Appendix B. Attachments

Appendix B, Attachment 1

Emission rates and locations of past stationary air emissions

Building Number	Easting (meters)	Northing (meters)	Emission Rate (g/s)
Benzene			
BLDG_003	643403.44	4171958.25	3.716963E-04
BLDG_009	642750.25	4171896.25	7.666236E-04
BLDG_036	642130.06	4170109.0	1.215643E-08
BLDG_053	641198.88	4169204.75	4.706397E-05
BLDG_062	641198.88	4169204.75	2.416111E-05
BLDG_063	640863.15	4169672.55	2.013426E-05
BLDG_065	640544.69	4169687.13	4.108452E-03
BLDG_082	639870.56	4170894.0	5.808811E-05
BLDG_086	639651.5	4171084.25	1.013861E-05
BLDG_089	639689.0	4171134.75	1.977116E-06
BLDG_096	642721.25	4171791.25	1.678367E-05
BLDG_098	639679.5	4172361.5	7.544674E-08
BLDG_114	640029.56	4172104.5	1.990896E-05
BLDG_142	641055.81	4172696.5	2.519330E-05
BLDG_159	641769.35	4173519.08	2.643540E-07

Building Number	Easting (meters)	Northing (meters)	Emission Rate (g/s)
1,3-Butadiene			
BLDG_655	640544.69	4169687.13	1.580000E-02

Building Number	Easting (meters)	Northing (meters)	Emission Rate (g/s)
Chromium-Sources used in sensitivity analysis			
BLDG_030	642041.27	4171147.04	2.241729E-04
BLDG_032	642461.19	4170806.06	1.807650E-04
BLDG_033	642293.13	4170746.0	8.631835E-07
BLDG_036	641652.64	4171415.92	4.574073E-04
BLDG_037	641799.0	4170576.0	2.100413E-04
BLDG_038	643401.38	4171946.25	2.100413E-04
BLDG_053	641198.88	4169204.75	4.791997E-06
BLDG_064	640479.69	4169650.75	2.877278E-05
BLDG_065	640544.69	4169687.13	6.252336E-04
BLDG_082	639870.56	4170894.0	3.740462E-05
BLDG_114	640029.56	4172104.5	1.086371E-05
BLDG_205	638908.31	4170765.0	2.913244E-05

Building Number	Easting (meters)	Northing (meters)	Emission Rate (g/s)
Ethylene Benzene			
BLDG_003	643403.438	4171958.250	1.0624e-04
BLDG_004	643516.438	4172127.500	3.9676e-05
BLDG_008	643160.375	4171753.250	3.4500e-06
BLDG_009	642750.250	4171896.250	2.1913e-04
BLDG_030	642039.062	4171204.250	1.7250e-06
BLDG_032	642529.188	4170732.000	7.3314e-05
BLDG_035	642120.062	4170665.000	6.9000e-06
BLDG_036	642130.062	4170109.000	1.9200e-07

BLDG_037	641799.000	4170576.000	2.9325e-05
BLDG_038	643401.375	4171946.250	2.9325e-05
BLDG_053	641200.875	4169207.750	1.3700e-06
BLDG_062	640798.750	4169691.750	8.0200e-07
BLDG_063	640866.750	4169669.750	8.0200e-07
BLDG_064	640479.688	4169650.750	1.7250e-06
BLDG_065	640542.688	4169685.750	5.1440e-06
BLDG_082	639870.562	4170894.000	3.7088e-05
BLDG_086	639651.500	4171084.250	2.8979e-06
BLDG_089	639690.500	4171132.250	1.1680e-10
BLDG_094	638908.312	4172108.500	8.6300e-07
BLDG_096	642721.250	4171791.250	4.7970e-06
BLDG_098	639694.500	4172342.500	4.3500e-07
BLDG_114	640029.562	4172104.500	7.0581e-10
BLDG_142	641055.812	4172696.500	7.0581e-10
BLDG_159	641624.000	4173499.750	7.0581e-10
BLDG_205	638908.312	4170765.000	3.4500e-06

Building Number	Easting (meters)	Northing (meters)	Emission Rate (g/s)
Methyl Ethyl Ketone			
BLDG_005	643305.375	4171849.250	2.7332e-03
BLDG_008	643160.375	4171753.250	5.1050e-02
BLDG_030	642185.594	4171098.625	8.9946e-02
BLDG_032	642529.188	4170732.000	8.6238e-01
BLDG_033	642133.062	4170778.000	6.6980e-04
BLDG_035	642120.062	4170665.000	2.4310e-03
BLDG_036	641786.000	4171156.200	4.7493e+00
BLDG_037	641799.000	4170576.000	1.2422e+00
BLDG_038	643401.375	4171946.250	8.1559e-01
BLDG_052	641148.344	4169358.750	2.1636e-01
BLDG_064	640468.355	4169635.083	4.7404e-02
BLDG_082	639898.562	4170929.333	5.4028e-01
BLDG_090	639360.407	4171818.750	1.0908e-01
BLDG_094	638908.312	4172108.500	1.0028e-02
BLDG_141	642695.250	4171616.250	3.6464e-03
BLDG_142	641066.812	4172716.500	1.8232e-02
BLDG_205	638908.312	4170765.000	1.9752e-02

Building Number	Easting (meters)	Northing (meters)	Emission Rate (g/s)
Methylene Chloride			
BLDG_032	642529.188	4170732.000	0.810127767
BLDG_033	642268.125	4170467.000	0.012274663
BLDG_035	642120.062	4170665.000	0.024549326
BLDG_036	641740.000	4171439.250	2.172615401
BLDG_037	641810.500	4170497.500	69.750773318
BLDG_038	643401.375	4171946.250	1.687766181
BLDG_062	640817.750	4169672.667	2.780635652
BLDG_063	640863.150	4169672.550	2.317196381
BLDG_064	640468.355	4169635.083	4.05063884
BLDG_082	639870.562	4170894.000	0.699655799
BLDG_142	641066.812	4172716.500	0.024549326
BLDG_005	643305.375	4171849.250	0.009974559
BLDG_030	642035.062	4171149.750	10.2891548
BLDG_032	642516.188	4170779.000	12.24327768
BLDG_036	641616.438	4171349.250	8.955193021
BLDG_037	641850.000	4170618.000	8.583610039
BLDG_062	640817.750	4169672.667	1.537964586
BLDG_063	640863.150	4169672.550	1.281637078

Building Number	Easting (meters)	Northing (meters)	Emission Rate (g/s)
Tetrachloroethylene (PCE)			
BLDG_005	643305.375	4171849.250	0.009974559
BLDG_030	642035.062	4171149.750	10.2891548
BLDG_032	642516.188	4170779.000	12.24327768
BLDG_036	641616.438	4171349.250	8.955193021
BLDG_037	641850.000	4170618.000	8.583610039
BLDG_062	640817.750	4169672.667	1.537964586
BLDG_063	640863.150	4169672.550	1.281637078
Building Number	**Easting (meters)**	**Northing (meters)**	**Emission Rate (g/s)**
Toluene			
BLDG_003	643403.438	4171958.250	0.0027391
BLDG_004	643516.438	4172127.500	0.0022311
BLDG_005	643305.375	4171849.250	0.00022168
BLDG_008	643160.375	4171753.250	0.00089195
BLDG_009	642750.250	4171896.250	0.0056494
BLDG_030	642185.594	4171098.625	0.003671
BLDG_032	642469.167	4170769.000	0.0082629
BLDG_033	642268.125	4170467.000	0.00055778
BLDG_035	642120.062	4170665.000	0.0017771
BLDG_036	641889.825	4170925.950	0.011377
BLDG_037	641799.000	4170576.000	0.011298
BLDG_038	643401.375	4171946.250	0.011117
BLDG_053	641198.875	4169204.750	6.2955E-5
BLDG_062	640817.750	4169672.667	7.2377E-5
BLDG_063	640863.150	4169672.550	6.0314E-5
BLDG_064	640468.355	4169635.083	0.005487
BLDG_065	640544.688	4169687.125	0.0054956
BLDG_082	639870.562	4170894.000	0.0058632
BLDG_086	639651.500	4171084.250	7.4713E-5
BLDG_089	639689.000	4171134.750	1.457E-5
BLDG_094	638908.312	4172108.500	0.0001816
BLDG_096	642721.250	4171791.250	0.00012368
BLDG_098	639679.500	4172361.500	4.2102E-6
BLDG_114	640029.562	4172104.500	2.6434E-5
BLDG_141	642695.250	4171616.250	2.5943E-5
BLDG_142	641061.312	4172706.500	0.00091206
BLDG_159	641769.354	4173519.083	6.3239E-6
BLDG_205	638908.312	4170765.000	0.00048643

Final Report. Historical Air Emissions Estimate. Kelly AFB, TX. EARTH TECH, Inc. San Antonio, TX. March 27, 2000.

Appendix B, Attachment 2

DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE FOR ENVIRONMENT, SAFETY AND
OCCUPATIONAL HEALTH RISK ANALYSIS (AFMC)
BROOKS AIR FORCE BASE TEXAS

13 February 2001

MEMORANDUM FOR AFBCA/DK
ATTENTION: MR CHARLES WILLIAMS

FROM: AFIERA/RSRE
2513 Kennedy Circle
Brooks AFB, TX 78235-5123

SUBJECT: Consultative Letter, IERA-RS-BR-CL-2001-0011, Availability of Information Related to Unburned Fuel and Oil Misting Emissions From Aircraft Takeoffs and Landings

1. The Agency for Toxic Substances and Disease Registry (ATSDR) requested available information related to emissions from aircraft takeoffs and landings. This information is needed to address community and ATSDR public health concerns related to aircraft fuel and oil misting. The specific question posed by ATSDR was whether any available data exists on sampled or modeled unburned fuel or oil mist emissions during takeoffs and landings.

