0	0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	0	0	0
12.17	2.155	diesel generator	5.6	65	0.0	0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	0	0	0
Area 12 P-Tunnel																										
12.18		diesel compressor	0.2	75		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.19		diesel air dryer	0.2	75		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.20	2.701	gasoline generator	0.0683	75	0.0	0	6.372E-05	0	0	0	0	0	0	0	0	2.793E-05	1.947E-05	0.0001762	2.671E-06	8.059E-05	5.239E-05	6.318E-06	5.792E-06	0	0	0
Area 12 T-Tunnel						0	0.0054114	0	0	0	0	0	0	0	0	0.0023722	0.001653	0.014964	0.0002268	0.006844	0.0044486	0.0005365	0.0004918	0	0	0
12.21		diesel generator	0.2	120		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.22	2.153	diesel generator	5.6	65	0.0	0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	0	0	0
Area 12 U-Tunnel						0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.23		diesel generator	0.2	65		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
Area 12 Yard						0	0.0039992	0	0	0	0	0	0	0	0	0.0017531	0.0012216	0.0110589	0.0001676	0.005058	0.0032877	0.0003965	0.0003635	0	0	0
12.24		diesel generator	0.512	65		0	0.0004777	0	0	0	0	0	0	0	0	0.0002094	0.0001459	0.001321	2.002E-05	0.0006042	0.0003927	4.736E-05	4.342E-05	0	0	0
12.25		diesel generator	0.512	65		0	0.0004777	0	0	0	0	0	0	0	0	0.0002094	0.0001459	0.001321	2.002E-05	0.0006042	0.0003927	4.736E-05	4.342E-05	0	0	0
12.26		diesel generator	0.512	65		0	0.0004777	0	0	0	0	0	0	0	0	0.0002094	0.0001459	0.001321	2.002E-05	0.0006042	0.0003927	4.736E-05	4.342E-05	0	0	0
12.27		diesel generator	0.512	65		0	0.0004777	0	0	0	0	0	0	0	0	0.0002094	0.0001459	0.001321	2.002E-05	0.0006042	0.0003927	4.736E-05	4.342E-05	0	0	0
12.28		diesel generator	0.512	65		0	0.0004777	0	0	0	0	0	0	0	0	0.0002094	0.0001459	0.001321	2.002E-05	0.0006042	0.0003927	4.736E-05	4.342E-05	0	0	0
12.29		diesel generator	0.2	65		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.30		diesel generator	0.2	65		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.31		diesel generator	0.2	65		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.32		diesel generator	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.33		diesel generator	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.34		diesel generator	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.35		diesel generator	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.36		diesel generator	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.37		diesel generator	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.38		diesel generator	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0

12.39		diesel generator	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001206	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.40		diesel generator	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001206	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.41		diesel generator	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001206	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.42		diesel generator	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001206	7.854E-05	9.472E-06	8.684E-06	0	0	0
Area 23 (Mercury)								[illegible]	[illegible]	[illegible]	[illegible]	7.831E-06	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0
23.01	2.464	generator/B1000	0.07	330		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000626	5.369E-05	6.475E-06	5.936E-06	0	0	0
23.02	2.804	generator/B1010	0.3413	2		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0006806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
23.03	2.400	boiler/B111	0.468	238.8		1.872E-06	1.404E-06	1.404E-06	1.404E-06	4.212E-06	1.404E-06	2.806E-06	1.404E-06	7.02E-06	7.205E-07	2.087E-05	0	0	0	0.0002055	0	0	3.805E-06	2.141E-07	3.67E-07	0
23.04	2.401	boiler/B128	0.836	290.7		3.344E-06	2.508E-06	2.508E-06	2.508E-06	7.524E-06	2.508E-06	5.016E-06	2.508E-06	1.254E-05	1.287E-06	3.729E-05	0	0	0	0.000367	0	0	6.796E-06	3.825E-07	6.556E-07	0
23.05	2.409	boiler/B156	0.3345	437.8		1.338E-06	1.004E-06	1.004E-06	1.004E-06	3.011E-06	1.004E-06	2.007E-06	1.004E-06	5.018E-06	5.15E-07	1.492E-05	0	0	0	0.0001468	0	0	2.719E-06	1.531E-07	2.623E-07	0
23.06	2.601	emergency generator	0.0683	3		0	6.372E-05	0	0	0	0	0	0	0	0	2.793E-05	1.947E-05	0.0001762	2.671E-06	8.059E-05	5.239E-05	6.318E-06	5.792E-06	0	0	0
23.07	2.411	boiler/B536	1.77	563.9		7.08E-06	5.31E-06	5.31E-06	5.31E-06	1.593E-05	5.31E-06	1.062E-05	5.31E-06	2.655E-06	2.725E-06	7.895E-05	0	0	0	0.000777	0	0	1.439E-05	8.099E-07	1.388E-06	0
23.08		diesel generator	0.2	7		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
23.09	2.157	emergency generator	4.2	3		0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
23.10	2.164	emergency generator	4.2	195		0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
23.11	2.070	boiler/B754 Café	3.2	1010.9		0.0000128	0.0000096	0.0000096	0.0000096	0.0000288	0.0000096	0.0000192	0.0000096	0.000048	4.927E-06	0.0001427	0	0	0	0.0014048	0	0	2.601E-05	1.464E-06	2.509E-06	0
23.12	2.071	boiler/B753	6.44	576.2		2.576E-05	1.932E-05	1.932E-05	1.932E-05	5.796E-05	1.932E-05	3.864E-05	1.932E-05	0.0000966	9.915E-06	0.0002873	0	0	0	0.0028272	0	0	5.235E-05	2.947E-06	5.05E-06	0
23.13	2.152	incinerator	0.315	872	99.0	1.26E-08	9.45E-09	9.45E-09	9.45E-09	2.835E-08	9.45E-09	1.89E-08	9.45E-09	4.725E-08	4.85E-09	1.405E-07	0	0	0	1.383E-06	0	0	2.561E-06	1.441E-09	2.47E-09	0
23.14		generator/RSN MAT	0.2	120		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
23.15		generator/RSN MAT	0.2	120		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
23.57	2.070	boiler/B754 Café	3.2	270.7		0.0000128	0.0000096	0.0000096	0.0000096	0.0000288	0.0000096	0.0000192	0.0000096	0.000048	4.927E-06	0.0001427	0	0	0	0.0014048	0	0	2.601E-05	1.464E-06	2.509E-06	0
Area 25								[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	#VALUE!	[illegible]	#VALUE!
25.01	2.410	boiler/B4015	2.6757	2600		1.07E-05	8.027E-06	8.027E-06	8.027E-06	2.408E-05	8.027E-06	1.605E-05	8.027E-06	4.014E-05	4.119E-06	0.0001193	0	0	0	0.0011746	0	0	2.175E-05	1.224E-06	2.098E-06	#VALUE!
25.02	2.406	boiler/B4215	0.8361	2600		3.344E-06	2.508E-06	2.508E-06	2.508E-06	7.525E-06	2.508E-06	5.017E-06	2.508E-06	1.254E-05	1.287E-06	3.729E-05	0	0	0	0.000367	0	0	6.797E-06	3.826E-07	6.556E-07	#VALUE!
25.03	2.683	generator/ Skull Mtn.	0.2048	10		0	0.0001911	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0005284	8.008E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	#VALUE!
25.04	2.529	air comp./ X-tunnel	0.7	75		0	0.0006531	0	0	0	0	0	0	0	0	0.0002863	0.0001995	0.001806	2.737E-05	0.000626	0.0005369	6.475E-05	5.936E-05	0	0	#VALUE!
Area 27								0	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	#VALUE!	0	0
27.01	2.131	emergency generator	5.6	35		0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006606	0.0042952	0.000518	0.0004749	#VALUE!	0	0
27.02	2.130	emergency generator	5.6	9		0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006606	0.0042952	0.000518	0.0004749	#VALUE!	0	0
27.03	2.619	diesel generator	0.0512	65		0	4.777E-05	0	0	0	0	0	0	0	0	2.094E-05	1.459E-05	0.0001321	2.002E-06	6.042E-05	3.927E-05	4.736E-06	4.342E-06	#VALUE!	0	0
27.04	2.669	diesel generator	0.1365	65		0	0.0001274	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	#VALUE!	0	0
Area 29								0	0	0	0	0	0	0	0	[illegible]	9.727E-05	[illegible]	[illegible]	[illegible]	[illegible]	3.157E-05	[illegible]	#VALUE!	0	0
29.01	2.602	diesel generator	0.3413	65		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0006806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	#VALUE!	0	0

Nevada Test Site Emission Inventory

LBS/HR

Hazardous Air Pollutant Emissions

emission source #	old permit #	Equipment	process rate (ton/hr) or *heat rate (MMBtu/hr)*	operating hours (hr/yr)	control (%)	As (lb/hr)	Be (lb/hr)	Cd (lb/hr)	Cr (lb/hr)	Pb (lb/hr)	Hg (lb/hr)	Mn (lb/hr)	Ni (lb/hr)	Se (lb/hr)	Benzene (lb/hr)	Toluene (lb/hr)	Xylenes (lb/hr)	Propylene (lb/hr)	1,3-Butadiene (lb/hr)	Formaldahyde (lb/hr)	Acetaldehyde (lb/hr)	Acrolein (lb/hr)	Napthalene (lb/hr)	Ethylbenzene (lb/hr)	o-Xylene (lb/hr)	Phosphorous (P) (lb/hr)
						Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals
						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0.0004749	4.66E-05	0.056951	0.0470653	0.4260648	0.006457	0.206726	0.1266635	0.0152756	0.0142606	#VALUE!	2.476E-05	#VALUE!
AGGREGATE PROCESSING EQUIPMENT																										
Area 1 Shaker Plant						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
1.14		Baghouse 02				#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
14A	1.016	C-7 to Rotary dryer	100	250	99	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
14B	2.023	Rotary Dryer	100	250	99	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
Area 1 Concrete Batch Plant						1.566E-05	1.629E-07	2.148E-06	4.566E-06	7.309E-06	0	0.0019361	0.0001654	0	0	0	0	0	0	0	0	0	0	0	0	0.0000826
1.46		Baghouse 04				1.176E-05	1.253E-07	1.638E-06	1.764E-06	5.152E-06	0	0.001414	0.0001232	0	0	0	0	0	0	0	0	0	0	0	0	0.0000826
46A	2.026	loading overhead bin	50	44.2	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46B	1.057	loading weigh hopper	50	44.2	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46C		loading temp. bin A	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46D		discharge temp bin A	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46E		loading temp. bin B	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46F		discharge temp bin B	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46G		loading temp. bin C	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46H		discharge temp bin C	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46I	2.111	loading Silo #3	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46J	2.112	discharge Silo #3	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46K	2.113	loading Silo #4	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46L	2.114	discharge Silo #4	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46M	2.115	loading Silo #5	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
46N	2.116	discharge Silo #5	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
1.47		Baghouse 06				3.899E-06	3.759E-08	5.103E-07	2.801E-06	2.157E-06	0	0.0005221	4.221E-05	0	0	0	0	0	0	0	0	0	0	0	0	0
47A	2.028	C-2 to funnel	160	1920	99	2.688E-06	2.864E-08	3.744E-07	4.032E-07	1.178E-06	0	0.0003232	2.816E-05	0	0	0	0	0	0	0	0	0	0	0	0	1.888E-05
47B	2.027	weigh hopper 2 to funnel	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
47C	2.029	truck loading	160	1920	99	3.712E-07	0	1.888E-08	2.272E-06	6.112E-07	0	9.792E-05	5.248E-06	0	0	0	0	0	0	0	0	0	0	0	0	3.232E-05
Area 6 Cementing Equipment						0.0001209	1.393E-06	1.664E-05	2.43E-05	5.426E-05	0	0.0144032	0.0012572	1.31E-06	0	0	0	0	0	0	0	0	0	0	0	0.0000671
6.001	2.032	Scale #1	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
6.002	2.033	Scale #2	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
6.003	2.034	Scale #3	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
123A		Baghouse 07/back-up				2.688E-06	2.864E-08	3.744E-07	4.032E-07	1.178E-06	0	0.0003232	2.816E-05	0	0	0	0	0	0	0	0	0	0	0	0	1.888E-05
123B		waste silo	10	1920	99	1.68E-07	1.79E-09	2.34E-08	2.52E-08	7.36E-08	0	0.0000202	1.76E-06	0	0	0	0	0	0	0	0	0	0	0	0	1.18E-06
6.004		Baghouse 10				1.636E-06	1.22E-07	2.3E-08	6.41E-06	2.001E-06	0	0.0000612	7.59E-06	1.31E-06	0	0	0	0	0	0	0	0	0	0	0	0.0000293
4A	2.035	Load blending tank	50	11	99	1.16E-07	0	5.9E-09	7.1E-07	1.91E-07	0	0.0000306	1.64E-06	0	0	0	0	0	0	0	0	0	0	0	0	0.0000101
4B	2.036	Blending tank discharge	50	11	99	1.52E-06	1.22E-07	1.71E-08	0.0000057	1.81E-06	0	0.0000306	5.95E-06	1.31E-06	0	0	0	0	0	0	0	0	0	0	0	0.0000192
6.005		Bin Vent #1				0.000014	1.492E-07	1.95E-06	0.0000021	6.133E-06	0	0.0016833	0.0001467	0	0	0	0	0	0	0	0	0	0	0	0	9.833E-05
6.006		Bin Vent #3				0.000014	1.492E-07	1.95E-06	0.0000021	6.133E-06	0	0.0016833	0.0001467	0	0	0	0	0	0	0	0	0	0	0	0	9.833E-05
6.007		Bin Vent #4				0.000014	1.492E-07	1.95E-06	0.0000021	6.133E-06	0	0.0016833	0.0001467	0	0	0	0	0	0	0	0	0	0	0	0	9.833E-05
567A	2.037	Silo #1	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
567B	2.038	Silo #2	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
567C	2.039	Silo #3	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
567D	2.040	Silo #4	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
567E	2.041	Silo #5	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
6.008		Bin Vent #8				0.0000168	1.79E-07	2.34E-06	2.52E-06	7.36E-06	0	0.00202	0.000176	0	0	0	0	0	0	0	0	0	0	0	0	0.000118
8A	2.042	Silo #7	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
8B	2.043	Silo #8	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
6.009	2.044	Silo #15	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
6.010	2.045	Silo #16	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
6.011		Bin Vent #18				0.0000126	1.343E-07	1.755E-06	1.89E-06	5.52E-06	0	0.001515	0.000132	0	0	0	0	0	0	0	0	0	0	0	0	0.0000885
6.012		Bin Vent #19				0.0000126	1.343E-07	1.755E-06	1.89E-06	5.52E-06	0	0.001515	0.000132	0	0	0	0	0	0	0	0	0	0	0	0	0.0000885
1112A	2.046	Silo #17	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
1112B	2.047	Silo #18	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
1112C	2.048	Silo #19	50	1920	90	0.0000084	8.95E-08	1.17E-06	1.26E-06	3.68E-06	0	0.00101	0.000088	0	0	0	0	0	0	0	0	0	0	0	0	0.000059
6.013		Baghouse 08				9.24E-06	9.845E-08	1.287E-06	1.386E-06	4.048E-06	0	0.001111	0.0000968	0	0	0	0	0	0	0	0	0	0	0	0	0.0000649
13A	2.049	Silo #9	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13B	2.050	Silo #10	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13C	2.051	Silo #11	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13D	2.052	Silo #12	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13E	2.053	Silo #13	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13F	2.054	Silo #14	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13G	2.055	Silo #27	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13H	2.056	Silo #28	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13I	2.057	Silo #29	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13J	2.058	Silo #30	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
13K	2.059	Silo #31	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
6.014		Baghouse 09				6.72E-06	7.16E-08	9.36E-07	1.008E-06	2.944E-06	0	0.000808	0.0000704	0	0	0	0	0	0	0	0	0	0	0	0	0.0000472

14A	2.060	Silo #21	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14B	2.061	Silo #22	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14C	2.062	Silo #23	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14D	2.063	Silo #24	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14E	2.064	Silo #25	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14F	2.065	Silo #26	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14G	2.066	Silo #32	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
14H	2.067	Silo #33	50	1920	99	8.4E-07	8.95E-09	1.17E-07	1.26E-07	3.68E-07	0	0.000101	0.0000088	0	0	0	0	0	0	0	0	0	0	0	0	0.0000059
Area 6 Construction storage yard						0	0.0933	0	0	0	0	0	0	0	0	0.02045	0.01425	0.129	0.001955	0.059	0.03835	0.004625	0.00424	0	0	0
6.111		Baghouse 11					0.04665	0	0	0	0	0	0	0	0	0.02045	0.01425	0.129	0.001955	0.059	0.03835	0.004625	0.00424	0	0	0
6.110	2.119	misc portable silos (7)	50	1920	99	0	0.04665	0	0	0	0	0	0	0	0	0.02045	0.01425	0.129	0.001955	0.059	0.03835	0.004625	0.00424	0	0	0
Area 12 Batch Plant						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.01	1.067	loading hopper	50	504	75.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.02	1.068	discharge hopper	50	504	50.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.03		Baghouse 11				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3A	2.073	loading silo #1	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3B	2.074	loading silo #2	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.04		Baghouse 13				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4A		weigh hopper/scale	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4B	2.075	conveyor to loadout	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.05	2.076	loadout	50	504	50.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 12 Portable Cement Bins						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.06		Baghouse 14				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6A		Mutiple portable bins	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6B		Mutiple portable bins	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6C	2.125	surge #1 loading	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6D	2.126	surge #1 discharge	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6E	2.127	surge #2 loading	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6F	2.128	surge #2 discharge	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
USTA						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.111		Baghouse 11				.0000008.4	0	0	0	0	#REFI	0	0	0.0003511	3.603E-05	0	0	0	0	0	0	0	0	1.071E-05	1.635E-05	0
6.093	2.119	portable silo	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.094	2.121	portable silo	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.095	2.123	portable silo	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

COMBUSTION EQUIPMENT

Area 1 U1A						0	0.0013062	0	0	0	0	0	0	0	0	0.0005726	0.000399	0.003612	5.474E-05	0.001652	0.0010738	0.0001295	0.0001187	0	0	0
1.75	2.521	diesel air compressor	0.70	75	0	0	0.0006531	0	0	0	0	0	0	0	0	0.0002863	0.0001995	0.001806	2.737E-05	0.000826	0.0005369	6.475E-05	5.936E-05	0	0	0
1.76		diesel generator	0.70	8	0	0	0.0006531	0	0	0	0	0	0	0	0	0.0002863	0.0001995	0.001806	2.737E-05	0.000826	0.0005369	6.475E-05	5.936E-05	0	0	0
Area 1 U1G						0	0.0041097	0	0	0	0	0	0	0	0	0.0018016	0.0012554	0.0113644	0.0001722	0.0051977	0.0033785	0.0004074	0.0003736	0	0	0
1.77	2.679	diesel generator	0.20	65	0	0	0.0001911	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0005284	8.006E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	0
1.78	2.161	emergency generator	4.20	16	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
Area 1 Drilling Storage Yard						#REFI	#REFI	#REFI	#REFI	#REFI	#REFI	#REFI	#REFI	0	0	0.0011452	0.000798	0.007224	0.0001095	0.003304	0.0021476	0.000259	0.0002374	0	0	0
1.79	2.804	fluid pump	1.40	50	0	0	0.0013062	0	0	0	0	0	0	0	0	0.0005726	0.000399	0.003612	5.474E-05	0.001652	0.0010738	0.0001295	0.0001187	0	0	0
1.80	2.806	mud pump	1.40	300	0	#REFI	#REFI	#REFI	#REFI	#REFI	#REFI	#REFI	#REFI	0	0	0.0005726	0.000399	0.003612	5.474E-05	0.001652	0.0010738	0.0001295	0.0001187	0	0	0
Area 5 Check Point Pass						0	0.0001911	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0005284	8.006E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0		
5.001	2.677	diesel gen.(60 KW)	0.2048	2			0.0001911							0	0	8.376E-05	5.837E-05	0.0005284	8.006E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	0
Area 5 WEF						0	0.0001062	0	0	0	0	0	0	0	0	4.744E-05	3.306E-05	0.0002993	4.536E-06	0.0001369	8.897E-05	1.073E-05	9.837E-06	0		
5.002	2.658	diesel gen.(34 KW)	0.116	18			0.0001062							0	0	4.744E-05	3.306E-05	0.0002993	4.536E-06	0.0001369	8.897E-05	1.073E-05	9.837E-06	0	0	0
Area 5 NPTEC						0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0		
5.007	2.165	diesel generator	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
Area 6 Heavy Equipment Yard																										
6.028	2.500	diesel air compressor	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001998	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.029	2.507	diesel air compressor	0.2083	75	0	0	0.0001943	0	0	0	0	0	0	0	0	8.519E-05	5.937E-05	0.0005374	8.145E-06	0.0002458	0.0001598	1.927E-05	1.766E-05	0	0	0
6.030	2.508	diesel air compressor	0.2083	4	0	0	0.0001943	0	0	0	0	0	0	0	0	8.519E-05	5.937E-05	0.0005374	8.145E-06	0.0002458	0.0001598	1.927E-05	1.766E-05	0	0	0
6.031	2.528	diesel air compressor	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001998	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.032	2.530	diesel air compressor	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001998	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.033	2.531	diesel air compressor	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001998	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.034	2.532	diesel air compressor	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001998	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.035	2.533	diesel air compressor	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001998	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.036	2.534	diesel air compressor	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001998	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.037	2.551	diesel air compressor	0.2038	75	0	0	0.0001901	0	0	0	0	0	0	0	0	8.335E-05	5.808E-05	0.0005258	7.969E-06	0.0002405	0.0001563	1.885E-05	1.728E-05	0	0	0
6.038	2.552	diesel air compressor	0.2038	75	0	0	0.0001901	0	0	0	0	0	0	0	0	8.335E-05	5.808E-05	0.0005258	7.969E-06	0.0002405	0.0001563	1.885E-05	1.728E-05	0	0	0
6.039	2.553	diesel air compressor	0.2038	4	0	0	0.0001901	0	0	0	0	0	0	0	0	8.335E-05	5.808E-05	0.0005258	7.969E-06	0.0002405	0.0001563	1.885E-05	1.728E-05	0	0	0
6.040		diesel air compressor	0.2	75	0	0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.698E-05	0	0	0
6.041	2.141	diesel air compressor	1.8822	150	0	0	0.0017561	0	0	0	0	0	0	0	0	0.0007698	0.0005364	0.0048561	7.359E-05	0.002221	0.0014436	0.0001741	0.0001596	0	0	0
6.042		diesel generator	0.3413	65		0	0.0003184	0	0	0	0	0	0	0	0	0.0001398	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.043		diesel generator	0.3413	65		0	0.0003184	0	0	0	0	0	0	0	0	0.0001398	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.044	2.132	diesel generator	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.045	2.133	diesel generator	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.046	2.134	diesel generator	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.047	2.139	diesel generator	4.2	9	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.048	2.611	diesel generator	0.3413	65	0	0	0.0003184	0	0	0	0	0	0	0	0	0.0001398	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.049	2.628	diesel generator	0.07	65		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.050	2.647	diesel generator	0.07	65		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.051	2.648	diesel generator	0.07	65		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0

6.052	2.656	diesel generator	0.1	1		0	0.0000933	0	0	0	0	0	0	0	0	0.0000409	0.0000285	0.000258	3.91E-06	0.000118	0.0000767	9.25E-06	8.48E-06	0	0	0
6.053	2.657	diesel generator	0.1024	65	0	0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
6.054	2.681	diesel generator	0.2048	3	0	0	0.0001911	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0005284	8.008E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	0
6.055	2.605	diesel generator	0.3413	65	0	0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.056	2.606	diesel generator	0.3413	65	0	0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.057		diesel generator	0.3413	65		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.058		diesel generator	0.3413	65		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.059		diesel generator	0.3413	65		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.060		diesel generator	0.3413	65		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.061		gas generator	0.07	75		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.062		gas generator	0.07	75		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.063		gas generator	0.07	75		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.064		gas generator	0.07	75		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.065		gas generator	0.07	75		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.066		gas generator	0.07	75		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.067		gas generator	0.07	75		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001806	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
6.068		trash pump	0.026	50		0	2.426E-05	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
6.069		diesel cable reeler	0.026	50		0	2.426E-05	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
6.070		diesel cable reeler	0.026	50		0	2.426E-05	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
6.071		diesel cable reeler	0.026	50		0	2.426E-05	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
6.072		diesel cable reeler	0.026	50		0	2.426E-05	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
6.073		diesel cable reeler	0.026	50		0	2.426E-05	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
6.074		diesel cable reeler	0.026	50		0	2.426E-05	0	0	0	0	0	0	0	0	1.063E-05	7.41E-06	6.708E-05	1.017E-06	3.068E-05	1.994E-05	2.405E-06	2.205E-06	0	0	0
Area 6 CP-1						1.338E-05	0.0045973	1.003E-05	1.003E-05	3.01E-05	1.003E-05	2.007E-05	1.003E-05	5.017E-05	5.149E-06	0.0021601	0.0014013	0.0124851	0.0001922	0.00727	0.0037711	0.0004548	0.0004441	1.53E-06	2.623E-06	0
6.075	2.404	Boiler	1.6723	217.5	0	6.689E-06	5.017E-06	5.017E-06	5.017E-06	1.505E-05	5.017E-06	1.003E-05	5.017E-06	2.508E-05	2.575E-06	7.459E-05	0	0	0	0.0007341	0	0	1.359E-05	7.652E-07	1.311E-06	0
6.076	2.405	Boiler	1.6723	368.8	0	6.689E-06	5.017E-06	5.017E-06	5.017E-06	1.505E-05	5.017E-06	1.003E-05	5.017E-06	2.508E-05	2.575E-06	7.459E-05	0	0	0	0.0007341	0	0	1.359E-05	7.652E-07	1.311E-06	0
6.077	2.158	emerg. generator	4.2	1	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010636	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.078		diesel generator	0.3413	65	0	0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.079	2.614	diesel generator	0.3754	65	0	0	0.0003502	0	0	0	0	0	0	0	0	0.0001535	0.000107	0.0009685	1.468E-05	0.000443	0.0002879	3.472E-05	3.183E-05	0	0	0
Area 6 CP-18						0	0.0002388	0	0	0	0	0	0	0	0	0.0001047	7.296E-05	0.0006605	1.001E-05	0.0003021	0.0001964	2.368E-05	2.171E-05	0	0	0
6.080	2.690	diesel generator	0.256	19	0	0	0.0002388	0	0	0	0	0	0	0	0	0.0001047	7.296E-05	0.0006605	1.001E-05	0.0003021	0.0001964	2.368E-05	2.171E-05	0	0	0
Area 6 CP-40						0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
6.081	2.603	diesel generator	0.3413	8	0	0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
Area 6 CP-43						0	0.0001911	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0005284	8.008E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	0
6.082	2.673	diesel generator	0.2048	1	0	0	0.0001911	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0005284	8.008E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	0
Area 6 CP-70						0	0.000398	0	0	0	0	0	0	0	0	0.0001745	0.0001216	0.0011006	1.668E-05	0.0005034	0.0003272	3.946E-05	3.618E-05	0	0	0
6.083	2.618	diesel generator	0.4266	5	0	0	0.000398	0	0	0	0	0	0	0	0	0.0001745	0.0001216	0.0011006	1.668E-05	0.0005034	0.0003272	3.946E-05	3.618E-05	0	0	0
Area 6 CP-9						3.344E-06	0.0078397	2.508E-06	2.508E-06	7.525E-06	2.508E-06	5.017E-06	2.508E-06	1.254E-05	1.287E-06	0.0034729	0.002394	0.021672	0.0003284	0.010279	0.0064428	0.000777	0.0007191	3.826E-07	6.556E-07	0
6.084	2.403	Boiler	0.8361	676	0	3.344E-06	2.508E-06	2.508E-06	2.508E-06	7.525E-06	2.508E-06	5.017E-06	2.508E-06	1.254E-05	1.287E-06	3.729E-05	0	0	0	0.000367	0	0	6.797E-06	3.826E-07	6.556E-07	0
6.085	2.156	emerg. generator	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010636	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
6.086	2.163	emerg. generator	4.2	300	0	0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010636	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
Area 6 DAF						0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	0	0	0
6.087	2.160	emerg. generator	5.6	9	0	0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	0	0	0
6.088	2.159	emerg. generator	5.6	13	0	0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.006608	0.0042952	0.000518	0.0004749	0	0	0
6.089	2.407	Boiler	2.3412	2600	0	9.365E-06	7.024E-06	7.024E-06	7.024E-06	2.107E-05	7.024E-06	1.405E-05	7.024E-06	3.512E-05	3.604E-06	0.0001044	0	0	0	0.0010278	0	0	1.903E-05	1.071E-06	1.836E-06	0
6.090	2.408	Boiler	2.3412	2600	0	9.365E-06	7.024E-06	7.024E-06	7.024E-06	2.107E-05	7.024E-06	1.405E-05	7.024E-06	3.512E-05	3.604E-06	0.0001044	0	0	0	0.0010278	0	0	1.903E-05	1.071E-06	1.836E-06	0
Area 6 Decon						2.072E-05	1.554E-05	1.554E-05	1.554E-05	4.662E-05	1.554E-05	3.108E-05	1.554E-05	0.0000777	7.975E-06	0.0002311	0	0	0	0.002274	0	0	4.211E-05	2.37E-06	4.062E-06	0
6.091	2.068	Boiler	5.18	1000	0	2.072E-05	1.554E-05	1.554E-05	1.554E-05	4.662E-05	1.554E-05	3.108E-05	1.554E-05	0.0000777	7.975E-06	0.0002311	0	0	0	0.002274	0	0	4.211E-05	2.37E-06	4.062E-06	0
Area 6 Iron Workers Yard						0	0.000126	0	0	0	0	0	0	0	0	5.522E-05	3.848E-05	0.0003483	5.279E-06	0.0001593	0.0001035	1.249E-05	1.145E-05	0	0	0
6.092		diesel cable reeler	0.135	50		0	0.000126	0	0	0	0	0	0	0	0	5.522E-05	3.848E-05	0.0003483	5.279E-06	0.0001593	0.0001035	1.249E-05	1.145E-05	0	0	0
Area 6 Wall 3 Yard						0	0.0012689	0	0	0	0	0	0	0	0	0.0005562	0.0003876	0.0035088	5.316E-05	0.0016048	0.0010431	0.0001258	0.0001153	0	0	0
6.096	2.097	bin	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.097		diesel generator	0.34	65		0	0.0003172	0	0	0	0	0	0	0	0	0.0001391	0.0000969	0.0008772	1.329E-05	0.0004012	0.0002608	3.145E-05	2.883E-05	0	0	0
6.098		diesel generator	0.34	65		0	0.0003172	0	0	0	0	0	0	0	0	0.0001391	0.0000969	0.0008772	1.329E-05	0.0004012	0.0002608	3.145E-05	2.883E-05	0	0	0
6.099		diesel generator	0.34	65		0	0.0003172	0	0	0	0	0	0	0	0	0.0001391	0.0000969	0.0008772	1.329E-05	0.0004012	0.0002608	3.145E-05	2.883E-05	0	0	0
6.100		diesel generator	0.34	65		0	0.0003172	0	0	0	0	0	0	0	0	0.0001391	0.0000969	0.0008772	1.329E-05	0.0004012	0.0002608	3.145E-05	2.883E-05	0	0	0
Area 6 Wet/Wild						0	0.0105148	0	0	0	0	0	0	0	0	0.0046094	0.0032119	0.0290763	0.0004407	0.0132985	0.008644	0.0010425	0.0009557	0	0	0
6.101	2.542	diesel air compressor	1.9739	150	0	0	0.0018416	0	0	0	0	0	0	0	0	0.0008073	0.0005626	0.0050927	7.718E-05	0.0023292	0.001514	0.0001826	0.0001674	0	0	0
6.102	2.543	diesel air compressor	0.7004	75	0	0	0.0006535	0	0	0	0	0	0	0	0	0.0002865	0.0001998	0.001807	2.739E-05	0.0008265	0.0005372	6.479E-05	5.939E-05	0	0	0
6.103	2.544	diesel air compressor	1.9739	150	0	0	0.0018416	0	0	0	0	0	0	0	0	0.0008073	0.0005626	0.0050927	7.718E-05	0.0023292	0.001514	0.0001826	0.0001674	0	0	0
6.104	2.545	diesel air compressor	1.9739	150	0	0	0.0018416	0	0	0	0	0	0	0	0	0.0008073	0.0005626	0.0050927	7.718E-05	0.0023292	0.001514	0.0001826	0.0001674	0	0	0
6.105		diesel air compressor	1.9739	150		0	0.0018416	0	0	0	0	0	0	0	0	0.0008073	0.0005626	0.0050927	7.718E-05	0.0023292	0.001514	0.0001826	0.0001674	0	0	0
6.106		conveyor	250	100		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.107		pump	0.7	50		0	0.0006531	0	0	0	0	0	0	0	0	0.0002863	0.0001995	0.001806	2.737E-05	0.000826	0.0005369	6.475E-05	5.936E-05	0	0	0
6.108		diesel air compressor	1.9739	150	0	0	0.0018416	0	0	0	0	0	0	0	0	0.0008073	0.0005626	0.0050927	7.718E-05	0.0023292	0.001514	0.0001826	0.0001674	0	0	0
Area 6 Other misc. equipment						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.109		abrasive blaster		50		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 12 Cafeteria						2.149E-05	1.612E-05	1.612E-05	1.612E-05	4.835E-05	1.612E-05	3.224E-05	1.612E-05	8.059E-05	8.271E-06	0.0002397	0	0	0	0.0023586	0	0	4.368E-05	2.458E-06	4.213E-06	0
12.07	2.402	boiler	1.7726	2600	0.0	7.09E-06	5.318E-06	5.318E-06	5.318E-06	1.595E-05	5.318E-06	1.064E-05	5.318E-06	2.659E-05	2.729E-06	7.907E-05	0	0	0	0.0007782	0	0	1.441E-05	8.111E-07	1.39E-06	0
12.08	2.072	boiler	3.6	2600	0.0	0.0000144	0.0000108	0.0000108	0.0000108	0.0000324	0.0000108	0.0000216	0.0000108	0.000054	5.542E-06	0.0001606	0	0	0	0.0015804	0	0	2.927E-05	1.647E-06	2.823E-06	0
Area 12 G-Tunnel						1.092E-06	0.0006378	8.19E-07	8.19E-07	2.457E-06	8.19E-07	1.638E-06	8.19E-07	4.096E-06	4.203E-07	0.0002913	0.0001945	0.0017609	2.669E-05	0.0009252	0.0005235	6.313E-05	6.01E-05	1.249E-07	2.141E-07	0
12.09		diesel generator	0.1365	65	0.0	0	0.0001274	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	0	0	0
12.10		diesel generator	0.1365	65	0.0	0	0.0001274	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	0	0	0
12.11		diesel generator	0.1365	65	0.0	0	0.0001274	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	0	0	0
12.12		diesel generator/welder	0.1365	65	0.0	0	0.0001274	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	0	0	0
12.13		diesel generator	0.1365	65	0.0	0	0.0001274	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	0	0	0
12.14		industrial heater	0.1365	65	0.0	5.46E-07	4.095E-07	4.095E-07	4.095E-07	1.229E-06	4.095E-07	8.19E-07	4.095E-07	2.048E-06	2.102E-07	6.088E-06	0	0	0	5.992E-05	0	0	1.11E-06	6.246E-08	1.07E-07	0
12.15		steam cleaner	0.1365	65	0.0	5.46E-07	4.095E-07	4.095E-07	4.095E-07	1.229E-06	4.095E-07	8.19E-07	4.095E-07	2.048E-06	2.102E-07	6.088E-06	0	0	0	5.992E-05	0	0	1.11E-06	6.246E-08	1.07E-07	0
Area 12 N-Tunnel						0	0.0104496	0	0	0	0	0	0	0	0	0.0045806	0.003192	0.028896	0.0004379	0.013218	0.0085904	0.001036	0.0009496	0	0	0

12.16	2.154	diesel generator	5.6	65	0.0	0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.008608	0.0042952	0.000518	0.0004749	0	0	0
12.17	2.155	diesel generator	5.6	65	0.0	0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.008608	0.0042952	0.000518	0.0004749	0	0	0
Area 12 P-Tunnel																										
12.18		diesel compressor	0.2	75		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.19		diesel air dryer	0.2	75		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.20	2.701	gasoline generator	0.0683	75	0.0	0	6.372E-05	0	0	0	0	0	0	0	0	2.793E-05	1.947E-05	0.0001762	2.671E-06	8.059E-05	5.239E-05	6.318E-06	5.792E-06	0	0	0
Area 12 T-Tunnel						0	0.0054114	0	0	0	0	0	0	0	0	0.0023722	0.001653	0.014964	0.0002268	0.008844	0.0044486	0.0005365	0.0004919	0	0	0
12.21		diesel generator	0.2	120		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.22	2.153	diesel generator	5.6	65	0.0	0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.008608	0.0042952	0.000518	0.0004749	0	0	0
Area 12 U-Tunnel						0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.23		diesel generator	0.2	65		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
Area 12 Yard						0	0.0039992	0	0	0	0	0	0	0	0	0.0017581	0.0012218	0.0110669	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0
12.24		diesel generator	0.512	65		0	0.0004777	0	0	0	0	0	0	0	0	0.0002094	0.0001459	0.001321	2.002E-05	0.0006042	0.0003927	4.736E-05	4.342E-05	0	0	0
12.25		diesel generator	0.512	65		0	0.0004777	0	0	0	0	0	0	0	0	0.0002094	0.0001459	0.001321	2.002E-05	0.0006042	0.0003927	4.736E-05	4.342E-05	0	0	0
12.26		diesel generator	0.512	65		0	0.0004777	0	0	0	0	0	0	0	0	0.0002094	0.0001459	0.001321	2.002E-05	0.0006042	0.0003927	4.736E-05	4.342E-05	0	0	0
12.27		diesel generator	0.512	65		0	0.0004777	0	0	0	0	0	0	0	0	0.0002094	0.0001459	0.001321	2.002E-05	0.0006042	0.0003927	4.736E-05	4.342E-05	0	0	0
12.28		diesel generator	0.512	65		0	0.0004777	0	0	0	0	0	0	0	0	0.0002094	0.0001459	0.001321	2.002E-05	0.0006042	0.0003927	4.736E-05	4.342E-05	0	0	0
12.29		diesel generator	0.2	65		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.30		diesel generator	0.2	65		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.31		diesel generator	0.2	65		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
12.32		diesel generator	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.33		diesel generator	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.34		diesel generator	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.35		diesel generator	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.36		diesel generator	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.37		diesel generator	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.38		diesel generator	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.39		diesel generator	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.40		diesel generator	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.41		diesel generator	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
12.42		diesel generator	0.1024	65		0	9.554E-05	0	0	0	0	0	0	0	0	4.188E-05	2.918E-05	0.0002642	4.004E-06	0.0001208	7.854E-05	9.472E-06	8.684E-06	0	0	0
Area 23 (Mercury)								3.9158E-05	3.9158E-05	0.000117465	3.9158E-05	[illegible]	3.9158E-05	0.000195775	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.02347E-05	0
23.01	2.464	generator/B1000	0.07	4		0	6.531E-05	0	0	0	0	0	0	0	0	2.863E-05	1.995E-05	0.0001606	2.737E-06	0.0000826	5.369E-05	6.475E-06	5.936E-06	0	0	0
23.02	2.604	generator/B1010	0.3413	1		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	0	0	0
23.03	2.400	boiler/B111	0.468	423.8		1.672E-06	1.404E-06	1.404E-06	1.404E-06	4.212E-06	1.404E-06	2.808E-06	1.404E-06	7.02E-06	7.205E-07	2.087E-05	0	0	0	0.0002055	0	0	3.805E-06	2.141E-07	3.67E-07	0
23.04	2.401	boiler/B128	0.836	631.7		3.344E-06	2.508E-06	2.508E-06	2.508E-06	7.524E-06	2.508E-06	5.016E-06	2.508E-06	1.254E-05	1.287E-06	3.729E-05	0	0	0	0.000367	0	0	6.796E-06	3.825E-07	6.556E-07	0
23.05	2.409	boiler/B156	0.3345	785.1		1.338E-06	1.004E-06	1.004E-06	1.004E-06	3.011E-06	1.004E-06	2.007E-06	1.004E-06	5.018E-06	5.15E-07	1.492E-05	0	0	0	0.0001468	0	0	2.719E-06	1.531E-07	2.623E-07	0
23.06	2.601	emergency generator	0.0683	1		0	6.372E-05	0	0	0	0	0	0	0	0	2.793E-05	1.947E-05	0.0001762	2.671E-06	8.059E-05	5.239E-05	6.318E-06	5.792E-06	0	0	0
23.07	2.411	boiler/B536	1.77	563.9		7.08E-06	5.31E-06	5.31E-06	5.31E-06	1.593E-05	5.31E-06	1.062E-05	5.31E-06	2.655E-05	2.725E-06	7.895E-05	0	0	0	0.000777	0	0	1.439E-05	8.099E-07	1.388E-06	0
23.08		diesel generator	0.2	3		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
23.09	2.157	emergency generator	4.2	1		0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
23.10	2.164	emergency generator	4.2	195		0	0.0039186	0	0	0	0	0	0	0	0	0.0017178	0.001197	0.010836	0.0001642	0.004956	0.0032214	0.0003885	0.0003562	0	0	0
23.11	2.070	boiler/B754 Café	3.2	1211.3		0.0000128	0.0000096	0.0000096	0.0000096	0.0000288	0.0000096	0.0000192	0.0000096	0.000048	4.927E-06	0.0001427	0	0	0	0.0014048	0	0	2.601E-05	1.464E-06	2.509E-06	0
23.12	2.071	boiler/B753	6.44	1327.2		2.576E-05	1.932E-05	1.932E-05	1.932E-05	5.796E-05	1.932E-05	3.864E-05	1.932E-05	0.0000966	9.915E-06	0.0002873	0	0	0	0.0028272	0	0	5.236E-05	2.947E-06	5.05E-06	0
23.13	2.152	incinerator	0.315	872	99.0	1.26E-08	9.45E-09	9.45E-09	9.45E-09	2.835E-08	9.45E-09	1.89E-08	9.45E-09	4.725E-08	4.85E-09	1.405E-07	0	0	0	1.383E-06	0	0	2.561E-08	1.441E-09	2.47E-09	0
23.14		generator/RSN MAT	0.2	120		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
23.15		generator/RSN MAT	0.2	120		0	0.0001866	0	0	0	0	0	0	0	0	0.0000818	0.000057	0.000516	7.82E-06	0.000236	0.0001534	0.0000185	1.696E-05	0	0	0
23.57	2.070	boiler/B754 Café	3.2	293.9		0.0000128	0.0000096	0.0000096	0.0000096	0.0000288	0.0000096	0.0000192	0.0000096	0.000048	4.927E-06	0.0001427	0	0	0	0.0014048	0	0	2.601E-05	1.464E-06	2.509E-06	0
Area 25								[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	#VALUE!	[illegible]	#VALUE!
25.01	2.410	boiler/B4015	2.6757	2600		1.07E-05	8.027E-06	8.027E-06	8.027E-06	2.408E-05	8.027E-06	1.605E-05	8.027E-06	4.014E-05	4.119E-06	0.0001193	0	0	0	0.0011746	0	0	2.175E-05	1.224E-06	2.098E-06	#VALUE!
25.02	2.406	boiler/B4215	0.8361	2600		3.344E-06	2.508E-06	2.508E-06	2.508E-06	7.525E-06	2.508E-06	5.017E-06	2.508E-06	1.254E-05	1.287E-06	3.729E-05	0	0	0	0.000367	0	0	6.797E-06	3.826E-07	6.556E-07	#VALUE!
25.03	2.683	generator/ Skull Mtn.	0.2048	76		0	0.0001911	0	0	0	0	0	0	0	0	8.376E-05	5.837E-05	0.0005284	8.008E-06	0.0002417	0.0001571	1.894E-05	1.737E-05	0	0	#VALUE!
25.04	2.529	air comp./ X-tunnel	0.7	75		0	0.0006531	0	0	0	0	0	0	0	0	0.0002863	0.0001995	0.001806	2.737E-05	0.000826	0.0005369	6.475E-05	5.936E-05	0	0	#VALUE!
Area 27								0	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	#VALUE!	0	0
27.01	2.131	emergency generator	5.6	35		0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.008608	0.0042952	0.000518	0.0004749	#VALUE!	0	0
27.02	2.130	emergency generator	5.6	9		0	0.0052248	0	0	0	0	0	0	0	0	0.0022904	0.001596	0.014448	0.000219	0.008608	0.0042952	0.000518	0.0004749	#VALUE!	0	0
27.03	2.619	diesel generator	0.0512	65		0	4.777E-05	0	0	0	0	0	0	0	0	2.094E-05	1.459E-05	0.0001321	2.002E-06	6.042E-05	3.927E-05	4.736E-06	4.342E-06	#VALUE!	0	0
27.04	2.669	diesel generator	0.1365	65		0	0.0001274	0	0	0	0	0	0	0	0	5.583E-05	3.89E-05	0.0003522	5.337E-06	0.0001611	0.0001047	1.263E-05	1.158E-05	#VALUE!	0	0
Area 29								0	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	#VALUE!	0	0
29.01	2.602	diesel generator	0.3413	65		0	0.0003184	0	0	0	0	0	0	0	0	0.0001396	9.727E-05	0.0008806	1.334E-05	0.0004027	0.0002618	3.157E-05	2.894E-05	#VALUE!	0	0

Nevada Test Site Emission Inventory

TONS/YR

Hazardous Air Pollutant Emissions

emission source #	old permit #	Equipment	process rate (ton/hr) or *heat rate (MMBtu/hr)*	operating hours (hr/yr)	control (%)	As *(ton/yr)*	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
						Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals
						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0.000177	1.812E-05	0.02278	0.015506	0.14036	0.002127	0.06936	0.041727	0.005032	0.004709	#REF!	#REF!	#REF!
AGGREGATE PROCESSING EQUIPMENT																										
Area 1 Shaker Plant						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.14		Baghouse 02				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14A	1.016	C-7 to Rotary dryer	100	250	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14B	2.023	Rotary Dryer	100	250	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 1 Concrete Batch Plant						1.345E-05	1.39472E-07	1.841E-06	4.145E-06	6.32E-06	0	0.001668	0.000142	0	0	0	0	0	0	0	0	0	0	0	0	1E-04
1.46		Baghouse 04				2.646E-06	2.81925E-10	3.686E-09	3.969E-09	1.16E-06	0	3.18E-06	2.77E-07	0	0	0	0	0	0	0	0	0	0	0	0	2E-07
46A	2.026	loading overhead bin	50	31.5	99	1.323E-08	1.40963E-10	1.843E-09	1.985E-09	5.8E-09	0	1.59E-06	1.39E-07	0	0	0	0	0	0	0	0	0	0	0	0	9E-08
46B	1.057	loading weigh hopper	50	31.5	99	1.323E-08	1.40963E-10	1.843E-09	1.985E-09	5.8E-09	0	1.59E-06	1.39E-07	0	0	0	0	0	0	0	0	0	0	0	0	9E-08
46C		loading temp. bin A	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46D		discharge temp bin A	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46E		loading temp. bin B	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46F		discharge temp bin B	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46G		loading temp. bin C	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46H		discharge temp bin C	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46I	2.111	loading Silo #3	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46J	2.112	discharge Silo #3	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46K	2.113	loading Silo #4	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46L	2.114	discharge Silo #4	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46M	2.115	loading Silo #5	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46N	2.116	discharge Silo #5	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
1.47		Baghouse 06				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47A	2.028	C-2 to funnel	160	1920	99	2.58E-06	2.74944E-08	3.594E-07	3.871E-07	1.13E-06	0	0.00031	2.7E-05	0	0	0	0	0	0	0	0	0	0	0	0	2E-05
47B	2.027	weigh hopper 2 to funnel	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
47C	2.029	truck loading	160	1920	99	3.564E-07	0	1.812E-08	2.181E-06	5.87E-07	0	9.4E-05	5.04E-06	0	0	0	0	0	0	0	0	0	0	0	0	3E-05
Area 6 Cementing Equipment						0.0001145	1.15186E-06	1.505E-05	1.624E-05	4.73E-05	0	0.012993	0.001132	5.57E-09	0	0	0	0	0	0	0	0	0	0	0	8E-04
6.001	2.032	Scale #1	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
6.002	2.033	Scale #2	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
6.003	2.034	Scale #3	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
123A		Baghouse 07/back-up				2.58E-06	2.74944E-08	3.594E-07	3.871E-07	1.13E-06	0	0.00031	2.7E-05	0	0	0	0	0	0	0	0	0	0	0	0	2E-05
123B		waste silo	10	1920	99	1.613E-07	1.7184E-09	2.246E-08	2.419E-08	7.07E-08	0	1.94E-05	1.69E-06	0	0	0	0	0	0	0	0	0	0	0	0	1E-06
6.004		Baghouse 10				6.953E-09	5.185E-10	9.775E-11	2.724E-08	8.5E-09	0	2.6E-07	3.23E-08	5.57E-09	0	0	0	0	0	0	0	0	0	0	0	1E-07
4A	2.035	Load blending tank	50	8.5	99	4.93E-10	0	2.508E-11	3.018E-09	8.12E-10	0	1.3E-07	6.97E-09	0	0	0	0	0	0	0	0	0	0	0	0	4E-08
4B	2.036	Blending tank discharge	50	8.5	99	6.46E-09	5.185E-10	7.268E-11	2.423E-08	7.69E-09	0	1.3E-07	2.53E-08	5.57E-09	0	0	0	0	0	0	0	0	0	0	0	8E-08
6.005		Bin Vent #1				1.344E-05	1.432E-07	1.872E-06	2.016E-06	5.89E-06	0	0.001616	0.000141	0	0	0	0	0	0	0	0	0	0	0	0	9E-05
6.006		Bin Vent #3				1.344E-05	1.432E-07	1.872E-06	2.016E-06	5.89E-06	0	0.001616	0.000141	0	0	0	0	0	0	0	0	0	0	0	0	9E-05
6.007		Bin Vent #4				1.344E-05	1.432E-07	1.872E-06	2.016E-06	5.89E-06	0	0.001616	0.000141	0	0	0	0	0	0	0	0	0	0	0	0	9E-05
567A	2.037	Silo #1	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
567B	2.038	Silo #2	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
567C	2.039	Silo #3	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
567D	2.040	Silo #4	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
567E	2.041	Silo #5	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
6.008		Bin Vent #8				1.613E-05	1.7184E-07	2.246E-06	2.419E-06	7.07E-06	0	0.001939	0.000169	0	0	0	0	0	0	0	0	0	0	0	0	1E-04
8A	2.042	Silo #7	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
8B	2.043	Silo #8	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
6.009	2.044	Silo #15	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
6.010	2.045	Silo #16	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
6.011		Bin Vent #18				1.21E-05	1.2888E-07	1.685E-06	1.814E-06	5.3E-06	0	0.001454	0.000127	0	0	0	0	0	0	0	0	0	0	0	0	8E-05
6.012		Bin Vent #19				1.21E-05	1.2888E-07	1.685E-06	1.814E-06	5.3E-06	0	0.001454	0.000127	0	0	0	0	0	0	0	0	0	0	0	0	8E-05
1112A	2.046	Silo #17	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
1112B	2.047	Silo #18	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
1112C	2.048	Silo #19	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
6.013		Baghouse 08				8.87E-06	9.4512E-08	1.236E-06	1.331E-06	3.89E-06	0	0.001067	9.29E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
13A	2.049	Silo #9	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13B	2.050	Silo #10	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13C	2.051	Silo #11	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13D	2.052	Silo #12	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13E	2.053	Silo #13	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13F	2.054	Silo #14	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13G	2.055	Silo #27	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13H	2.056	Silo #28	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13I	2.057	Silo #29	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13J	2.058	Silo #30	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13K	2.059	Silo #31	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
6.014		Baghouse 09				6.451E-06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14A	2.060	Silo #21	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14B	2.061	Silo #22	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14C	2.062	Silo #23	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14D	2.063	Silo #24	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14E	2.064	Silo #25	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14F	2.065	Silo #26	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14G	2.066	Silo #32	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14H	2.067	Silo #33	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06

Nevada Test Site Emission Inventory

TONS/YR

Hazardous Air Pollutant Emissions

						Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals
						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0.000177	1.812E-05	0.02278	0.015505	0.14036	0.002127	0.06936	0.041727	0.005032	0.004709	#REF!	#REF!	#REF!
emission source #	old permit #	Equipment	process rate (ton/hr) or *heat rate (MMBtu/hr)*	operating hours (hr/yr)	control (%)	As (ton/yr)	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
Area 6 Construction storage yard						0	0.044784	0	0	0	0	0	0	0	0	0.01963	0.01368	0.12384	0.001877	0.05664	0.036816	0.00444	0.00407	0	0	0
6.111		Baghouse 11					0.044784	0	0	0	0	0	0	0	0	0.01963	0.01368	0.12384	0.001877	0.05664	0.036816	0.00444	0.00407	0	0	0
6.110	2.119	misc portable silos (7)	**50**	**1920**	**99**	0	0.044784	0	0	0	0	0	0	0	0	0.01963	0.01368	0.12384	0.001877	0.05664	0.036816	0.00444	0.00407	0	0	0
Area 12 Batch Plant						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.01	1.067	loading hopper	50	504	75.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.02	1.068	discharge hopper	50	504	50.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.03		Baghouse 11				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3A	2.073	loading silo #1	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3B	2.074	loading silo #2	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.04		Baghouse 13				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4A		weigh hopper/scale	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4B	2.075	conveyor to loadout	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.05	2.076	loadout	50	504	50.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 12 Portable Cement Bins						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.06		Baghouse 14				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6A		Mutiple portable bins	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6B		Mutiple portable bins	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6C	2.125	surge #1 loading	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6D	2.126	surge #1 discharge	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6E	2.127	surge #2 loading	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6F	2.128	surge #2 discharge	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Portable Baghouse/Silos (Previously UGTA)						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.111		Baghouse 11				.0000008.0	.0000008.06	.0000008.0	.0000008.0	.0000008.0	.0000008.0	.0000008.	.0000008.	.0000008.	.0000008.0	.0000008	.0000008.	.000000	.0000008.	.0000008.	.0000008.	.0000008.	.0000008.	.000008.0	.000008.0	.000008.06
6.093	2.119	portable silo	**50**	**1920**	**99**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.094	2.121	portable silo	**50**	**1920**	**99**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.095	2.123	portable silo	**50**	**1920**	**99**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

COMBUSTION EQUIPMENT

emission source #	old permit #	Equipment	process rate (ton/hr) or *heat rate (MMBtu/hr)*	operating hours (hr/yr)	control (%)	As (ton/yr)	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
Area 1 U1A						0	0.000045717	0	0	0	0	0	0	0	0	2E-05	1.4E-05	0.00013	1.92E-06	5.8E-05	3.75E-05	4.53E-06	4.16E-06	0	0	0
1.75	2.521	diesel air compressor	0.70	75	0	0	2.44913E-05	0	0	0	0	0	0	0	0	1.1E-05	7.48E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	0
1.76		diesel generator	0.70	65	0	0	2.12258E-05	0	0	0	0	0	0	0	0	9.3E-06	6.48E-06	5.9E-05	8.9E-07	2.7E-05	1.74E-05	2.1E-06	1.93E-06	0	0	0
Area 1 U1G						0	0.000133565	0	0	0	0	0	0	0	0	5.9E-05	4.06E-05	0.00037	5.6E-06	0.00017	0.00011	1.32E-05	1.21E-05	0	0	0
1.77	2.679	diesel generator	0.20	**65**	0	0	6.21005E-06	0	0	0	0	0	0	0	0	2.7E-06	1.9E-06	1.7E-05	2.6E-07	7.9E-06	5.11E-06	6.16E-07	5.64E-07	0	0	0
1.78	2.161	emergency generator	4.20	**65**	0	0	0.000127355	0	0	0	0	0	0	0	0	5.6E-05	3.89E-05	0.00035	5.34E-06	0.00016	0.000105	1.26E-05	1.16E-05	0	0	0
Area 1 Drilling Storage Yard						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0	0	0.0001	6.98E-05	0.00063	9.58E-06	0.00029	0.000188	2.27E-05	2.08E-05	#REF!	#REF!	#REF!
1.79	2.804	fluid pump	1.40	**50**	0	#REF!	0.000032655	0	0	0	0	0	0	0	0	1.4E-05	9.98E-06	9E-05	1.37E-06	4.1E-05	2.68E-05	3.24E-06	2.97E-06	#REF!	#REF!	#REF!
1.80	2.806	mud pump	1.40	**300**	0	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0	0	8.6E-05	5.99E-05	0.00054	8.21E-06	0.00025	0.000161	1.94E-05	1.78E-05	#REF!	#REF!	#REF!
Area 5 Check Point Pass						0	2.6751E-06	0	0	0	0	0	0	0	0	1.2E-06	8.17E-07	7.4E-06	1.12E-07	3.4E-06	2.2E-06	2.65E-07	2.43E-07	0		
5.001	2.677	diesel gen.(60 KW)	0.2	**28**	0	0	2.6751E-06	0	0	0	0	0	0	0	0	1.2E-06	8.17E-07	7.4E-06	1.12E-07	3.4E-06	2.2E-06	2.65E-07	2.43E-07	0	0	0
Area 5 WEF						0	9.74052E-07	0	0	0	0	0	0	0	0	4.3E-07	2.98E-07	2.7E-06	4.08E-08	1.2E-06	8.01E-07	9.66E-08	8.85E-08	0		
5.002	2.658	diesel gen.(34 KW)	0.12	**18**	0	0	9.74052E-07	0	0	0	0	0	0	0	0	4.3E-07	2.98E-07	2.7E-06	4.08E-08	1.2E-06	8.01E-07	9.66E-08	8.85E-08	0	0	0
Area 5 NPTEC																										
5.007	2.165	diesel generator	4.2	**300**	0	0	0.00058779	0	0	0	0	0	0	0	0	0.00026	0.00018	0.00163	2.46E-05	0.00074	0.000483	5.83E-05	5.34E-05	0	0	0
Area 6 Heavy Equipment Storage Yard						0	0.002242035	0	0	0	0	0	0	0	0	0.00098	0.000685	0.0062	9.4E-05	0.00284	0.001843	0.000222	0.000204	0	0	0
6.028	2.500	diesel air compressor	0.7	**75**	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1.1E-05	7.49E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	0
6.029	2.507	diesel air compressor	0.21	**75**	0	0	7.2879E-06	0	0	0	0	0	0	0	0	3.2E-06	2.23E-06	2E-05	3.05E-07	9.2E-06	5.99E-06	7.23E-07	6.62E-07	0	0	0
6.030	2.508	diesel air compressor	0.21	**30**	0	0	2.91516E-06	0	0	0	0	0	0	0	0	1.3E-06	8.9E-07	8.1E-06	1.22E-07	3.7E-06	2.4E-06	2.89E-07	2.65E-07	0	0	0
6.031	2.528	diesel air compressor	0.7	**75**	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1.1E-05	7.49E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	0
6.032	2.530	diesel air compressor	0.7	**75**	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1.1E-05	7.49E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	0
6.033	2.531	diesel air compressor	0.7	**75**	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1.1E-05	7.49E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	0
6.034	2.532	diesel air compressor	0.7	**75**	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1.1E-05	7.49E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	0
6.035	2.533	diesel air compressor	0.7	**75**	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1.1E-05	7.49E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	0
6.036	2.534	diesel air compressor	0.7	**75**	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1.1E-05	7.49E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	0
6.037	2.551	diesel air compressor	0.2	**75**	0	0	7.13045E-06	0	0	0	0	0	0	0	0	3.1E-06	2.18E-06	2E-05	2.99E-07	9E-06	5.86E-06	7.07E-07	6.48E-07	0	0	0
6.038	2.552	diesel air compressor	0.2	**75**	0	0	7.13045E-06	0	0	0	0	0	0	0	0	3.1E-06	2.18E-06	2E-05	2.99E-07	9E-06	5.86E-06	7.07E-07	6.48E-07	0	0	0
6.039	2.553	diesel air compressor	0.2	**17**	0	0	1.61624E-06	0	0	0	0	0	0	0	0	7.1E-07	4.94E-07	4.5E-06	6.77E-08	2E-06	1.33E-06	1.6E-07	1.47E-07	0	0	0
6.040		diesel air compressor	0.2	**75**	0	0	6.9975E-06	0	0	0	0	0	0	0	0	3.1E-06	2.14E-06	1.9E-05	2.93E-07	8.9E-06	5.75E-06	6.94E-07	6.36E-07	0	0	0
6.041	2.141	diesel air compressor	1.88	**150**	0	0	0.000131707	0	0	0	0	0	0	0	0	5.8E-05	4.02E-05	0.00036	5.52E-06	0.00017	0.000108	1.31E-05	1.2E-05	0	0	0
6.042		diesel generator	0.34	**65**		0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0
6.043		diesel generator	0.34	**65**		0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0
6.044	2.132	diesel generator	4.2	**300**	0	0	0.00058779	0	0	0	0	0	0	0	0	0.00026	0.00018	0.00163	2.46E-05	0.00074	0.000483	5.83E-05	5.34E-05	0	0	0
6.045	2.133	diesel generator	4.2	**300**	0	0	0.00058779	0	0	0	0	0	0	0	0	0.00026	0.00018	0.00163	2.46E-05	0.00074	0.000483	5.83E-05	5.34E-05	0	0	0
6.046	2.134	diesel generator	4.2	**300**	0	0	0.00058779	0	0	0	0	0	0	0	0	0.00026	0.00018	0.00163	2.46E-05	0.00074	0.000483	5.83E-05	5.34E-05	0	0	0
6.047	2.139	diesel generator	4.2	**9**	0	0	1.76337E-05	0	0	0	0	0	0	0	0	7.7E-06	5.39E-06	4.9E-05	7.39E-07	2.2E-05	1.45E-05	1.75E-06	1.6E-06	0	0	0
6.048	2.611	diesel generator	0.34	**65**	0	0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0
6.049	2.628	diesel generator	0.07	**65**		0	2.12258E-06	0	0	0	0	0	0	0	0	9.3E-07	6.48E-07	5.9E-06	8.9E-08	2.7E-06	1.74E-06	2.1E-07	1.93E-07	0	0	0
6.050	2.647	diesel generator	0.07	**65**		0	2.12258E-06	0	0	0	0	0	0	0	0	9.3E-07	6.48E-07	5.9E-06	8.9E-08	2.7E-06	1.74E-06	2.1E-07	1.93E-07	0	0	0
6.051	2.648	diesel generator	0.07	**65**		0	2.12258E-06	0	0	0	0	0	0	0	0	9.3E-07	6.48E-07	5.9E-06	8.9E-08	2.7E-06	1.74E-06	2.1E-07	1.93E-07	0	0	0
6.052	2.656	diesel generator	0.1	**9**		0	4.1985E-07	0	0	0	0	0	0	0	0	1.8E-07	1.28E-07	1.2E-06	1.76E-08	5.3E-07	3.45E-07	4.16E-08	3.82E-08	0	0	0
6.053	2.657	diesel generator	0.1	**65**	0	0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.48E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.08E-07	2.82E-07	0	0	0
6.054	2.681	diesel generator	0.2	**3**	0	0	2.86618E-07	0	0	0	0	0	0	0	0	1.3E-07	8.76E-08	7.9E-07	1.2E-08	3.6E-07	2.36E-07	2.84E-08	2.61E-08	0	0	0
6.055	2.605	diesel generator	0.34	**65**	0	0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0
6.056	2.606	diesel generator	0.34	**65**	0	0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0
6.057		diesel generator	0.34	**65**		0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0