2. We contacted the Federal Aviation Administration (FAA) and several organizations within the US Air Force (USAF): Robert Holsclaw, FAA, Environmental Section, Maj Jeanette Howard, Air Quality Branch (AFIERA/RSEQ), Maj Brian Blazicko (AFIERA/RSHI), and Carry Embree, Propulsion Environmental Working Group Member (OC-ALC/LR). No information was available from these groups related to quantitative analyses of aircraft fuel or oil misting (Wade, 2001). Three recently accomplished studies qualitatively describe fuel and oil misting, as referenced in four documents: Massport International (1997), Hoffnagle et al.(1997), KM Chng Environmental Inc.(1997), and KM Chng Environmental Inc.(1999) (Attachments 1-4). These studies were initiated in response to assertions from residents and government officials that aircraft using O'Hare and Logan airports caused the deposition of soot, particles or oily film on surfaces in communities near these airports. Hoffnagle et al.(1997), KM Chng (1997; 1999), and Massport International (1997) conclude that deposited particles monitored near the airports bore little resemblance to either unburned jet fuel or soot from jet exhaust.

3. ATSDR specifically asked us to obtain information related to unburned JP-8 aerosol exposure to ground crews during cold-engine start conditions. Maj Blazicko (2001) provided the following information regarding these evaluations:

a. The AF Institute for Environment, Safety, and Occupational Health Risk Analysis/Industrial Hygiene Branch's (AFIERA/RSHI) initial testing determined that existing sampling methods were inadequate to properly characterize the exposure due to the volatile nature of the JP-8 aerosol.

b. A current AFIERA/RSHI research effort with the University of North Carolina (Demonstration of Sampling Method for JP8 Aerosols; Contract F41622-97-C-0025) was established to develop and employ a methodology to evaluate ambient JP8 concentrations of aircraft emissions at temperatures of 0°F and below. The UNC study will be completed in the last quarter of 2001. This information is designed for

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Appendix B, Attachment 2

incorporation into an occupational health risk assessment of ground crews and includes no information on takeoffs and landings.

4. Joe Franzello, Brooks AFB Technical Library, assisted us in querying several databases to determine the availability of information related to emissions of unburned fuel and oil misting from aircrafts. The following databases and keywords were used:

Database	Keywords
FirstSearch	aircraft and oil mist aircraft and unburned fuel aircraft and soot and exhaust aircraft and carbon black
DialogTech	Aerosol or atomic or spray or mist and fuel or JP

No quantitative information was located as a result of these searches (Attachment 5).

5. Evaluations of ground crew exposures may not indicate unburned fuel or oil misting levels, but may assist ATSDR in evaluating their emission models due to the proximity of the ground crews to aircraft taxiing, takeoffs, and landings. Ground crew exposures to F-15, KC-135, and C-130 aircraft engine exhaust were evaluated through three studies (Johnston and Fritts, 1999a; Johnston and Fritts, 1999b; and Johnston and Lazenby, 1999, Attachments 6-8). Personal samples were collected from ground crew chiefs who are responsible for preparing aircraft for launch and, upon recovery, performing post-flight check procedures. Analyses included aldehydes, BTEXs (benzene, toluene, ethyl benzene, and xylenes), gases (carbon monoxide, nitric oxide, nitrogen dioxide, sulfer dioxide), JP-8 fuel (as naphthas), and polynuclear aromatic hydrocarbons (particulate and vapor fraction). Several aldehydes analyses were quantifiable. All other results were below their respective detection limits.

6. If you have any comments or questions, please call Mr Jody Wireman at (210)536-6123 or Mr Cornell Long at (210)536-6121.

Jody R. Wireman

JODY R. WIREMAN
Environmental Scientist
Environmental Sciences Branch

Attachments:
1. Massport International, 1997 (2 copies)
2. Hoffnagle et al., 1997 (2 copies)
3. KM Chng Environmental Inc., 1997 (2 copies)
4. KM Chng Environmental Inc., 1999 (2 copies)
5. Literature Search Results (2 copies)
6. Johnston and Fritts, 1999a (2 copies)
7. Johnston and Fritts, 1999b (2 copies)
8. Johnston and Lazenby, 1999 (2 copies)
9. References (2 copies)

Attachment 9 - References

Blazicko, 2001. Blazicko B. Personal communications about JP-8 cold engine startup occupational exposure research project. January 31, 2001.

DialogTech, 2001. DialogTech. http://www.dialogselect.com/tech/ January 22, 2001.

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Hoffnagle et al., 1997. Hoffnagle GF, Cooper JA, and Morris S. Soot Deposition Study: Logan Airport and Surrounding Communities. TRC Environmental Corporation, January 1997.

Johnston and Fritts, 1999. Johnston DS and Fritts GD. Consultative Letter, IERA-RS-BR-CL-1999-0008, Engine Exhaust Exposure of F-15 Crew Chiefs, Otis ANGB, MA. February 12, 1999.

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KM Chng Environmental Inc., 1997. KM Chng Environmental Inc. Soot Deposition Study: Logan Airport and Surrounding Communities. January 1997.

KM Chng Environmental Inc., 1999. KM Chng Environmental Inc. Findings Regarding Source Contributions to Soot Deposition: O'Hare International Airport and Surrounding Communities. December 1999.

Massport International, 1997. Massport International. Summary of Two Logan Soot Studies. January 1997.

Wade, 2001. Wade M. Personal communications about aircraft oil and fuel misting. AFIERA/RSHQ (Karta Technologies). January 19, 2001.

Appendix C. Chemical Mixtures Exposure

Chemical Mixtures Exposure

General comments about chemical mixtures

Environmental chemical research has mainly centered on toxicity testing and mechanistic studies of single chemicals. This research lead to a better understanding of the interactions of exposure and susceptibility. However, ATSDR recognizes that humans are often exposed to multiple chemicals. Knowledge based on individual chemical exposure and toxicity is often a limiting factor in the human health assessment process. While interactions among some chemicals have been demonstrated at high concentrations, interactions at low environmental levels have not been scientifically demonstrated. Predicting whether chemicals will act in a potentiating, additive, synergistic, antagonistic, or independent manner at environmental concentrations or in the workplace has limitations.

Chemicals mixtures are found in the air we breathe, the food we eat, and the water we drink. With over 80,000 existing chemicals and 2,000 more being added each year, people are exposed to thousands of chemicals in different combinations every day in the home, the environment, and the workplace. Some of these chemicals have similar mechanisms of action or affect the same organ or tissue, so interactions between these chemicals are possible.

Chemical mixtures may contain two or three chemicals of a similar class or more complex mixtures may contain hundreds of chemicals from different classes. These chemicals may express different levels of toxicity and different modes of action. Changes in one chemical caused by another may alter the resultant toxicity from predicted values. Though changes in toxicity have sometimes been described for simple mixtures, understanding the interactions of complex mixtures has not been achieved.

Individual testing of the endless number of potential combinations is virtually impossible. Even if cost were not considered, the number of animals required to perform statistically relevant toxicity tests with multiple doses for multiple exposure periods would be prohibitive. An experiment investigating three chemicals at five different dose levels at only one time point after exposure, would require 125 treatment groups and 750 animals, if only six animals are included in each treatment group. Therefore, it is unlikely that questions concerning chemical mixtures will be answered through traditional animal research in the near future.

Interactions between chemicals can be potentiating, additive, synergistic, antagonistic; or there may be no interaction and thus, independent. ATSDR evaluates the potential for chemical mixtures on a site-by-site basis. ATSDR assumes that chemicals act independently if they have different modes of action, but additively if the modes of action are the same or effects are on the same target organ, unless there is evidence of interaction between the chemicals. For non-cancer effects, ATSDR assumes that a threshold exists for health effects. For cancer effects, ATSDR assumes that a threshold may not exist for genotoxic chemicals.

ATSDR's approach for the assessment of exposure to chemical mixtures included

(1) Evaluating cumulative exposures by summing the individual risks for each carcinogen in the absence of compelling evidence supporting a greater than or less than additive model.

This method of addressing cumulative risks has been externally peer-reviewed and found to be appropriate and relevant [55]. Under this response addition model, the predicted response to the mixture would be simply additive. This model assumes the contaminants act independently. For past exposures to the maximum level estimated by ATSDR air dispersion modeling, the cumulative risk from individual chemical exposures is considered to be a *low* increase in the risk for developing cancer. Almost all of the estimated risk was due to 1,3-butadiene, benzene, and formaldehyde exposure. A cumulative risk of 4E-04 was estimated by summing individual risks (Table C-1). Actual risks would likely be considerably less than this estimate due to the conservative nature of the assessment using a worst-case emissions scenario and continuous lifetime exposure to maximum average annual concentrations, and assuming additive toxicity.

(2) Evaluating the evidence for potential interactions among the contaminants.

ATSDR investigated several approaches to evaluate interaction and concluded that scientific information was insufficient to compare the chemical mixture as a whole mixture, a similar mixture, or a component mixture. Epidemiological evidence of interaction involving 1,3-butadiene and benzene is inconclusive but recent evidence suggests independent action [56]. Evidence of interaction between formaldehyde and benzene or 1,3-butadiene was not located and formaldehyde appears to exert toxic effects by a different mode-of-action.

In assessing air emissions for potential interactions of chemical mixtures, ATSDR considered potential effects from the co-exposure of benzene and 1,3-butadiene. They were selected because these chemicals:

- represented the greatest estimated risk, considering quantity and toxicity,
- included the same organ system (bone marrow) as a target for carcinogenic effects, and
- epidemiological investigations of workers have reported confounding exposures to chemical mixtures.

Potential interactions between benzene and 1,3-butadiene have not been studied. Occupational exposure to high levels of benzene or 1,3-butadiene have been associated with the development of leukemia [57–59]. The metabolism of benzene and 1,3-butadiene appears to be similar in laboratory animals, with both chemicals metabolized primarily in the liver by the P450 family of enzymes (principally by the P450 isozyme 2E1 at these concentrations) [60–63]. Like benzene, 1,3-butadiene is metabolized to reactive metabolites but the precise mechanism is unknown [64]. Evidence indicates that the same metabolites detected in laboratory animals will be formed in humans, although the rates may be different [65]. Which metabolite(s) is responsible for the causation of cancer is still uncertain. Differences in measured concentration levels in mice and rats do not explain the differences in cancer in these species. All three metabolites are mutagenic *in vivo* and *in vitro*. Based on the overall evidence from human, animal, and mutagenicity investigations, EPA concludes 1,3-butadiene to be a known human carcinogen [29].

Benzene is a known human carcinogen in humans while 1,3-butadiene shows clear evidence of carcinogenicity in animals and more recent evidence suggests stronger carcinogenic potential in humans [56]. While occupational exposure to high concentrations of benzene is known to increase the risk for developing non-lymphocytic leukemia, high doses of 1,3-butadiene have been associated with cancers at multiple sites in laboratory animals, including hematopoietic cancers such as lymphocytic leukemia [66]. Epidemiological studies suggest that co-exposure to 1,3-butadiene, styrene, and benzene may be associated with leukemia whereas exposure to 1,3-butadiene alone may be associated with lymphosarcomas [29]. Evidence of an association with high doses of 1,3-butadiene and leukemia in occupational studies is often confounded by co-exposure to other chemicals. The strongest evidence for the carcinogenicity of 1,3-butadiene in humans has occurred during co-exposure to styrene and benzene [56].

Occupational studies are evaluated for the relevance of the effect and the chemical mixture. Relevance is evaluated by assessing the temporality, strength of association, consistency, specificity, dose response, and biological plausibility. The recent University of Alabama-Birmingham (UAB) study was found to be particularly relevant to exposures of 1,3-butadiene, styrene, and benzene [56]. The UAB study investigated styrene and benzene exposures as well as 1,3-butadiene and concluded that the observed associations of leukemia with 1,3-butadiene exposure were not due to confounding exposures to the other chemicals. The authors conclude that exposures to 1,3-butadiene alone were associated with leukemia mortality. The dose-response analysis generated by the authors was used by ATSDR to compare to potential exposures around Kelly AFB. ATSDR compared the highest potential exposure period at Kelly AFB (before 1970) to the dose response of the UAB study.

The highest potential exposure period to benzene and 1,3-butadiene at Kelly would have occurred before 1970 based on operational information, type of jet fuel use, and air dispersion modeling of estimated emissions. Levels of 1,3-butadiene in the community are estimated to have been 20 $\mu g/m^3$ (9 parts per billion [ppb]). The majority of housing in the communities was started in the 1950s which would equate to a maximum cumulative dosage of 180 ppb-years, assuming a 20-year exposure (1950–1970). Exposures after that time would be much less compared to the time period before 1970 because operations were significantly less (82,000 takeoff and landings/year compared to 330,000/year. See Appendix B). Exposures after 1970 resulted in a cumulative exposure dose of 54 ppb-years for the period 1970–1994. Kelly AFB changed from JP-4 jet fuel to JP-8 jet fuel in 1994. JP-4 jet fuel contained at least 100 times the benzene concentration measured in JP-8 jet fuel [3].

In the UAB cohort, the median cumulative exposure to 1,3-butadiene, styrene, and benzene was 11,200, 7,400, and 2,900 ppb-years, respectively. Among those dying of leukemia, the median cumulative exposure to 1,3-butadiene was 36,400 ppb-years, 200 times greater than the maximum estimated annual average exposure at Kelly AFB (180 ppb-years). The UAB cohort consisted of workers, generally considered the healthiest segment of the general population.

Benzene is a known human carcinogen with the bone marrow as the primary target organ. Exposures to high concentrations of benzene have been associated with the development of leukemia, primarily acute non-lymphocytic leukemia (ANLL). Levels above 40 ppm-years are considered to increase the risk for developing leukemia in occupational exposures [27].

Occupational exposure (8 hours/day, 5 days/week, 50 weeks/year) to benzene at 40 ppm-years would be mathematically equivalent to a lifetime environmental exposure (76 years) of 120 ppb (384 $\mu g/m^3$). The estimated community exposure to past levels of benzene of 20 $\mu g/m^3$ for 20 years is equivalent to a lifetime exposure to 6 $\mu g/m^3$, or 64 times less than the lowest level of concern reported in epidemiological studies of occupational exposures. The estimated community exposure was also five times less than the level ATSDR considers as no apparent health hazard (32 $\mu g/m^3$) [54].

Occupational studies have reported an association with benzene or 1,3-butadiene exposure and leukemia mortality in workers. Exposure to levels of benzene and 1,3-butadiene estimated with limited data and air dispersion modeling to have been present in the community prior to 1970 would not be expected to result in leukemia mortality in healthy individuals. Susceptible members of the community may be at greater risk for developing hematopoietic perturbations than workers because

- *These occupational studies were performed on workers with daily 8-hour exposures who died of leukemia. The potential health effects these same levels might have to more susceptible members of the general population, continually exposed to lower concentrations, is uncertain.*
- *These occupational studies do not identify the types of exposures which may have resulted in developing disease, as some individuals may be exposed to higher concentrations for shorter periods of time than others.*
- *These occupational studies reported mortality (death) from leukemia. It is not known if other workers developed disease or incurred reduced quality of life as a result of exposure.*
- *Scientific studies have not been performed on potential health effects from exposure to a chemical mixture of 1,3-butadiene and benzene.*

Although increased risks for leukemia have been found in medical workers and other professionals exposed to formaldehyde, studies in industrial workers, who are thought to have higher exposures, have shown inconsistent associations [21, 22]. Some scientists have concluded that there is little likelihood that formaldehyde can induce toxicity at sites remote from the respiratory tract [67].

Summary

Estimated levels of past air exposures to benzene, 1,3-butadiene, and formaldehyde

- are above some comparison values which are levels that ATSDR considers “safe,” even to more sensitive populations. Exceeding a comparison value does *not* indicate that health effects would be likely, but indicates additional investigation may be warranted.
- are below levels associated with worker mortality from leukemia.

Cumulative estimated risks for past air exposures to benzene, 1,3-butadiene, and formaldehyde

- are based on the addition of estimates of individual contaminant risks as interactions have not been demonstrated [56].
- results in an estimated low increase in the risk for developing cancer.

Epidemiological evidence indicates that

- exposure to high levels of either benzene or 1,3-butadiene is associated with leukemia mortality in workers, but at levels much higher than estimates of past exposures of either contaminant at Kelly AFB.
- exposure to high levels of formaldehyde has been associated with leukemia in medical professionals and embalmers, but results of exposure in industrial workers has not been consistent.

ATSDR concludes that additional investigation is warranted because

The community has been exposed to chemicals which have been associated with cancer in workers.

1. Confidence in the representative nature and the comprehensiveness of the data is very low because most of the sampling and analytical data provided by Kelly AFB were collected before regulatory agencies began reviewing data. Exposure scenarios are also uncertain.
2. Health outcome data indicate that a biologically plausible health outcome, leukemia , was elevated (statistically significant) between 1990–1994 in three zip codes, two of which were downwind and the third was off-base military housing.
3. Potential cumulative effects of chemical mixtures like 1,3-butadiene and benzene are unknown.

Table C-1. Estimated cumulative cancer risks from benzene, 1,3-butadiene, and formaldehyde exposure to stationary and aircraft historical air emissions.

Chemical	*Scenario*	*Estimated Cancer Risk*[d]
1,3-butadiene	B52 human data [a]	4E-5
benzene	B52 human data [b]	7E-05
formaldehyde	B52 animal data [c]	3E-04
Total Estimated Cumulative Risk 4E-04		

a. Cancer Slope Factor (4.3E-6/$\mu g/m^3$) derived from human data [External Review Draft - Health Risk Assessment of 1,3-Butadiene. US EPA. NCEA-W-0267. January 1998. National Center for Environmental Assessment. Office of Research and Development. Washington, DC.]

b. Cancer Slope Factor (7.8E-06/$\mu g/m^3$) derived from human data [IRIS].

c. Cancer Slope Factor (0.000013/$\mu g/m^3$) from animal data [IRIS]. No human data available.

d. All risk estimates are based on continuous 20 year exposures before 1973 and from 1973 to 1994 to estimated maximum annual average concentrations during each era. Level of operations was assumed to be 336,000 before 1973 and 112,000 1973 to 1994. Risks were summed for both eras.

Appendix D. Response to Comments from External Peer Review

Response to Comments from External Peer Review

1. Does the public health consultation adequately describe the nature and extent of contamination?

Reviewer 1
Comment: The consultation describes the contamination about as well as can be expected. Of course, we would all wish for better data. However, given the overall circumstances, the consultation does an excellent job.
Response: No response needed.

Reviewer 2
Comment: In Background, the authors explained the importance of past air emissions and considered contaminations in this consultation. Also, they described contaminants from industrial and aircraft emissions in pages 9 and 10. The characteristics, emissions, and known adverse health effects of those contaminants are explained in detail in Appendix B. This document adequately described the nature and extent of possible past contamination by activities at Kelly AFB.
Response: No response needed.

Reviewer 3
Comment: More description in the text including criteria or standard levels is needed. Measured data results would also be desirable. Discussion of impacts could be expanded.
Response: The target audience for this document is the community. So as not to detract from the intended message to be communicated in the text, ATSDR puts as much of the detail as possible in appendices.

2. Does the public health consultation adequately describe the existence of potential pathways of human exposure?

Reviewer 1
Comment: As with the previous question, the pathways of human exposure are fraught with uncertainty in this particular assessment. However, the consultation does an excellent job of describing the major concerns for the potential pathways.
Response: No response needed.

Reviewer 2
Comment: The authors described the potential exposure pathway elements in Table 1 in which only direct airborne exposures are described. Because toxic chemicals and organic carbons (both gaseous and particulate) can adhere to airborne particles and accumulate on them, the deposited and resuspended particles can act as an airborne vector for these compounds. This represents a potential exposure to residents downwind. Even though this indirect exposure seems to be beyond the scope of this consultation, it is worth noting it in the document.