Nevada Test Site Emission Inventory

TONS/YR

Hazardous Air Pollutant Emissions

emission source #	old permit #	Equipment	process rate (ton/hr) or *heat rate (MMBtu/hr)*	operating hours (hr/yr)	control (%)	As (ton/yr)	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
Totals						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0.000177	1.812E-05	0.02278	0.015505	0.14036	0.002127	0.08936	0.041727	0.005032	0.004709	#REF!	#REF!	#REF!
6.058		diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0
6.059		diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0
6.060		diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0
6.061		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1.1E-06	7.48E-07	6.8E-06	1.03E-07	3.1E-06	2.01E-06	2.43E-07	2.23E-07	0	0	0
6.062		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1.1E-06	7.48E-07	6.8E-06	1.03E-07	3.1E-06	2.01E-06	2.43E-07	2.23E-07	0	0	0
6.063		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1.1E-06	7.48E-07	6.8E-06	1.03E-07	3.1E-06	2.01E-06	2.43E-07	2.23E-07	0	0	0
6.064		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1.1E-06	7.48E-07	6.8E-06	1.03E-07	3.1E-06	2.01E-06	2.43E-07	2.23E-07	0	0	0
6.065		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1.1E-06	7.48E-07	6.8E-06	1.03E-07	3.1E-06	2.01E-06	2.43E-07	2.23E-07	0	0	0
6.066		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1.1E-06	7.48E-07	6.8E-06	1.03E-07	3.1E-06	2.01E-06	2.43E-07	2.23E-07	0	0	0
6.067		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1.1E-06	7.48E-07	6.8E-06	1.03E-07	3.1E-06	2.01E-06	2.43E-07	2.23E-07	0	0	0
6.068		trash pump	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	2.7E-07	1.85E-07	1.7E-06	2.54E-08	7.7E-07	4.99E-07	6.01E-08	5.51E-08	0	0	0
6.069		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	2.7E-07	1.85E-07	1.7E-06	2.54E-08	7.7E-07	4.99E-07	6.01E-08	5.51E-08	0	0	0
6.070		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	2.7E-07	1.85E-07	1.7E-06	2.54E-08	7.7E-07	4.99E-07	6.01E-08	5.51E-08	0	0	0
6.071		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	2.7E-07	1.85E-07	1.7E-06	2.54E-08	7.7E-07	4.99E-07	6.01E-08	5.51E-08	0	0	0
6.072		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	2.7E-07	1.85E-07	1.7E-06	2.54E-08	7.7E-07	4.99E-07	6.01E-08	5.51E-08	0	0	0
6.073		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	2.7E-07	1.85E-07	1.7E-06	2.54E-08	7.7E-07	4.99E-07	6.01E-08	5.51E-08	0	0	0
6.074		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	2.7E-07	1.85E-07	1.7E-06	2.54E-08	7.7E-07	4.99E-07	6.01E-08	5.51E-08	0	0	0
Area 6 CP-1						8.168E-07	4.3897E-05	6.126E-07	6.126E-07	1.84E-06	6.126E-07	1.23E-06	6.13E-07	3.06E-06	3.144E-07	2.8E-05	1.32E-05	0.00012	1.81E-06	0.00014	3.56E-05	4.29E-06	5.59E-06	9.34E-08	1.601E-07	0
6.075	2.404	Boiler	1.67	36.3	0	1.214E-07	9.10567E-08	9.106E-08	9.106E-08	2.73E-07	9.106E-08	1.82E-07	9.11E-08	4.55E-07	4.673E-08	1.4E-06	0	0	0	1.3E-05	0	0	2.47E-07	1.39E-06	2.38E-08	0
6.076	2.405	Boiler	1.67	208	0	6.953E-07	5.21507E-07	5.215E-07	5.215E-07	1.56E-06	5.215E-07	1.04E-06	5.22E-07	2.61E-06	2.676E-07	7.8E-06	0	0	0	7.6E-05	0	0	1.41E-06	7.95E-08	1.363E-07	0
6.077	2.158	emerg. generator	4.2	11	0	0	2.15523E-05	0	0	0	0	0	0	0	0	9.4E-06	6.58E-06	6E-05	9.03E-07	2.7E-05	1.77E-05	2.14E-06	1.96E-06	0	0	0
6.078		diesel generator	0.34	65	0	0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0
6.079	2.614	diesel generator	0.38	65	0	0	1.13831E-05	0	0	0	0	0	0	0	0	5E-06	3.48E-06	3.1E-05	4.77E-07	1.4E-05	9.36E-06	1.13E-06	1.03E-06	0	0	0
Area 6 CP-18						0	7.76256E-06	0	0	0	0	0	0	0	0	3.4E-06	2.37E-06	2.1E-05	3.25E-07	9.8E-06	6.38E-06	7.7E-07	7.06E-07	0	0	0
6.080	2.690	diesel generator	0.26	65	0	0	7.76256E-06	0	0	0	0	0	0	0	0	3.4E-06	2.37E-06	2.1E-05	3.25E-07	9.8E-06	6.38E-06	7.7E-07	7.06E-07	0	0	0
Area 6 CP-40						0	7.96082E-07	0	0	0	0	0	0	0	0	3.5E-07	2.43E-07	2.2E-06	3.34E-08	1E-06	6.54E-07	7.89E-08	7.24E-08	0	0	0
6.081	2.603	diesel generator	0.34	5	0	0	7.96082E-07	0	0	0	0	0	0	0	0	3.5E-07	2.43E-07	2.2E-06	3.34E-08	1E-06	6.54E-07	7.89E-08	7.24E-08	0	0	0
Area 6 CP-45						0	2.48402E-06	0	0	0	0	0	0	0	0	1.1E-06	7.59E-07	6.9E-06	1.04E-07	3.1E-06	2.04E-06	2.48E-07	2.26E-07	0	0	0
6.082	2.673	diesel generator	0.2	26	0	0	2.48402E-06	0	0	0	0	0	0	0	0	1.1E-06	7.59E-07	6.9E-06	1.04E-07	3.1E-06	2.04E-06	2.48E-07	2.26E-07	0	0	0
Area 6 CP-70						0	6.96531E-06	0	0	0	0	0	0	0	0	3.1E-06	2.13E-06	1.9E-05	2.92E-07	8.8E-06	5.73E-06	6.91E-07	6.33E-07	0	0	0
6.083	2.618	diesel generator	0.43	35	0	0	6.96531E-06	0	0	0	0	0	0	0	0	3.1E-06	2.13E-06	1.9E-05	2.92E-07	8.8E-06	5.73E-06	6.91E-07	6.33E-07	0	0	0
Area 6 CP-9						6.983E-07	0.001176104	5.237E-07	5.237E-07	1.57E-06	5.237E-07	1.05E-06	5.24E-07	2.62E-06	2.688E-07	0.00052	0.000360	0.00325	4.93E-05	0.00156	0.000966	0.000117	0.000108	7.99E-08	1.369E-07	0
6.084	2.403	Boiler	0.84	418	0	6.983E-07	5.23733E-07	5.237E-07	5.237E-07	1.57E-06	5.237E-07	1.05E-06	5.24E-07	2.62E-06	2.688E-07	7.8E-06	0	0	0	7.7E-05	0	0	1.42E-06	7.99E-08	1.369E-07	0
6.085	2.156	emerg. generator	4.2	300	0	0	0.00058779	0	0	0	0	0	0	0	0	0.00026	0.00018	0.00163	2.46E-05	0.00074	0.000483	5.83E-05	5.34E-05	0	0	0
6.086	2.163	emerg. generator	4.2	300	0	0	0.00058779	0	0	0	0	0	0	0	0	0.00026	0.00018	0.00163	2.46E-05	0.00074	0.000483	5.83E-05	5.34E-05	0	0	0
Area 6 DAF						0	3.39612E-05	0	0	0	0	0	0	0	0	1.5E-05	1.04E-05	9.4E-05	1.42E-06	4.3E-05	2.79E-05	3.37E-06	3.09E-06	0	0	0
6.087	2.160	emerg. generator	5.6	13	0	0	3.39612E-05	0	0	0	0	0	0	0	0	1.5E-05	1.04E-05	9.4E-05	1.42E-06	4.3E-05	2.79E-05	3.37E-06	3.09E-06	0	0	0
6.088	2.159	emerg. generator	5.6	13	0	0	3.39612E-05	0	0	0	0	0	0	0	0	1.5E-05	1.04E-05	9.4E-05	1.42E-06	4.3E-05	2.79E-05	3.37E-06	3.09E-06	0	0	0
6.089	2.407	Boiler	2.34	2600	0	1.217E-05	9.13068E-06	9.131E-06	9.131E-06	2.74E-05	9.131E-06	1.83E-05	9.13E-06	4.57E-05	4.686E-06	0.00014	0	0	0	0.00134	0	0	2.47E-05	1.39E-06	2.387E-06	0
6.090	2.408	Boiler	2.34	2600	0	1.217E-05	9.13068E-06	9.131E-06	9.131E-06	2.74E-05	9.131E-06	1.83E-05	9.13E-06	4.57E-05	4.686E-06	0.00014	0	0	0	0.00134	0	0	2.47E-05	1.39E-06	2.387E-06	0
Area 6 Decon						1.036E-05	0.00000777	7.77E-06	7.77E-06	2.33E-05	7.77E-06	1.55E-05	7.77E-06	3.89E-05	3.987E-06	0.00012	0	0	0	0.00114	0	0	2.11E-05	1.19E-06	2.031E-06	0
6.091	2.088	Boiler	5.18	1000	0	1.036E-05	0.00000777	7.77E-06	7.77E-06	2.33E-05	7.77E-06	1.55E-05	7.77E-06	3.89E-05	3.987E-06	0.00012	0	0	0	0.00114	0	0	2.11E-05	1.19E-06	2.031E-06	0
Area 6 Iron Workers Yard						0	3.14888E-06	0	0	0	0	0	0	0	0	1.4E-06	9.62E-07	8.7E-06	1.32E-07	4E-06	2.59E-06	3.12E-07	2.86E-07	0	0	0
6.092		diesel cable reeler	0.14	50		0	3.14888E-06	0	0	0	0	0	0	0	0	1.4E-06	9.62E-07	8.7E-06	1.32E-07	4E-06	2.59E-06	3.12E-07	2.86E-07	0	0	0
Area 6 Well 3 Yard						0	4.12388E-05	0	0	0	0	0	0	0	0	1.8E-05	1.26E-05	0.00011	1.73E-06	5.2E-05	3.39E-05	4.08E-06	3.75E-06	0	0	0
6.096	2.097	bin	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.097		diesel generator	0.34	65		0	1.03097E-05	0	0	0	0	0	0	0	0	4.5E-06	3.15E-06	2.9E-05	4.32E-07	1.3E-05	8.48E-06	1.02E-06	9.37E-07	0	0	0
6.098		diesel generator	0.34	65		0	1.03097E-05	0	0	0	0	0	0	0	0	4.5E-06	3.15E-06	2.9E-05	4.32E-07	1.3E-05	8.48E-06	1.02E-06	9.37E-07	0	0	0
6.099		diesel generator	0.34	65		0	1.03097E-05	0	0	0	0	0	0	0	0	4.5E-06	3.15E-06	2.9E-05	4.32E-07	1.3E-05	8.48E-06	1.02E-06	9.37E-07	0	0	0
6.100		diesel generator	0.34	65		0	1.03097E-05	0	0	0	0	0	0	0	0	4.5E-06	3.15E-06	2.9E-05	4.32E-07	1.3E-05	8.48E-06	1.02E-06	9.37E-07	0	0	0
Area 6 Wet/Wild						0	0.000731461	0	0	0	0	0	0	0	0	0.00032	0.000223	0.00202	3.07E-05	0.00093	0.000601	7.25E-05	6.65E-05	0	0	0
6.101	2.542	diesel air compressor	1.97	150	0	0	0.000138124	0	0	0	0	0	0	0	0	6.1E-05	4.22E-05	0.00038	5.79E-06	0.00017	0.000114	1.37E-05	1.26E-05	0	0	0
6.102	2.543	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1.1E-05	7.49E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	0
6.103	2.544	diesel air compressor	1.97	150	0	0	0.000138124	0	0	0	0	0	0	0	0	6.1E-05	4.22E-05	0.00038	5.79E-06	0.00017	0.000114	1.37E-05	1.26E-05	0	0	0
6.104	2.545	diesel air compressor	1.97	150	0	0	0.000138124	0	0	0	0	0	0	0	0	6.1E-05	4.22E-05	0.00038	5.79E-06	0.00017	0.000114	1.37E-05	1.26E-05	0	0	0
6.105		diesel air compressor	1.97	150		0	0.000138124	0	0	0	0	0	0	0	0	6.1E-05	4.22E-05	0.00038	5.79E-06	0.00017	0.000114	1.37E-05	1.26E-05	0	0	0
6.106		conveyor	250	100		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.107		pump	0.7	50		0	1.63275E-05	0	0	0	0	0	0	0	0	7.2E-06	4.99E-06	4.5E-05	6.84E-07	2.1E-05	1.34E-05	1.62E-06	1.48E-06	0	0	0
6.108		diesel air compressor	1.97	150	0	0	0.000138124	0	0	0	0	0	0	0	0	6.1E-05	4.22E-05	0.00038	5.79E-06	0.00017	0.000114	1.37E-05	1.26E-05	0	0	0
Area 6 Other misc. equipment						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.109		abrasive blaster		50		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 12 Cafeteria						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.07	2.402	boiler	1.77	2600	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.08	2.072	boiler	3.6	2600	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 12G-Tunnel						3.549E-08	2.07217E-05	2.662E-08	2.662E-08	7.99E-08	2.662E-08	5.32E-08	2.66E-08	1.33E-07	1.366E-08	9.5E-06	6.32E-06	5.7E-05	8.67E-07	3E-05	1.7E-05	2.05E-06	1.95E-06	4.06E-09	6.958E-09	0
12.09		diesel generator	0.14	65	0.0	0	4.13902E-06	0	0	0	0	0	0	0	0	1.8E-06	1.26E-06	1.1E-05	1.73E-07	5.2E-06	3.4E-06	4.1E-07	3.76E-07	0	0	0
12.10		diesel generator	0.14	65	0.0	0	4.13902E-06	0	0	0	0	0	0	0	0	1.8E-06	1.26E-06	1.1E-05	1.73E-07	5.2E-06	3.4E-06	4.1E-07	3.76E-07	0	0	0
12.11		diesel generator	0.14	65	0.0	0	4.13902E-06	0	0	0	0	0	0	0	0	1.8E-06	1.26E-06	1.1E-05	1.73E-07	5.2E-06	3.4E-06	4.1E-07	3.76E-07	0	0	0
12.12		diesel generator/welder	0.14	65	0.0	0	4.13902E-06	0	0	0	0	0	0	0	0	1.8E-06	1.26E-06	1.1E-05	1.73E-07	5.2E-06	3.4E-06	4.1E-07	3.76E-07	0	0	0
12.13		diesel generator	0.14	65	0.0	0	4.13902E-06	0	0	0	0	0	0	0	0	1.8E-06	1.26E-06	1.1E-05	1.73E-07	5.2E-06	3.4E-06	4.1E-07	3.76E-07	0	0	0
12.14		industrial heater	0.14	65	0.0	1.775E-08	1.33088E-08	1.331E-08	1.331E-08	3.99E-08	1.331E-08	2.66E-08	1.33E-08	6.65E-08	6.83E-09	2E-07	0	0	0	1.9E-06	0	0	3.61E-08	2.03E-09	3.479E-09	0
12.15		steam cleaner	0.14	65	0.0	1.775E-08	1.33088E-08	1.331E-08	1.331E-08	3.99E-08	1.331E-08	2.66E-08	1.33E-08	6.65E-08	6.83E-09	2E-07	0	0	0	1.9E-06	0	0	3.61E-08	2.03E-09	3.479E-09	0
Area 12N-Tunnel						0	0.000339612	0	0	0	0	0	0	0	0	0.00015	0.000104	0.00094	1.42E-05	0.00043	0.000279	3.37E-05	3.09E-05	0	0	0
12.16	2.154	diesel generator	5.6	65	0.0	0	0.000169806	0	0	0	0	0	0	0	0	7.4E-05	5.19E-05	0.00047	7.12E-06	0.00021	0.00014	1.68E-05	1.54E-05	0	0	0
12.17	2.155	diesel generator	5.6	65	0.0	0	0.000169806	0	0	0	0	0	0	0	0	7.4E-05	5.19E-05	0.00047	7.12E-06	0.00021	0.00014	1.68E-05	1.54E-05	0	0	0
Area 12 P-Tunnel						0	1.63846E-05	0	0	0	0	0	0	0	0	7.2E-06	5E-06	4.5E-05	6.87E-07	2.1E-05	1.35E-05	1.62E-06	1.49E-06	0	0	0

Nevada Test Site Emission Inventory

TONS/YR

Hazardous Air Pollutant Emissions

emission source #	old permit #	Equipment	process rate (ton/hr) or *heat rate (MMBtu/hr)*	operating hours (hr/yr)	control (%)	As *(ton/yr)*	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
						Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals
						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0.000177	1.812E-05	0.02278	0.015506	0.14036	0.002127	0.06936	0.041727	0.005032	0.004709	#REF!	#REF!	#REF!
12.18		diesel compressor	0.2	75		0	6.9975E-06	0	0	0	0	0	0	0	0	3.1E-06	2.14E-06	1.9E-05	2.93E-07	8.9E-06	5.75E-06	6.94E-07	6.36E-07	0	0	0
12.19		diesel air dryer	0.2	75		0	6.9975E-06	0	0	0	0	0	0	0	0	3.1E-06	2.14E-06	1.9E-05	2.93E-07	8.9E-06	5.75E-06	6.94E-07	6.36E-07	0	0	0
12.20	2.701	gasoline generator	0.07	75	0.0	0	2.38965E-06	0	0	0	0	0	0	0	0	1E-06	7.3E-07	6.6E-06	1E-07	3E-06	1.96E-06	2.37E-07	2.17E-07	0	0	0
Area 12 T-Tunnel						0	0.000181002	0	0	0	0	0	0	0	0	7.9E-05	5.53E-05	0.0006	7.59E-06	0.00023	0.000149	1.79E-05	1.65E-05	0	0	0
12.21		diesel generator	0.2	120		0	0.000011196	0	0	0	0	0	0	0	0	4.9E-06	3.42E-06	3.1E-05	4.69E-07	1.4E-05	9.2E-06	1.11E-06	1.02E-06	0	0	0
12.22	2.153	diesel generator	5.6	65	0.0	0	0.000169806	0	0	0	0	0	0	0	0	7.4E-05	5.19E-05	0.00047	7.12E-06	0.00021	0.00014	1.68E-05	1.54E-05	0	0	0
Area 12 U-Tunnel						0	6.0645E-06	0	0	0	0	0	0	0	0	2.7E-06	1.85E-06	1.7E-05	2.54E-07	7.7E-06	4.99E-06	6.01E-07	5.51E-07	0	0	0
12.23		diesel generator	0.2	65		0	6.0645E-06	0	0	0	0	0	0	0	0	2.7E-06	1.85E-06	1.7E-05	2.54E-07	7.7E-06	4.99E-06	6.01E-07	5.51E-07	0	0	0
Area 12 Yard						0	0.000129874	0	0	0	0	0	0	0	0	5.7E-05	3.97E-05	0.00036	5.45E-06	0.00016	0.000107	1.29E-05	1.18E-05	0	0	0
12.24		diesel generator	0.51	65		0	1.55251E-05	0	0	0	0	0	0	0	0	6.8E-06	4.74E-06	4.3E-05	6.51E-07	2E-05	1.28E-05	1.54E-06	1.41E-06	0	0	0
12.25		diesel generator	0.51	65		0	1.55251E-05	0	0	0	0	0	0	0	0	6.8E-06	4.74E-06	4.3E-05	6.51E-07	2E-05	1.28E-05	1.54E-06	1.41E-06	0	0	0
12.26		diesel generator	0.51	65		0	1.55251E-05	0	0	0	0	0	0	0	0	6.8E-06	4.74E-06	4.3E-05	6.51E-07	2E-05	1.28E-05	1.54E-06	1.41E-06	0	0	0
12.27		diesel generator	0.51	65		0	1.55251E-05	0	0	0	0	0	0	0	0	6.8E-06	4.74E-06	4.3E-05	6.51E-07	2E-05	1.28E-05	1.54E-06	1.41E-06	0	0	0
12.28		diesel generator	0.51	65		0	1.55251E-05	0	0	0	0	0	0	0	0	6.8E-06	4.74E-06	4.3E-05	6.51E-07	2E-05	1.28E-05	1.54E-06	1.41E-06	0	0	0
12.29		diesel generator	0.2	65		0	6.0645E-06	0	0	0	0	0	0	0	0	2.7E-06	1.85E-06	1.7E-05	2.54E-07	7.7E-06	4.99E-06	6.01E-07	5.51E-07	0	0	0
12.30		diesel generator	0.2	65		0	6.0645E-06	0	0	0	0	0	0	0	0	2.7E-06	1.85E-06	1.7E-05	2.54E-07	7.7E-06	4.99E-06	6.01E-07	5.51E-07	0	0	0
12.31		diesel generator	0.2	65		0	6.0645E-06	0	0	0	0	0	0	0	0	2.7E-06	1.85E-06	1.7E-05	2.54E-07	7.7E-06	4.99E-06	6.01E-07	5.51E-07	0	0	0
12.32		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.48E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.06E-07	2.82E-07	0	0	0
12.33		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.48E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.06E-07	2.82E-07	0	0	0
12.34		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.48E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.06E-07	2.82E-07	0	0	0
12.35		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.48E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.06E-07	2.82E-07	0	0	0
12.36		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.48E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.06E-07	2.82E-07	0	0	0
12.37		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.48E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.06E-07	2.82E-07	0	0	0
12.38		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.48E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.06E-07	2.82E-07	0	0	0
12.39		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.48E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.06E-07	2.82E-07	0	0	0
12.40		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.48E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.06E-07	2.82E-07	0	0	0
12.41		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.48E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.06E-07	2.82E-07	0	0	0
12.42		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.48E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.06E-07	2.82E-07	0	0	0
Area 23 (Mercury)						1.691E-05	0.000465106	1.268E-05	1.268E-05	3.8E-05	1.268E-05	2.54E-05	1.27E-05	6.34E-05	6.509E-06	0.00039	0.000138	0.00125	1.9E-05	0.00243	0.000372	4.46E-05	7.56E-05	1.93E-06	3.315E-06	
23.01	2.646	generator/B1000	0.07	330		0	1.07762E-05	0	0	0	0	0	0	0	0	4.7E-06	3.29E-06	3E-05	4.52E-07	1.4E-05	8.86E-06	1.07E-06	9.79E-07	0	0	
23.02	2.604	generator/B1010	0.34	15		0	2.38825E-06	0	0	0	0	0	0	0	0	1E-06	7.3E-07	6.6E-06	1E-07	3E-06	1.96E-06	2.37E-07	2.17E-07	0	0	
23.03	2.400	boiler/B111	0.47	239		2.235E-07	1.67638E-07	1.676E-07	1.676E-07	5.03E-07	1.676E-07	3.35E-07	1.68E-07	8.38E-07	8.603E-08	2.5E-06	0	0	0	2.5E-05	0	0	4.54E-07	2.56E-08	4.382E-08	
23.04	2.401	boiler/B128	0.84	300		5.011E-07	3.75824E-07	3.758E-07	3.758E-07	1.13E-06	3.758E-07	7.52E-07	3.76E-07	1.88E-06	1.929E-07	5.6E-06	0	0	0	5.5E-05	0	0	1.02E-06	5.73E-08	9.824E-08	
23.05	2.409	boiler/B156	0.33	438		2.929E-07	2.19666E-07	2.197E-07	2.197E-07	6.59E-07	2.197E-07	4.39E-07	2.2E-07	1.1E-06	1.127E-07	3.3E-06	0	0	0	3.2E-05	0	0	5.95E-07	3.35E-08	5.742E-08	
23.06	2.601	emergency generator	0.07	3		0	9.55859E-08	0	0	0	0	0	0	0	0	4.2E-08	2.92E-08	2.6E-07	4.01E-09	1.2E-07	7.66E-08	9.48E-09	8.69E-09	0	0	
23.07	2.411	boiler/B536	1.77	564		1.996E-06	1.49715E-06	1.497E-06	1.497E-06	4.49E-06	1.497E-06	2.99E-06	1.5E-06	7.49E-06	7.683E-07	2.2E-05	0	0	0	0.00022	0	0	4.06E-06	2.28E-07	3.913E-07	
23.08		diesel generator	0.2	120		0	0.000011196	0	0	0	0	0	0	0	0	4.9E-06	3.42E-06	3.1E-05	4.69E-07	1.4E-05	9.2E-06	1.11E-06	1.02E-06	0	0	
23.09	2.157	emergency generator	4.2	12		0	2.35116E-05	0	0	0	0	0	0	0	0	1E-05	7.18E-06	6.5E-05	9.85E-07	3E-05	1.93E-05	2.33E-06	2.14E-06	0	0	
23.10	2.164	emergency generator	4.2	195		0	0.000382064	0	0	0	0	0	0	0	0	0.00017	0.000117	0.00106	1.6E-05	0.00048	0.000314	3.79E-05	3.47E-05	0	0	
23.11	2.070	boiler/B754 Café	3.2	1011		6.47E-06	4.85232E-06	4.852E-06	4.852E-06	1.46E-05	4.852E-06	9.7E-06	4.85E-06	2.43E-05	2.49E-06	7.2E-05	0	0	0	0.00071	0	0	1.31E-05	7.4E-07	1.268E-06	
23.12	2.071	boiler/B753	6.44	576		7.421E-06	5.56609E-06	5.566E-06	5.566E-06	1.67E-05	5.566E-06	1.11E-05	5.57E-06	2.78E-05	2.856E-06	8.3E-05	0	0	0	0.00061	0	0	1.51E-05	8.49E-07	1.455E-06	
23.13	2.152	incinerator	0.32	872	99.0	5.494E-09	4.1202E-09	4.12E-09	4.12E-09	1.24E-08	4.12E-09	8.24E-09	4.12E-09	2.06E-08	2.114E-09	6.1E-08	0	0	0	6E-07	0	0	1.12E-08	6.28E-10	1.077E-09	
23.14		generator/RSN MAT	0.2	120		0	0.000011196	0	0	0	0	0	0	0	0	4.9E-06	3.42E-06	3.1E-05	4.69E-07	1.4E-05	9.2E-06	1.11E-06	1.02E-06	0	0	
23.15		generator/RSN MAT	0.2	120		0	0.000011196	0	0	0	0	0	0	0	0	4.9E-06	3.42E-06	3.1E-05	4.69E-07	1.4E-05	9.2E-06	1.11E-06	1.02E-06	0	0	
23.57	2.070	boiler/B754 Café	3.2	271		1.732E-06	1.29936E-06	1.299E-06	1.299E-06	3.9E-06	1.299E-06	2.6E-06	1.3E-06	6.5E-06	6.668E-07	1.9E-05	0	0	0	0.00019	0	0	3.52E-06	1.98E-07	3.396E-07	
Area 25						1.829E-05	1.3696E-05	1.37E-05	1.37E-05	4.11E-05	1.37E-05	2.74E-05	1.37E-05	6.85E-05	7.029E-06	0.0002	0	0	0	0.002	0	0	3.71E-05	2.09E-06	3.58E-06	
25.01	2.410	boiler/B4015	2.68	2600		1.391E-05	1.04352E-05	1.044E-05	1.044E-05	3.13E-05	1.044E-05	2.09E-05	1.04E-05	5.22E-05	5.355E-06	0.00016	0	0	0	0.00153	0	0	2.83E-05	1.59E-06	2.728E-06	
25.02	2.406	boiler/B4215	0.84	2600		4.348E-06	3.26079E-06	3.261E-06	3.261E-06	9.78E-06	3.261E-06	6.52E-06	3.26E-06	1.63E-05	1.673E-06	4.8E-05	0	0	0	0.00048	0	0	8.84E-06	4.97E-07	8.523E-07	
25.03	2.683	generator/ Skull Mtn.	0.2	25		0.00E+00	2.39E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.0E-06	7.3E-07	6.6E-06	1.0E-07	3.0E-06	2.0E-06	2.4E-07	2.2E-07	0.0E+00	0.0E+00	
25.04	2.529	air comp./ X-tunnel	0.7	75		0	2.44913E-05	0	0	0	0	0	0	0	0	1.1E-05	7.48E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	
Area 27						0	0.000117658	0	0	0	0	0	0	0	0	5.2E-05	3.59E-05	0.00033	4.93E-06	0.00015	9.66E-05	1.17E-05	1.07E-05	#VALUE!	0	
27.01	2.131	emergency generator	5.6	35		0	0.000091434	0	0	0	0	0	0	0	0	4E-05	2.79E-05	0.00025	3.83E-06	0.00012	7.52E-05	9.07E-06	8.31E-06	#VALUE!	0	
27.02	2.130	emergency generator	5.6	10		0	0.000026124	0	0	0	0	0	0	0	0	1.1E-05	7.98E-06	7.2E-05	1.09E-06	3.3E-05	2.15E-05	2.59E-06	2.37E-06	#VALUE!	0	
27.03	2.619	diesel generator	0.05	65		0	1.55251E-06	0	0	0	0	0	0	0	0	6.8E-07	4.74E-07	4.3E-06	6.51E-08	2E-06	1.28E-06	1.54E-07	1.41E-07	#VALUE!	0	
27.04	2.669	diesel generator	0.14	65		0	4.13902E-06	0	0	0	0	0	0	0	0	1.8E-06	1.26E-06	1.1E-05	1.73E-07	5.2E-06	3.4E-06	4.1E-07	3.76E-07	#VALUE!	0	
Area 29						0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	#VALUE!	0	
29.01	2.602	diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	#VALUE!	0	

Nevada Test Site Emission Inventory

TONS/YR

Hazardous Air Pollutant Emissions

emission source #	old permit #	Equipment	process rate (ton/hr) or *heat rate (MMBtu/hr)*	operating hours (hr/yr)	control (%)	As (ton/yr)	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
						Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals
						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0.000177	1.812E-05	0.02276	0.015505	0.14038	0.002127	0.05036	0.041727	0.005032	0.004709	#REF!	#REF!	#REF!
CHEMICAL RELEASES/FUME HOODS																										
AREA 5																										
HSC																										
HSC Chemical Releases																										
5.008		Chemical releases																								

Nevada Test Site Emission Inventory

TONS/YR

Hazardous Air Pollutant Emissions

emission source #	old permit #	Equipment	process rate (ton/hr) or heat rate (MMBtu/hr)	operating hours (hr/yr)	control (%)	As (ton/yr)	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
Totals						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0.000177	1.812E-05	0.0227	0.015453	0.13969	0.00212	0.06915	0.041586	0.005015	0.004694	#REF!	#REF!	#REF!
AGGREGATE PROCESSING EQUIPMENT																										
Area 1 Shaker Plant						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.14		Baghouse 02				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14A	1.016	C-7 to Rotary dryer	100	250	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14B	2.023	Rotary Dryer	100	250	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 1 Concrete Batch Plant						1.345E-05	1.39472E-07	1.841E-06	4.145E-06	6.32E-06	0	0.001668	0.000142	0	0	0	0	0	0	0	0	0	0	0	0	1E-04
1.46		Baghouse 04				2.646E-08	2.81925E-10	3.686E-09	3.969E-09	1.16E-08	0	3.18E-06	2.77E-07	0	0	0	0	0	0	0	0	0	0	0	0	2E-07
46A	2.026	loading overhead bin	50	31.5	99	1.323E-08	1.40963E-10	1.843E-09	1.985E-09	5.8E-09	0	1.59E-06	1.39E-07	0	0	0	0	0	0	0	0	0	0	0	0	9E-08
46B	1.057	loading weigh hopper	50	31.5	99	1.323E-08	1.40963E-10	1.843E-09	1.985E-09	5.8E-09	0	1.59E-06	1.39E-07	0	0	0	0	0	0	0	0	0	0	0	0	9E-08
46C		loading temp. bin A	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46D		discharge temp bin A	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46E		loading temp. bin B	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46F		discharge temp bin B	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46G		loading temp. bin C	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46H		discharge temp bin C	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46I	2.111	loading Silo #3	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46J	2.112	discharge Silo #3	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46K	2.113	loading Silo #4	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46L	2.114	discharge Silo #4	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46M	2.115	loading Silo #5	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46N	2.116	discharge Silo #5	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
1.47		Baghouse 06				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47A	2.028	C-2 to funnel	160	1920	99	2.58E-06	2.74944E-08	3.594E-07	3.871E-07	1.13E-06	0	0.00031	2.7E-05	0	0	0	0	0	0	0	0	0	0	0	0	2E-05
47B	2.027	weigh hopper 2 to funnel	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
47C	2.029	truck loading	160	1920	99	3.564E-07	0	1.812E-08	2.181E-06	5.87E-07	0	9.4E-05	5.04E-06	0	0	0	0	0	0	0	0	0	0	0	0	3E-05
Area 6 Cementing Equipment						0.0001145	1.15186E-06	1.505E-05	1.624E-05	4.73E-05	0	0.012993	0.001132	5.57E-09	0	0	0	0	0	0	0	0	0	0	0	6E-04
6.001	2.032	Scale #1	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
6.002	2.033	Scale #2	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
6.003	2.034	Scale #3	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
123A		Baghouse 07/back-up				2.58E-06	2.74944E-08	3.594E-07	3.871E-07	1.13E-06	0	0.00031	2.7E-05	0	0	0	0	0	0	0	0	0	0	0	0	2E-05
123B		waste silo	10	1920	99	1.613E-07	1.7184E-09	2.246E-08	2.419E-08	7.07E-08	0	1.94E-05	1.69E-06	0	0	0	0	0	0	0	0	0	0	0	0	1E-06
6.004		Baghouse 10				6.953E-09	5.185E-10	9.775E-11	2.724E-08	8.5E-09	0	2.6E-07	3.23E-08	5.57E-09	0	0	0	0	0	0	0	0	0	0	0	1E-07
4A	2.035	Load blending tank	50	8.5	99	4.93E-10	0	2.508E-11	3.018E-09	8.12E-10	0	1.3E-07	6.97E-09	0	0	0	0	0	0	0	0	0	0	0	0	4E-08
4B	2.036	Blending tank discharge	50	8.5	99	6.46E-09	5.185E-10	7.268E-11	2.423E-08	7.69E-09	0	1.3E-07	2.53E-08	5.57E-09	0	0	0	0	0	0	0	0	0	0	0	8E-08
6.005		Bin Vent #1				1.344E-05	1.432E-07	1.872E-06	2.016E-06	5.89E-06	0	0.001616	0.000141	0	0	0	0	0	0	0	0	0	0	0	0	9E-05
6.006		Bin Vent #3				1.344E-05	1.432E-07	1.872E-06	2.016E-06	5.89E-06	0	0.001616	0.000141	0	0	0	0	0	0	0	0	0	0	0	0	9E-05
6.007		Bin Vent #4				1.344E-05	1.432E-07	1.872E-06	2.016E-06	5.89E-06	0	0.001616	0.000141	0	0	0	0	0	0	0	0	0	0	0	0	9E-05
567A	2.037	Silo #1	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
567B	2.038	Silo #2	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
567C	2.039	Silo #3	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
567D	2.040	Silo #4	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
567E	2.041	Silo #5	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
6.008		Bin Vent #8				1.613E-05	1.7184E-07	2.246E-06	2.419E-06	7.07E-06	0	0.001939	0.000169	0	0	0	0	0	0	0	0	0	0	0	0	1E-04
8A	2.042	Silo #7	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
8B	2.043	Silo #8	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
6.009	2.044	Silo #15	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
6.010	2.045	Silo #16	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
6.011		Bin Vent #18				1.21E-05	1.2888E-07	1.685E-06	1.814E-06	5.3E-06	0	0.001454	0.000127	0	0	0	0	0	0	0	0	0	0	0	0	8E-05
6.012		Bin Vent #19				1.21E-05	1.2888E-07	1.685E-06	1.814E-06	5.3E-06	0	0.001454	0.000127	0	0	0	0	0	0	0	0	0	0	0	0	8E-05
1112A	2.046	Silo #17	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
1112B	2.047	Silo #18	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
1112C	2.048	Silo #19	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
6.013		Baghouse 08				8.87E-06	9.4512E-08	1.236E-06	1.331E-06	3.89E-06	0	0.001067	9.29E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
13A	2.049	Silo #9	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13B	2.050	Silo #10	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13C	2.051	Silo #11	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13D	2.052	Silo #12	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13E	2.053	Silo #13	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13F	2.054	Silo #14	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13G	2.055	Silo #27	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13H	2.056	Silo #28	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13I	2.057	Silo #29	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13J	2.058	Silo #30	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13K	2.059	Silo #31	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
6.014		Baghouse 09				6.451E-06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14A	2.060	Silo #21	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14B	2.061	Silo #22	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14C	2.062	Silo #23	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14D	2.063	Silo #24	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14E	2.064	Silo #25	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14F	2.065	Silo #26	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14G	2.066	Silo #32	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14H	2.067	Silo #33	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06

Nevada Test Site Emission Inventory

TONS/YR

Hazardous Air Pollutant Emissions

emission source #	old permit #	Equipment	process rate (ton/hr) or heat rate (MMBtu/hr)	operating hours (hr/yr)	control (%)	As (ton/yr)	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
Totals						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0.000177	1.812E-05	0.0227	0.015453	0.13998	0.00212	0.06915	0.041588	0.005015	0.004694	#REF!	#REF!	#REF!
Area 6 Construction storage yard						0	0.044784	0	0	0	0	0	0	0	0	0.01963	0.01368	0.12384	0.001877	0.05664	0.036816	0.00444	0.00407	0	0	0
6.111		Baghouse 11					0.044784	0	0	0	0	0	0	0	0	0.01963	0.01368	0.12384	0.001877	0.05664	0.036816	0.00444	0.00407	0	0	0
6.110	2.119	misc portable silos (7)	50	1920	99	0	0.044784	0	0	0	0	0	0	0	0	0.01963	0.01368	0.12384	0.001877	0.05664	0.036816	0.00444	0.00407	0	0	0
Area 12 Batch Plant						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.01	1.067	loading hopper	50	504	75.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.02	1.068	discharge hopper	50	504	50.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.03		Baghouse 11				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3A	2.073	loading silo #1	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3B	2.074	loading silo #2	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.04		Baghouse 13				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4A		weigh hopper/scale	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4B	2.075	conveyor to loadout	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.05	2.076	loadout	50	504	50.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 12 Portable Cement Bins						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.06		Baghouse 14				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6A		Mutiple portable bins	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6B		Mutiple portable bins	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6C	2.125	surge #1 loading	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6D	2.126	surge #1 discharge	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6E	2.127	surge #2 loading	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6F	2.128	surge #2 discharge	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Portable Baghouse/Silos (Previously UGTA)						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.111		Baghouse 11				.0000008.0E	.0000008.06	.0000008.0	.0000008.0(	.0000008.0	.0000008.0(	.0000008.(	.0000008.	.0000008.(	.0000008.0(	.0000008	.0000008.(	.000000E	.0000008.	.0000008.	.0000008.(	.0000008.(	.0000008.	.0000008.C	.0000008.0(	.0000008.06
6.093	2.119	portable silo	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.094	2.121	portable silo	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.095	2.123	portable silo	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