Response: ATSDR agrees that deposition and resuspension may represent a pathway of concern. ATSDR chose to conservatively address the concern attributed to the potential pathway by assuming the inhalation exposure represented 100% of the exposure from air emissions, not reducing the exposure to account for deposition. Direct 100% inhalation exposure would be a greater exposure than a portion of the exposure from inhalation and a portion of exposure from chemicals deposited.

Reviewer 3
Comment: Discussion of potential pathways could be expanded. Sources are defined well, but exposure is not directly addressed.
Response: This document is one of several documents prepared to assess environmental exposures at Kelly AFB. The potential pathways were discussed in the Phase I document. This document focused on past air emissions.

3. Are all relevant environmental and toxicological data (i.e., hazard identification, exposure assessment) being appropriately used?

Reviewer 1
Comment: I am not aware of all the potential sources of environmental data for this particular consultation. However, it appears to be a reasonable collection of data (albeit from a highly uncertain history), and the data appear to support reasonable conclusions.
More specifically, when conservative assumptions about the data lead to the conclusion of "no significant risk," this is an appropriate use of data. This is a classic screening approach that is "good enough" to answer most of the questions being posed.
Response: No response needed.

Reviewer 2
Comment: The authors utilized industrial emission data, specific aircraft emission data, and detailed aircraft operational information supplied by Kelly AFB (Appendix B). The hexavalent chromium emission data, jet fuel misting information, and incineration emission data were not available. The model-estimated concentrations were compared with ATSDR chronic non-cancer data, worker exposure data, ATSDR cancer comparison data, and estimated cancer risk data. In pages 7 and 8, the authors clearly explained their selection of contaminants. All environmental and toxicological data were appropriately used for the consultation.
Response: No response needed.

Reviewer 3
Comment: Yes, this has been done but detail could be added.
Response: The target audience for this document is the community. As such the level of detail is deemed appropriate.

4. Does the public health consultation accurately and clearly communicate the health threat posed by the site?

Reviewer 1
Comment: The consultation does a good job in this area. However, the ATSDR should be prepared to answer the following questions.
Have other groups made estimates of the risks at Kelly Air Force Base? If so, how do they compare with this report?
Are there estimates of the risks at other Air Force Bases? If so, how do they compare with this report?
Response: Kelly AFB through the RCRA and Superfund programs have completed risk assessments on individual operable units and solid waste management units. These risk assessments, however, do not cover past air emissions.

The U.S. Army Center for Health Promotion and Preventive Medicine Environmental Health Risk Assessment Program (CHPPM), in response to our report, modeled past aircraft emissions using the Federal Aviation Administration's EDMS model [49]. ATSDR has recently been given a draft document. The report includes modeled ambient air concentrations from aircraft emissions but does not include calculations of cancer risk. CHPPM's predicted air concentrations from B52 emissions are within 10% of ATSDR predictions. The B52 was used as a worst case (largest emitter) to determine if further evaluation was necessary.

The CHPPM also predicted air concentrations from a "more realistic" fleet of aircraft which was not available to ATSDR at the time the work on this report was initiated. The results of this scenario and its assumptions need to be evaluated further.

ATSDR will consider the results of the CHPPM report when it becomes final.

ATSDR does not know of any other risk estimates from past air emissions from other Air Force bases.

Reviewer 2
Comment: The reviewer cannot judge the accuracy, but the authors clearly described and considered possible health threat posed by Kelly AFB in Appendix C. Also, they reported information on potentially susceptible populations (page 13).
Response: No response needed.

Reviewer 3
Comment: The threat is accurately described, but more text is required to clearly communicate the threat. Detail should not only appear in tables, but should be discussed.
Response: ATSDR also provides fact sheets with presentations or availability sessions to clearly communicate messages and provide health education.

5. Are the conclusions and recommendations appropriate in view of the site's condition as described in the public health consultation?

Reviewer 1
Comment: Yes, overall they seem reasonable. However, see question #7 for further comments in this area.
Response: No response needed.

Reviewer 2
Comment: The authors' conclusions for the individual contaminations from stationary sources and aircraft sources are appropriate. Their recommendations of further studies on elevated leukemia outcomes and on-base exposure are relevant.
Response: No response needed.

Reviewer 3
Comment: Yes, I agree with the recommendations and conclusions.
Response: No response needed.

6. Given the available information, are the methods used suitable for determining the range of historic ambient air concentrations from aircraft emissions?

Reviewer 1
Comment: They are suitable given the fundamental uncertainty of the data. However, it may be useful for the reader to see a summary of all the assumptions that make ISCST a conservative model for this consultation. The assumptions and conservative nature of this model will be important in interpreting the results.
Response: The assumptions and methodology of the ISC modeling are presented in the discussion of Aircraft Emissions which includes 7 to 8 pages of text. A short summary of these assumptions were added as Table A-1.

Reviewer 2
Comment: All available data and operation information were utilized to estimate downwind concentrations in this consultation. The available air transport models were suitable used. While the authors mentioned ISCST model for the estimation of aircraft emissions, they did not clarify which model they used for the stationary emissions. From the reference (Rodgers et al., J.Exp.Anal.Env. Epi. 9, 535, 1999), the reviewer assumes simple Gaussian dispersion model was used. These steady state plume models (Gaussian model and ISCST model) make an important simplifying assumption, namely that there is no vertical variation in either the wind speed or turbulence intensity. They only consider the standard deviation of Gaussian distribution as dispersion parameters. This drawback often results in overestimations of gaseous or particulate pollutant concentrations (Winges KD USEPA/910/988/202/R, 1990; Kim, E. and Larson, T.V. Atmospheric Environment 35, 3509–3519). It can be one of the possible reason for high estimated concentrations in Tables B-1 and B-8. It looks to the reviewer that Figures B2 and B3 are identical, and Figures B4 and B5 are identical, even though the emissions are different between Butadiene and Benzene. It needs some clarification.

Response: The ISCST3 model was also used for the stationary sources. Appendix B was modified to include this information. The ISCST3 model uses a Gaussian distribution and the dispersion parameters of Pasquill-Gifford. The ISC model includes a variation of wind velocity (EPA 1995; EPA-454/B-95-003a available at http://www.epa.gov/scram001/tt22.htm#isc) with height. The Fugitive Dust Model (FDM) described by Winges (1990) does not. As the reviewer points out, neither ISC nor the FDM vary settling velocity of particulates with height. For the modeling, ATSDR assumed all emissions were gaseous. ATSDR acknowledges the uncertainty of this assumption but it presents a worst-case or highest exposure concentration scenario for the modeling of metals and organics.

ATSDR also acknowledges the inherent uncertainty in the ISCST3 model. Using a Gaussian-plume model, Rodgers et al. (J.Exp.Anal.Env. Epi. 9, 535, 1999), identify an uncertainty of approximately a factor of 2 in flat terrain (i.e., modeled concentrations range from ½ to 2 times the actual values). This range of uncertainty is relevant in this case because the terrain at Kelly AFB is flat. The Section titled "How did ATSDR evaluate past emissions at Kelly AFB" and Appendix B were modified to include this description of uncertainty.

We are aware that Figures B2 and B3 (predicted air concentrations of butadiene and benzene, from B52 emissions) and Figures B4 and B5 (predicted air concentrations of butadiene and benzene from F16 emissions) appear the same. This occurred because the emission rates of 1,3-butadiene and benzene are similar for the significant mode of operation. For the B52, modes contributing the predominant risk are startup, shutdown, and taxi. The engine setting during these modes is idle. The total emissions for the time the plane is using an idle engine setting are 2544 g/plane benzene and 2534 g/plane butadiene.

For the F16, the mode contributing the predominant risk is engine check and takeoff as seen by the higher concentrations at the ends of the runway. The engine check emissions are 204 g/plane benzene and 173 g/plane butadiene. The takeoff emissions are 305 g/plane benzene and 322 g/plane butadiene.

Reviewer 3

Comment: It would appear so, but more detail and better organization of presented data is needed.

Response: The target audience for this document is the community. As such the level of detail is deemed appropriate.

7. ATSDR identifies a range of risk estimates (identified in Table B-8) for potential past exposures to benzene and butadiene by utilizing the B52 aircraft as a worst-case and the F16 aircraft as a best case emissions scenario. From a public health perspective and considering the uncertainty, would modeling each individual aircraft emissions (more than 50 different types of aircraft) change the conclusions and recommendations?

Reviewer 1
Comment: There is no need to consider further data when the worst-case scenario leads to the conclusion that a public health concern is "unlikely." Lower exposures would yield the same conclusion, and the assumptions about the best and worst case seem very reasonable. This is screening assessment at its best.

The more provocative conclusion -- #3 on page 14 – is that the exposures "may have resulted in an increased risk for developing cancer." Given the uncertainties throughout this consultation (not just with the ISCST modeling), it may be more accurate to say that "the data are inconclusive with regard to cancer risks and follow-up is needed." Both statements may be true, but it is a strategic decision on which statement to use. The former statement may evoke needless fear from the public. In my view, the later statement cannot be seen as overly optimistic, particularly since it calls for follow-up. However, the investigators who are closest to the community will make the most appropriate judgment on this issue.

In either case, follow-up with the Health Outcome Data Evaluation Health Consultation is still very appropriate.

Response: No response needed.

Reviewer 2
Comment: It does not seem to the reviewer that the conclusion and recommendations would change by modeling each aircraft emission. The number of operations was not specified for each individual aircraft. Therefore, the estimated concentrations downwind would be between the worst and the best case concentrations, if all model inputs are the same except source strength.
Response: No response needed.

Reviewer 3
Comment: Yes, the levels would decrease substantially.
Response: No response needed.

8. Are there any other comments that you would like to make about the health consultation?

Reviewer 1
Comment: No comment.

Reviewer 2
Comment: None.