COMBUSTION EQUIPMENT

emission source #	old permit #	Equipment	process rate (ton/hr) or heat rate (MMBtu/hr)	operating hours (hr/yr)	control (%)	As (ton/yr)	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
Area 1 U1A						0	0.000045717	0	0	0	0	0	0	0	0	2E-05	1.4E-05	0.00013	1.92E-06	5.8E-05	3.76E-05	4.53E-06	4.16E-06	0	0	0
1.75	2.521	diesel air compressor	0.70	75	0	0	2.44913E-05	0	0	0	0	0	0	0	0	1.1E-05	7.48E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	0
1.76		diesel generator	0.70	65	0	0	2.12258E-05	0	0	0	0	0	0	0	0	9.3E-06	6.48E-06	5.9E-05	8.9E-07	2.7E-05	1.74E-05	2.1E-06	1.93E-06	0	0	0
Area 1 U1G						0	3.75588E-05	0	0	0	0	0	0	0	0	1.6E-05	1.15E-05	0.0001	1.57E-06	4.8E-05	3.09E-05	3.72E-06	3.41E-06	0	0	0
1.77	2.679	diesel generator	0.20	65	0	0	6.21005E-06	0	0	0	0	0	0	0	0	2.7E-06	1.9E-06	1.7E-05	2.6E-07	7.9E-06	5.11E-06	6.16E-07	5.64E-07	0	0	0
1.78	2.161	emergency generator	4.20	16	0	0	3.13488E-05	0	0	0	0	0	0	0	0	1.4E-05	9.58E-06	8.7E-05	1.31E-06	4E-05	2.58E-05	3.11E-06	2.85E-06	0	0	0
Area 1 Drilling Storage Yard						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0	0	0.0001	6.98E-05	0.00063	9.58E-06	0.00029	0.000188	2.27E-05	2.08E-05	#REF!	#REF!	#REF!
1.79	2.804	fluid pump	1.40	50	0	#REF!	0.000032655	0	0	0	0	0	0	0	0	1.4E-05	9.98E-06	9E-05	1.37E-06	4.1E-05	2.68E-05	3.24E-06	2.97E-06	#REF!	#REF!	#REF!
1.80	2.806	mud pump	1.40	300	0	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0	0	8.6E-05	5.99E-05	0.00054	8.21E-06	0.00025	0.000161	1.94E-05	1.78E-05	#REF!	#REF!	#REF!
Area 5 Check Point Pass						0	2.86618E-07	0	0	0	0	0	0	0	0	1.3E-07	8.76E-08	7.9E-07	1.2E-08	3.6E-07	2.36E-07	2.84E-08	2.61E-08	0		
5.001	2.677	diesel gen.(60 KW)	0.2	3	0	0	2.86618E-07	0	0	0	0	0	0	0	0	1.3E-07	8.76E-08	7.9E-07	1.2E-08	3.6E-07	2.36E-07	2.84E-08	2.61E-08	0	0	0
Area 5 WEF						0	9.74052E-07	0	0	0	0	0	0	0	0	4.3E-07	2.98E-07	2.7E-06	4.08E-08	1.2E-06	8.01E-07	9.68E-08	8.85E-08	0		
5.002	2.658	diesel gen.(34 KW)	0.12	18	0	0	9.74052E-07	0	0	0	0	0	0	0	0	4.3E-07	2.98E-07	2.7E-06	4.08E-08	1.2E-06	8.01E-07	9.68E-08	8.85E-08	0	0	0
Area 5 NPTEC																										
5.007	2.165	diesel generator	4.2	300	0	0	0.00058779	0	0	0	0	0	0	0	0	0.00026	0.00018	0.00163	2.46E-05	0.00074	0.000483	5.83E-05	5.34E-05	0	0	0
Area 6 Heavy Equipment Storage Yard						0	0.002239709	0	0	0	0	0	0	0	0	0.00098	0.000684	0.00619	9.39E-05	0.00283	0.001841	0.000222	0.000204	0	0	0
6.028	2.500	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1.1E-05	7.49E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	0
6.029	2.507	diesel air compressor	0.21	75	0	0	7.2879E-06	0	0	0	0	0	0	0	0	3.2E-06	2.23E-06	2E-05	3.05E-07	9.2E-06	5.99E-06	7.23E-07	6.62E-07	0	0	0
6.030	2.508	diesel air compressor	0.21	9	0	0	8.74548E-07	0	0	0	0	0	0	0	0	3.8E-07	2.67E-07	2.4E-06	3.67E-08	1.1E-06	7.19E-07	8.67E-08	7.95E-08	0	0	0
6.031	2.528	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1.1E-05	7.49E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	0
6.032	2.530	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1.1E-05	7.49E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	0
6.033	2.531	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1.1E-05	7.49E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	0
6.034	2.532	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1.1E-05	7.49E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	0
6.035	2.533	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1.1E-05	7.49E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	0
6.036	2.534	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1.1E-05	7.49E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	0
6.037	2.551	diesel air compressor	0.2	75	0	0	7.13045E-06	0	0	0	0	0	0	0	0	3.1E-06	2.16E-06	2E-05	2.99E-07	9E-06	5.86E-06	7.07E-07	6.48E-07	0	0	0
6.038	2.552	diesel air compressor	0.2	75	0	0	7.13045E-06	0	0	0	0	0	0	0	0	3.1E-06	2.16E-06	2E-05	2.99E-07	9E-06	5.86E-06	7.07E-07	6.48E-07	0	0	0
6.039	2.553	diesel air compressor	0.2	14	0	0	1.33102E-06	0	0	0	0	0	0	0	0	5.8E-07	4.07E-07	3.7E-06	5.58E-08	1.7E-06	1.09E-06	1.32E-07	1.21E-07	0	0	0
6.040		diesel air compressor	0.2	75	0	0	6.9975E-06	0	0	0	0	0	0	0	0	3.1E-06	2.14E-06	1.9E-05	2.93E-07	8.9E-06	5.75E-06	6.94E-07	6.36E-07	0	0	0
6.041	2.141	diesel air compressor	1.88	150	0	0	0.000131707	0	0	0	0	0	0	0	0	5.8E-05	4.02E-05	0.00036	5.52E-06	0.00017	0.000108	1.31E-05	1.2E-05	0	0	0
6.042		diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0
6.043		diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0
6.044	2.132	diesel generator	4.2	300	0	0	0.00058779	0	0	0	0	0	0	0	0	0.00026	0.00018	0.00163	2.46E-05	0.00074	0.000483	5.83E-05	5.34E-05	0	0	0
6.045	2.133	diesel generator	4.2	300	0	0	0.00058779	0	0	0	0	0	0	0	0	0.00026	0.00018	0.00163	2.46E-05	0.00074	0.000483	5.83E-05	5.34E-05	0	0	0
6.046	2.134	diesel generator	4.2	300	0	0	0.00058779	0	0	0	0	0	0	0	0	0.00026	0.00018	0.00163	2.46E-05	0.00074	0.000483	5.83E-05	5.34E-05	0	0	0
6.047	2.139	diesel generator	4.2	9	0	0	1.76337E-05	0	0	0	0	0	0	0	0	7.7E-06	5.39E-06	4.9E-05	7.39E-07	2.2E-05	1.45E-05	1.75E-06	1.6E-06	0	0	0
6.048	2.611	diesel generator	0.34	65	0	0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0
6.049	2.628	diesel generator	0.07	65		0	2.12258E-06	0	0	0	0	0	0	0	0	9.3E-07	6.48E-07	5.9E-06	8.9E-08	2.7E-06	1.74E-06	2.1E-07	1.93E-07	0	0	0
6.050	2.647	diesel generator	0.07	65		0	2.12258E-06	0	0	0	0	0	0	0	0	9.3E-07	6.48E-07	5.9E-06	8.9E-08	2.7E-06	1.74E-06	2.1E-07	1.93E-07	0	0	0
6.051	2.648	diesel generator	0.07	65		0	2.12258E-06	0	0	0	0	0	0	0	0	9.3E-07	6.48E-07	5.9E-06	8.9E-08	2.7E-06	1.74E-06	2.1E-07	1.93E-07	0	0	0
6.052	2.656	diesel generator	0.1	9		0	4.1965E-07	0	0	0	0	0	0	0	0	1.8E-07	1.28E-07	1.2E-06	1.76E-08	5.3E-07	3.45E-07	4.16E-08	3.82E-08	0	0	0
6.053	2.657	diesel generator	0.1	65	0	0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.48E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.06E-07	2.82E-07	0	0	0
6.054	2.681	diesel generator	0.2	3	0	0	2.86618E-07	0	0	0	0	0	0	0	0	1.3E-07	8.76E-08	7.9E-07	1.2E-08	3.6E-07	2.36E-07	2.84E-08	2.61E-08	0	0	0
6.055	2.605	diesel generator	0.34	65	0	0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0
6.056	2.606	diesel generator	0.34	65	0	0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0
6.057		diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0

Nevada Test Site Emission Inventory

TONS/YR

Hazardous Air Pollutant Emissions

emission source #	old permit #	Equipment	process rate (ton/hr) or *heat rate (MMBtu/hr)*	operating hours (hr/yr)	control (%)	As (ton/yr)	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
						Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals
						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0.000177	1.612E-05	0.0227	0.015453	0.13969	0.00212	0.06915	0.041588	0.005015	0.004694	#REF!	#REF!	#REF!
6.058		diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0
6.059		diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0
6.060		diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0
6.061		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1.1E-06	7.48E-07	6.8E-06	1.03E-07	3.1E-06	2.01E-06	2.43E-07	2.23E-07	0	0	0
6.062		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1.1E-06	7.48E-07	6.8E-06	1.03E-07	3.1E-06	2.01E-06	2.43E-07	2.23E-07	0	0	0
6.063		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1.1E-06	7.48E-07	6.8E-06	1.03E-07	3.1E-06	2.01E-06	2.43E-07	2.23E-07	0	0	0
6.064		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1.1E-06	7.48E-07	6.8E-06	1.03E-07	3.1E-06	2.01E-06	2.43E-07	2.23E-07	0	0	0
6.065		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1.1E-06	7.48E-07	6.8E-06	1.03E-07	3.1E-06	2.01E-06	2.43E-07	2.23E-07	0	0	0
6.066		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1.1E-06	7.48E-07	6.8E-06	1.03E-07	3.1E-06	2.01E-06	2.43E-07	2.23E-07	0	0	0
6.067		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1.1E-06	7.48E-07	6.8E-06	1.03E-07	3.1E-06	2.01E-06	2.43E-07	2.23E-07	0	0	0
6.068		trash pump	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	2.7E-07	1.85E-07	1.7E-06	2.54E-08	7.7E-07	4.99E-07	6.01E-08	5.51E-08	0	0	0
6.069		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	2.7E-07	1.85E-07	1.7E-06	2.54E-08	7.7E-07	4.99E-07	6.01E-08	5.51E-08	0	0	0
6.070		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	2.7E-07	1.85E-07	1.7E-06	2.54E-08	7.7E-07	4.99E-07	6.01E-08	5.51E-08	0	0	0
6.071		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	2.7E-07	1.85E-07	1.7E-06	2.54E-08	7.7E-07	4.99E-07	6.01E-08	5.51E-08	0	0	0
6.072		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	2.7E-07	1.85E-07	1.7E-06	2.54E-08	7.7E-07	4.99E-07	6.01E-08	5.51E-08	0	0	0
6.073		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	2.7E-07	1.85E-07	1.7E-06	2.54E-08	7.7E-07	4.99E-07	6.01E-08	5.51E-08	0	0	0
6.074		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	2.7E-07	1.85E-07	1.7E-06	2.54E-08	7.7E-07	4.99E-07	6.01E-08	5.51E-08	0	0	0
Area 6 CP-1						8.168E-07	2.4304E-05	6.126E-07	6.126E-07	1.84E-06	6.126E-07	1.23E-06	6.13E-07	3.06E-06	3.144E-07	1.9E-05	7.24E-06	6.6E-05	9.93E-07	0.00012	1.96E-05	2.35E-06	3.81E-06	9.34E-08	1.601E-07	0
6.075	2.404	Boiler	1.67	36.3	0	1.214E-07	9.10567E-08	9.106E-08	9.106E-08	2.73E-07	9.106E-08	1.82E-07	9.11E-08	4.55E-07	4.673E-08	1.4E-06	0	0	0	1.3E-05	0	0	2.47E-07	1.39E-08	2.38E-08	0
6.076	2.405	Boiler	1.67	208	0	6.953E-07	5.21507E-07	5.215E-07	5.215E-07	1.56E-06	5.215E-07	1.04E-06	5.22E-07	2.61E-06	2.676E-07	7.8E-06	0	0	0	7.6E-05	0	0	1.41E-06	7.95E-08	1.363E-07	0
6.077	2.158	emerg. generator	4.2	1	0	0	1.9593E-06	0	0	0	0	0	0	0	0	8.6E-07	5.99E-07	5.4E-06	8.21E-08	2.5E-06	1.61E-06	1.94E-07	1.78E-07	0	0	0
6.078		diesel generator	0.34	65	0	0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0
6.079	2.614	diesel generator	0.38	65	0	0	1.13831E-05	0	0	0	0	0	0	0	0	5E-06	3.48E-06	3.1E-05	4.77E-07	1.4E-05	9.36E-06	1.13E-06	1.03E-06	0	0	0
Area 6 CP-15						0	2.26906E-06	0	0	0	0	0	0	0	0	9.9E-07	6.93E-07	6.3E-06	9.51E-08	2.9E-06	1.87E-06	2.25E-07	2.06E-07	0	0	0
6.080	2.690	diesel generator	0.26	19	0	0	2.26906E-06	0	0	0	0	0	0	0	0	9.9E-07	6.93E-07	6.3E-06	9.51E-08	2.9E-06	1.87E-06	2.25E-07	2.06E-07	0	0	0
Area 6 CP-40						0	3.18433E-07	0	0	0	0	0	0	0	0	1.4E-07	9.73E-08	8.8E-07	1.33E-08	4E-07	2.62E-07	3.16E-08	2.89E-08	0	0	0
6.081	2.603	diesel generator	0.34	2	0	0	3.18433E-07	0	0	0	0	0	0	0	0	1.4E-07	9.73E-08	8.8E-07	1.33E-08	4E-07	2.62E-07	3.16E-08	2.89E-08	0	0	0
Area 6 CP-43						0	2.1974E-06	0	0	0	0	0	0	0	0	9.6E-07	6.71E-07	6.1E-06	9.21E-08	2.8E-06	1.81E-06	2.18E-07	2E-07	0	0	0
6.082	2.673	diesel generator	0.2	23	0	0	2.1974E-06	0	0	0	0	0	0	0	0	9.6E-07	6.71E-07	6.1E-06	9.21E-08	2.8E-06	1.81E-06	2.18E-07	2E-07	0	0	0
Area 6 CP-70						0	6.96531E-06	0	0	0	0	0	0	0	0	3.1E-06	2.13E-06	1.9E-05	2.92E-07	8.8E-06	5.73E-06	6.91E-07	6.33E-07	0	0	0
6.083	2.618	diesel generator	0.43	35	0	0	6.96531E-06	0	0	0	0	0	0	0	0	3.1E-06	2.13E-06	1.9E-05	2.92E-07	8.8E-06	5.73E-06	6.91E-07	6.33E-07	0	0	0
Area 6 CP-8						6.983E-07	0.001176104	5.237E-07	5.237E-07	1.57E-06	5.237E-07	1.05E-06	5.24E-07	2.62E-06	2.688E-07	0.00052	0.000369	0.00325	4.93E-05	0.00156	0.000966	0.000117	0.000108	7.99E-08	1.369E-07	0
6.084	2.403	Boiler	0.84	418	0	6.983E-07	5.23733E-07	5.237E-07	5.237E-07	1.57E-06	5.237E-07	1.05E-06	5.24E-07	2.62E-06	2.688E-07	7.8E-06	0	0	0	7.7E-05	0	0	1.42E-06	7.99E-08	1.369E-07	0
6.085	2.156	emerg. generator	4.2	300	0	0	0.00058779	0	0	0	0	0	0	0	0	0.00026	0.00018	0.00163	2.46E-05	0.00074	0.000483	5.83E-05	5.34E-05	0	0	0
6.086	2.163	emerg. generator	4.2	300	0	0	0.00058779	0	0	0	0	0	0	0	0	0.00026	0.00018	0.00163	2.46E-05	0.00074	0.000483	5.83E-05	5.34E-05	0	0	0
Area 6 DAF						0	3.39612E-05	0	0	0	0	0	0	0	0	1.5E-05	1.04E-05	9.4E-05	1.42E-06	4.3E-05	2.79E-05	3.37E-06	3.09E-06	0	0	0
6.087	2.160	emerg. generator	5.6	13	0	0	3.39612E-05	0	0	0	0	0	0	0	0	1.5E-05	1.04E-05	9.4E-05	1.42E-06	4.3E-05	2.79E-05	3.37E-06	3.09E-06	0	0	0
6.088	2.159	emerg. generator	5.6	13	0	0	3.39612E-05	0	0	0	0	0	0	0	0	1.5E-05	1.04E-05	9.4E-05	1.42E-06	4.3E-05	2.79E-05	3.37E-06	3.09E-06	0	0	0
6.089	2.407	Boiler	2.34	2600	0	1.217E-05	9.13068E-06	9.131E-06	9.131E-06	2.74E-05	9.131E-06	1.83E-05	9.13E-06	4.57E-05	4.686E-06	0.00014	0	0	0	0.00134	0	0	2.47E-05	1.39E-06	2.387E-06	0
6.090	2.408	Boiler	2.34	2600	0	1.217E-05	9.13068E-06	9.131E-06	9.131E-06	2.74E-05	9.131E-06	1.83E-05	9.13E-06	4.57E-05	4.686E-06	0.00014	0	0	0	0.00134	0	0	2.47E-05	1.39E-06	2.387E-06	0
Area 6 Decon						1.036E-05	0.00000777	7.77E-06	7.77E-06	2.33E-05	7.77E-06	1.55E-05	7.77E-06	3.89E-05	3.987E-06	0.00012	0	0	0	0.00114	0	0	2.11E-05	1.19E-06	2.031E-06	0
6.091	2.068	Boiler	5.18	1000	0	1.036E-05	0.00000777	7.77E-06	7.77E-06	2.33E-05	7.77E-06	1.55E-05	7.77E-06	3.89E-05	3.987E-06	0.00012	0	0	0	0.00114	0	0	2.11E-05	1.19E-06	2.031E-06	0
Area 6 Iron Workers Yard						0	3.14888E-06	0	0	0	0	0	0	0	0	1.4E-06	9.62E-07	8.7E-06	1.32E-07	4E-06	2.59E-06	3.12E-07	2.86E-07	0	0	0
6.092		diesel cable reeler	0.14	50		0	3.14888E-06	0	0	0	0	0	0	0	0	1.4E-06	9.62E-07	8.7E-06	1.32E-07	4E-06	2.59E-06	3.12E-07	2.86E-07	0	0	0
Area 6 Well 3 Yard						0	4.12388E-05	0	0	0	0	0	0	0	0	1.8E-05	1.26E-05	0.00011	1.73E-06	5.2E-05	3.39E-05	4.08E-06	3.75E-06	0	0	0
6.096	2.097	bin	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.097		diesel generator	0.34	65		0	1.03097E-05	0	0	0	0	0	0	0	0	4.5E-06	3.15E-06	2.9E-05	4.32E-07	1.3E-05	8.48E-06	1.02E-06	9.37E-07	0	0	0
6.098		diesel generator	0.34	65		0	1.03097E-05	0	0	0	0	0	0	0	0	4.5E-06	3.15E-06	2.9E-05	4.32E-07	1.3E-05	8.48E-06	1.02E-06	9.37E-07	0	0	0
6.099		diesel generator	0.34	65		0	1.03097E-05	0	0	0	0	0	0	0	0	4.5E-06	3.15E-06	2.9E-05	4.32E-07	1.3E-05	8.48E-06	1.02E-06	9.37E-07	0	0	0
6.100		diesel generator	0.34	65		0	1.03097E-05	0	0	0	0	0	0	0	0	4.5E-06	3.15E-06	2.9E-05	4.32E-07	1.3E-05	8.48E-06	1.02E-06	9.37E-07	0	0	0
Area 6 Wet/Wild						0	0.000731451	0	0	0	0	0	0	0	0	0.00032	0.000223	0.00202	3.07E-05	0.00093	0.000601	7.25E-05	6.67E-05	0	0	0
6.101	2.542	diesel air compressor	1.97	150	0	0	0.000138124	0	0	0	0	0	0	0	0	6.1E-05	4.22E-05	0.00038	5.79E-06	0.00017	0.000114	1.37E-05	1.26E-05	0	0	0
6.102	2.543	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1.1E-05	7.49E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	0
6.103	2.544	diesel air compressor	1.97	150	0	0	0.000138124	0	0	0	0	0	0	0	0	6.1E-05	4.22E-05	0.00038	5.79E-06	0.00017	0.000114	1.37E-05	1.26E-05	0	0	0
6.104	2.545	diesel air compressor	1.97	150	0	0	0.000138124	0	0	0	0	0	0	0	0	6.1E-05	4.22E-05	0.00038	5.79E-06	0.00017	0.000114	1.37E-05	1.26E-05	0	0	0
6.105		diesel air compressor	1.97	150		0	0.000138124	0	0	0	0	0	0	0	0	6.1E-05	4.22E-05	0.00038	5.79E-06	0.00017	0.000114	1.37E-05	1.26E-05	0	0	0
6.106		conveyor	250	100		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.107		pump	0.7	50		0	1.63275E-05	0	0	0	0	0	0	0	0	7.2E-06	4.99E-06	4.5E-05	6.84E-07	2.1E-05	1.34E-05	1.62E-06	1.46E-06	0	0	0
6.108		diesel air compressor	1.97	150	0	0	0.000138124	0	0	0	0	0	0	0	0	6.1E-05	4.22E-05	0.00038	5.79E-06	0.00017	0.000114	1.37E-05	1.26E-05	0	0	0
Area 6 Other misc. equipment						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.109		abrasive blaster		50		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 12 Cafeteria						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.07	2.402	boiler	1.77	2600	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.08	2.072	boiler	3.6	2600	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 12G-Tunnel						3.549E-08	2.07217E-05	2.662E-08	2.662E-08	7.99E-08	2.662E-08	5.32E-08	2.66E-08	1.33E-07	1.366E-08	9.5E-06	6.32E-06	5.7E-05	8.67E-07	3E-05	1.7E-05	2.05E-06	1.95E-06	4.06E-09	6.958E-09	0
12.09		diesel generator	0.14	65	0.0	0	4.13902E-06	0	0	0	0	0	0	0	0	1.8E-06	1.26E-06	1.1E-05	1.73E-07	5.2E-06	3.4E-06	4.1E-07	3.76E-07	0	0	0
12.10		diesel generator	0.14	65	0.0	0	4.13902E-06	0	0	0	0	0	0	0	0	1.8E-06	1.26E-06	1.1E-05	1.73E-07	5.2E-06	3.4E-06	4.1E-07	3.76E-07	0	0	0
12.11		diesel generator	0.14	65	0.0	0	4.13902E-06	0	0	0	0	0	0	0	0	1.8E-06	1.26E-06	1.1E-05	1.73E-07	5.2E-06	3.4E-06	4.1E-07	3.76E-07	0	0	0
12.12		diesel generator/welder	0.14	65	0.0	0	4.13902E-06	0	0	0	0	0	0	0	0	1.8E-06	1.26E-06	1.1E-05	1.73E-07	5.2E-06	3.4E-06	4.1E-07	3.76E-07	0	0	0
12.13		diesel generator	0.14	65	0.0	0	4.13902E-06	0	0	0	0	0	0	0	0	1.8E-06	1.26E-06	1.1E-05	1.73E-07	5.2E-06	3.4E-06	4.1E-07	3.76E-07	0	0	0
12.14		industrial heater	0.14	65	0.0	1.775E-08	1.33088E-08	1.331E-08	1.331E-08	3.99E-08	1.331E-08	2.66E-08	1.33E-08	6.65E-08	6.83E-09	2E-07	0	0	0	1.9E-06	0	0	3.61E-08	2.03E-09	3.479E-09	0
12.15		steam cleaner	0.14	65	0.0	1.775E-08	1.33088E-08	1.331E-08	1.331E-08	3.99E-08	1.331E-08	2.66E-08	1.33E-08	6.65E-08	6.83E-09	2E-07	0	0	0	1.9E-06	0	0	3.61E-08	2.03E-09	3.479E-09	0
Area 12N-Tunnel						0	0.000339612	0	0	0	0	0	0	0	0	0.00015	0.000104	0.00094	1.42E-05	0.00043	0.000279	3.37E-05	3.08E-05	0	0	0
12.16	2.154	diesel generator	5.6	65	0.0	0	0.000169806	0	0	0	0	0	0	0	0	7.4E-05	5.19E-05	0.00047	7.12E-06	0.00021	0.00014	1.68E-05	1.54E-05	0	0	0
12.17	2.155	diesel generator	5.6	65	0.0	0	0.000169806	0	0	0	0	0	0	0	0	7.4E-05	5.19E-05	0.00047	7.12E-06	0.00021	0.00014	1.68E-05	1.54E-05	0	0	0
Area 12 P-Tunnel						0	1.63846E-05	0	0	0	0	0	0	0	0	7.2E-06	5E-06	4.5E-05	6.67E-07	2.1E-05	1.36E-05	1.62E-06	1.49E-06	0	0	0

Nevada Test Site Emission Inventory

TONS/YR

Hazardous Air Pollutant Emissions

emission source #	old permit #	Equipment	process rate (ton/hr) or heat rate (MMBtu/hr)	operating hours (hr/yr)	control (%)	As (ton/yr)	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylene (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
Totals						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0.000177	1.612E-05	0.0227	0.018453	0.13998	0.00212	0.05915	0.041558	0.005015	0.004894	#REF!	#REF!	#REF!
12.18		diesel compressor	0.2	75		0	6.9975E-06	0	0	0	0	0	0	0	0	3.1E-06	2.14E-06	1.9E-05	2.93E-07	8.9E-06	5.75E-06	6.94E-07	6.36E-07	0	0	0
12.19		diesel air dryer	0.2	75		0	6.9975E-06	0	0	0	0	0	0	0	0	3.1E-06	2.14E-06	1.9E-05	2.93E-07	8.9E-06	5.75E-06	6.94E-07	6.36E-07	0	0	0
12.20	2.701	gasoline generator	0.07	75	0.0	0	2.38965E-06	0	0	0	0	0	0	0	0	1E-06	7.3E-07	6.6E-06	1E-07	3E-06	1.96E-06	2.37E-07	2.17E-07	0	0	0
Area 12 T-Tunnel						0	0.000181002	0	0	0	0	0	0	0	0	7.9E-05	5.53E-05	0.0005	7.59E-06	0.00022	0.000149	1.79E-05	1.65E-05	0	0	0
12.21		diesel generator	0.2	120		0	0.000011196	0	0	0	0	0	0	0	0	4.9E-06	3.42E-06	3.1E-05	4.69E-07	1.4E-05	9.2E-06	1.11E-06	1.02E-06	0	0	0
12.22	2.153	diesel generator	5.6	65	0.0	0	0.000169806	0	0	0	0	0	0	0	0	7.4E-05	5.19E-05	0.00047	7.12E-06	0.00021	0.00014	1.68E-05	1.54E-05	0	0	0
Area 12 U-Tunnel						0	6.0645E-06	0	0	0	0	0	0	0	0	2.7E-06	1.85E-06	1.7E-05	2.54E-07	7.7E-06	4.99E-06	6.01E-07	5.51E-07	0	0	0
12.23		diesel generator	0.2	65		0	6.0645E-06	0	0	0	0	0	0	0	0	2.7E-06	1.85E-06	1.7E-05	2.54E-07	7.7E-06	4.99E-06	6.01E-07	5.51E-07	0	0	0
Area 12 Yard						0	0.000129971	0	0	0	0	0	0	0	0	5.7E-05	3.97E-05	0.00036	5.45E-06	0.00016	0.000107	1.29E-05	1.18E-05	0	0	0
12.24		diesel generator	0.51	65		0	1.55251E-05	0	0	0	0	0	0	0	0	6.8E-06	4.74E-06	4.3E-05	6.51E-07	2E-05	1.28E-05	1.54E-06	1.41E-06	0	0	0
12.25		diesel generator	0.51	65		0	1.55251E-05	0	0	0	0	0	0	0	0	6.8E-06	4.74E-06	4.3E-05	6.51E-07	2E-05	1.28E-05	1.54E-06	1.41E-06	0	0	0
12.26		diesel generator	0.51	65		0	1.55251E-05	0	0	0	0	0	0	0	0	6.8E-06	4.74E-06	4.3E-05	6.51E-07	2E-05	1.28E-05	1.54E-06	1.41E-06	0	0	0
12.27		diesel generator	0.51	65		0	1.55251E-05	0	0	0	0	0	0	0	0	6.8E-06	4.74E-06	4.3E-05	6.51E-07	2E-05	1.28E-05	1.54E-06	1.41E-06	0	0	0
12.28		diesel generator	0.51	65		0	1.55251E-05	0	0	0	0	0	0	0	0	6.8E-06	4.74E-06	4.3E-05	6.51E-07	2E-05	1.28E-05	1.54E-06	1.41E-06	0	0	0
12.29		diesel generator	0.2	65		0	6.0645E-06	0	0	0	0	0	0	0	0	2.7E-06	1.85E-06	1.7E-05	2.54E-07	7.7E-06	4.99E-06	6.01E-07	5.51E-07	0	0	0
12.30		diesel generator	0.2	65		0	6.0645E-06	0	0	0	0	0	0	0	0	2.7E-06	1.85E-06	1.7E-05	2.54E-07	7.7E-06	4.99E-06	6.01E-07	5.51E-07	0	0	0
12.31		diesel generator	0.2	65		0	6.0645E-06	0	0	0	0	0	0	0	0	2.7E-06	1.85E-06	1.7E-05	2.54E-07	7.7E-06	4.99E-06	6.01E-07	5.51E-07	0	0	0
12.32		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.48E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.08E-07	2.82E-07	0	0	0
12.33		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.48E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.08E-07	2.82E-07	0	0	0
12.34		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.48E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.08E-07	2.82E-07	0	0	0
12.35		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.48E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.08E-07	2.82E-07	0	0	0
12.36		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.48E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.08E-07	2.82E-07	0	0	0
12.37		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.48E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.08E-07	2.82E-07	0	0	0
12.38		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.48E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.08E-07	2.82E-07	0	0	0
12.39		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.48E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.08E-07	2.82E-07	0	0	0
12.40		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.48E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.08E-07	2.82E-07	0	0	0
12.41		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.48E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.08E-07	2.82E-07	0	0	0
12.42		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.48E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.08E-07	2.82E-07	0	0	0
Area 23 (Mercury)						1.891E-05	0.000425547	1.298E-05	1.298E-05	3.9E-05	1.298E-05	2.84E-05	1.27E-05	6.34E-05	6.609E-06	0.00037	0.000128	0.00114	1.72E-05	0.00236	0.000836	4.08E-05	7.18E-05	1.93E-06	3.316E-06	
23.01	2.646	generator/B1000	0.07	5		0	1.63275E-07	0	0	0	0	0	0	0	0	7.2E-08	4.99E-08	4.5E-07	6.84E-09	2.1E-07	1.34E-07	1.62E-08	1.48E-08	0	0	
23.02	2.604	generator/B1010	0.34	2		0	3.18433E-07	0	0	0	0	0	0	0	0	1.4E-07	9.73E-08	8.8E-07	1.33E-08	4E-07	2.62E-07	3.16E-08	2.89E-08	0	0	
23.03	2.400	boiler/B111	0.47	239		2.235E-07	1.67838E-07	1.676E-07	1.676E-07	5.03E-07	1.676E-07	3.35E-07	1.68E-07	8.38E-07	8.603E-08	2.5E-06	0	0	0	2.5E-05	0	0	4.54E-07	2.56E-08	4.382E-08	
23.04	2.401	boiler/B128	0.84	300		5.011E-07	3.75824E-07	3.758E-07	3.758E-07	1.13E-06	3.758E-07	7.52E-07	3.76E-07	1.88E-06	1.929E-07	5.6E-06	0	0	0	5.5E-05	0	0	1.02E-06	5.73E-08	9.824E-08	
23.05	2.409	boiler/B156	0.33	436		2.929E-07	2.19866E-07	2.197E-07	2.197E-07	6.59E-07	2.197E-07	4.39E-07	2.2E-07	1.1E-06	1.127E-07	3.3E-06	0	0	0	3.2E-05	0	0	5.95E-07	3.35E-08	5.742E-08	
23.06	2.601	emergency generator	0.07	3		0	9.55659E-08	0	0	0	0	0	0	0	0	4.2E-08	2.92E-08	2.6E-07	4.01E-09	1.2E-07	7.86E-08	9.48E-09	8.69E-09	0	0	
23.07	2.411	boiler/B536	1.77	564		1.998E-06	1.49715E-06	1.497E-06	1.497E-06	4.49E-06	1.497E-06	2.99E-06	1.5E-06	7.49E-06	7.683E-07	2.2E-05	0	0	0	0.00022	0	0	4.06E-06	2.28E-07	3.913E-07	
23.08		diesel generator	0.2	7		0	6.531E-07	0	0	0	0	0	0	0	0	2.9E-07	2E-07	1.8E-06	2.74E-08	8.3E-07	5.37E-07	6.48E-08	5.94E-08	0	0	
23.09	2.157	emergency generator	4.2	3		0	5.6779E-06	0	0	0	0	0	0	0	0	2.6E-06	1.8E-06	1.6E-05	2.46E-07	7.4E-06	4.83E-06	5.83E-07	5.34E-07	0	0	
23.10	2.164	emergency generator	4.2	195		0	0.000382064	0	0	0	0	0	0	0	0	0.00017	0.000117	0.00106	1.6E-05	0.00048	0.000314	3.79E-05	3.47E-05	0	0	
23.11	2.070	boiler/B754 Café	3.2	1011		6.47E-06	4.85232E-06	4.852E-06	4.852E-06	1.46E-05	4.852E-06	9.7E-06	4.85E-06	2.43E-05	2.49E-06	7.2E-05	0	0	0	0.00071	0	0	1.31E-05	7.4E-07	1.268E-06	
23.12	2.071	boiler/B753	6.44	576		7.421E-06	5.56609E-06	5.566E-06	5.566E-06	1.67E-05	5.566E-06	1.11E-05	5.57E-06	2.78E-05	2.856E-06	8.3E-05	0	0	0	0.00081	0	0	1.51E-05	8.49E-07	1.455E-06	
23.13	2.152	incinerator	0.32	872	99.0	5.494E-09	4.1202E-09	4.12E-09	4.12E-09	1.24E-08	4.12E-09	8.24E-09	4.12E-09	2.06E-08	2.114E-09	6.1E-08	0	0	0	6E-07	0	0	1.12E-08	6.26E-10	1.077E-09	
23.14		generator/RSN MAT	0.2	120		0	0.000011196	0	0	0	0	0	0	0	0	4.9E-06	3.42E-06	3.1E-05	4.69E-07	1.4E-05	9.2E-06	1.11E-06	1.02E-06	0	0	
23.15		generator/RSN MAT	0.2	120		0	0.000011196	0	0	0	0	0	0	0	0	4.9E-06	3.42E-06	3.1E-05	4.69E-07	1.4E-05	9.2E-06	1.11E-06	1.02E-06	0	0	
23.57	2.070	boiler/B754 Café	3.2	271		1.732E-06	1.29936E-06	1.299E-06	1.299E-06	3.9E-06	1.299E-06	2.6E-06	1.3E-06	6.5E-06	6.666E-07	1.9E-05	0	0	0	0.00019	0	0	3.52E-06	1.98E-07	3.398E-07	
Area 25						1.826E-05	3.91397E-05	1.37E-05	1.37E-05	4.11E-05	1.37E-05	2.742E-05	1.37E-05	6.85E-05	7.028E-06	0.0002	0	0	0	0.002	0	0	3.71E-05	2.09E-06	3.58E-06	
25.01	2.410	boiler/B4015	2.68	2600		1.391E-05	1.04352E-05	1.044E-05	1.044E-05	3.13E-05	1.044E-05	2.09E-05	1.04E-05	5.22E-05	5.355E-06	0.00016	0	0	0	0.00153	0	0	2.83E-05	1.59E-06	2.728E-06	
25.02	2.406	boiler/B4215	0.84	2600		4.348E-06	3.26079E-06	3.261E-06	3.261E-06	9.78E-06	3.261E-06	6.52E-06	3.26E-06	1.63E-05	1.673E-06	4.8E-05	0	0	0	0.00048	0	0	8.84E-06	4.97E-07	8.523E-07	
25.03	2.683	generator/ Skull Mtn.	0.2	10		0.00E+00	9.55E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.2E-07	2.9E-07	2.6E-06	4.0E-08	1.2E-06	7.9E-07	9.5E-08	8.7E-08	0.0E+00	0.0E+00	
25.04	2.529	air comp./ X-tunnel	0.7	75		0	2.44913E-05	0	0	0	0	0	0	0	0	1.1E-05	7.48E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	
Area 27						0	0.000120646	0	0	0	0	0	0	0	0	5E-05	3.51E-05	0.00032	4.82E-06	0.00015	9.45E-05	1.14E-05	1.05E-05	#VALUE!	0	
27.01	2.131	emergency generator	5.6	35		0	0.000091434	0	0	0	0	0	0	0	0	4E-05	2.79E-05	0.00025	3.83E-06	0.00012	7.52E-05	9.07E-06	8.31E-06	#VALUE!	0	
27.02	2.130	emergency generator	5.6	9		0	2.35116E-05	0	0	0	0	0	0	0	0	1E-05	7.18E-06	6.5E-05	9.85E-07	3E-05	1.93E-05	2.33E-06	2.14E-06	#VALUE!	0	
27.03	2.619	diesel generator	0.05	65		0	1.55251E-06	0	0	0	0	0	0	0	0	6.8E-07	4.74E-07	4.3E-06	6.51E-08	2E-06	1.28E-06	1.54E-07	1.41E-07	#VALUE!	0	
27.04	2.669	diesel generator	0.14	65		0	4.13902E-06	0	0	0	0	0	0	0	0	1.8E-06	1.26E-06	1.1E-05	1.73E-07	5.2E-06	3.4E-06	4.1E-07	3.76E-07	#VALUE!	0	
Area 29						0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	#VALUE!	0	
29.01	2.602	diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	#VALUE!	0	

Nevada Test Site Emission Inventory

TONS/YR

Hazardous Air Pollutant Emissions

emission source #	old permit #	Equipment	process rate (ton/hr) or *heat rate (MMBtu/hr)*	operating hours (hr/yr)	control (%)	As (ton/yr)	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
						Totals #REF!	Totals #REF!	Totals #REF!	Totals #REF!	Totals #REF!	Totals #REF!	Totals #REF!	Totals #REF!	Totals 0.000177	Totals 1.812E-05	Totals 0.0227	Totals 0.015453	Totals 0.13969	Totals 0.00212	Totals 0.00916	Totals 0.041569	Totals 0.006016	Totals 0.004694	Totals #REF!	Totals #REF!	Totals #REF!

CHEMICAL RELEASES/FUME HOODS

AREA 5

HSC

HSC Chemical Releases

5.006		Chemical releases

Nevada Test Site Emission Inventory

TONS/YR

Hazardous Air Pollutant Emissions

emission source #	old permit #	Equipment	process rate (ton/hr) or *heat rate (MMBtu/hr)*	operating hours (hr/yr)	control (%)	As (ton/yr)	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
						Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals
						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0.000227	2.331E-05	0.02283	0.01544	0.13977	0.002118	0.07057	0.041553	0.005011	0.004717	#REF!	#REF!	#REF!
AGGREGATE PROCESSING EQUIPMENT																										
Area 1 Shaker Plant						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.14		Baghouse 02				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14A	1.016	C-7 to Rotary dryer	100	250	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14B	2.023	Rotary Dryer	100	250	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 1 Concrete Batch Plant						1.346E-05	1.39588E-07	1.843E-06	4.146E-06	6.33E-06	0	0.001669	0.000142	0	0	0	0	0	0	0	0	0	0	0	0	1E-04
1.46		Baghouse 04				3.713E-08	3.9559E-10	5.171E-09	5.569E-09	1.63E-08	0	4.46E-06	3.89E-07	0	0	0	0	0	0	0	0	0	0	0	0	3E-07
46A	2.026	loading overhead bin	50	44.2	99	1.856E-08	1.97795E-10	2.586E-09	2.785E-09	8.13E-09	0	2.23E-06	1.94E-07	0	0	0	0	0	0	0	0	0	0	0	0	1E-07
46B	1.057	loading weigh hopper	50	44.2	99	1.856E-08	1.97795E-10	2.586E-09	2.785E-09	8.13E-09	0	2.23E-06	1.94E-07	0	0	0	0	0	0	0	0	0	0	0	0	1E-07
46C		loading temp. bin A	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46D		discharge temp bin A	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46E		loading temp. bin B	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46F		discharge temp bin B	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46G		loading temp. bin C	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46H		discharge temp bin C	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46I	2.111	loading Silo #3	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46J	2.112	discharge Silo #3	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46K	2.113	loading Silo #4	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46L	2.114	discharge Silo #4	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46M	2.115	loading Silo #5	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
46N	2.116	discharge Silo #5	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
1.47		Baghouse 06				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47A	2.028	C-2 to funnel	160	1920	99	2.58E-06	2.74944E-08	3.594E-07	3.871E-07	1.13E-06	0	0.00031	2.7E-05	0	0	0	0	0	0	0	0	0	0	0	0	2E-05
47B	2.027	weigh hopper 2 to funnel	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
47C	2.029	truck loading	160	1920	99	3.564E-07	0	1.812E-08	2.181E-06	5.87E-07	0	9.4E-05	5.04E-06	0	0	0	0	0	0	0	0	0	0	0	0	3E-05
Area 6 Cementing Equipment						0.0001145	1.162E-06	1.506E-05	1.624E-05	4.74E-05	0	0.012993	0.001132	7.21E-09	0	0	0	0	0	0	0	0	0	0	0	8E-04
6.001	2.032	Scale #1	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
6.002	2.033	Scale #2	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
6.003	2.034	Scale #3	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
123A		Baghouse 07/back-up				2.58E-06	2.74944E-08	3.594E-07	3.871E-07	1.13E-06	0	0.00031	2.7E-05	0	0	0	0	0	0	0	0	0	0	0	0	2E-05
123B		waste silo	10	1920	99	1.613E-07	1.7184E-09	2.246E-08	2.419E-08	7.07E-08	0	1.94E-05	1.69E-06	0	0	0	0	0	0	0	0	0	0	0	0	1E-06
6.004		Baghouse 10				8.998E-09	6.71E-10	1.265E-10	3.526E-08	1.1E-08	0	3.37E-07	4.17E-08	7.21E-09	0	0	0	0	0	0	0	0	0	0	0	2E-07
4A	2.035	Load blending tank	50	11	99	6.38E-10	0	3.245E-11	3.905E-09	1.05E-09	0	1.68E-07	9.02E-09	0	0	0	0	0	0	0	0	0	0	0	0	6E-08
4B	2.036	Blending tank discharge	50	11	99	8.36E-09	6.71E-10	9.405E-11	3.135E-08	9.96E-09	0	1.68E-07	3.27E-08	7.21E-09	0	0	0	0	0	0	0	0	0	0	0	1E-07
6.005		Bin Vent #1				1.344E-05	1.432E-07	1.872E-06	2.016E-06	5.89E-06	0	0.001616	0.000141	0	0	0	0	0	0	0	0	0	0	0	0	9E-05
6.006		Bin Vent #3				1.344E-05	1.432E-07	1.872E-06	2.016E-06	5.89E-06	0	0.001616	0.000141	0	0	0	0	0	0	0	0	0	0	0	0	9E-05
6.007		Bin Vent #4				1.344E-05	1.432E-07	1.872E-06	2.016E-06	5.89E-06	0	0.001616	0.000141	0	0	0	0	0	0	0	0	0	0	0	0	9E-05
567A	2.037	Silo #1	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
567B	2.038	Silo #2	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
567C	2.039	Silo #3	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
567D	2.040	Silo #4	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
567E	2.041	Silo #5	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
6.008		Bin Vent #8				1.613E-05	1.7184E-07	2.246E-06	2.419E-06	7.07E-06	0	0.001939	0.000169	0	0	0	0	0	0	0	0	0	0	0	0	1E-04
8A	2.042	Silo #7	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
8B	2.043	Silo #8	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
6.009	2.044	Silo #15	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
6.010	2.045	Silo #16	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
6.011		Bin Vent #18				1.21E-05	1.2888E-07	1.685E-06	1.814E-06	5.3E-06	0	0.001454	0.000127	0	0	0	0	0	0	0	0	0	0	0	0	8E-05
6.012		Bin Vent #19				1.21E-05	1.2888E-07	1.685E-06	1.814E-06	5.3E-06	0	0.001454	0.000127	0	0	0	0	0	0	0	0	0	0	0	0	8E-05
1112A	2.046	Silo #17	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
1112B	2.047	Silo #18	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
1112C	2.048	Silo #19	50	1920	90	8.064E-06	8.592E-08	1.123E-06	1.21E-06	3.53E-06	0	0.00097	8.45E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
6.013		Baghouse 08				8.87E-06	9.4512E-08	1.236E-06	1.331E-06	3.89E-06	0	0.001067	9.29E-05	0	0	0	0	0	0	0	0	0	0	0	0	6E-05
13A	2.049	Silo #9	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13B	2.050	Silo #10	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13C	2.051	Silo #11	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13D	2.052	Silo #12	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13E	2.053	Silo #13	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13F	2.054	Silo #14	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13G	2.055	Silo #27	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13H	2.056	Silo #28	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13I	2.057	Silo #29	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13J	2.058	Silo #30	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
13K	2.059	Silo #31	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
6.014		Baghouse 09				6.451E-06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14A	2.060	Silo #21	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14B	2.061	Silo #22	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14C	2.062	Silo #23	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14D	2.063	Silo #24	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14E	2.064	Silo #25	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14F	2.065	Silo #26	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14G	2.066	Silo #32	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06
14H	2.067	Silo #33	50	1920	99	8.064E-07	8.592E-09	1.123E-07	1.21E-07	3.53E-07	0	9.7E-05	8.45E-06	0	0	0	0	0	0	0	0	0	0	0	0	6E-06

Nevada Test Site Emission Inventory

TONS/YR

Hazardous Air Pollutant Emissions

emission source #	old permit #	Equipment	process rate (ton/hr) or heat rate (MMBtu/hr)	operating hours (hr/yr)	control (%)	As (ton/yr)	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
Totals						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0.000227	2.331E-05	0.02283	0.01544	0.13977	0.002118	0.07067	0.041553	0.005011	0.004717	#REF!	#REF!	#REF!
Area 6 Construction storage yard						0	0.044784	0	0	0	0	0	0	0	0	0.01963	0.01368	0.12384	0.001877	0.05664	0.036816	0.00444	0.00407	0	0	0
6.111		Baghouse 11					0.044784	0	0	0	0	0	0	0	0	0.01963	0.01368	0.12384	0.001877	0.05664	0.036816	0.00444	0.00407	0	0	0
6.110	2.119	misc portable silos (7)	50	1920	99	0	0.044784	0	0	0	0	0	0	0	0	0.01963	0.01368	0.12384	0.001877	0.05664	0.036816	0.00444	0.00407	0	0	0
Area 12 Batch Plant						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.01	1.067	loading hopper	50	504	75.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.02	1.068	discharge hopper	50	504	50.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.03		Baghouse 11				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3A	2.073	loading silo #1	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3B	2.074	loading silo #2	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.04		Baghouse 13				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4A		weigh hopper/scale	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4B	2.075	conveyor to loadout	50	504	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.05	2.076	loadout	50	504	50.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 12 Portable Cement Silos						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.06		Baghouse 14				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6A		Mutiple portable bins	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6B		Mutiple portable bins	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6C	2.125	surge #1 loading	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6D	2.126	surge #1 discharge	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6E	2.127	surge #2 loading	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6F	2.128	surge #2 discharge	50	1920	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Portable Baghouses/Silos (Previously UGTA)						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.111		Baghouse 11				.0000008.0E	.0000008.06	.0000008.0	.0000008.0	.0000008.0	.0000008.0(	.0000008.C	.0000008.	.0000008.(	.0000008.0	.0000008	.0000008.(	.000000E	.0000006.	.0000008.	.0000008.!	.0000008.(	.0000008.	.0000008.C	.0000008.0E	.0000008.06
6.093	2.119	portable silo	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.094	2.121	portable silo	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.095	2.123	portable silo	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

COMBUSTION EQUIPMENT

emission source #	old permit #	Equipment	process rate (ton/hr) or heat rate (MMBtu/hr)	operating hours (hr/yr)	control (%)	As (ton/yr)	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
Area 1 U1A						0	2.71037E-05	0	0	0	0	0	0	0	0	1.2E-05	8.28E-06	7.5E-05	1.14E-06	3.4E-05	2.23E-05	2.69E-06	2.46E-06	0	0	0
1.75	2.521	diesel air compressor	0.70	75	0	0	2.44913E-05	0	0	0	0	0	0	0	0	1.1E-05	7.48E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	0
1.76		diesel generator	0.70	8	0	0	2.6124E-06	0	0	0	0	0	0	0	0	1.1E-06	7.98E-07	7.2E-06	1.09E-07	3.3E-06	2.15E-06	2.59E-07	2.37E-07	0	0	0
Area 1 U1G						0	3.75586E-05	0	0	0	0	0	0	0	0	1.67E-05	1.15E-05	0.0001	1.57E-06	4.8E-05	3.09E-05	3.73E-06	3.41E-06	0	0	0
1.77	2.679	diesel generator	0.20	65	0	0	6.21005E-06	0	0	0	0	0	0	0	0	2.7E-06	1.9E-06	1.7E-05	2.6E-07	7.9E-06	5.11E-06	6.16E-07	5.64E-07	0	0	0
1.78	2.161	emergency generator	4.20	16	0	0	3.13486E-05	0	0	0	0	0	0	0	0	1.4E-05	9.58E-06	8.7E-05	1.31E-06	4E-05	2.58E-05	3.11E-06	2.85E-06	0	0	0
Area 1 Drilling Storage Yard						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0	0	0.0001	6.98E-05	0.00063	9.58E-06	0.00029	0.000188	2.27E-05	2.08E-05	#REF!	#REF!	#REF!
1.79	2.804	fluid pump	1.40	50	0	#REF!	0.000032655	0	0	0	0	0	0	0	0	1.4E-05	9.98E-06	9E-05	1.37E-06	4.1E-05	2.68E-05	3.24E-06	2.97E-06	#REF!	#REF!	#REF!
1.80	2.806	mud pump	1.40	300	0	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0	0	8.6E-05	5.99E-05	0.00054	8.21E-06	0.00025	0.000161	1.94E-05	1.78E-05	#REF!	#REF!	#REF!
Area 5 Check Point Pass						0	1.91078E-07	0	0	0	0	0	0	0	0	8.4E-08	5.84E-08	5.3E-07	8.01E-09	2.4E-07	1.57E-07	1.89E-08	1.74E-08	0		
5.001	2.677	diesel gen.(60 KW)	0.2	2	0	0	1.91078E-07	0	0	0	0	0	0	0	0	8.4E-08	5.84E-08	5.3E-07	8.01E-09	2.4E-07	1.57E-07	1.89E-08	1.74E-08	0	0	0
Area 5 WEF						0	9.74052E-07	0	0	0	0	0	0	0	0	4.3E-07	2.98E-07	2.7E-06	4.06E-08	1.2E-06	8.01E-07	9.66E-08	8.85E-08	0		
5.002	2.658	diesel gen.(34 KW)	0.12	18	0	0	9.74052E-07	0	0	0	0	0	0	0	0	4.3E-07	2.98E-07	2.7E-06	4.06E-08	1.2E-06	8.01E-07	9.66E-08	8.85E-08	0	0	0
Area 5 NPTEC																										
5.007	2.165	diesel generator	4.2	300	0	0	0.00056779	0	0	0	0	0	0	0	0	0.00026	0.00018	0.00163	2.46E-05	0.00074	0.000483	5.83E-05	5.34E-05	0	0	0
Area 6 Heavy Equipment Storage Yard						0	0.005227599	0	0	0	0	0	0	0	0	0.00098	0.000684	0.00619	9.36E-05	0.00283	0.00184	0.000222	0.000205	0	0	0
6.028	2.500	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1.1E-05	7.49E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	0
6.029	2.507	diesel air compressor	0.21	75	0	0	7.2879E-06	0	0	0	0	0	0	0	0	3.2E-06	2.23E-06	2E-05	3.05E-07	9.2E-06	5.99E-06	7.23E-07	6.62E-07	0	0	0
6.030	2.508	diesel air compressor	0.21	4	0	0	3.88688E-07	0	0	0	0	0	0	0	0	1.7E-07	1.19E-07	1.1E-06	1.63E-08	4.9E-07	3.2E-07	3.85E-08	3.53E-08	0	0	0
6.031	2.528	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1.1E-05	7.49E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	0
6.032	2.530	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1.1E-05	7.49E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	0
6.033	2.531	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1.1E-05	7.49E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	0
6.034	2.532	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1.1E-05	7.49E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	0
6.035	2.533	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1.1E-05	7.49E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	0
6.036	2.534	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1.1E-05	7.49E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	0
6.037	2.551	diesel air compressor	0.2	75	0	0	7.13045E-06	0	0	0	0	0	0	0	0	3.1E-06	2.18E-06	2E-05	2.99E-07	9E-06	5.86E-06	7.07E-07	6.48E-07	0	0	0
6.038	2.552	diesel air compressor	0.2	75	0	0	7.13045E-06	0	0	0	0	0	0	0	0	3.1E-06	2.18E-06	2E-05	2.99E-07	9E-06	5.86E-06	7.07E-07	6.48E-07	0	0	0
6.039	2.553	diesel air compressor	0.2	4	0	0	3.80291E-07	0	0	0	0	0	0	0	0	1.7E-07	1.16E-07	1.1E-06	1.59E-08	4.8E-07	3.13E-07	3.77E-08	3.46E-08	0	0	0
6.040		diesel air compressor	0.2	75	0	0	6.9975E-06	0	0	0	0	0	0	0	0	3.1E-06	2.14E-06	1.9E-05	2.93E-07	8.9E-06	5.75E-06	6.94E-07	6.36E-07	0	0	0
6.041	2.141	diesel air compressor	1.88	150	0	0	0.000131707	0	0	0	0	0	0	0	0	5.8E-05	4.02E-05	0.00036	5.52E-06	0.00017	0.000108	1.31E-05	1.2E-05	0	0	0
6.042		diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0
6.043		diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0
6.044	2.132	diesel generator	4.2	300	0	0	0.00056779	0	0	0	0	0	0	0	0	0.00026	0.00018	0.00163	2.46E-05	0.00074	0.000483	5.83E-05	5.34E-05	0	0	0
6.045	2.133	diesel generator	4.2	300	0	0	0.00056779	0	0	0	0	0	0	0	0	0.00026	0.00018	0.00163	2.46E-05	0.00074	0.000483	5.83E-05	5.34E-05	0	0	0
6.046	2.134	diesel generator	4.2	300	0	0	0.00056779	0	0	0	0	0	0	0	0	0.00026	0.00018	0.00163	2.46E-05	0.00074	0.000483	5.83E-05	5.34E-05	0	0	0
6.047	2.139	diesel generator	4.2	9	0	0	1.76337E-05	0	0	0	0	0	0	0	0	7.7E-06	5.39E-06	4.9E-05	7.39E-07	2.2E-05	1.45E-05	1.75E-06	1.6E-06	0	0	0
6.048	2.611	diesel generator	0.34	65	0	0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0
6.049	2.628	diesel generator	0.07	65		0	2.12258E-06	0	0	0	0	0	0	0	0	9.3E-07	6.46E-07	5.9E-06	8.9E-08	2.7E-06	1.74E-06	2.1E-07	1.93E-07	0	0	0
6.050	2.647	diesel generator	0.07	65		0	2.12258E-06	0	0	0	0	0	0	0	0	9.3E-07	6.46E-07	5.9E-06	8.9E-08	2.7E-06	1.74E-06	2.1E-07	1.93E-07	0	0	0
6.051	2.648	diesel generator	0.07	65		0	2.12258E-06	0	0	0	0	0	0	0	0	9.3E-07	6.46E-07	5.9E-06	8.9E-08	2.7E-06	1.74E-06	2.1E-07	1.93E-07	0	0	0
6.052	2.656	diesel generator	0.1	1		0	4.665E-08	0	0	0	0	0	0	0	0	2E-08	1.43E-08	1.3E-07	1.98E-09	5.9E-08	3.84E-08	4.63E-09	4.24E-09	0	0	0
6.053	2.657	diesel generator	0.1	65	0	0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.46E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.08E-07	2.82E-07	0	0	0
6.054	2.681	diesel generator	0.2	3	0	0	2.86618E-07	0	0	0	0	0	0	0	0	1.3E-07	8.76E-08	7.9E-07	1.2E-08	3.6E-07	2.36E-07	2.84E-08	2.61E-08	0	0	0
6.055	2.605	diesel generator	0.34	65	0	0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0
6.056	2.606	diesel generator	0.34	65	0	0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0
6.057		diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0

Nevada Test Site Emission Inventory

TONS/YR

Hazardous Air Pollutant Emissions

emission source #	old permit #	Equipment	process rate (ton/hr) or *heat rate (MMBtu/hr)*	operating hours (hr/yr)	control (%)	As (ton/yr)	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
						Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals
						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0.000227	2.331E-05	0.02283	0.01544	0.13977	0.002118	0.07057	0.041553	0.005011	0.004717	#REF!	#REF!	#REF!
6.058		diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0
6.059		diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0
6.060		diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0
6.061		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1.1E-06	7.48E-07	6.8E-06	1.03E-07	3.1E-06	2.01E-06	2.43E-07	2.23E-07	0	0	0
6.062		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1.1E-06	7.48E-07	6.8E-06	1.03E-07	3.1E-06	2.01E-06	2.43E-07	2.23E-07	0	0	0
6.063		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1.1E-06	7.48E-07	6.8E-06	1.03E-07	3.1E-06	2.01E-06	2.43E-07	2.23E-07	0	0	0
6.064		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1.1E-06	7.48E-07	6.8E-06	1.03E-07	3.1E-06	2.01E-06	2.43E-07	2.23E-07	0	0	0
6.065		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1.1E-06	7.48E-07	6.8E-06	1.03E-07	3.1E-06	2.01E-06	2.43E-07	2.23E-07	0	0	0
6.066		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1.1E-06	7.48E-07	6.8E-06	1.03E-07	3.1E-06	2.01E-06	2.43E-07	2.23E-07	0	0	0
6.067		gas generator	0.07	75		0	2.44913E-06	0	0	0	0	0	0	0	0	1.1E-06	7.48E-07	6.8E-06	1.03E-07	3.1E-06	2.01E-06	2.43E-07	2.23E-07	0	0	0
6.068		trash pump	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	2.7E-07	1.85E-07	1.7E-06	2.54E-08	7.7E-07	4.99E-07	6.01E-08	5.51E-08	0	0	0
6.069		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	2.7E-07	1.85E-07	1.7E-06	2.54E-08	7.7E-07	4.99E-07	6.01E-08	5.51E-08	0	0	0
6.070		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	2.7E-07	1.85E-07	1.7E-06	2.54E-08	7.7E-07	4.99E-07	6.01E-08	5.51E-08	0	0	0
6.071		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	2.7E-07	1.85E-07	1.7E-06	2.54E-08	7.7E-07	4.99E-07	6.01E-08	5.51E-08	0	0	0
6.072		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	2.7E-07	1.85E-07	1.7E-06	2.54E-08	7.7E-07	4.99E-07	6.01E-08	5.51E-08	0	0	0
6.073		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	2.7E-07	1.85E-07	1.7E-06	2.54E-08	7.7E-07	4.99E-07	6.01E-08	5.51E-08	0	0	0
6.074		diesel cable reeler	0.03	50		0	6.0645E-07	0	0	0	0	0	0	0	0	2.7E-07	1.85E-07	1.7E-06	2.54E-08	7.7E-07	4.99E-07	6.01E-08	5.51E-08	0	0	0
Area 6 CP-1						1.961E-06	2.51621E-05	1.471E-06	1.471E-06	4.41E-06	1.471E-06	2.94E-06	1.47E-06	7.36E-06	7.547E-07	3.2E-05	7.24E-06	6.6E-05	9.93E-07	0.00025	1.95E-05	2.35E-06	6.14E-06	2.24E-07	3.844E-07	0
6.075	2.404	Boiler	1.67	218	0	7.275E-07	5.45568E-07	5.456E-07	5.456E-07	1.64E-06	5.456E-07	1.09E-06	5.46E-07	2.73E-06	2.8E-07	8.1E-06	0	0	0	8E-05	0	0	1.48E-06	8.32E-08	1.426E-07	0
6.076	2.405	Boiler	1.67	369	0	1.233E-06	9.25116E-07	9.251E-07	9.251E-07	2.78E-06	9.251E-07	1.85E-06	9.25E-07	4.63E-06	4.748E-07	1.4E-05	0	0	0	0.00014	0	0	2.51E-06	1.41E-07	2.418E-07	0
6.077	2.158	emerg. generator	4.2	1	0	0	1.9593E-06	0	0	0	0	0	0	0	0	8.6E-07	5.99E-07	5.4E-06	8.21E-08	2.5E-06	1.61E-06	1.94E-07	1.76E-07	0	0	0
6.078		diesel generator	0.34	65	0	0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	0	0	0
6.079	2.614	diesel generator	0.38	65	0	0	1.13831E-05	0	0	0	0	0	0	0	0	5E-06	3.48E-06	3.1E-05	4.77E-07	1.4E-05	9.36E-06	1.13E-06	1.03E-06	0	0	0
Area 6 CP-18						0	2.26906E-06	0	0	0	0	0	0	0	0	9.9E-07	6.93E-07	6.3E-06	9.51E-08	2.9E-06	1.87E-06	2.25E-07	2.06E-07	0	0	0
6.080	2.690	diesel generator	0.26	19	0	0	2.26906E-06	0	0	0	0	0	0	0	0	9.9E-07	6.93E-07	6.3E-06	9.51E-08	2.9E-06	1.87E-06	2.25E-07	2.06E-07	0	0	0
Area 6 CP-40						0	1.27373E-06	0	0	0	0	0	0	0	0	5.6E-07	3.89E-07	3.5E-06	5.34E-08	1.6E-06	1.05E-06	1.26E-07	1.16E-07	0	0	0
6.081	2.603	diesel generator	0.34	8	0	0	1.27373E-06	0	0	0	0	0	0	0	0	5.6E-07	3.89E-07	3.5E-06	5.34E-08	1.6E-06	1.05E-06	1.26E-07	1.16E-07	0	0	0
Area 6 CP-43						0	9.55392E-08	0	0	0	0	0	0	0	0	4.2E-08	2.92E-08	2.6E-07	4E-09	1.2E-07	7.85E-08	9.47E-09	8.68E-09	0	0	0
6.082	2.673	diesel generator	0.2	1	0	0	9.55392E-08	0	0	0	0	0	0	0	0	4.2E-08	2.92E-08	2.6E-07	4E-09	1.2E-07	7.85E-08	9.47E-09	8.68E-09	0	0	0
Area 6 CP-70						0	9.95045E-07	0	0	0	0	0	0	0	0	4.4E-07	3.04E-07	2.8E-06	4.17E-08	1.3E-06	8.18E-07	9.87E-08	9.04E-08	0	0	0
6.083	2.618	diesel generator	0.43	5	0	0	9.95045E-07	0	0	0	0	0	0	0	0	4.4E-07	3.04E-07	2.8E-06	4.17E-08	1.3E-06	8.18E-07	9.87E-08	9.04E-08	0	0	0
Area 6 CP-6						1.13E-06	0.001176428	8.478E-07	8.478E-07	2.54E-06	8.478E-07	1.7E-06	8.48E-07	4.24E-06	4.351E-07	0.00053	0.000369	0.00325	4.93E-05	0.00161	0.000966	0.000117	0.000109	1.29E-07	2.216E-07	0
6.084	2.403	Boiler	0.84	676	0	1.13E-06	8.47805E-07	8.478E-07	8.478E-07	2.54E-06	8.478E-07	1.7E-06	8.48E-07	4.24E-06	4.351E-07	1.3E-05	0	0	0	0.00012	0	0	2.3E-06	1.29E-07	2.216E-07	0
6.085	2.156	emerg. generator	4.2	300	0	0	0.00058779	0	0	0	0	0	0	0	0	0.00026	0.00018	0.00163	2.46E-05	0.00074	0.000483	5.83E-05	5.34E-05	0	0	0
6.086	2.163	emerg. generator	4.2	300	0	0	0.00058779	0	0	0	0	0	0	0	0	0.00026	0.00018	0.00163	2.46E-05	0.00074	0.000483	5.83E-05	5.34E-05	0	0	0
Area 6 DAF						0	2.35116E-05	0	0	0	0	0	0	0	0	1E-05	7.18E-06	6.5E-05	9.85E-07	3E-05	1.93E-05	2.33E-06	2.14E-06	0	0	0
6.087	2.160	emerg. generator	5.6	9	0	0	2.35116E-05	0	0	0	0	0	0	0	0	1E-05	7.18E-06	6.5E-05	9.85E-07	3E-05	1.93E-05	2.33E-06	2.14E-06	0	0	0
6.088	2.159	emerg. generator	5.6	13	0	0	3.39612E-05	0	0	0	0	0	0	0	0	1.5E-05	1.04E-05	9.4E-05	1.42E-06	4.3E-05	2.79E-05	3.37E-06	3.09E-06	0	0	0
6.089	2.407	Boiler	2.34	2600	0	1.217E-05	9.13068E-06	9.131E-06	9.131E-06	2.74E-05	9.131E-06	1.83E-05	9.13E-06	4.57E-05	4.686E-06	0.00014	0	0	0	0.00134	0	0	2.47E-05	1.39E-06	2.387E-06	0
6.090	2.408	Boiler	2.34	2600	0	1.217E-05	9.13068E-06	9.131E-06	9.131E-06	2.74E-05	9.131E-06	1.83E-05	9.13E-06	4.57E-05	4.686E-06	0.00014	0	0	0	0.00134	0	0	2.47E-05	1.39E-06	2.387E-06	0
Area 6 Decon						1.036E-05	0.00000777	7.77E-06	7.77E-06	2.33E-05	7.77E-06	1.55E-05	7.77E-06	3.89E-05	3.987E-06	0.00012	0	0	0	0.00114	0	0	2.11E-05	1.19E-06	2.031E-06	0
6.091	2.088	Boiler	5.18	1000	0	1.036E-05	0.00000777	7.77E-06	7.77E-06	2.33E-05	7.77E-06	1.55E-05	7.77E-06	3.89E-05	3.987E-06	0.00012	0	0	0	0.00114	0	0	2.11E-05	1.19E-06	2.031E-06	0
Area 6 Iron Workers Yard						0	3.14888E-06	0	0	0	0	0	0	0	0	1.4E-06	9.62E-07	8.7E-06	1.32E-07	4E-06	2.59E-06	3.12E-07	2.86E-07	0	0	0
6.092		diesel cable reeler	0.14	50		0	3.14888E-06	0	0	0	0	0	0	0	0	1.4E-06	9.62E-07	8.7E-06	1.32E-07	4E-06	2.59E-06	3.12E-07	2.86E-07	0	0	0
Area 6 Well 3 Yard						0	4.12388E-05	0	0	0	0	0	0	0	0	1.8E-05	1.26E-05	0.00011	1.73E-06	5.2E-05	3.39E-05	4.08E-06	3.75E-06	0	0	0
6.096	2.097	bin	50	1920	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.097		diesel generator	0.34	65		0	1.03097E-05	0	0	0	0	0	0	0	0	4.5E-06	3.15E-06	2.9E-05	4.32E-07	1.3E-05	8.48E-06	1.02E-06	9.37E-07	0	0	0
6.098		diesel generator	0.34	65		0	1.03097E-05	0	0	0	0	0	0	0	0	4.5E-06	3.15E-06	2.9E-05	4.32E-07	1.3E-05	8.48E-06	1.02E-06	9.37E-07	0	0	0
6.099		diesel generator	0.34	65		0	1.03097E-05	0	0	0	0	0	0	0	0	4.5E-06	3.15E-06	2.9E-05	4.32E-07	1.3E-05	8.48E-06	1.02E-06	9.37E-07	0	0	0
6.100		diesel generator	0.34	65		0	1.03097E-05	0	0	0	0	0	0	0	0	4.5E-06	3.15E-06	2.9E-05	4.32E-07	1.3E-05	8.48E-06	1.02E-06	9.37E-07	0	0	0
Area 6 Wet/Wild						0	0.000731451	0	0	0	0	0	0	0	0	0.00032	0.000223	0.00202	3.07E-05	0.00093	0.000601	7.25E-05	6.65E-05	0	0	0
6.101	2.542	diesel air compressor	1.97	150	0	0	0.000138124	0	0	0	0	0	0	0	0	6.1E-05	4.22E-05	0.00038	5.79E-06	0.00017	0.000114	1.37E-05	1.26E-05	0	0	0
6.102	2.543	diesel air compressor	0.7	75	0	0	2.45052E-05	0	0	0	0	0	0	0	0	1.1E-05	7.49E-06	6.8E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	0
6.103	2.544	diesel air compressor	1.97	150	0	0	0.000138124	0	0	0	0	0	0	0	0	6.1E-05	4.22E-05	0.00038	5.79E-06	0.00017	0.000114	1.37E-05	1.26E-05	0	0	0
6.104	2.545	diesel air compressor	1.97	150	0	0	0.000138124	0	0	0	0	0	0	0	0	6.1E-05	4.22E-05	0.00038	5.79E-06	0.00017	0.000114	1.37E-05	1.26E-05	0	0	0
6.105		diesel air compressor	1.97	150		0	0.000138124	0	0	0	0	0	0	0	0	6.1E-05	4.22E-05	0.00038	5.79E-06	0.00017	0.000114	1.37E-05	1.26E-05	0	0	0
6.106		conveyor	250	100		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.107		pump	0.7	50		0	1.63275E-05	0	0	0	0	0	0	0	0	7.2E-06	4.99E-06	4.5E-05	6.84E-07	2.1E-05	1.34E-05	1.62E-06	1.48E-06	0	0	0
6.108		diesel air compressor	1.97	150	0	0	0.000138124	0	0	0	0	0	0	0	0	6.1E-05	4.22E-05	0.00038	5.79E-06	0.00017	0.000114	1.37E-05	1.26E-05	0	0	0
Area 6 Other misc. equipment						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.109		abrasive blaster		50		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 12 Cafeteria						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.07	2.402	boiler	1.77	2600	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.08	2.072	boiler	3.6	2600	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 12G-Tunnel						3.549E-08	2.07217E-05	2.662E-08	2.662E-08	7.99E-08	2.662E-08	5.32E-08	2.66E-08	1.33E-07	1.366E-08	9.5E-06	6.32E-06	5.7E-05	8.67E-07	3E-05	1.7E-05	2.05E-06	1.95E-06	4.06E-09	6.958E-09	0
12.09		diesel generator	0.14	65	0.0	0	4.13902E-06	0	0	0	0	0	0	0	0	1.8E-06	1.26E-06	1.1E-05	1.73E-07	5.2E-06	3.4E-06	4.1E-07	3.76E-07	0	0	0
12.10		diesel generator	0.14	65	0.0	0	4.13902E-06	0	0	0	0	0	0	0	0	1.8E-06	1.26E-06	1.1E-05	1.73E-07	5.2E-06	3.4E-06	4.1E-07	3.76E-07	0	0	0
12.11		diesel generator	0.14	65	0.0	0	4.13902E-06	0	0	0	0	0	0	0	0	1.8E-06	1.26E-06	1.1E-05	1.73E-07	5.2E-06	3.4E-06	4.1E-07	3.76E-07	0	0	0
12.12		diesel generator/welder	0.14	65	0.0	0	4.13902E-06	0	0	0	0	0	0	0	0	1.8E-06	1.26E-06	1.1E-05	1.73E-07	5.2E-06	3.4E-06	4.1E-07	3.76E-07	0	0	0
12.13		diesel generator	0.14	65	0.0	0	4.13902E-06	0	0	0	0	0	0	0	0	1.8E-06	1.26E-06	1.1E-05	1.73E-07	5.2E-06	3.4E-06	4.1E-07	3.76E-07	0	0	0
12.14		industrial heater	0.14	65	0.0	1.775E-08	1.33088E-08	1.331E-08	1.331E-08	3.99E-08	1.331E-08	2.66E-08	1.33E-08	6.65E-08	6.83E-09	2E-07	0	0	0	1.9E-06	0	0	3.61E-08	2.03E-09	3.479E-09	0
12.15		steam cleaner	0.14	65	0.0	1.775E-08	1.33088E-08	1.331E-08	1.331E-08	3.99E-08	1.331E-08	2.66E-08	1.33E-08	6.65E-08	6.83E-09	2E-07	0	0	0	1.9E-06	0	0	3.61E-08	2.03E-09	3.479E-09	0
Area 12N-Tunnel						0	0.000339612	0	0	0	0	0	0	0	0	0.00015	0.000104	0.00094	1.42E-05	0.00043	0.000279	3.37E-05	3.08E-05	0	0	0
12.16	2.154	diesel generator	5.6	65	0.0	0	0.000169806	0	0	0	0	0	0	0	0	7.4E-05	5.19E-05	0.00047	7.12E-06	0.00021	0.00014	1.68E-05	1.54E-05	0	0	0
12.17	2.155	diesel generator	5.6	65	0.0	0	0.000169806	0	0	0	0	0	0	0	0	7.4E-05	5.19E-05	0.00047	7.12E-06	0.00021	0.00014	1.68E-05	1.54E-05	0	0	0
Area 12 P-Tunnel						0	1.63846E-05	0	0	0	0	0	0	0	0	7.2E-06	5E-06	4.5E-05	6.87E-07	2.1E-05	1.36E-05	1.62E-06	1.49E-06	0	0	0