Reviewer 3
Comment: Yes. Please see attached pages.
Response: ATSDR has responded to each comment in the following section.

9. Are there any comments on ATSDR's peer review process?

Reviewer 1
Comment: No comment.

Reviewer 2
Comment: None.

Reviewer 3
Comment: No.

10. Are there any other comments?

Reviewer 1
Comment: No comment.

Reviewer 2
Comment: Typo:
pp.72, please correct ‘Figure B-8’ to Figure B-9’.
pp. 40, 11th line of 4th paragraph, please delete ‘and’ in An individual’s actual risk and may …’
Response: These corrections were made.

Reviewer 3
Comment: No.

Reviewer 3 comments to question 8.

General Comments:

Comment: The main body of the text should include more detail on methodology, data, and maps. The reader finds considerable detail but often it is hidden in the footnotes of tables or is only included in the appendices. Conclusions seem to be valid, but a better presentation would lead to more reader confidence.
Response: ATSDR has adopted the present format on advice from health educators and risk communicators because the target audience of the health assessment is the general public, not the scientific community. Detail, whenever possible, is relegated to appendices, footnotes, etc., to avoid distraction from the intended messages to the general public, but still included for the scientific readers.

Specific Comments:

Comment: Page 2, 1st Paragraph, Line 4: The sentence that begins "In an attempt” ...... is slightly awkward and should be two sentences.
Response: The sentence has been restructured.

Comment: Page 3, 1st Finding: The text does not seem to agree with Table 1. Perhaps it should state that analysis of hexavalent chromium before 1980 was not possible. As stated, it seems to imply that hexavalent chromium from stationary sources did have adverse health effects.

Response: ATSDR has clarified the message.

Comment*:* Page 6, 1st Paragraph, Line 7: A conclusion of the study is presented in the background section with no support. Reasons should be given.
Response: The conclusion refers to current air emissions and the assessment and reasons for that conclusion are contained in that document.

Comment*:* Page 6, 1st Paragraph, Line 9: The reference to past air emissions (before 1995) is not supported. Earlier in the report (Table l) past was also given as 1980. 1 think the text is trying to tell me that only pre-1995 emissions were evaluated due to the change to JP-8, but I cannot be sure.
Response: The text states that pre-1995 air emissions were evaluated because of the use of JP-4 jet fuel before 1995. That point in time was necessarily used for all emissions even though chromium emissions changed in 1980. ATSDR initiated an investigation in 1996 and published a public health assessment (August 1999) addressing emissions from 1995 through base closure (2001).

Comment*:* Page 7, 2nd Paragraph, Line 1: I think the first sentence should be qualified by including "...at Kelly AFB." since this statement does not apply to the general literature. The next sentence stating distant past also has the same problem.
Response: This section applies to the general literature. For example, EPA's Air Toxics Monitoring Program began in the 1980s. ATSDR has modified the sentence to clarify.

Comment*:* Page 7, 4th Paragraph, Line 3: The sentence that begins on this line is confusing. It should be known if the chemicals were present or not.
Response**:** It is not known at what level the chemicals were present.

Comment*:* Page 9, 1st Paragraph, Line 6: Why include such a long listing of chemicals if it is not complete?
Response: This listing identifies the chemicals for which data was provided.

Comment*:* Page 9, 1st Paragraph, Line 8: If most chemicals did not exceed health-based comparison values the important information is which ones did. This should be reworded or stated. Then the following sentence says no chemicals exceeded the noncancer comparison values while the next sentence said two did. A clean up is needed in this paragraph.
Response: Health-based comparison values includes both cancer and noncancer comparison values. The text continues to specify that *noncancer* comparison values were *not* exceeded and two *cancer* comparison values were exceeded.

Comment*:* Page 9, 2nd Paragraph: This conclusion in bold font does not seem to agree with the previous paragraph.
Response: Exceeding a comparison value does not constitute a public health hazard, but identifies chemicals for which further evaluation is indicated.

Comment*:* Page 10, 1st Paragraph: The details on how much risk is involved and details should really be included in the main text and not only in the appendix.
Response: See general comments response.

Comment*:* Page 10, 2nd Paragraph: Again the conclusion in bold font does not seem to agree with the previous paragraph.
Response: Exceeding a comparison value does not constitute a public health hazard, but identifies chemicals for which further evaluation is indicated.

Comment*:* Page 12, 1st Paragraph: What health outcomes were further evaluated and why? This is important information.
Response: The information is given in following paragraphs.

Comment*:* Page 12, 5th Paragraph: The maps should be presented in the main body of the text and would really help the reader.
Response: Because there may be multiple references to the same maps, ATSDR elects to locate maps in one place to avoid duplication.

Comment*:* Page 12, 6th Paragraph: If results are available, why not include them here?
Response: Results are not yet available.

Comment*:* Page 13: Nice discussion, but what is needed is a summary paragraph of how these issues directly apply to this project.
Response: While the information may be relevant to this project, its direct relevance remains to be determined by followup activities and is best presented by those investigators. For example, the association of acute nonlymphocytic leukemia in children and parental occupational exposures to benzene may have relevance to the ZIP Code containing off-base housing and reporting elevated leukemia outcomes. Further investigation would be needed and the information is best presented in its entirety at that time. A summary statement has been added.

Comment*:* Page 17, 2nd Paragraph, Line 4: Site topography and geometry are also key inputs.
Response: “Site topography and geometry” have been added.

Comment*:* Page 17, 2nd Set of Bullet Items, 1st Bullet: “….24 hours a day for any time period..." is a little confusing.
Response: The text was clarified by stating that the models can be used to estimate a substance’s concentration for different time periods for which both emissions and meteorological data exist and that the ISCST model used in this report generates an hourly model result. The hourly results can then be compiled to generate maximum and average values over different time periods.

Comment*:* Page 18, 1st Paragraph: If the concentrations were measured, they did exist. I think what you may be trying to say is that these results are not applicable to all times or can be used for other nearby locations.
Response: The interpretation is as intended and no response is needed.

Comment*:* Page 18, Last Paragraph, Line 5: The sentence ending on this line should include “...... at the modeled locations." This is true because further downwind longer half-lives do make a difference.

Response: The text specifies that the point is near the base perimeter and that downwind concentrations will increase and thus "do make a difference." The text was changed to indicate that the fixed point off base was at the modeled location at the base perimeter.

Comment*:* Page 19, Figure A-1: Why does the last data point (~1500 minutes) does the concentration go down?
Response: The last data point was in error. The concentration was incorrectly entered as 0.00117 $\mu g/m^3$ and the correct value is 0.00122 $\mu g/m^3$. ATSDR also ran the model with half-lives of 280 minutes and 2,160 minutes to fill in the time between 60 and 500 minutes and to extend the end of the curve. These additional points confirm the conclusion that the concentration becomes stable at the location of concern as the half-life approached 3 to 4 hours (180–240 minutes). Figure A-1 has been corrected and revised. The geographic location is in the Kelly Gardens community immediately north of and adjacent to Kelly AFB. The location in geographic coordinates is 641,600 meters west and 4,173,700 meters north in statewide grid, Texas South Central Zone, North American Datum of 1983.

Comment*:* Page 19, 1st Paragraph, Line 8: Should this be a factor be less than 50? 1 don't get this number from Figure A-2.
Response: The factor of 50 was the result of the change in the model parameters (release height, downwash, and rural versus urban dispersion) and the decrease in concentration as a function of distance within 300 meters of the source. Because this was not apparent, the number has been changed to 3 to represent the change in model parameters only and a factor of about 50 depending on the receptors location inside the base boundaries.

Comment*:* Page 19: This would also be the place to introduce which models were used, what inputs, were worst case or typical weather values used, etc.
Response: ATSDR added this information.

Comment*:* Page 19, Caption for Figure A-2: Some parameters would have an effect. Those in the evaluation shown in the Figure perhaps have no effect.
Response: The caption for Figure A-2 has been changed to:
"Figure A-2. Input Parameter Comparison. Selection of model parameters shown in the Figure have no effect on off-base concentrations of contaminants, but may have significant effects upon on-base concentrations."

Comment*:* Page 21, Last Paragraph: Since hexavalent chromium is a solid, while the other pollutants are a gas, you may wish to mention modeling assumptions here, such as settling.
Response: ATSDR added text to describe the assumption that all chemicals including metals were assumed to be in the gas form.

Comment*:* Page 22, 2nd Paragraph: More description of details would really help the reader. The levels that are used for comparisons (both criteria and measured) would indicate support for the statements made. The details do come out after a very careful review of Table B-1, but such important statements used in the paragraph should be supported in the text.
Response: See response to general comment.

Comment*:* Page 24, 1st Paragraph: Just a thought, but could the efficiency of the scrubber used for control be included and possibly allow better interpretation of impacts before 1980?
Response: Scrubber efficiency was considered but ATSDR determined that the uncertainty was too large to evaluate further. The uncertainty exists because the operation of the scrubbers in Building 301 changed in 1980 and four other plating shops existed prior to 1980.

The text states that scrubbers were installed in 1980 in Building 301. Additional information obtained by ATSDR shows that the scrubbers were installed when the building was constructed in 1977 with stack sampling tests in 1980. The text was clarified with this information (Kelly AFB 2001). The scrubbers on Building 301 were originally designed to operate in a wet mode. However, a memorandum indicates that insufficient deionized water was available to operate the units so decisions were made to operate the units in a dry mode (Backlund 1995). The stack tests were completed in 1980 in a dry mode. The actual efficiencies prior to 1980 are not known. Emissions can be estimated from plating operations by knowing the level of plating operations but these data has not been identified.

Four other plating shops existed prior to 1980. The most significant one is the operation in Buildings 258/259 which began operation in 1942 and shutdown in 1977 (Kelly AFB 2001). The Air Force considered the information on past emissions from Buildings 258/259 incomplete and of low confidence because the buildings were demolished prior to this inquiry, there is missing data, lack of confidence in personnel interviews, and lack of construction drawings (EARTTECH 2000a, 2000b). As a result of these uncertainties, ATSDR did not evaluate impact before 1980.