Nevada Test Site Emission Inventory

TONS/YR

Hazardous Air Pollutant Emissions

						Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals
						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0.000227	2.331E-05	0.02263	0.01544	0.13977	0.002118	0.07057	0.041553	0.005011	0.004717	#REF!	#REF!	#REF!
emission source #	old permit #	Equipment	process rate (ton/hr) or heat rate (MMBtu/hr)	operating hours (hr/yr)	control (%)	As (ton/yr)	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
12.18		diesel compressor	0.2	75		0	6.9975E-06	0	0	0	0	0	0	0	0	3.1E-06	2.14E-06	1.9E-05	2.93E-07	8.9E-06	5.75E-06	6.94E-07	6.36E-07	0	0	0
12.19		diesel air dryer	0.2	75		0	6.9975E-06	0	0	0	0	0	0	0	0	3.1E-06	2.14E-06	1.9E-05	2.93E-07	8.9E-06	5.75E-06	6.94E-07	6.36E-07	0	0	0
12.20	2.701	gasoline generator	0.07	75	0.0	0	2.38965E-06	0	0	0	0	0	0	0	0	1E-06	7.3E-07	6.6E-06	1E-07	3E-06	1.98E-06	2.37E-07	2.17E-07	0	0	0
Area 12 T-Tunnel						0	0.000180802	0	0	0	0	0	0	0	0	7.89E-05	5.53E-05	0.0005	7.59E-06	0.00022	0.000149	1.79E-05	1.64E-05	0	0	0
12.21		diesel generator	0.2	120		0	0.000011196	0	0	0	0	0	0	0	0	4.9E-06	3.42E-06	3.1E-05	4.69E-07	1.4E-05	9.2E-06	1.11E-06	1.02E-06	0	0	0
12.22	2.153	diesel generator	5.6	65	0.0	0	0.000169806	0	0	0	0	0	0	0	0	7.4E-05	5.19E-05	0.00047	7.12E-06	0.00021	0.00014	1.68E-05	1.54E-05	0	0	0
Area 12 U-Tunnel						0	6.0645E-06	0	0	0	0	0	0	0	0	2.7E-06	1.85E-06	1.7E-05	2.54E-07	7.7E-06	4.99E-06	6.01E-07	5.51E-07	0	0	0
12.23		diesel generator	0.2	65		0	6.0645E-06	0	0	0	0	0	0	0	0	2.7E-06	1.85E-06	1.7E-05	2.54E-07	7.7E-06	4.99E-06	6.01E-07	5.51E-07	0	0	0
Area 12 Yard						0	0.000129974	0	0	0	0	0	0	0	0	5.7E-05	3.97E-05	0.00036	5.45E-06	0.00016	0.000107	1.29E-05	1.18E-05	0	0	0
12.24		diesel generator	0.51	65		0	1.55251E-05	0	0	0	0	0	0	0	0	6.8E-06	4.74E-06	4.3E-05	6.51E-07	2E-05	1.28E-05	1.54E-06	1.41E-06	0	0	0
12.25		diesel generator	0.51	65		0	1.55251E-05	0	0	0	0	0	0	0	0	6.8E-06	4.74E-06	4.3E-05	6.51E-07	2E-05	1.28E-05	1.54E-06	1.41E-06	0	0	0
12.26		diesel generator	0.51	65		0	1.55251E-05	0	0	0	0	0	0	0	0	6.8E-06	4.74E-06	4.3E-05	6.51E-07	2E-05	1.28E-05	1.54E-06	1.41E-06	0	0	0
12.27		diesel generator	0.51	65		0	1.55251E-05	0	0	0	0	0	0	0	0	6.8E-06	4.74E-06	4.3E-05	6.51E-07	2E-05	1.28E-05	1.54E-06	1.41E-06	0	0	0
12.28		diesel generator	0.51	65		0	1.55251E-05	0	0	0	0	0	0	0	0	6.8E-06	4.74E-06	4.3E-05	6.51E-07	2E-05	1.28E-05	1.54E-06	1.41E-06	0	0	0
12.29		diesel generator	0.2	65		0	6.0645E-06	0	0	0	0	0	0	0	0	2.7E-06	1.85E-06	1.7E-05	2.54E-07	7.7E-06	4.99E-06	6.01E-07	5.51E-07	0	0	0
12.30		diesel generator	0.2	65		0	6.0645E-06	0	0	0	0	0	0	0	0	2.7E-06	1.85E-06	1.7E-05	2.54E-07	7.7E-06	4.99E-06	6.01E-07	5.51E-07	0	0	0
12.31		diesel generator	0.2	65		0	6.0645E-06	0	0	0	0	0	0	0	0	2.7E-06	1.85E-06	1.7E-05	2.54E-07	7.7E-06	4.99E-06	6.01E-07	5.51E-07	0	0	0
12.32		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.46E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.06E-07	2.82E-07	0	0	0
12.33		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.46E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.06E-07	2.82E-07	0	0	0
12.34		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.46E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.06E-07	2.82E-07	0	0	0
12.35		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.46E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.06E-07	2.82E-07	0	0	0
12.36		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.46E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.06E-07	2.82E-07	0	0	0
12.37		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.46E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.06E-07	2.82E-07	0	0	0
12.38		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.46E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.06E-07	2.82E-07	0	0	0
12.39		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.46E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.06E-07	2.82E-07	0	0	0
12.40		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.46E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.06E-07	2.82E-07	0	0	0
12.41		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.46E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.06E-07	2.82E-07	0	0	0
12.42		diesel generator	0.1	65		0	3.10502E-06	0	0	0	0	0	0	0	0	1.4E-06	9.46E-07	8.6E-06	1.3E-07	3.9E-06	2.55E-06	3.06E-07	2.82E-07	0	0	0
Area 23 (Mercury)						2.882E-05	0.000428636	2.162E-05	2.162E-05	6.49E-05	2.162E-05	4.32E-05	2.16E-05	0.000108	1.11E-05	0.0005	0.000124	0.00113	1.71E-05	0.00369	0.000335	4.04E-05	9.55E-05	3.3E-06	5.651E-06	
23.01	2.646	generator/B1000	0.07	4		0	1.3062E-07	0	0	0	0	0	0	0	0	5.7E-08	3.99E-08	3.6E-07	5.47E-09	1.7E-07	1.07E-07	1.3E-08	1.19E-08	0	0	
23.02	2.604	generator/B1010	0.34	1		0	1.58616E-07	0	0	0	0	0	0	0	0	7E-08	4.86E-08	4.4E-07	6.67E-09	2E-07	1.31E-07	1.58E-08	1.45E-08	0	0	
23.03	2.400	boiler/B111	0.47	424		3.967E-07	2.97506E-07	2.975E-07	2.975E-07	8.93E-07	2.975E-07	5.95E-07	2.98E-07	1.49E-06	1.527E-07	4.4E-06	0	0	0	4.4E-05	0	0	8.06E-07	4.54E-08	7.777E-08	
23.04	2.401	boiler/B128	0.84	632		1.056E-06	7.92152E-07	7.922E-07	7.922E-07	2.38E-06	7.922E-07	1.58E-06	7.92E-07	3.96E-06	4.065E-07	1.2E-05	0	0	0	0.00012	0	0	2.15E-06	1.21E-07	2.071E-07	
23.05	2.409	boiler/B156	0.33	785		5.252E-07	3.93924E-07	3.939E-07	3.939E-07	1.18E-06	3.939E-07	7.88E-07	3.94E-07	1.97E-06	2.022E-07	5.9E-06	0	0	0	5.8E-05	0	0	1.07E-06	6.01E-08	1.03E-07	
23.06	2.601	emergency generator	0.07	1		0	3.1864E-08	0	0	0	0	0	0	0	0	1.4E-08	9.73E-09	8.6E-08	1.34E-09	4E-08	2.62E-08	3.16E-09	2.9E-09	0	0	
23.07	2.411	boiler/B536	1.77	564		1.986E-06	1.49715E-06	1.497E-06	1.497E-06	4.49E-06	1.497E-06	2.99E-06	1.5E-06	7.49E-06	7.683E-07	2.2E-05	0	0	0	0.00022	0	0	4.06E-06	2.28E-07	3.913E-07	
23.08		diesel generator	0.2	3		0	2.799E-07	0	0	0	0	0	0	0	0	1.2E-07	8.55E-08	7.7E-07	1.17E-08	3.5E-07	2.3E-07	2.78E-08	2.54E-08	0	0	
23.09	2.157	emergency generator	4.2	1		0	1.9593E-06	0	0	0	0	0	0	0	0	8.6E-07	5.99E-07	5.4E-06	8.21E-08	2.5E-06	1.61E-06	1.94E-07	1.78E-07	0	0	
23.10	2.164	emergency generator	4.2	195		0	0.000382064	0	0	0	0	0	0	0	0	0.00017	0.000117	0.00106	1.6E-05	0.00048	0.000314	3.79E-05	3.47E-05	0	0	
23.11	2.070	boiler/B754 Café	3.2	1211		7.752E-06	5.81424E-06	5.814E-06	5.814E-06	1.74E-05	5.814E-06	1.16E-05	5.81E-06	2.91E-05	2.984E-06	8.6E-05	0	0	0	0.00086	0	0	1.58E-05	8.87E-07	1.52E-06	
23.12	2.071	boiler/B753	6.44	1327		1.709E-05	1.28208E-05	1.282E-05	1.282E-05	3.85E-05	1.282E-05	2.56E-05	1.28E-05	6.41E-05	6.579E-06	0.00019	0	0	0	0.00188	0	0	3.47E-05	1.96E-06	3.351E-06	
23.13	2.152	incinerator	0.32	872	99.0	5.494E-09	4.1202E-09	4.12E-09	4.12E-09	1.24E-08	4.12E-09	8.24E-09	4.12E-09	2.06E-08	2.114E-09	6.1E-08	0	0	0	6E-07	0	0	1.12E-08	6.26E-10	1.077E-09	
23.14		generator/RSN MAT	0.2	120		0	0.000011196	0	0	0	0	0	0	0	0	4.9E-06	3.42E-06	3.1E-05	4.69E-07	1.4E-05	9.2E-06	1.11E-06	1.02E-06	0	0	
23.15		generator/RSN MAT	0.2	120		0	0.000011196	0	0	0	0	0	0	0	0	4.9E-06	3.42E-06	3.1E-05	4.69E-07	1.4E-05	9.2E-06	1.11E-06	1.02E-06	0	0	
23.57	2.070	boiler/B754 Café	3.2	294		1.861E-06	1.41072E-06	1.411E-06	1.411E-06	4.23E-06	1.411E-06	2.82E-06	1.41E-06	7.05E-06	7.24E-07	2.1E-05	0	0	0	0.00021	0	0	3.82E-06	2.15E-07	3.687E-07	
Area 25						1.826E-05	1.3696E-05	1.37E-05	1.37E-05	4.11E-05	1.37E-05	2.74E-05	1.37E-05	6.85E-05	7.028E-06	0.0002	0	0	0	0.002	0	0	3.71E-05	2.09E-06	3.58E-06	
25.01	2.410	boiler/B4015	2.68	2600		1.391E-05	1.04352E-05	1.044E-05	1.044E-05	3.13E-05	1.044E-05	2.09E-05	1.04E-05	5.22E-05	5.355E-06	0.00016	0	0	0	0.00153	0	0	2.83E-05	1.59E-06	2.728E-06	
25.02	2.406	boiler/B4215	0.84	2600		4.348E-06	3.26079E-06	3.261E-06	3.261E-06	9.78E-06	3.261E-06	6.52E-06	3.26E-06	1.63E-05	1.673E-06	4.8E-05	0	0	0	0.00048	0	0	8.84E-06	4.97E-07	8.523E-07	
25.03	2.683	generator/ Skull Mtn.	0.2	76		0.00E+00	7.26E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.2E-06	2.2E-06	2.0E-05	3.0E-07	9.2E-06	6.0E-06	7.2E-07	6.6E-07	0.0E+00	0.0E+00	
25.04	2.529	air comp./ X-tunnel	0.7	75		0	2.44913E-05	0	0	0	0	0	0	0	0	1.1E-05	7.49E-06	6.6E-05	1.03E-06	3.1E-05	2.01E-05	2.43E-06	2.23E-06	0	0	
Area 27						0	0.000114946	0	0	0	0	0	0	0	0	5E-05	3.51E-05	0.00032	4.82E-06	0.00015	9.45E-05	1.14E-05	1.04E-05	#VALUE!	0	
27.01	2.131	emergency generator	5.6	35		0	0.000091434	0	0	0	0	0	0	0	0	4E-05	2.79E-05	0.00025	3.83E-06	0.00012	7.52E-05	9.07E-06	8.31E-06	#VALUE!	0	
27.02	2.130	emergency generator	5.6	9		0	2.35116E-05	0	0	0	0	0	0	0	0	1E-05	7.18E-06	6.5E-05	9.85E-07	3E-05	1.93E-05	2.33E-06	2.14E-06	#VALUE!	0	
27.03	2.619	diesel generator	0.05	65		0	1.55251E-06	0	0	0	0	0	0	0	0	6.8E-07	4.74E-07	4.3E-06	6.51E-08	2E-06	1.28E-06	1.54E-07	1.41E-07	#VALUE!	0	
27.04	2.669	diesel generator	0.14	65		0	4.13902E-06	0	0	0	0	0	0	0	0	1.8E-06	1.26E-06	1.1E-05	1.73E-07	5.2E-06	3.4E-06	4.1E-07	3.76E-07	#VALUE!	0	
Area 29						0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	#VALUE!	0	
29.01	2.602	diesel generator	0.34	65		0	1.03491E-05	0	0	0	0	0	0	0	0	4.5E-06	3.16E-06	2.9E-05	4.34E-07	1.3E-05	8.51E-06	1.03E-06	9.41E-07	#VALUE!	0	

Nevada Test Site Emission Inventory

TONS/YR

emission source #	old permit #	Equipment	process rate (ton/hr) or *heat rate (MMBtu/hr)*	operating hours (hr/yr)	control (%)	As (ton/yr)	Be (ton/yr)	Cd (ton/yr)	Cr (ton/yr)	Pb (ton/yr)	Hg (ton/yr)	Mn (ton/yr)	Ni (ton/yr)	Se (ton/yr)	Benzene (ton/yr)	Toluene (ton/yr)	Xylenes (ton/yr)	Propylene (ton/yr)	1,3-Butadiene (ton/yr)	Formaldehyde (ton/yr)	Acetaldehyde (ton/yr)	Acrolein (ton/yr)	Napthalene (ton/yr)	Ethylbenzene (ton/yr)	o-Xylene (ton/yr)	Phosphorous (P) (ton/yr)
						Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals	Totals
Hazardous Air Pollutant Emissions						#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0.000227	2.331E-05	0.02283	0.01544	0.13077	0.002118	0.07057	0.041583	0.005011	0.004717	#REF!	#REF!	#REF!
CHEMICAL RELEASES/FUME HOODS																										
AREA 5																										
HSC																										
HSC Chemical Releases																										
5.008		Chemical releases																								

Nevada Test Site Emission Inventory

EMISSION FACTORS

Hazardous Air Pollutant Emission Factors

emission source #	Equipment	process rate (ton/hr) or *heat rate (MMBtu/hr)*	operating hours (hr/yr)	As *(lb/ton or lb/MMBtu)*	Be (lb/ton or lb/MMBtu)	Cd (lb/ton or lb/MMBtu)	Cr (lb/ton or lb/MMBtu)	Pb (lb/ton or lb/MMBtu)	Hg (lb/ton or lb/MMBtu)	Mn (lb/ton or lb/MMBtu)	Ni (lb/ton or lb/MMBtu)	Se (lb/ton or lb/MMBtu)	Benzene (lb/ton or lb/MMBtu)	Toluene (lb/ton or lb/MMBtu)	Xylenes (lb/ton or lb/MMBtu)	Propylene (lb/ton or lb/MMBtu)	1,3-Butadiene (lb/ton or lb/MMBtu)	Formaldehyde (lb/ton or lb/MMBtu)	Acetaldehyde (lb/ton or lb/MMBtu)	Acrolein (lb/ton or lb/MMBtu)	Napthalene (lb/ton or lb/MMBtu)	Ethylbenzene (lb/ton or lb/MMBtu)	o-Xylene (lb/ton or lb/MMBtu)	Phosphorous (P) (lb/ton or lb/MMBtu)	Emission Factor References
47A	C-2 to funnel	160	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
47B	weigh hopper 2 to funnel	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
47C	truck loading	160	1920	2.32E-07		1.18E-08	1.42E-08	3.82E-07		6.12E-05	3.28E-08													2.02E-05	AP-42 (10/01update), Sec. 11.12
Area 6 Cementing Equipment																									
6.001	Scale #1	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
6.002	Scale #2	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
6.003	Scale #3	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
123A	Baghouse 07/back-up			1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
123B	waste silo	10	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
6.004	Baghouse 10																								N/A
4A	Load blending tank	50	1920	2.32E-07		1.18E-08	1.42E-08	3.82E-07		6.12E-06	3.28E-08													2.02E-05	AP-42 (10/01update), Sec. 11.12
4B	Blending tank discharge	50	1920	3.04E-06	2.44E-07	3.42E-08	1.14E-05	3.62E-06		6.12E-05	1.19E-05	2.62E-06												3.84E-05	AP-42 (10/01update), Sec. 11.12
6.005	Bin Vent #1																								N/A
6.006	Bin Vent #3																								N/A
6.007	Bin Vent #4																								N/A
567A	Silo #1	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
567B	Silo #2	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
567C	Silo #3	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
567D	Silo #4	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
567E	Silo #5	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
6.008	Bin Vent #8																								N/A
8A	Silo #7	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
8B	Silo #8	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
6.009	Silo #15	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
6.010	Silo #16	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
6.011	Bin Vent #18																								N/A
6.012	Bin Vent #19																								N/A
1112A	Silo #17	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
1112B	Silo #18	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
1112C	Silo #19	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
6.013	Baghouse 08																								N/A
13A	Silo #9	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
13B	Silo #10	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
13C	Silo #11	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
13D	Silo #12	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
13E	Silo #13	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
13F	Silo #14	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
13G	Silo #27	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
13H	Silo #28	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
13I	Silo #29	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
13J	Silo #30	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
13K	Silo #31	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
6.014	Baghouse 09																								N/A
14A	Silo #21	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
14B	Silo #22	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
14C	Silo #23	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
14D	Silo #24	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
14E	Silo #25	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
14F	Silo #26	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12
14G	Silo #32	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07		2.02E-04	1.76E-05													1.18E-05	AP-42 (10/01update), Sec. 11.12

14H	Silo #33	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07	2.02E-04	1.76E-05	1.18E-05	AP-42 (10/01update), Sec. 11.12
Construction storage yard												
6.111	Baghouse 11											
6.110	misc portable silos (7)	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07	2.02E-04	1.76E-05	1.18E-05	AP-42 (10/01update), Sec. 11.12
Area 12 Batch Plant												
12.01	loading hopper	50	504									N/A
12.02	discharge hopper	50	504									N/A
12.03	Baghouse 11											N/A
3A	loading silo #1	50	504	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07	2.02E-04	1.76E-05	1.18E-05	AP-42 (10/01update), Sec. 11.12
3B	loading silo #2	50	504	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07	2.02E-04	1.76E-05	1.18E-05	AP-42 (10/01update), Sec. 11.12
12.04	Baghouse 13											N/A
4A	weigh hopper/scale	50	504	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07	2.02E-04	1.76E-05	1.18E-05	AP-42 (10/01update), Sec. 11.12
4B	conveyor to loadout	50	504	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07	2.02E-04	1.76E-05	1.18E-05	AP-42 (10/01update), Sec. 11.12
12.05	loadout	50	504	2.32E-07		1.18E-08	1.42E-08	3.82E-07	6.12E-05	3.28E-06	2.02E-05	AP-42 (10/01update), Sec. 11.12
Portable Cement Bins												
12.06	Baghouse 14											N/A
6A	Mutiple portable bins	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07	2.02E-04	1.76E-05	1.18E-05	AP-42 (10/01update), Sec. 11.12
6B	Mutiple portable bins	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07	2.02E-04	1.76E-05	1.18E-06	AP-42 (10/01update), Sec. 11.12
6C	surge #1 loading	50	1920	1.68E-06	1.79E-08	2.34E-07	2.52E-07	7.36E-07	2.02E-04	1.76E-05	1.18E-05	AP-42 (10/01update), Sec. 11.12
6D	surge #1 discharge	50	1920	2.32E-07		1.18E-08	1.42E-08	3.82E-07	6.12E-05	3.28E-06	2.02E-06	AP-42 (10/01update), Sec. 11.12

COMBUSTION EQUIPMENT

Area 1 U1A																								
1.75	diesel air compressor	0.75	75		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
1.76	diesel generator	0.75	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
U1G																								
1.77	diesel generator	0.20	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
1.78	emergency generator	4.20	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
Drilling Storage Yard																								
1.79	fluid pump	1.40	50		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
1.80	mud pump	1.40	300		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
Area 5 Check Point Pass																								
5.001	diesel gen.(60 KW)	0.2048	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
WEF																								
5.002	diesel gen.(34 KW)	0.116	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
Area 5 NPTEC																								
5.007	diesel generator	4.2	300		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
Area 6 Heavy Equipment Storage Yard																								
6.028	diesel air compressor	0.7004	75		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.029	diesel air compressor	0.2083	75		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.030	diesel air compressor	0.2083	75		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.031	diesel air compressor	0.7004	75		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.032	diesel air compressor	0.7004	75		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.033	diesel air compressor	0.7004	75		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.034	diesel air compressor	0.7004	75		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.035	diesel air compressor	0.7004	75		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.036	diesel air compressor	0.7004	75		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.037	diesel air compressor	0.2038	75		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.038	diesel air compressor	0.2038	75		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.039	diesel air compressor	0.2038	75		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.040	diesel air compressor	0.2	75		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.041	diesel air compressor	1.8622	150		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.4
6.042	diesel generator	0.3413	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.043	diesel generator	0.3413	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.044	diesel generator	4.2	300		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.045	diesel generator	4.2	300		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.046	diesel generator	4.2	300		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.4
6.047	diesel generator	4.2	300		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.048	diesel generator	0.3413	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.049	diesel generator	0.07	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.050	diesel generator	0.07	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.051	diesel generator	0.07	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.052	diesel generator	0.1	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.053	diesel generator	0.1024	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.054	diesel generator	0.2048	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.055	diesel generator	0.3413	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.056	diesel generator	0.3413	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.057	diesel generator	0.3413	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.058	diesel generator	0.3413	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.059	diesel generator	0.3413	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.060	diesel generator	0.3413	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.061	gas generator	0.07	75		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.062	gas generator	0.07	75		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.063	gas generator	0.07	75		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.064	gas generator	0.07	75		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.065	gas generator	0.07	75		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.066	gas generator	0.07	75		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.067	gas generator	0.07	75		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.068	trash pump	0.026	50		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.069	diesel cable reeler	0.026	50		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.070	diesel cable reeler	0.026	50		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.071	diesel cable reeler	0.026	50		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.072	diesel cable reeler	0.026	50		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.073	diesel cable reeler	0.026	50		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.074	diesel cable reeler	0.026	50		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
CP-1																								
6.075	Boiler	1.6723	2800	4E-06	3E-06	3E-06	3E-06	9E-06	3E-06	6E-06	3E-06	1.5E-05	1.54E-06	4.46E-05				4.39E-04			8.1295E-06	4.58E-07	7.842E-07	
6.076	Boiler	1.6723	2800	4E-06	3E-06	3E-06	3E-06	9E-06	3E-06	6E-06	3E-06	1.5E-05	1.54E-06	4.46E-05				4.39E-04			8.1295E-06	4.58E-07	7.842E-07	
6.077	emerg. generator	4.2	300		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			
6.078	diesel generator	0.3413	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			
6.079	diesel generator	0.3754	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			
CP-18																								
6.080	diesel generator	0.256	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
CP-40																								
6.081	diesel generator	0.3413	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
CP-43																								
6.082	diesel generator	0.2048	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
CP-70																								
6.083	diesel generator	0.4266	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
CP-6																								
6.084	Boiler	0.8361	2600	4E-06	3E-06	3E-06	3E-06	9E-06	3E-06	6E-06	3E-06	1.5E-05	1.54E-06	4.46E-05				4.39E-04			8.1295E-06	4.58E-07	7.842E-07	AP-42 (9/98 update), Sec. 1.3

6.085	emerg. generator	4.2	300		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.086	emerg. generator	4.2	300		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
Area 6 DAF																								
6.087	emerg. generator	5.6	300		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.4
6.088	emerg. generator	5.6	300		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.4
6.089	Boiler	2.3412	2600	4E-06	3E-06	3E-06	3E-06	9E-06	3E-06	6E-06	3E-06	1.5E-05	1.54E-06	4.46E-05				4.39E-04			8.1295E-06	4.58E-07	7.842E-07	AP-42 (9/98 update), Sec. 1.3
6.090	Boiler	2.3412	2600	4E-06	3E-06	3E-06	3E-06	9E-06	3E-06	6E-06	3E-06	1.5E-05	1.54E-06	4.46E-05				4.39E-04			8.1295E-06	4.58E-07	7.842E-07	AP-42 (9/98 update), Sec. 1.3
Decon																								
6.091	Boiler	5.18	1000	4E-06	3E-06	3E-06	3E-06	9E-06	3E-06	6E-06	3E-06	1.5E-05	1.54E-06	4.46E-05				4.39E-04			8.1295E-06	4.58E-07	7.842E-07	AP-42 (9/98 update), Sec. 1.3
Iron Workers Yard																								
6.092	diesel cable reeler	0.135	50		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
Well 3 Yard																								
6.096	bin	50	1920																					
6.097	diesel generator	0.34	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.098	diesel generator	0.34	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.099	diesel generator	0.34	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.100	diesel generator	0.34	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
Wet/Wild																								
6.101	diesel air compressor	1.9739	150		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.4
6.102	diesel air compressor	0.7004	75		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.103	diesel air compressor	1.9739	150		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.104	diesel air compressor	1.9739	150		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.105	diesel air compressor	1.9739	150		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.106	conveyor	250	100																					AP-42 (10/96 Update), Sec. 3.3
6.107	pump	0.7	50		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.3
6.108	diesel air compressor	1.9739	150		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42 (10/96 Update), Sec. 3.4
Other sites, equipment																								
6.109	abrasive blaster		50																					N/A
Area 12 Cafeteria																								
12.07	boiler	1.7726	2600	4E-06	3E-06	3E-06	3E-06	9E-06	3E-06	6E-06	3E-06	1.5E-05	1.54E-06	4.46E-05				[redacted]			8.1295E-06	4.58E-07	7.842E-07	AP-42 (9/98 update), Sec. 1.3
12.08	boiler	3.6	2600	4E-06	3E-06	3E-06	3E-06	9E-06	3E-06	6E-06	3E-06	1.5E-05	1.54E-06	4.46E-05				[redacted]			8.1295E-06	4.58E-07	7.842E-07	AP-42 (9/98 update), Sec. 1.3
G-Tunnel																								
12.09	diesel generator	0.1365	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
12.10	diesel generator	0.1365	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
12.11	diesel generator	0.1365	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
12.12	diesel generator/welder	0.1365	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
12.13	diesel generator	0.1365	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
12.14	industrial heater	0.1365	65	4E-06	3E-06	3E-06	3E-06	9E-06	3E-06	6E-06	3E-06	1.5E-05	1.54E-06	4.46E-05				4.39E-04			8.1295E-06	4.58E-07	7.842E-07	AP-42, Sec. 3.3
12.15	steam cleaner	0.1365	65	4E-06	3E-06	3E-06	3E-06	9E-06	3E-06	6E-06	3E-06	1.5E-05	1.54E-06	4.46E-05				4.39E-04			8.1295E-06	4.58E-07	7.842E-07	AP-42, Sec. 3.3
N-Tunnel																								
12.16	diesel generator	5.6	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
12.17	diesel generator	5.6	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
P-Tunnel																								
12.18	diesel compressor	0.2	75		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
12.19	diesel air dryer	0.2	75		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
12.20	gasoline generator	0.0683	75		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
T-Tunnel																								
12.21	diesel generator	0.2	120		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
12.22	diesel generator	5.6	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
U-Tunnel																								
12.23	diesel generator	0.2	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
Yard																								
12.24	diesel generator	0.512	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
12.25	diesel generator	0.512	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
12.26	diesel generator	0.512	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
12.27	diesel generator	0.512	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
12.28	diesel generator	0.512	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
12.29	diesel generator	0.2	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
12.30	diesel generator	0.2	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
12.31	diesel generator	0.2	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
12.32	diesel generator	0.1024	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
12.33	diesel generator	0.1024	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
12.34	diesel generator	0.1024	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
12.35	diesel generator	0.1024	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
12.36	diesel generator	0.1024	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
12.37	diesel generator	0.1024	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
12.38	diesel generator	0.1024	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
12.39	diesel generator	0.1024	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
12.40	diesel generator	0.1024	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
12.41	diesel generator	0.1024	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
12.42	diesel generator	0.1024	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			AP-42, Sec. 3.3
Area 23 (Mercury)																								
23.01	generator/B1000	0.07	120		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			
23.02	generator/B1010	0.3413	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			
23.03	boiler/B111	0.468	2600	4E-06	3E-06	3E-06	3E-06	9E-06	3E-06	6E-06	3E-06	1.5E-05	1.54E-06	4.46E-05				4.39E-04			8.1295E-06	4.58E-07	7.842E-07	
23.04	boiler/B128	0.836	2600	4E-06	3E-06	3E-06	3E-06	9E-06	3E-06	6E-06	3E-06	1.5E-05	1.54E-06	4.46E-05				4.39E-04			8.1295E-06	4.58E-07	7.842E-07	
23.05	boiler/B156	0.3345	2600	4E-06	3E-06	3E-06	3E-06	9E-06	3E-06	6E-06	3E-06	1.5E-05	1.54E-06	4.46E-05				4.39E-04			8.1295E-06	4.58E-07	7.842E-07	
23.06	emergency generator	0.0683	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			
23.07	boiler/B538	1.77	2600	4E-06	3E-06	3E-06	3E-06	9E-06	3E-06	6E-06	3E-06	1.5E-05	1.54E-06	4.46E-05				4.39E-04			8.1295E-06	4.58E-07	7.842E-07	
23.08	diesel generator	0.2	120		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			
23.09	emergency generator	4.2	300		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			
23.10	emergency generator	4.2	300		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			
23.11	boiler/B754 Café	3.2	2600	4E-06	3E-06	3E-06	3E-06	9E-06	3E-06	6E-06	3E-06	1.5E-05	1.54E-06	4.46E-05				4.39E-04			8.1295E-06	4.58E-07	7.842E-07	
23.12	boiler/B753	6.44	2500	4E-06	3E-06	3E-06	3E-06	9E-06	3E-06	6E-06	3E-06	1.5E-05	1.54E-06	4.46E-05				4.39E-04			8.1295E-06	4.58E-07	7.842E-07	

23.13	incinerator	0.315	872	4E-06	3E-06	3E-06	3E-06	9E-06	3E-06	6E-06	3E-06	1.5E-05	1.54E-06	4.46E-05				4.39E-04			8.1295E-06	4.58E-07	7.842E-07	
23.14	generator/RSN MAT	0.2	120		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			
23.15	generator/RSN MAT	0.2	120		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			
23.57	boiler/B754 Café	3.2	2600	4E-06	3E-06	3E-06	3E-06	9E-06	3E-06	6E-06	3E-06	1.5E-05	1.54E-06	4.46E-05				4.39E-04			8.1295E-06	4.58E-07	7.842E-07	
Area 25																						
25.01	boiler/B4015	2.6757	2600	4E-06	3E-06	3E-06	3E-06	9E-06	3E-06	6E-06	3E-06	1.5E-05	1.54E-06	4.46E-05				4.39E-04			8.1295E-06	4.58E-07	7.842E-07	(9/98
25.02	boiler/B4215	0.8361	2600	4E-06	3E-06	3E-06	3E-06	9E-06	3E-06	6E-06	3E-06	1.5E-05	1.54E-06	4.46E-05				4.39E-04			8.1295E-06	4.58E-07	7.842E-07	(9/98
25.03	generator/ Skull Mtn.	0.2048	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			Sec. 3.3
25.04	air comp./ X-tunnel	0.7	75		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05			Sec. 3.3
Area 27																						
27.01	emergency generator	5.6	300		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05	-42, Sec. 3.3		
27.02	emergency generator	5.6	300		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05	-42, Sec. 3.3		
27.03	diesel generator	0.0512	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05	-42, Sec. 3.3		
27.04	diesel generator	0.1365	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05	-42, Sec. 3.3		
Area 29																						
29.01	diesel generator	0.3413	65		9.33E-04									4.09E-04	2.85E-04	2.58E-03	3.91E-05	1.18E-03	7.67E-04	9.25E-05	8.48E-05	AP-42, Sec. 3.3		

CHEMICAL RELEASES/FUME HOODS

AREA 5

HSC

HSC Chemical Releases

5.006 Chemical releases

Attachment R

EVENTS5_	EVENTS5_ID	EVENTS51	EVENTS5__1	EVENT_NO_	EVENT_NAME	DATE_	LOCATION	NORTHING_2	EASTING_27	LONGITUDE_	LATITUDE_8	LAND_ELEV	HOLE_DEPTH	TYPE
39	39	39	39	62	Apple-2	05/05/55	T1	838781.0	664589.0	-116.10400000	37.05300000	0	0.00000000	Tower
283	283	283	283	647	Diamond Dust	05/12/70	U-16a.05	823100.0	635700.0	-116.20300000	37.01000000	6321	-9999.00000000	Tunnel
285	285	285	285	672	Diamond Mine	07/01/71	U-16a.06	823495.0	635259.0	-116.20400000	37.01100000	6310	-9999.00000000	Tunnel
310	310	310	310	465	Double Play	06/15/66	U-16a.03	822812.0	635402.0	-116.20400000	37.01000000	6499	-9999.00000000	Tunnel
325	325	325	325	27	Easy (TS-5)	05/07/52	T1	838781.0	664589.0	-116.10400000	37.05300000	0	0.00000000	Tower
393	393	393	393	106	Galileo	09/02/57	T1	838781.0	664589.0	-116.10400000	37.05300000	0	0.00000000	Tower
420	420	420	420	409	Gum Drop	04/21/65	U-16a.02	821902.0	635652.0	-116.20300000	37.00700000	6425	-9999.00000000	Tunnel
578	578	578	578	261	Marshmallow	06/28/62	U-16a	822612.0	635951.0	-116.20200000	37.00900000	7442	-9999.00000000	Tunnel
609	609	609	609	575	Ming Vase	11/20/68	U-16a.04	822869.0	634378.0	-116.20700000	37.01000000	6425	-9999.00000000	Tunnel
851	851	851	851	39	Simon	04/25/53	T1	838781.0	664589.0	-116.10400000	37.05300000	0	0.00000000	Tower

OPERATION	VENT	A_U	PURPOSE	YIELD_RANG	BOREHOLE_D	EST_GW_INT	WT_INTERSE	COMMENTS	POLYGONID	SCALE	ANGLE	DATA_NOTES
Teapot		A	Weapons Related	29 kt	0.0	NO	0.00000000		0	1.00000000	1	
Mandrel		U	Vela Uniform	Less than 20 kt	830.0	NO	0.00000000	DoD Test; Nuclear test detection experiment	0	1.00000000	1	
Grommet		U	Vela Uniform	Less than 20 kt	873.0	NO	0.00000000	DoD Test; Nuclear test detection experiment	0	1.00000000	1	
Flintlock		U	Weapons Effects	Less than 20 kt	1075.0	NO	0.00000000	DoD Test; Accidental release of radioactivity detected off site	0	1.00000000	1	
Tumbler-Snapper		A	Weapons Related	12 kt	0.0	NO	0.00000000		0	1.00000000	1	
Plumbbob		A	Weapons Related	11 kt	0.0	NO	0.00000000		0	1.00000000	1	
Whetstone		U	Weapons Effects	Less than 20 kt	1000.0	NO	0.00000000	DoD Test	0	1.00000000	1	
Nougat		U	Weapons Effects	Low	1020.0	NO	0.00000000	Accidental release of radioactivity detected on site only	0	1.00000000	1	
Bowline		U	Weapons Effects	Less than 20 kt	1010.0	NO	0.00000000	DoD Test	0	1.00000000	1	
Upshot-Knothole	F	A	Weapons Related	43 kt	0.0	NO	0.00000000		0	1.00000000	1	

Attachment S

DIVINE STRAKE AIR DISPERSION MODELING RESULTS
for
SULFUR DIOXIDE

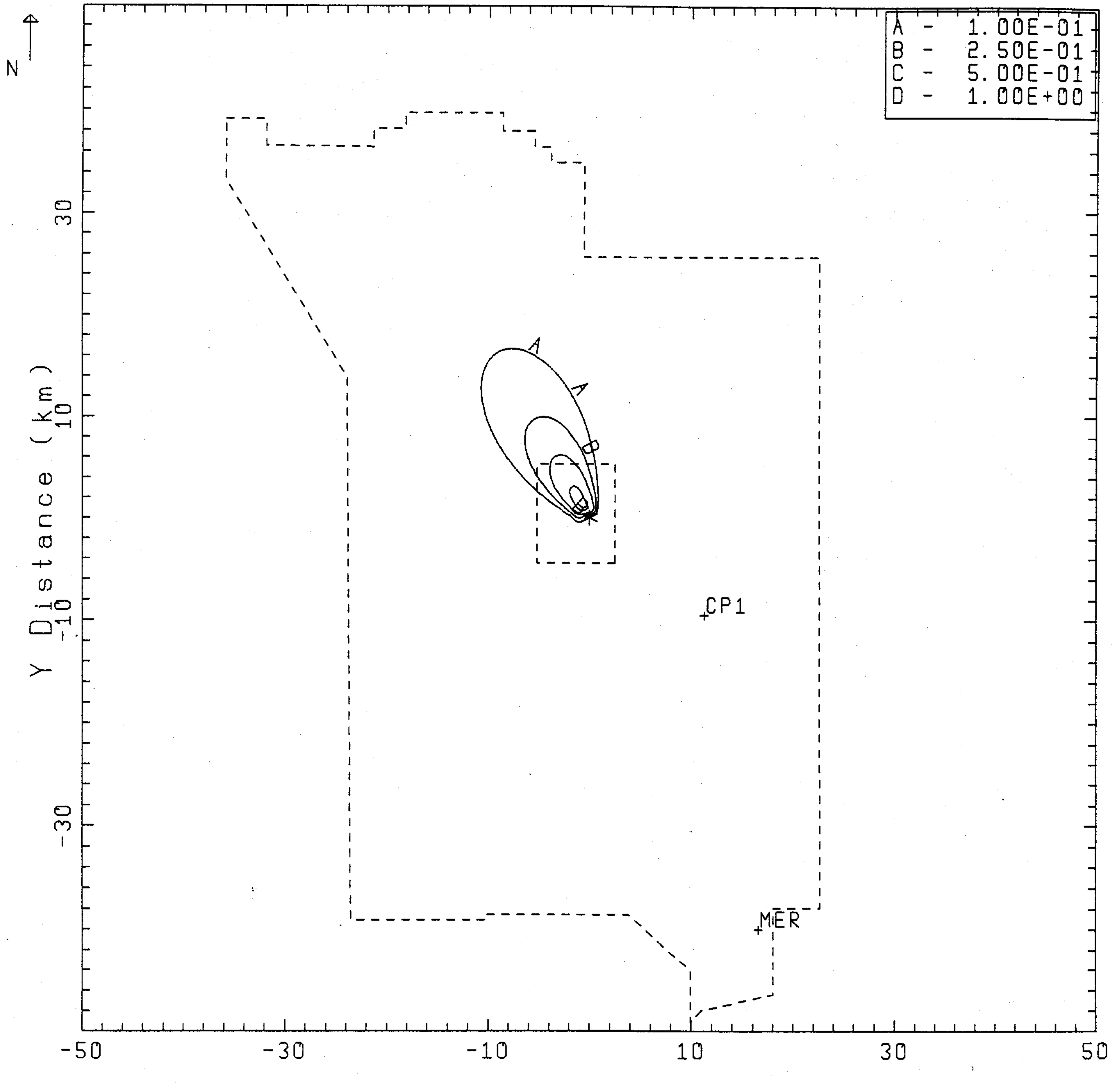
The attached table is updated to include estimated sulfur dioxide concentrations resulting from the Divine Strake Experiment. Output from the POLU4WN model was used to estimate quantities of all emissions from the proposed explosive experiment. All emissions of oxides of sulfur were combined to provide input into Open Burn/Open Detonation Model (OBODM) to model the dispersion; thus overestimating the concentration of sulfur dioxide that may be expected to result from Divine Strake. The sulfur oxide compounds that were reported by POLU4WN and used as input to OBODM are: Sulfuric Acid (H_2SO_4), Sulfur Oxide (S_2O), Sulfur trioxide (SO_3), Sulfur Dioxide (SO_2), Carbon Oxide Sulfide (CSO), and Sulfur Oxide (SO). Despite the overestimation, the concentration of sulfur dioxide is expected to be well within the Nevada Ambient Air Quality Standards at the boundary of the Nevada Test Site. Following the table are the OBODM one hour, three hour, and 24 hour plume plots for sulfur dioxide.

Updated Air Dispersion Modeling Results

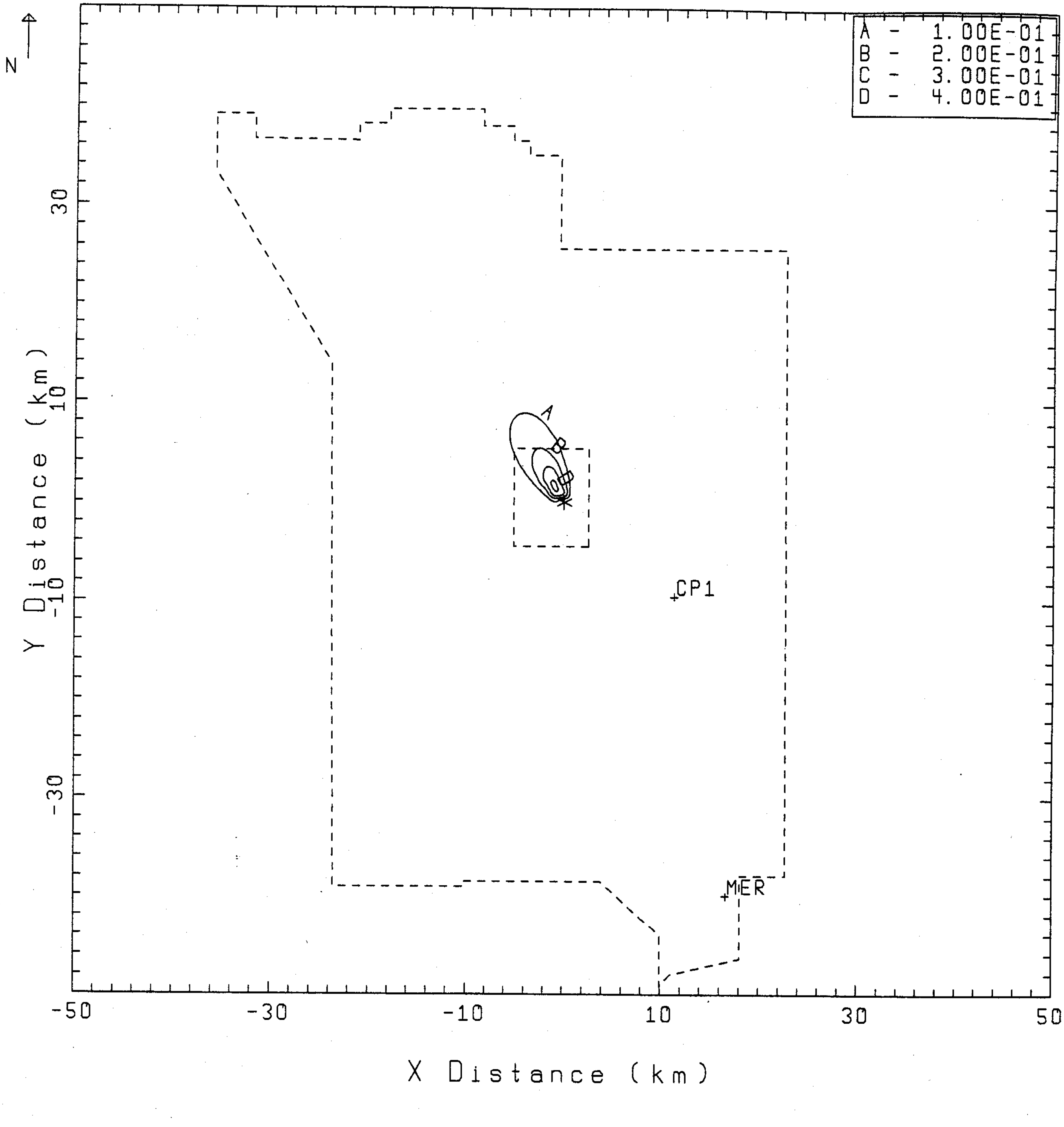
Pollutant	Averaging Period	Maximum Modeled NTS Sources[f] (u/m^3)[a]	Background Concen-tration[f] (u/m^3) [a]	Modeled Divine Strake Test (u/m^3)[a]	Total NTS Concentration (u/m^3)[a]	NAAQS[g] Standard (u/m^3) [a]	NV AAQS[g] Standard (u/m^3) [a]
Nitrogen Dioxide	Annual	2.5	0	0.00001	2.50001	100	100
Sulfur Dioxide	Annual	0.6	0			80	80
	24-hour	17.0	0	0.00096	17.00096	365[b]	365
	3-hour	74.9	0	0.00767	74.90767	1,300[b]	1,300
Carbon Monoxide	8-hour	42.2	0	0	42.2	10,000[b]	10,000[c]
	1-hour	222.5	0	0.00010	222.50010	40,000[b]	40,000
PM10[d]	Annual	0.6	9.0			50	50
	24-hour	17.4	10.2	0.01673	27.61673	150[b]	150
Ozone	1-hour	204.7[e]	0	0.10094	204.80094	235[b]	235

a u/m^3 = micrograms per cubic meter
b Not to be exceeded more than once per calendar year
c 6,670 μ/m^3 at areas equal to or greater than 5,000 feet above Mean Sea Level
d Particulate matter with aerodynamic diameter less than or equal to 10 microns
e Ozone concentrations were conservatively assumed to be equal to VOC concentrations
f Source: Appendix 7, NTS Air Quality Operating Permit Renewal Application Package, March, 2002
g Source: NAC 445B.22097

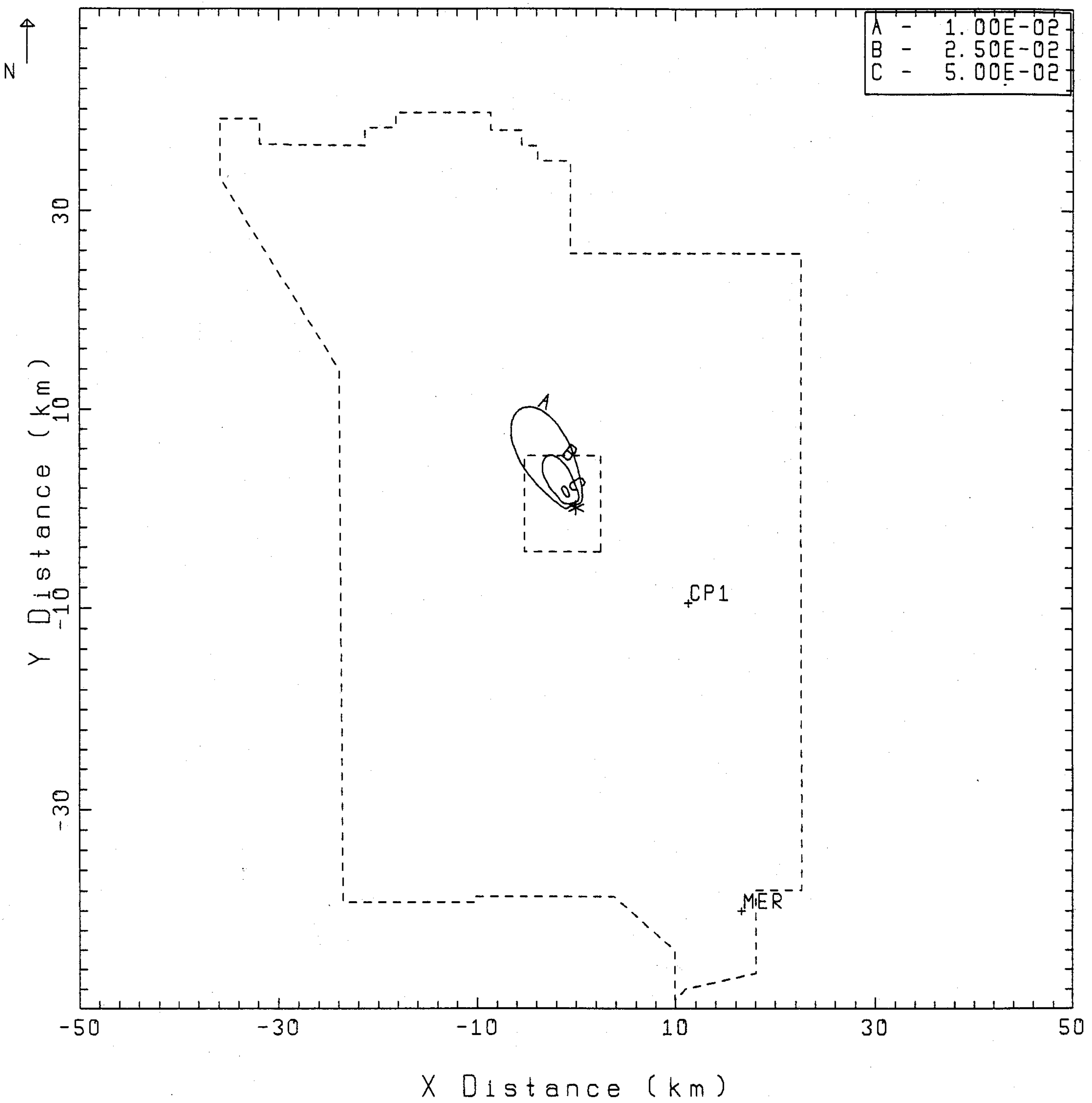
Note: All concentrations of emissions are modeled at the boundary of the Nevada Test Site



Divine Strake - June 3 Climatology
Highest 1-hr Sulfur Oxides (SOX) Concentration
(ppb)



Divine Strake - June 3 Climatology
Highest 3-hr Average Sulfur Oxides (SOX)
Concentration (ppb)



Divine Strake - June 3 Climatology
Highest 24-hr Average Sulfur Oxides (SOX)
Concentration (ppb)

***START---INPUT DATA	Start Data Input
DSsulfur100.doc	Document name for saving model output
DSsulfur100,May 08, 2006	Name of file, date of file
1,0,11,0,10,1,1,1,0,0,0	Data in input batch file: ingredient parameters (FORTRAN format)
0.0,30.0,20.0,40.0,50.0,60.0,70.0,80.0,90.0,100.0	Chemical Reaction Percentages (e.g., 0.0%air:100%ingredients, etc.
45,380,197,138,728,7,251,1130,910,812,15	Number in the program associated with the ingredients
1000,14.7,85.7,6.06,0.002,0.08,0.2,0.2,0.2,2.7,4.7,0.03,0.0,2	PSI (1000 to 14.7); 85.7% AN, 6.06% Fuel Oil, 0.002% C-4, etc. as identified in the ingredient list below).
1400000.	Total wt. of all ingredients in lbs.
***END---INPUT DATA	End of data input

```
 TITLE OF RUN
 MATERIAL=DSsulfur100, May 08, 2006
 MAY 08, 2006    3:02:01 PM


  DETONATION BURN---MATERIAL DETONATES BEFORE REACTING WITH AIR---
*** PAU1A2 (INFILE.12) JANNAF THERMOCHEMICAL TAPE - UPDATED 05 JAN 2003 JMH ***
```