References

Backlund 1995. Memorandum for Information from SA_ALC/EMC, Department of the Airforce, Headquarters San Antonio Air Logistics Center (AFMC), Kelly Air Force Base, Texas (R.J. Backland, P.E.) To SA-ALC/EMC (D.S. Guadarrama, P.E.), Subject Shutdown of Wet Scrubber Mode at Bldg 301 and Stack Sampling).

Kelly AFB 2001. Point Paper for Chromium Emission Data from Historical Plating Operations, Kelly AFB, Draft, June 26, 2001.

EARTHTECH 2000a. Final Report. Historical Air Emissions Estimate. Kelly AFB, TX. EARTH TECH, Inc. San Antonio, TX. March 27, 2000.

EARTHTECH 2000b. Addendum to the Historical Air Emissions Estimate Report, March 20, 2000. EARTH TECH, Inc. August 28, 2000. Transmitted by Charles Williams (Kelly AFB) on December 20, 2000

Comment*:* Page 25, 3rd Paragraph: The model used is included, but an earlier introduction would be better for reader understanding. Also, how the model was used should be mentioned. Details are given later but the fact a volume approach using ISCST with estimated positions rather than using EDMS should be discussed.

Response: The following changes, shown in italics with accompanying text were made to address this comment.

Page 8 – First Paragraph
Data on JP-4 jet fuel speciation acquired by ATSDR and operational data provided by Kelly AFB were used to conduct an air dispersion model of aircraft emissions. A worst-case jet fuel emissions scenario was used for modeling aircraft emissions. *The Industrial Source Complex air dispersion model was used (ISCST3, see Appendix B for details).*

Page 25.
Model Inputs

The Industrial Source Complex-Short Term (ISCST) model was used to perform the air modeling. To use this model, information on the source of pollutants, ambient meteorology, and information on receptor locations must be entered into the model. The model simulates the movement of the pollutants in the atmosphere and calculates a concentration at the given receptor locations. *The emissions were treated as a series of volume sources behind the aircraft (see page 32 for details).*

Bottom of Page 33 and Top of Page 34.
Forty-eight volume sources were used to represent taxiway emissions. Fourteen were used to represent takeoffs. Thirty were used to represent climbout. Eighty were used to represent approach. These sources represent aircraft movement at approximately 3-second intervals. Sources in each category were spaced according to their respective speed during that mode.

The commenter suggests that the EDMS model should be discussed in conjunction with the use of the ISCST model with volume sources. The ISCST model was used for modeling jet aircraft emissions using volume sources. The size and location of these volume sources were estimated and discussed in Appendix B. The use of the EDMS model at the time the modeling for this report was developed (March 2001 through June 2001) was not an option. In March 2001, version 3 was the current version of the EDMS model. EDMS version 4 was released in May 2001. The EDMS models (Versions 3 and 4) were developed for criteria air pollutants plus hydrocarbons (carbon monoxide, nitrogen oxides, sulphur oxides, hydrocarbons, and suspended particles). The EDMS V3 was not easily adaptable for other emission factors and chemicals including hazardous air pollutants that were the subject of this study. EDMS currently was not designed to perform air toxic analyses for aviation sources, but could have been supplemented with other air toxic methodology and models ([Federal Register: October 13, 1999 (Volume 64, Number 197)] [Notices] [Page 55525–55595]). The EDMS V4 model now has the flexibility to import the emission factors for new aircraft and additional chemicals. The EDMS V3 did not.

EDMS V3 used two models called PAL2 and CALINE3 that simulated aircraft emissions as line sources. CALINE3 is a line source model and assumes that a zone (volume) containing the line source exists with the zone. The size of the zone is a function of line width and an initial vertical dispersion. The contaminants in this zone then undergo vertical and horizontal dispersion using a steady-state Gaussian model (Benson 1979). PAL2 calculates a line source by integration of point sources (EPA 1978). The location accuracy of the points and lines representing the planes and the relative accuracy when compared to ATSDR's volumes sources is not known.

EDMS V4 is a significant revision of EDMS V3. EDMS V4 uses EPA's AERMOD air dispersion model. AERMOD in EDMS uses areas sources for aircraft taxiing, aircraft queuing, aircraft accelerating on the runway, aircraft after takeoff and during the landing approach. The area source was selected, as opposed to using a series of volume sources based on recommendations from the American Meteorological Society/EPA Regulatory Model Improvement Committee (AERMIC) (CSSI Inc. 2002). A comparison of the EDMS V4 model with ATSDR's approach is possible because the U.S. Army Center for Health Promotion and Preventive Medicine (CHPPM), in the fall of 2003, used the EDMS V4 to evaluate ATSDR's results. Using ATSDR's assumption of 336,000 operations of the B52H and the emission rates identified in ATSDR's report, CHPPM's result at the point of maximum impact were within 10% of ATSDR's result (personal communication, Les Pilcher, US Army Center for Health Promotion and Preventive Medicine, December 19, 2003, [49]. This indicates that the different models using the same assumptions have good agreement.

References

Benson, Paul 1979. Abridged version of "CALINE3 - A Versatile Dispersion Model for Predicting Air Pollutant Levels Near Highways and Arterial Streets-Interim Report" Report Number FHWA/CA/TL-79/23, Nov. 1979. Paul E. Benson, Office of Transportation Laboratory, California Department of Transportation. Abridged Version by Computer Sciences Corporation [http://www.epa.gov/scram001/userg/regmod/caline3.pdf].

CSSI, Inc. 2002. Emissions and Dispersion Modeling System (EDMS) Reference Manual. Prepared for U.S. Department of Transportation, Federal Aviation Administration, Washington, D.C. Document Number FAA-AEE-01-01

US Environmental Protection Agency (EPA). 1978. User's guide for PAL, A guassian-plume algorithm for point, area, and line sources. Research Triangle Park (NC): Office of Research and Development, Environmental Sciences Research Laboratory, February. Report No. EPA-600/4-78-013.

Comment: Page 26, 5th Paragraph: Listing of all these aircraft would seem to be better in a table.

Response: The list was revised as a table.

Comment*:* Page 26, 5th Paragraph: If only the B52H and F16 are to be used, why include that emission data exist for all of these other aircraft were found?
Response: The list of aircraft with available emissions data was provided to demonstrate the process ATSDR went through to reconstruct past exposures. The list more clearly demonstrates the advantages and disadvantages of the assumption to only use the B52-H and the F16. It also provides readers with knowledge of the data that is available. No change was made in the text.

Comment*:* Page 27, Table B-2: The numbers look too high. Could a B52H emit 113 kilograms of hydrocarbons during the taxi-out? This is true of Table B-3 as well. Also, if Touch & Go are not going to be used, why include?

Response: ATSDR checked the source document and it indeed lists 113 kilograms of hydrocarbons (HCs) during the taxi-out (Seitchek 1985). This number does seem high. It was derived based on time-in-mode, engine setting, and HC emission rate. The power setting for taxi-out is idle which has the highest HC emissions rate. For the TF33-3 engine, the rate is 84 g HC/kg fuel. The fuel rate is 0.11 kg/s so the HC emission rate is 9.24 g/s. For 113 kilograms, the time-in-mode for taxi-out would need to be 3.4 hours which seems very unrealistic. ATSDR checked the KC-135A from this reference for taxi-out and came up with 11.5 hours which is even more unrealistic. ATSDR suspects a systematic error in Table A of Seitchek (1985). It's possible that the units for the table are kilograms and not metric tons. A note was added to Table B-2 about this possible error.

Because the values in Table B-2 were only used for a comparison among planes and not used in the emissions modeling, the error in Seitchek (1985) does not change our results. The hydrocarbon rates used in the modeling was 94 g HC/kg fuel and 0.14 kg/s of fuel (Spicer et al 1988). These values are similar to Seitchek (1985). The times-in-mode used in the ATSDR modeling was 9 minutes for taxi-out (Naugle et al 1975) for a total of 7.1 kg HC released during taxi-out.

References

Aircraft Emissions Characterization. C.W. Spicer, M.W. Holdren, S.E. Miller, D.L. Smith, R.N. Smith, D.P. Hughes. Final Report, March 1988, Engineering and Services Laboratory, Air Force Engineering & Services Center, Tyndall Air Force Base, ESL-TR-87-63.

USAF Aircraft Engine Emissions Estimator, Glenn D. Seitchek, ESL-TR-85-14, November 1985.

USAF Aircraft Pollution Emission Factors and Landing and Takeoff (LTO), Dennis Naugle, et al, AD/A-006 239 (February 1975).

Comment*:* Page 29, Equation at Top of Page: Derivation of this formula should be discussed. I get different answers when using moles for mass conversion.
Response: The equation is

(1) $$\%wt\,\frac{HAP}{HC} = \left(\frac{[HAP]}{[HC]}\right)\times\left(\frac{Number\ of\ C_{HC}}{Number\ of\ C_{HAP}}\right)\times\left(\frac{MW_{HAP}}{MW_{HC}}\right)$$

where:
[HAP] = concentration of organic compound in ppm_vC
[HC] = concentration of total hydrocarbons in ppm_vC
Number of C_{HC} = Number of carbon molecules, 9.3 is used for HC*
Number of C_{HAP} = Number of carbon molecules in the HAP
MW_{HAP} = Molecular Weight of the [HAP]
MW_{HC} = Molecular weight of the total hydrocarbons = 130*

*Douglas, Everett, Naval Aviation Depot, Naval Air Station, San Diego, California. Email record of personal communication regarding information about converting units and data on the number of carbons and molecular weights of total hydrocarbons in jet fuel, February 12, 2001.

The units of concentration in this formula require ppm_vC. Moles should not to be used in this formula as it is based on a volume per volume basis. The formula was taken from AESO (1999) and the text will be referenced accordingly. There was a typographically error and OC was changed to HAP and the subscript "v" was added to indicate that it is based on volume not mass.

The derivation of the formula is based on two equations:

(2)

$$ppm_v = \frac{ppm_v}{\#C}$$

where ppm_v = parts per million by volume
ppmC = parts per million carbon
#C = number of carbons in the molecule

and the ideal gas law,

(3) PV = nRT,

which is used to convert ppm_v to a mass basis.

Where P = pressure of the gas
V = the volume it occupies
T = its temperature (in Kelvin)
n = number of moles of gas present
R = universal gas constant

First, using the ideal gas law, the volume of 1 mole of air (V) is calculated.

(4)

$$V = R\left(\frac{L - atm}{{}^oK - Mole}\right) \times \frac{T({}^oK)}{1atm} = \frac{L}{mole}$$

At standard temperature and pressure (273^{o}K and 1 atm). The volume is

(5)

$$V_{STP} = 0.8206\left(\frac{L - atm}{{}^oK - Mole}\right) \times \frac{273^o K}{1atm} = 22.4\frac{L}{mole}$$

ppm_v is defined as

(6) $$ppm_v = \frac{\mu L_{HAP}}{L_{air}}$$

where V_{air} is the total volume of air, V_{HAP} is the volume of air occupied by the HAP

Using dimensional analysis and equations 5 and 6.

(7) $$ppm_v = \frac{\mu L_{HAP}}{L_{air}} \times \frac{10^3}{1m^3{}_{air}} \times \frac{1L_{HAP}}{10^6\,\mu L_{HAP}} \times \frac{mole}{22.4L_{HAP}} \times MW\frac{g}{mole} \times \frac{10^3 mg}{g}$$

or

(8) $$ppm_v = \left(\frac{MW_{HAP}}{22.4L_{HAP}}\right) {mg}/{m^3}$$

Combining with equation 1 and solving for mass

(9) concentration in mg/m^3 = $$\frac{ppm_v C_{HAP}}{\#C_{HAP}} \times \left(\frac{MW_{HAP}}{22.4L_{HAP}}\right) {mg}/{m^3{}_{air}}$$

To obtain a weight ratio of HAP to hydrocarbon (HC)

(10) $$\%wt\left(\frac{HAP}{HC}\right) = \frac{\frac{ppm_v}{\#C_{HAP}} \times \left(\frac{MW_{HAP}}{22.4L_{HAP}}\right) {mg}/{m^3{}_{air}}}{\frac{ppm_v C_{HC}}{\#C_{HC}} \times \left(\frac{MW_{HC}}{22.4L_{hC}}\right) {mg}/{m^3{}_{air}}}$$

Simplifying and rearranging brings us back to equation 1.

(11) $$\%wt\left(\frac{HAP}{HC}\right) = \frac{\frac{ppm_v C_{HAP}}{\#C_{HAP}} \times (MW_{HAP})}{\frac{ppm_v C_{HC}}{\#C_{HC}} \times (MW_{HC})} = \frac{ppm_v C_{HAP} \times (MW_{HAP}) \times \#C_{HC}}{ppm_v C_{HC} \times (MW_{HC}) \times \#C_{HAP}}$$

Note that this equation is independent of temperature and pressure.

References

Aircraft Environmental Support Office (AESO), 1999. Toxic Organic Contaminants in the Exhaust of Gas Turbine Engines for JP-5 and JP-8 Fuel: Draft. San Diego (CA): U.S. Navy, Aircraft Environmental Support Office Naval Support Depot-North Island. AESO Report No. 12-90, Revision B. February.

Comment*:* Page 30, Continuation of Table: Headings should be included at the top of the page.
Response: The heading was added.

Comment*:* Page 33, 2nd Paragraph: Do you mean Touch & Go operations were divided equally among takeoffs and landings?
Response: Touch and go operations were not specified in the number of annual operations. Since the annual operations most likely did include touch and go operations, ATSDR took the most conservative approach (highest emissions) and assumed that the unknown number of touch and go operations was a takeoff or a landing but not both. This means that the 336,000 operations were divided into 168,000 takeoffs and 168,000 landings. This text was added to the report for clarity.

Comment*:* Page 33, 9th Paragraph: "...... from about 480 meters." Does this mean to the ground, around this height, or something else?
Response: This meant that source release heights for approach varied from about 480 to 0 meters above ground. The text was modified for clarification.

Comment*:* Page 33, 11^{th} Paragraph-. 46 minutes seems like a very long taxi time.
Response: The taxi time is the total time for taxi during takeoff and taxi during landing (see Table B-4)and includes time for startup (20 minutes), outbound taxi (9 minutes), inbound taxi (12 minutes), and idle at shutdown (4.8 minutes). This data was obtained from USAF Aircraft Pollution Emission Factors and Landing and Takeoff (LTO), Dennis Naugle, et al, AD/A-006 239 (February 1975). The text was clarified accordingly.

References

USAF Aircraft Pollution Emission Factors and Landing and Takeoff (LTO), Dennis Naugle, et al, AD/A-006 239 (February 1975)

Comment*:* Page 34: I expected information on the F- 16 to also be presented instead of just the B52H.
Response: This page does include information on the F16.

Comment*:* Page 34, 2nd Paragraph: It would be good to tell the reader what the level where health effects begin is and from what reference in this paragraph.
Response: See response to general comment and Figures B-6 and B-7.

Comment*:* Page 44, Figure B-7: The public may have the wrong idea of what is toxic when outdoor levels at Kelly AFB are reported to be above those in a smoked-fill bar. Some description in the text may help.

Response: ATSDR objectively presents information reported in the scientific literature to give a complete perspective.

Comment*:* Page 46: It is confusing to have two Appendix Bs. Perhaps B1 andB2?
Response: There is only one Appendix B, containing two attachments.

Comment*:* Page 55, 1st Paragraph, Line 3: The words "...near Kelly AFB." after the word "...susceptibility...." may be called for.
Response: This is a general statement not specific to Kelly AFB.

Comment*:* Page 55, 5th Paragraph: This paragraph should be included in main body of text.
Response: ATSDR prefers that these general methodological statements remain with other like statements in an appendix than inserted into a discussion of findings in the main body of text.

Comment*:* Page 56, 1st Paragraph: How risk factors were developed is not completely described. More detail would be helpful.
Response: More detail was added to the tables and text.

Comment*:* Page 59, 4th Bullet Item: Is there a low to moderate increase in risk or a low to moderate risk?
Response: There is a low to moderate increase in estimated risk over the background risk.

Comment*:* Page 60, Table C- 1: That 6 people in 1000 would be at cancer risk is quite high. This needs more discussion in the text as does even 3 people in 1000.
Response: Clarification has been added to text.

Comment*:* Page 64, Reference 40: A much more recent reference exists.
Response: ATSDR agrees that a more recent reference exists; however, the data came from Reference 40 because it was the document that was available at the time.

Comment*:* Page 66, 4th Paragraph: It would be good to report measured values.
Response: The text in this paragraph referred to concentrations reported from the air toxics monitor located about 10 to 15 miles northeast of Kelly AFB at 254 Seale Road, San Antonio, Texas. The concentrations are shown below. These values are annual maximum numbers. Detection levels were used when a compound was not detected. This table and the information about the monitor was not included in the revised report (response to peer review comments) because this data was provided for clarification purposes only and do not impact the results and conclusions on past air emissions.

Year	Butadiene		Benzene		Total Risk
	µg/m3	Risk	µg/m3	Risk	
1994	0.17	4.73E-05	2.15	0	0.0000641
1995	0.71*	1.98E-04	1.63	1.27E-05	2.11E-04
1996	0.71*	1.98E-04	1.38	1.08E-05	2.09E-04
1997	0.71*	1.98E-04	1.76	1.37E-05	2.12E-04
1998	0.71*	1.98E-04	1.46	1.14E-05	2.09E-04
1999	0.74	2.07E-04	1.42	0	2.18E-04
2000	0.10	2.93E-05	1.09	0	3.78E-05
2001	0.11	3.15E-05	1.57	1.22E-05	0.0000437
Average	0.49	0	1.56	0	0.000151

Inhalation unit risk used for butadiene = 0.00028 $(\mu g/m^3)^{-1}$

Inhalation unit risk used for benzene = 0.0000078 $(\mu g/m^3)^{-1}$

* Detection level used

***Comment**:* Page 67, 4th Paragraph: What was the logic for only using a 9 hour half-life? This doesn't appear to follow from the table above the paragraph.
Response: ATSDR concurs that the table and text are not clear. 1,3-butadiene is estimated to have a short atmospheric lifetime because of its reactivity. The actual lifetime depends upon the conditions at the time of release. The primary removal mechanisms are through chemical reactions with hydroxyl radicals and ozone. Therefore, factors influencing 1,3-butadiene's atmospheric lifetime, such as the time of day, sunlight intensity, temperature, etc., also include those affecting the availability of hydroxyl radicals and ozone (EPA 1993). The literature reports different half-lives and in many cases, do not specify controlling factors that would influence butadiene degradation. The Table was an attempt to show the half-lives as a function of a single factor.

For the modeling, ATSDR used a report by the California Air Resources Board that stated “[a]tmospheric half-lives of 1 to 9 hours are expected.” (CARB 1997). This range was reasonable to evaluate as 1 hour was near the lower end reported. Nine hours was reasonable to use as a higher value because it is in the range of the higher values. Higher half-lives would not significantly change the concentrations near the base where the population of interest resides because the travel of air emissions time is much faster than 9 hours (Figure A-1 demonstrated this for hexavalent chromium). The model was run with no degradation as a worst case.

ATSDR clarified this in the text and merged this discussion with text in Appendix B under a new section called *Sensitivity Analysis*.

References

EPA 1993. Motor Vehicle-Related Air Toxics Study, April 1993. Technical Support Branch, Emission Planning and Strategies Division, Office of Mobile Sources, Office of Air and Radiation, U.S. Environmental Protection Agency, Washington D.C.