Elemental Constituents in the Ingredient List Below: H, C, N, O, S, CL, Ca

Chemicals Entered into Model

```
                                                                                % of Chemicala
 1.  AMMONIUM NITRATE -AN     0.0040.0000.0020.0030.0000.0000.0000.0000.0000.0000.0000.000   85.700      -1090.  0.0623
 2.  FUEL OIL (NO.6)          0.0120.0070.0000.0000.0000.0000.0000.0000.0000.0000.0000.000    6.060       -422.  0.0325
 3.  COMP C-4                 0.0040.0020.0020.0020.0000.0000.0000.0000.0000.0000.0000.000    0.002         30.  0.0587
 4.  N-BUTANE                 0.0100.0040.0000.0000.0000.0000.0000.0000.0000.0000.0000.000    0.080       -513.  0.0217
 5.  POLYMETHYLMETHACRYL      0.0080.0050.0000.0020.0000.0000.0000.0000.0000.0000.0000.000    0.200      -1028.  0.0340
 6.  ACRYLONITRILE            0.0060.0060.0000.0000.0000.0000.0000.0000.0000.0000.0000.000    0.200        333.  0.0361
 7.  DICHLOROMETHANE(GAS)     0.0020.0010.0000.0000.0000.0020.0000.0000.0000.0000.0000.000    0.200       -270.  0.0001
 8.  CALCIUM NITRATE          0.0000.0000.0020.0060.0000.0000.0010.0000.0000.0000.0000.000    2.700      -1365.  0.0852
 9.  WATER - H20              0.0020.0000.0000.0010.0000.0000.0000.0000.0000.0000.0000.000    4.700      -3792.  0.0361
 10. SULFUR                   0.0000.0000.0000.0000.0010.0000.0000.0000.0000.0000.0000.000    0.030          0.  0.0739
 11. AIR-Gas                  0.0000.0000.0060.0010.0000.0000.0000.0000.0000.0000.0000.000    0.000          0.  0.0000
                                                                                ~100.0%


0GRAM ATOM AMOUNTS FOR MATERIAL WEIGHT OF    99.872                                        1.0000
0    (H )      (C )      (N )      (O )      (S )      (CL)      (CA)      (
  5.588158  0.476015  2.174171  3.575593  0.000936  0.004709  0.016454

a: Percentage of total, i.e., 1.4 E+06 lbs.

FN is zero in EQUIL;  NP =  141
0 RESULTS NO DAMN GOOD
 WT. - MATERIAL          99.872    69.910    79.898    59.923    49.936    39.949    29.962    19.974     9.987    -0.013
 WT. - LAST INGREDIENT    0.000    30.000    20.000    40.000    50.000    60.000    70.000    80.000    90.000   100.000
 OXID/ MATERIAL RATIO     0.0000    0.4291    0.2503    0.6675    1.0013    1.5019    2.3363    4.0051    9.0115-7811.2036
 WT. MATERIAL+ OXID!  1400000.0 2000769.0 1750448.6 2334529.5 2801794.5 3502691.5 4670853.0 7007178.514016151.0**********
```

```
 DENSITY-TOT WT GR/CC    0.60149    0.00367    0.00549    0.00276    0.00221    0.00184    0.00158    0.00138    0.00123    0.00123

  ---COMBUSTION CONDITIONS: AIR IS MIXED WITH THE MATERIAL'S COMBUSTION PRODUCTS AFTER---
  ---THE MATERIAL HAS EXPLODED. (WT. MATERIAL/WT. AIR IS SHOWN ABOVE)---
--CAUTION: DATA BELOW FLAME TEMP. OF 300 K QUESTIONABLE.

 FLAME TEMP. T(K)        983.699  1047.632  1116.523   977.297   892.343   798.060   693.005   575.469   443.868   443.869
 FLAME TEMP. T(F)       1311.257  1426.338  1550.341  1299.735  1146.818   977.109   788.008   576.445   339.563   339.564
 ENTHAL KCAL/100 GRS!   -172.381  -120.512  -137.728  -103.296   -86.080   -68.864   -51.648   -34.432   -17.216   -17.216

  ---COMBUSTION CONDITIONS: THE COMBUSTION PRODUCTS BELOW ARE FROM THE MATERIAL/AIR---
  ---MIXTURES ABOVE AFTER EXPANDING FROM  1000.00 PSI TO  14.7000 PSI---

 FLAME TEMP. T(K)        412.953   394.961   434.455   354.347   348.042   338.358   327.285   304.358   249.642   249.642
 FLAME TEMP. T(F)        283.915   251.529   322.619   178.424   167.075   149.644   129.712    88.444   -10.044   -10.045
 ENTHAL KCAL/100 GRS!   -196.400  -143.482  -163.021  -123.881  -104.278   -84.752   -65.303   -45.962   -26.536   -26.536
 2T.VOL. GASES- LIT.! 1333522.4 1800431.4 1605520.6 2060297.5 2424091.8 2800798.5 3539941.3 5055439.010290812.0**********
 --GASES ONLY AT STP
 TOTAL HEAT RELEASED*    564.662   666.524   666.556   666.476   664.955   665.932   665.385   664.365   663.045**********
 COMBUSTION PRODUCTS ROUNDED OFF TO     1.00E-05
 NS, IPRINT, LBS-AT EXHT PRINT OUT =    2    1    2
```

```
         ---POUNDS OF PRODUCT FORMED FROM OB/OD OF      1400000.000 POUNDS OF MATERIAL.

           [   0%   ] [  20%   ] [  30% ]  [  40%   ] [  50%   ] [  60%   ] [  70%   ] [  80%   ] [illegible]  [  100%  ]
H2O        0.678E+06 0.702E+06 0.702E+06 0.702E+06 0.701E+06 0.566E+06 0.429E+06 0.185E+06 0.700E+04  -0.546E+07
N2         0.427E+06 0.901E+06 0.703E+06 0.116E+07 0.153E+07 0.208E+07 0.301E+07 0.485E+07 0.104E+08  -0.809E+10
CO2        0.266E+06 0.294E+06 0.294E+06 0.294E+06 0.293E+06 0.294E+06 0.294E+06 0.293E+06 0.293E+06  -0.229E+09
CaH2O2&    0.147E+05 0.147E+05 0.147E+05 0.147E+05 0.150E+05 0.147E+05 0.147E+05 0.147E+05 0.148E+05  -0.115E+08
CH4        0.102E+05 0.321E+00 0.281E+00 0.375E+00-0.112E+02 0.562E+00 0.749E+00 0.112E+01 0.225E+01  -0.175E+04
CaCl2&     0.361E+04 0.359E+04 0.360E+04 0.358E+04 0.313E+04 0.354E+04 0.350E+04 0.341E+04 0.319E+04  -0.249E+07
H2S        0.416E+03 0.682E+00 0.597E+00 0.796E+00 0.481E+00 0.119E+01 0.159E+01 0.239E+01 0.478E+01  -0.373E+04
H2         0.635E+02 0.403E-01 0.353E-01 0.471E-01-0.838E-02 0.706E-01 0.942E-01 0.141E+00 0.283E+00  -0.220E+03
NH3        0.236E+02 0.341E+00 0.298E+00 0.398E+00 0.452E+00 0.597E+00 0.796E+00 0.119E+01 0.239E+01  -0.186E+04
S8         0.359E+01 0.418E+01 0.366E+01 0.488E+01 0.316E+01 0.732E+01 0.350E+01 0.119E+02 0.194E+02  -0.152E+05
C2Cl6      0.331E+01 0.474E+01 0.414E+01 0.553E+01 0.663E+01 0.829E+01 0.111E+02 0.166E+02 0.270E+02  -0.211E+05
S7         0.314E+01 0.366E+01 0.393E+01 0.524E+01 0.512E+01 0.425E+01 0.854E+01 0.850E+01 0.329E+01  -0.257E+04
S6         0.269E+01 0.385E+01 0.337E+01 0.366E+01 0.439E+01 0.364E+01 0.899E+01 0.135E+02 0.220E+02  -0.171E+05
C2Cl4      0.232E+01 0.332E+01 0.290E+01 0.387E+01 0.465E+01 0.581E+01 0.775E+01 0.116E+02 0.232E+02  -0.181E+05
S5         0.224E+01 0.321E+01 0.281E+01 0.374E+01 0.298E+01 0.457E+01 0.405E+01 0.745E+01 0.355E+01  -0.277E+04
CCl4       0.215E+01 0.308E+01 0.269E+01 0.359E+01 0.431E+01 0.539E+01 0.719E+01 0.108E+02 0.216E+02  -0.168E+05
S2Cl2      0.189E+01 0.270E+01 0.236E+01 0.315E+01 0.378E+01 0.473E+01 0.631E+01 0.946E+01 0.553E+01  -0.431E+04
S2Cl2*     0.189E+01 0.270E+01 0.236E+01 0.315E+01 0.378E+01 0.473E+01 0.631E+01 0.946E+01 0.189E+02  -0.148E+05
SO2Cl2     0.189E+01 0.270E+01 0.236E+01 0.315E+01 0.378E+01 0.473E+01 0.630E+01 0.946E+01 0.189E+02  -0.148E+05
S4         0.180E+01 0.257E+01 0.225E+01 0.299E+01 0.359E+01 0.366E+01 0.599E+01 0.732E+01 0.971E+01  -0.758E+04
CHCl3      0.167E+01 0.239E+01 0.209E+01 0.279E+01 0.335E+01 0.418E+01 0.558E+01 0.837E+01 0.167E+02  -0.131E+05
CCl3       0.166E+01 0.237E+01 0.207E+01 0.276E+01 0.332E+01 0.415E+01 0.553E+01 0.830E+01 0.166E+02  -0.129E+05
NH4O4Cl&   0.164E+01 0.235E+01 0.206E+01 0.274E+01 0.329E+01 0.412E+01 0.549E+01 0.823E+01 0.165E+02  -0.128E+05
CaCl2      0.155E+01 0.222E+01 0.194E+01 0.259E+01 0.311E+01 0.389E+01 0.518E+01 0.778E+01 0.156E+02  -0.121E+05
CaCl2*     0.155E+01 0.222E+01 0.194E+01 0.259E+01 0.311E+01 0.389E+01 0.518E+01 0.778E+01 0.156E+02  -0.121E+05
N2O5       0.151E+01 0.216E+01 0.189E+01 0.252E+01 0.303E+01 0.378E+01 0.505E+01 0.757E+01 0.151E+02  -0.118E+05
SCl2       0.144E+01 0.206E+01 0.180E+01 0.240E+01 0.289E+01 0.361E+01 0.481E+01 0.722E+01 0.958E+01  -0.747E+04
SCl2*      0.144E+01 0.206E+01 0.180E+01 0.240E+01 0.289E+01 0.361E+01 0.481E+01 0.722E+01 0.144E+02  -0.113E+05
S2Cl       0.139E+01 0.199E+01 0.174E+01 0.232E+01 0.279E+01 0.349E+01 0.465E+01 0.463E+01 0.408E+01  -0.318E+04
COCl2      0.138E+01 0.198E+01 0.173E+01 0.231E+01 0.277E+01 0.347E+01 0.462E+01 0.693E+01 0.139E+02  -0.108E+05
H2SO4      0.137E+01 0.116E+04 0.118E+04 0.114E+04 0.305E+03 0.109E+04 0.103E+04 0.913E+03 0.736E+03  -0.574E+06
S3         0.137E+01 0.192E+01 0.168E+01 0.225E+01 0.269E+01 0.337E+01 0.366E+01 0.297E+01 0.321E+01  -0.250E+04
C2Cl2      0.133E+01 0.190E+01 0.166E+01 0.222E+01 0.266E+01 0.333E+01 0.443E+01 0.665E+01 0.133E+02  -0.104E+05
N2O4       0.129E+01 0.184E+01 0.161E+01 0.215E+01 0.258E+01 0.322E+01 0.430E+01 0.645E+01 0.129E+02  -0.101E+05
N2O4&      0.129E+01 0.184E+01 0.161E+01 0.215E+01 0.258E+01 0.322E+01 0.430E+01 0.645E+01 0.129E+02  -0.101E+05
N2O4*      0.129E+01 0.184E+01 0.161E+01 0.215E+01 0.258E+01 0.322E+01 0.430E+01 0.645E+01 0.129E+02  -0.101E+05
OCl2       0.122E+01 0.174E+01 0.152E+01 0.203E+01 0.244E+01 0.304E+01 0.406E+01 0.609E+01 0.122E+02  -0.950E+04
CH2Cl2     0.119E+01 0.170E+01 0.149E+01 0.198E+01 0.238E+01 0.298E+01 0.397E+01 0.595E+01 0.119E+02  -0.929E+04
CCl2       0.116E+01 0.166E+01 0.145E+01 0.194E+01 0.232E+01 0.290E+01 0.387E+01 0.581E+01 0.116E+02  -0.907E+04
NO2Cl      0.114E+01 0.163E+01 0.143E+01 0.190E+01 0.228E+01 0.285E+01 0.381E+01 0.571E+01 0.114E+02  -0.891E+04
Ca2        0.112E+01 0.160E+01 0.140E+01 0.187E+01 0.225E+01 0.281E+01 0.374E+01 0.562E+01 0.112E+02  -0.876E+04
S2O        0.112E+01 0.160E+01 0.140E+01 0.187E+01 0.225E+01 0.281E+01 0.374E+01 0.561E+01 0.745E+01  -0.581E+04
SO3        0.112E+01 0.160E+01 0.140E+01 0.187E+01 0.641E+03 0.280E+01 0.374E+01 0.561E+01 0.112E+02  -0.875E+04
CS2        0.107E+01 0.152E+01 0.133E+01 0.178E+01 0.213E+01 0.267E+01 0.356E+01 0.534E+01 0.708E+01  -0.552E+04
C4N2       0.106E+01 0.152E+01 0.133E+01 0.178E+01 0.213E+01 0.266E+01 0.355E+01 0.533E+01 0.107E+02  -0.832E+04
N2O3       0.106E+01 0.152E+01 0.133E+01 0.177E+01 0.213E+01 0.266E+01 0.355E+01 0.533E+01 0.107E+02  -0.831E+04
CaCl       0.106E+01 0.151E+01 0.132E+01 0.176E+01 0.212E+01 0.265E+01 0.353E+01 0.529E+01 0.106E+02  -0.826E+04
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	[0%]	[20%]	[30%]	[40%]	[50%]	[60%]	[70%]	[80%]	[90%]	[100%]
CaH2O2	0.104E+01	0.148E+01	0.130E+01	0.173E+01	0.208E+01	0.260E+01	0.346E+01	0.519E+01	0.104E+02	-0.810E+04
CaS	0.101E+01	0.144E+01	0.126E+01	0.168E+01	0.202E+01	0.253E+01	0.337E+01	0.506E+01	0.824E+01	-0.643E+04
CaS	0.101E+01	0.144E+01	0.126E+01	0.168E+01	0.202E+01	0.253E+01	0.337E+01	0.506E+01	0.824E+01	-0.643E+04
CaS&	0.101E+01	0.144E+01	0.126E+01	0.168E+01	0.202E+01	0.253E+01	0.337E+01	0.506E+01	0.101E+02	-0.789E+04
Cl2	0.993E+00	0.142E+01	0.124E+01	0.166E+01	0.199E+01	0.248E+01	0.331E+01	0.497E+01	0.994E+01	-0.775E+04
C3O2	0.952E+00	0.136E+01	0.119E+01	0.159E+01	0.191E+01	0.238E+01	0.318E+01	0.477E+01	0.954E+01	-0.744E+04
SCl	0.945E+00	0.135E+01	0.118E+01	0.158E+01	0.189E+01	0.237E+01	0.315E+01	0.473E+01	0.946E+01	-0.738E+04
O2Cl	0.944E+00	0.135E+01	0.118E+01	0.157E+01	0.189E+01	0.236E+01	0.315E+01	0.473E+01	0.945E+01	-0.738E+04
NOCl	0.917E+00	0.131E+01	0.115E+01	0.153E+01	0.183E+01	0.229E+01	0.306E+01	0.459E+01	0.918E+01	-0.716E+04
S2	0.898E+00	0.128E+01	0.112E+01	0.150E+01	0.180E+01	0.225E+01	0.300E+01	0.449E+01	0.596E+01	-0.465E+04
SO2	0.897E+00	0.128E+01	0.112E+01	0.150E+01	0.308E+02	0.224E+01	0.299E+01	0.449E+01	0.898E+01	-0.701E+04
COCl	0.889E+00	0.127E+01	0.111E+01	0.148E+01	0.178E+01	0.222E+01	0.296E+01	0.445E+01	0.890E+01	-0.694E+04
NHO3	0.882E+00	0.126E+01	0.110E+01	0.147E+01	0.177E+01	0.221E+01	0.294E+01	0.442E+01	0.883E+01	-0.689E+04
NO3	0.868E+00	0.124E+01	0.109E+01	0.145E+01	0.174E+01	0.217E+01	0.290E+01	0.435E+01	0.869E+01	-0.678E+04
CNCl	0.861E+00	0.123E+01	0.108E+01	0.144E+01	0.172E+01	0.215E+01	0.287E+01	0.431E+01	0.862E+01	-0.672E+04
C2HCl	0.847E+00	0.121E+01	0.106E+01	0.141E+01	0.169E+01	0.212E+01	0.283E+01	0.424E+01	0.848E+01	-0.661E+04
CSO	0.841E+00	0.120E+01	0.105E+01	0.140E+01	0.168E+01	0.210E+01	0.281E+01	0.421E+01	0.842E+01	-0.657E+04
C5	0.841E+00	0.120E+01	0.105E+01	0.140E+01	0.168E+01	0.210E+01	0.281E+01	0.421E+01	0.842E+01	-0.657E+04
CaHO	0.799E+00	0.114E+01	0.999E+00	0.133E+01	0.160E+01	0.200E+01	0.267E+01	0.400E+01	0.800E+01	-0.624E+04
CaO	0.785E+00	0.112E+01	0.982E+00	0.131E+01	0.157E+01	0.196E+01	0.262E+01	0.393E+01	0.786E+01	-0.613E+04
CaO	0.785E+00	0.112E+01	0.982E+00	0.131E+01	0.157E+01	0.196E+01	0.262E+01	0.393E+01	0.786E+01	-0.613E+04
CaO&	0.785E+00	0.112E+01	0.982E+00	0.131E+01	0.157E+01	0.196E+01	0.262E+01	0.393E+01	0.786E+01	-0.613E+04
CaO*	0.785E+00	0.112E+01	0.982E+00	0.131E+01	0.157E+01	0.196E+01	0.262E+01	0.393E+01	0.786E+01	-0.613E+04
CaO&	0.785E+00	0.112E+01	0.982E+00	0.131E+01	0.157E+01	0.196E+01	0.262E+01	0.393E+01	0.786E+01	-0.613E+04
NH4Cl&	0.749E+00	0.107E+01	0.936E+00	0.125E+01	0.150E+01	0.187E+01	0.250E+01	0.375E+01	0.750E+01	-0.585E+04
NH4Cl&	0.749E+00	0.107E+01	0.936E+00	0.125E+01	0.150E+01	0.187E+01	0.250E+01	0.375E+01	0.750E+01	-0.585E+04
HOCl	0.735E+00	0.105E+01	0.918E+00	0.122E+01	0.147E+01	0.184E+01	0.245E+01	0.368E+01	0.735E+01	-0.574E+04
C2N2	0.729E+00	0.104E+01	0.911E+00	0.121E+01	0.146E+01	0.182E+01	0.243E+01	0.365E+01	0.729E+01	-0.569E+04
OCl	0.720E+00	0.103E+01	0.901E+00	0.120E+01	0.144E+01	0.180E+01	0.240E+01	0.361E+01	0.721E+01	-0.563E+04
CH3Cl	0.707E+00	0.101E+01	0.884E+00	0.118E+01	0.141E+01	0.177E+01	0.236E+01	0.354E+01	0.708E+01	-0.552E+04
CHCl	0.679E+00	0.970E+00	0.849E+00	0.113E+01	0.136E+01	0.170E+01	0.226E+01	0.340E+01	0.679E+01	-0.530E+04
SO	0.673E+00	0.962E+00	0.841E+00	0.112E+01	0.135E+01	0.168E+01	0.225E+01	0.337E+01	0.674E+01	-0.526E+04
C4	0.673E+00	0.961E+00	0.841E+00	0.112E+01	0.135E+01	0.168E+01	0.224E+01	0.337E+01	0.673E+01	-0.525E+04
O3	0.672E+00	0.960E+00	0.840E+00	0.112E+01	0.134E+01	0.168E+01	0.224E+01	0.336E+01	0.673E+01	-0.525E+04
CCl	0.665E+00	0.950E+00	0.831E+00	0.111E+01	0.133E+01	0.166E+01	0.222E+01	0.333E+01	0.665E+01	-0.519E+04
NHO2	0.658E+00	0.941E+00	0.823E+00	0.110E+01	0.132E+01	0.165E+01	0.220E+01	0.329E+01	0.659E+01	-0.514E+04
NHO2	0.658E+00	0.941E+00	0.823E+00	0.110E+01	0.132E+01	0.165E+01	0.220E+01	0.329E+01	0.659E+01	-0.514E+04
NS	0.645E+00	0.922E+00	0.807E+00	0.108E+01	0.129E+01	0.161E+01	0.215E+01	0.323E+01	0.646E+01	-0.504E+04
NO2	0.644E+00	0.921E+00	0.805E+00	0.107E+01	0.134E+02	0.161E+01	0.215E+01	0.322E+01	0.645E+01	-0.503E+04
CS	0.617E+00	0.882E+00	0.772E+00	0.103E+01	0.123E+01	0.154E+01	0.206E+01	0.309E+01	0.618E+01	-0.482E+04
C2H4O	0.617E+00	0.881E+00	0.771E+00	0.103E+01	0.123E+01	0.154E+01	0.206E+01	0.309E+01	0.617E+01	-0.482E+04
N2O	0.616E+00	0.881E+00	0.770E+00	0.103E+01	0.123E+01	0.154E+01	0.206E+01	0.308E+01	0.617E+01	-0.481E+04
CNHO	0.602E+00	0.861E+00	0.753E+00	0.100E+01	0.121E+01	0.151E+01	0.201E+01	0.301E+01	0.603E+01	-0.470E+04
N3	0.588E+00	0.841E+00	0.736E+00	0.981E+00	0.118E+01	0.147E+01	0.196E+01	0.294E+01	0.589E+01	-0.460E+04
CNO	0.588E+00	0.841E+00	0.736E+00	0.981E+00	0.118E+01	0.147E+01	0.196E+01	0.294E+01	0.589E+01	-0.459E+04
CaH	0.575E+00	0.822E+00	0.719E+00	0.959E+00	0.115E+01	0.144E+01	0.192E+01	0.288E+01	0.576E+01	-0.449E+04
Ca	0.561E+00	0.802E+00	0.702E+00	0.936E+00	0.112E+01	0.140E+01	0.187E+01	0.281E+01	0.562E+01	-0.438E+04
Ca&	0.561E+00	0.802E+00	0.702E+00	0.936E+00	0.112E+01	0.140E+01	0.187E+01	0.281E+01	0.562E+01	-0.438E+04
Ca&	0.561E+00	0.802E+00	0.702E+00	0.936E+00	0.112E+01	0.140E+01	0.187E+01	0.281E+01	0.562E+01	-0.438E+04

	[0%]	[20%]	[30%]	[40%]	[50%]	[60%]	[70%]	[80%]	[illegible]	[100%]
Ca*	0.561E+00	0.802E+00	0.702E+00	0.936E+00	0.112E+01	0.140E+01	0.187E+01	0.281E+01	0.562E+01	-0.438E+04
CN2	0.560E+00	0.801E+00	0.701E+00	0.934E+00	0.112E+01	0.140E+01	0.187E+01	0.280E+01	0.561E+01	-0.438E+04
CN2	0.560E+00	0.801E+00	0.701E+00	0.934E+00	0.112E+01	0.140E+01	0.187E+01	0.280E+01	0.561E+01	-0.438E+04
C2O	0.560E+00	0.801E+00	0.701E+00	0.934E+00	0.112E+01	0.140E+01	0.187E+01	0.280E+01	0.561E+01	-0.438E+04
C2N	0.532E+00	0.761E+00	0.666E+00	0.888E+00	0.107E+01	0.133E+01	0.178E+01	0.266E+01	0.533E+01	-0.416E+04
HCl	0.511E+00	0.730E+00	0.638E+00	0.851E+00	0.287E+03	0.128E+01	0.170E+01	0.256E+01	0.511E+01	-0.399E+04
C3	0.504E+00	0.721E+00	0.631E+00	0.841E+00	0.101E+01	0.126E+01	0.168E+01	0.252E+01	0.505E+01	-0.394E+04
Cl	0.496E+00	0.709E+00	0.621E+00	0.828E+00	0.993E+00	0.124E+01	0.166E+01	0.248E+01	0.497E+01	-0.388E+04
H2O2	0.476E+00	0.681E+00	0.595E+00	0.794E+00	0.953E+00	0.119E+01	0.159E+01	0.238E+01	0.477E+01	-0.372E+04
HS	0.463E+00	0.662E+00	0.579E+00	0.772E+00	0.927E+00	0.116E+01	0.154E+01	0.232E+01	0.464E+01	-0.362E+04
HO2	0.462E+00	0.660E+00	0.578E+00	0.771E+00	0.925E+00	0.116E+01	0.154E+01	0.231E+01	0.463E+01	-0.361E+04
S	0.449E+00	0.642E+00	0.561E+00	0.749E+00	0.898E+00	0.112E+01	0.150E+01	0.225E+01	0.449E+01	-0.351E+04
S&	0.449E+00	0.642E+00	0.561E+00	0.749E+00	0.898E+00	0.112E+01	0.150E+01	0.225E+01	0.449E+01	-0.351E+04
S*	0.449E+00	0.642E+00	0.561E+00	0.749E+00	0.898E+00	0.112E+01	0.150E+01	0.225E+01	0.449E+01	-0.351E+04
S*	0.449E+00	0.642E+00	0.561E+00	0.749E+00	0.898E+00	0.112E+01	0.150E+01	0.225E+01	0.449E+01	-0.351E+04
S&	0.449E+00	0.642E+00	0.561E+00	0.749E+00	0.898E+00	0.112E+01	0.150E+01	0.225E+01	0.449E+01	-0.351E+04
N2H4	0.449E+00	0.641E+00	0.561E+00	0.748E+00	0.898E+00	0.112E+01	0.150E+01	0.225E+01	0.449E+01	-0.350E+04
N2H4*	0.449E+00	0.641E+00	0.561E+00	0.748E+00	0.898E+00	0.112E+01	0.150E+01	0.225E+01	0.449E+01	-0.350E+04
O2	0.448E+00	0.851E+05	0.322E+05	0.156E+06	0.255E+06	0.403E+06	0.650E+06	0.114E+07	0.263E+07	-0.205E+10
NHO	0.434E+00	0.621E+00	0.543E+00	0.724E+00	0.869E+00	0.109E+01	0.145E+01	0.217E+01	0.435E+01	-0.339E+04
N2H2	0.420E+00	0.601E+00	0.526E+00	0.701E+00	0.841E+00	0.105E+01	0.140E+01	0.210E+01	0.421E+01	-0.328E+04
CH2O	0.420E+00	0.601E+00	0.526E+00	0.701E+00	0.841E+00	0.105E+01	0.140E+01	0.210E+01	0.421E+01	-0.328E+04
NO	0.420E+00	0.600E+00	0.525E+00	0.701E+00	0.146E+02	0.105E+01	0.140E+01	0.210E+01	0.421E+01	-0.328E+04
CHO	0.406E+00	0.581E+00	0.508E+00	0.677E+00	0.813E+00	0.102E+01	0.136E+01	0.203E+01	0.407E+01	-0.317E+04
C2H4	0.393E+00	0.561E+00	0.491E+00	0.655E+00	0.786E+00	0.983E+00	0.131E+01	0.197E+01	0.393E+01	-0.307E+04
CO	0.392E+00	0.560E+00	0.490E+00	0.654E+00	0.785E+00	0.981E+00	0.131E+01	0.196E+01	0.393E+01	-0.306E+04
CNH	0.378E+00	0.541E+00	0.473E+00	0.631E+00	0.757E+00	0.947E+00	0.126E+01	0.189E+01	0.379E+01	-0.296E+04
C2H2	0.365E+00	0.521E+00	0.456E+00	0.608E+00	0.730E+00	0.912E+00	0.122E+01	0.182E+01	0.365E+01	-0.285E+04
CN	0.364E+00	0.521E+00	0.455E+00	0.607E+00	0.729E+00	0.911E+00	0.122E+01	0.182E+01	0.365E+01	-0.284E+04
C2H	0.350E+00	0.501E+00	0.438E+00	0.584E+00	0.701E+00	0.877E+00	0.117E+01	0.175E+01	0.351E+01	-0.274E+04
C2	0.336E+00	0.481E+00	0.420E+00	0.561E+00	0.673E+00	0.841E+00	0.112E+01	0.168E+01	0.337E+01	-0.263E+04
H2O*	0.252E+00	0.360E+00	0.315E+00	0.421E+00	0.505E+00	0.136E+06	0.273E+06	0.517E+06	0.695E+06	-0.542E+09
H2O*	0.252E+00	0.360E+00	0.315E+00	0.421E+00	0.505E+00	0.631E+00	0.842E+00	0.126E+01	0.253E+01	-0.197E+04
HO	0.238E+00	0.340E+00	0.298E+00	0.397E+00	0.477E+00	0.596E+00	0.794E+00	0.119E+01	0.238E+01	-0.186E+04
NH2	0.224E+00	0.321E+00	0.280E+00	0.374E+00	0.449E+00	0.561E+00	0.748E+00	0.112E+01	0.225E+01	-0.175E+04
O	0.224E+00	0.320E+00	0.280E+00	0.374E+00	0.448E+00	0.560E+00	0.747E+00	0.112E+01	0.224E+01	-0.175E+04
CH3	0.210E+00	0.301E+00	0.263E+00	0.351E+00	0.421E+00	0.527E+00	0.702E+00	0.105E+01	0.211E+01	-0.164E+04
NH	0.210E+00	0.300E+00	0.263E+00	0.351E+00	0.421E+00	0.526E+00	0.701E+00	0.105E+01	0.210E+01	-0.164E+04
CH2	0.196E+00	0.281E+00	0.246E+00	0.327E+00	0.393E+00	0.491E+00	0.655E+00	0.983E+00	0.197E+01	-0.153E+04
N	0.196E+00	0.280E+00	0.245E+00	0.327E+00	0.392E+00	0.491E+00	0.654E+00	0.982E+00	0.196E+01	-0.153E+04
CH	0.182E+00	0.260E+00	0.228E+00	0.304E+00	0.365E+00	0.456E+00	0.608E+00	0.912E+00	0.182E+01	-0.142E+04
C	0.168E+00	0.240E+00	0.210E+00	0.280E+00	0.337E+00	0.421E+00	0.561E+00	0.842E+00	0.168E+01	-0.131E+04
C&	0.168E+00	0.240E+00	0.210E+00	0.280E+00	0.337E+00	0.421E+00	0.561E+00	0.842E+00	0.168E+01	-0.131E+04
H	0.141E-01	0.202E-01	0.176E-01	0.235E-01	0.282E-01	0.353E-01	0.471E-01	0.706E-01	0.141E+00	-0.110E+03

*THE TOTAL HEAT RELEASED---UNITS--CALORIES/GRAM AT 298 KELVIN AND 14.7 PSI.
FOR TOTWT OF MATERIAL BURNED OR DETONATED. USE THESE VALUES IN DISPERSION MODELS.

FORMULAS AND NAMES AFTER EXPANSION---USE FOR EPA REPORTING

FORMULA NAME	FORMULA	FORMULA NAME	FORMULA	FORMULA NAME	FORMULA
NUMBER OF SPECIES LISTED	137 [redacted]				
Water	H2O	Nitrogen	N2	Carbon Dioxide	CO2
Calcium Hydroxide	CaH2O2&	Methane	CH4	Calcium Chloride	CaCl2&
Hydrogen Sulfide	H2S	Hydrogen	H2	Ammonia	NH3
Sulfur	S8	Hexachloroethane	C2Cl6	Sulfur	S7
Sulfur	S6	Tetrachloroethene	C2Cl4	Sulfur	S5
Tetrachloromethane	CCl4	Sulfur Chloride	S2Cl2	Sulfur Chloride	S2Cl2*
Sulfuryl Chloride	SO2Cl2	Sulfur	S4	Trichloromethane	CHCl3
Trichloromethyl	CCl3	Ammonium Perchlorate	NH4O4Cl&	Calcium Chloride	CaCl2
Calcium Chloride	CaCl2*	Nitrogen Oxide	N2O5	Sulfur Chloride	S2Cl
Carbonic Dichloride	COCl2	Sulfuric Acid	H2SO4	Sulfur	S3
Dichloroethyne	C2Cl2	Nitrogen Oxide	N2O4	Nitrogen Oxide	N2O4&
Nitrogen Oxide	N2O4*	Chlorine Oxide	OCl2	Dichloromethane	CH2Cl2
Dichloromethylene	CCl2	Nitryl Chloride	NO2Cl	Calcium	Ca2
Sulfur Oxide	S2O	Sulfur Trioxide	SO3	Carbon Disulfide	CS2
2-Butynedinitrile	C4N2	Nitrogen Oxide	N2O3	Calcium Chloride	CaCl
Calcium Hydroxide	CaH2O2	Calcium Sulfide	CaS	Calcium Sulfide	CaS
Calcium Sulfide	CaS&	Chlorine	Cl2	Carbon Suboxide	C3O2
Sulfur Chloride	SCl	Chlorine Oxide	O2Cl	Nitrosyl Chloride	NOCl
Sulfur	S2	Sulfur Dioxide	SO2	Carbonyl Chloride	COCl
Nitric Acid	NHO3	Nitrogen Oxide	NO3	Cyanogen Chloride	CNCl
Chloroethyne	C2HCl	Carbon Oxide Sulfide	CSO	Carbon	C5
Calcium Hydroxide	CaHO	Calcium Oxide	CaO	Calcium Oxide	CaO
Calcium Oxide	CaO&	Calcium Oxide	CaO*	Calcium Oxide	CaO&
Ammonium Chloride-II	NH4Cl&	Ammonium Chloride-II	NH4Cl&	Hypochlorous Acid	HOCl
Ethanedinitrile	C2N2	Chlorine Oxide	OCl	Chloromethane	CH3Cl
Chloromethylene	CHCl	Sulfur Oxide	SO	Carbon	C4
Ozone	O3	Chloromethylidyne	CCl	Nitrous Acid, Cis	NHO2
Nitrous Acid, Cis	NHO2	Nitrogen Sulfide	NS	Nitrogen Oxide	NO2
Carbon Sulfide	CS	Oxirane	C2H4O	Nitrogen Oxide	N2O
Hydrogen IsocyanAte	CNHO	Azide	N3	NCO Radical	CNO
Calcium	Ca	Calcium, Alpha	Ca&	Calcium, Alpha	Ca&
Calcium	Ca*	CNN Radical	CN2	CNN Radical	CN2
CCO Radical	C2O	CNC Radical	C2N	Hydrogen Chloride	HCl
Carbon	C3	Chlorine	Cl	Hydrogen Peroxide	H2O2
Mercapto	HS	Hydroperoxo	HO2	Sulfur	S
Sulfur, Orthorhombic	S&	Sulfur-Alpha	S*	Sulfur-Alpha	S*
Sulfur, Orthorhombic	S&	Hydrazine	N2H4	Hydrazine	N2H4*
Oxygen	O2	Nitrosyl Hydride	NHO	Diazene, Cis	N2H2
Formaldehyde	CH2O	Nitrogen Oxide	NO	Formyl	CHO
Ethene	C2H4	Carbon Monoxide	CO	Hydrogen Cyanide	CNH
Ethyne	C2H2	Cyanogen	CN	Ethynyl	C2H
Carbon	C2	Water	H2O*	Water	H2O*
Hydroxyl	HO	Amidogen	NH2	Oxygen	O
Methyl	CH3	Imidogen	NH	Methylene	CH2
Nitrogen	N	Methylidyne	CH	Carbon	C
Carbon	C&	Hydrogen	H		

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(!)*********GLOSSARY FOR COMPLETE PRINT OUTS********
CAL--------------------CALORIES--UNITS OF ENERGY
COND-------------------CONDENSED SPECIES (ALL SOLIDS AND LIQUIDS)
DENSITY-TOT WT GR/CC---DENSITY OF TOTAL WT. OF ALL INPUT INGREDIENTS--GRAMS/CUBIC CENTIMETER
ENTHAL KCAL/100 GRS----ENTHALPY---KILOCALORIES/100 GRAMS OF TOWT
GSL--------------------TOTAL SPECIES---GASES + SOLIDS + LIQUIDS
K----------------------DEGREES KELVIN
MOL. WT.---------------MOLECULAR WEIGHT
OXID-------------------OXIDIZER OR THE LAST INGREDIENT ENTERED
OXID/ MATERIAL RATIO---RATIO OF ALL INGREDIENTS (MINUS LAST INGREDIENT)/LAST INGREDIENT (USUALLY AIR OR OXYGEN)
SYSWT------------------THE MASS IN GRAMS USED IN DEFINING THE HEAT CAPACITY UNITS.  IT IS NORMALLY 100 GRAMS.
1T.VOL. GASES- LIT.----TOTAL VOLUME OF GASES IN ROW (1MOLES GASES ONLY) FORMED
-----------------------AT STANDARD TEMPERATURE (273 DEG. KELVIN),AND PRESSURE (14.7 PSI)
2T.VOL. GASES- LIT.----TOTAL VOLUME OF GASES IN ROW (4MOLES GASES ONLY) FORMED
-----------------------AT STANDARD TEMPERATURE (273 DEG. KELVIN),AND PRESSURE (14.7 PSI)
TOTWT------------------WEIGHT OF ALL INGREDIENTS INCLUDING LAST ONE--SAME AS "WT.MATERIAL+ OXID"
WT.MATERIAL+ OXID------WEIGHT OF ALL INGREDIENTS + THE LAST INGREDIENT USED IN CALCULATIONS--SAME AS "TOTWT"

*********IDENTITY OF TERMS FOR*********
 ---COMBUSTION CONDITIONS: THE MATERIAL AND AIR ARE BURNED TOGETHER AT  1000.00 PSI---

1MOLES GASES ONLY---------MOLES OF GASES ONLY--FOR WT. OF GASES AS GIVEN IN ROW (1TOTWT GASES ONLY)
1MWT GASES ONLY-----------MOL. WT. OF GASES ONLY--CALCULATED, ROW (1TOTWT GASES ONLY)/ROW (1MOLES GASES ONLY)
1TOTWT GASES ONLY---------TOTAL WT. OF GASES ONLY

2MOLES (GASES+COND)-------TOTAL MOLES OF GASES+COND--FOR WT.  OF GASES AS GIVEN IN ROW (2TOTWT GASES+COND)
2MWT (GASES+COND)---------MOL. WT. OF GASES+COND--CALCULATED, ROW (2TOTWT GASES+COND)/ROW (2MOLES GASES+COND)
2TOTWT (GASES+COND)-------TOTAL WT. OF GASES+COND

3MOLES COND ONLY----------MOLES OF COND ONLY--FOR WT. OF GASES AS GIVEN IN ROW (3TOTWT COND ONLY)
3MWT COND. ONLY-----------MOL. WT. OF COND ONLY--CALCULATED,  ROW (3TOTWT COND ONLY)/ROW (3MOLES COND ONLY)
3TOTWT COND ONLY----------TOTAL WT. OF COND ONLY

******IDENTITY OF 1GM, 1CP, 1CV, 2GM, 2CP, 2CV*******
"SYSWT" =     99.872 GRAMS---THE UNITS OF 1CP, 1CV, 2CP, 2CV =  CALORIES/(     99.872 GRS )*(DEG KELVIN)
1GM GASES CP/CV-----------GAMMA FOR GASES, RATIO 1CP GASES/1CV GASES
1CP GASES CAL/SYSWT-K-----HEAT CAPACITY AT CONSTANT PRESSURE FOR GASES ONLY
--------------------------UNITS--CALORIES/("SYSWT" GRS )*(DEG.KELVIN)
1CV GASES CAL/SYSWT-K-----HEAT CAPACITY AT CONSTANT VOLUME FOR GASES ONLY
--------------------------UNITS--CALORIES/("SYSWT" GRS )*(DEG.KELVIN)
2GM GSL CP/CV-------------GAMMA FOR GSL, RATIO 2CP GSL/2CV GSL
2CP GSL CAL/SYSWT-K-------HEAT CAPACITY AT CONSTANT PRESSURE FOR GSL
--------------------------UNITS--CALORIES/("SYSWT" GRS )*(DEG.KELVIN)
2CV GSL CAL/SYSWT-K-------HEAT CAPACITY AT CONSTANT VOLUME FOR GSL
--------------------------UNITS--CALORIES/("SYSWT" GRS )*(DEG.KELVIN)

**********IDENTITY OF TERMS FOR**********

 ---COMBUSTION CONDITIONS: THE COMBUSTION PRODUCTS FROM MATERIAL AND AIR AFTER EXPANDING FROM  1000.00 PSI TO  14.7000 PSI---

4MOLES GASES ONLY---------MOLES OF GASES ONLY--FOR WT. OF GASES AS GIVEN IN ROW (4TOTWT GASES ONLY)
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4MWT GASES ONLY-----------MOL. WT. OF GASES ONLY--CALCULATED, ROW (4TOTWT GASES ONLY)/ROW (4MOLES GASES ONLY)
4TOTWT GASES ONLY---------TOTAL WT. OF GASES ONLY

5MOLES (GASES+COND)-------TOTAL MOLES OF GASES+COND--FOR WT.  OF GASES AS GIVEN IN ROW (5TOTWT GASES+COND)
5MWT (GASES+COND)---------MOL. WT. OF GASES+COND--CALCULATED, ROW (5TOTWT GASES+COND)/ROW (5MOLES GASES+COND)
5TOTWT (GASES+COND)-------TOTAL WT. OF GASES+COND

6MOLES COND ONLY----------MOLES OF COND ONLY--FOR WT. OF GASES AS GIVEN IN ROW (6TOTWT COND ONLY)
6MWT COND. ONLY-----------MOL. WT. OF COND ONLY--CALCULATED,  ROW (6TOTWT COND ONLY)/ROW (6MOLES COND ONLY)
6TOTWT COND ONLY----------TOTAL WT. OF COND ONLY


******IDENTITY OF 4GM, 4CP, 4CV, 5GM, 5CP, 5CV*******
"SYSWT" =     99.872 GRAMS---THE UNITS OF 4CP, 4CV, 5CP, 5CV = CALORIES/(     99.872 GRS )*(DEG KELVIN)
4GM GASES CP/CV-----------GAMMA FOR GASES, RATIO 4CP GASES/4CV GASES
4CP GASES CAL/SYSWT-K-----HEAT CAPACITY AT CONSTANT PRESSURE FOR GASES ONLY
--------------------------UNITS--CALORIES/("SYSWT" GRS )*(DEG.KELVIN)
4CV GASES CAL/SYSWT-K-----HEAT CAPACITY AT CONSTANT VOLUME FOR GASES ONLY
--------------------------UNITS--CALORIES/("SYSWT" GRS )*(DEG.KELVIN)
5GM GSL CP/CV-------------GAMMA FOR GSL, RATIO 5CP GSL/5CV GSL
5CP GSL CAL/SYSWT-K-------HEAT CAPACITY AT CONSTANT PRESSURE FOR GSL
--------------------------UNITS--CALORIES/("SYSWT" GRS )*(DEG.KELVIN)
5CV GSL CAL/SYSWT-K-------HEAT CAPACITY AT CONSTANT VOLUME FOR GSL
--------------------------UNITS--CALORIES/("SYSWT" GRS )*(DEG.KELVIN)
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