CARB 1997. Toxic Air Contaminant Identification List Summaries, September 1997. Stationary Source Division, Substance Evaluation Section, California Air Resources Board, California Environmental Protection Agency, Sacramento, CA.

Comment*:* Page 69, Table B-8: Again, high risk values are reported and probably need to be discussed more.
Response: Clarification has been added to text.

Appendix E. Response to Public Comments

This appendix consists of the response to comments on the public comment draft of the ATSDR Health Consultation on Past Air at Kelly Air Force Base. The comment period was open from October 12, 2004 to November 30, 2004.

In total, ATSDR received many comments from two individuals. Many of those comments were similar. Within a set of comments, concerns were often repeated, and sometimes the question to be answered was unclear.

To provide responses in this Appendix, ATSDR includes a summary of the concerns. This summary gathers together similar issues, and ATSDR's perception of the comments. Following each summary is ATSDR's response.

This appendix also contains ATSDR responses to technical comments made in a March 29 , 2005, report to the Restoration Advisory Board (RAB) by a contractor under a Technical Assistance for Public Participation (TAPP) grant.

<u>This appendix is organized as follows:</u>

I. **General response to comments**
A number of comments were received that indicate a need for a review of ATSDR's purpose and procedure for conducting activities at a site, the nature of those activities, and specifics about activities at Kelly AFB, which preceded this document release. ATSDR addressed these and other issues during the health assessment process but some individuals providing comments may not have been participants at the time. Therefore, this section provides a summary of the health assessment process and past ATSDR activities.

II. **Response to specific comments**
Many comments were identified as relating to general categories and were addressed together, while other comments were included under miscellaneous concerns. Therefore, comments and responses are sorted into the following categories:
    - Data sources
    - The air dispersion model
    - Regulations, permitting, and compliance
    - Radioactive weapons
    - Exposure and toxicology
    - Miscellaneous concerns

III. **Response to the RAB TAPP grant contractor comments**
Responses to comments made by the contractor during this review are intended to clarify issues identified during the review.

I. General response to comments

ATSDR first conducted site evaluations and community meetings in 1996. Many meetings with community members were held during the first two years of ATSDR involvement, during which concerns were collected and described in the Public Health Assessment for Kelly Air Force Base. With community involvement and participation, health education workshops were held with community members, physicians, and nurses working in the community. During these meetings and workshops, ATSDR described how a health assessment is conducted, what ATSDR could and could not do, what the community should expect from ATSDR's involvement, and health education about toxicology, epidemiology, and environmental health. While repeating these efforts would be prohibitively extensive, comments by community members new to the process indicate a need for reiteration of some of the fundamental concepts of the ATSDR public health assessment process.

ATSDR was asked by the late Congressman Tejada to investigate whether contamination from Kelly AFB could have caused health conditions reported by communities north and southeast of the base. The petition specifies investigation of current health concerns (in 1996) in specific communities and relates to contamination that had potentially moved from the base into those communities. The issue involved contamination from Kelly AFB, not other sources of contamination. Therefore, the investigation focused on these issues and precipitated the East Kelly public health assessment as a separate investigation (requested by the community) as well as specific health consultations on the Tampa Street spill, the DRMO fire, Current Air Emissions Exposure of On-Base Personnel, Past Exposure to Drinking Water from On-Base Wells 313 and 314, Health Outcome Data Evaluation, and Past Air Emissions.

ATSDR's investigation evaluates

1. whether contamination exists,
2. whether the levels of contamination are high enough to be of health concern,
3. whether the contamination has migrated to the community at levels of health concern,
4. whether people come into contact with the contamination, and by what routes of exposure, and
5. whether these exposure would likely result in adverse health effects.

Note that exposure (e.g., breathing, eating or drinking, or skin contact) must occur, and the level must be high enough for a long enough period of time for the contaminants to affect a health outcome.

If ATSDR determines that the described exposures would likely result in adverse health effects, intervention is recommended to reduce or mitigate exposures.

If ATSDR cannot determine whether exposures would likely result in adverse health effects, it recommends further investigation to clarify the possibility of adverse health effects. If possible, further investigations may include additional environmental sampling, biomonitoring, epidemiological investigations, dose reconstruction, or other means of gathering information to support reducing the indeterminate nature of the exposure.

All documents released, including or as a result of the Kelly AFB Public Health Assessment, have been peer-reviewed by an independent panel of scientific experts. Peer-review comments and responses from ATSDR are included in each final document.

At Kelly AFB, ATSDR found that contamination from the base was not *currently* migrating into the community at levels of health concern or that exposure was not occurring. Past air emissions were investigated to estimate potential contaminant levels that may have occurred in the past and to examine the possibility that reported health outcomes could have resulted from past exposures. In this document, ATSDR develops conclusions and makes recommendations for further investigation.

II. Response to specific comments

Data Sources

Comment: Did ATSDR include the paint stripping, plating, and jet test cell operations?
Response: The acquisition of the data used in this report is discussed starting on page 9. In general, the data for industrial emissions came from specific information gathered by the Air Force and its contractors at the request of ATSDR. ATSDR worked with the Air Force and its contractors, which resulted in one initial report and two follow-up reports. These reports were a compilation of buildings, their operations, and the chemicals emitted to the air. The list of buildings and industrial emissions are included in Appendix B, attachment 1 and include paint stripping, plating, and jet test cell operations.

Data for aircraft emissions came from Air Force reports detailing the speciation of emissions from different aircraft engines and general operational characteristics such as the length of time for runway roll. Information on the number of aircraft operations came from the Air Force and the Department of Justice. The source of this information is included in the report.

Comment: Does the Alamo Area Council of Governments have information on past air emissions?
Response: ATSDR reviewed the data available from the Alamo Area Council of Governments (AACG) for past air emissions. The emissions data the AACG compiled include an emissions inventory for a 12-county area for 1996, 1999, and 2002. Because ATSDR's evaluation for past air emissions is for the period prior to 1996, these data are not applicable.

Comment: Did ATSDR consider spills and accidental releases?

Response: ATSDR did consider spills and accidental releases. ATSDR addressed the Tampa Street Spill in a 1997 health consultation (Tampa Street Spill Health Consultation, 1997). Fugitive-type emissions such as routine spills and leaks were included in the emissions inventory and were addressed.

Other non-routine spills were not considered further because of three reasons:

1. the predominant source of long-term exposures was exhaust from routine operation of aircraft,
2. air emissions from spills or accidental releases are intermittent and short-term, and
3. for most spills or accidental releases, data are not available, and the prediction of the emission rate and potential exposure would be subject to more uncertainty than would the modeling completed for industrial and aircraft sources.

Comment: What about emissions from the release of soil vapor to the atmosphere?
Response: This consultation involves past air emissions from the base. Depending on location, volatilization of groundwater was addressed previously in the 1999 Public Health Assessment or will be addressed in the East Kelly report. Emissions from the release of vapor from the soil to the atmosphere are not considered a source of concern because the release rates would be very slow. The vapors from subsurface contamination are a concern if the vapors are trapped in a building such as a house. Soil gas was addressed in the public health assessment. The East Kelly report discusses soil vapor intrusion into homes. Vapors originating from surface spills could be a concern if the soils are saturated and consist of free liquid. The previous paragraph discusses these spills.

Comment: More information on the cyanide incinerator is needed.
Response: The Past Air Emissions health consultation reports that the Air Force stated that the cyanide incinerator actually operated for less than a year, and no data was kept. Mr. William Ryan, USAF, stated to the RAB that information collected about the cyanide incinerator site indicated the site was designated Operable Unit OT-1 from 1977-82 and housed an incinerator. Some have misunderstood this to mean that an incinerator operated during this entire time period. Additional information has been requested from the Air Force, but as yet no data have been located. In the event data are located after the release of this document, ATSDR will evaluate those data.

Comment: Were motor vehicles emissions included?
Response: ATSDR did not model automobile and truck emissions at Kelly because these types of emissions are widespread in urban areas. Therefore, ATSDR focused on the largest contributor of exposure, which were aircraft.

Comment: Why not include the period 1918 to 1960?
Response: The period from 1918 to 1960 was not included because

- There are insufficient environmental data for this period of time.
- Prior to 1970, the Clean Air Act did not regulate hazardous air pollutants. As a result, the time period from 1918 to 1960 could not be studied; practically no information existed and the uncertainty would have been too great.
- Jet engine use increased significantly after 1960.
- The Viet Nam War resulted in substantially increased operations and maintenance at Kelly AFB after 1960.
- The potentially exposed population increased significantly during the late 50s and 60s. The number of residents in the zone of concern for past air emissions (see Figures A1 – A5 and Figure B) was 311 in 1920 and 11,326 in 1960. Most of the residents located in the zone of concern were living in zip code 78237. They represent about one-third of the population in that zip code, while in other zip codes they represent less than 10%. The population residing in and not residing in the zone of concern is depicted in Figure B. The progression of occupancy is displayed in Figures C-1 (1920), C-2 (1940), C-3 (1960), and C-4 (1980). Note that the area defined as North Kelly Gardens is largely unpopulated until after 1960.
- The Texas Department of Health began keeping cancer incidence data and a birth defects registry in 1990. Given a cancer latency period of 20-30 years, this would capture most cancers initiated after 1960, but not before. Birth defects data were not compiled before 1990.

Comment: Comments were made questioning the source of the emissions data used in the dispersion modeling, such as where the data come from, what the data contain, from whom we get the data, under what requirements is it collected, and why references are used instead of actual data. Additional comments questioned why ATSDR puts most data in appendices.
Response: ATSDR does not include all data and narrative from all scientific papers and reports in its documents; it relies on the use of references to document sources of such information. Details from data, scientific papers, and reports are often referenced, and the reader should address those references for desired detail. Relevant data are included in documents if the data are difficult to obtain or they are perceived as necessary to avoid misunderstanding. In this Past Air Emissions health consultation, information about the emissions is included in the appendices so that the narrative of discussion is not interrupted. But it remains within the document for reader convenience.

The Air Dispersion Model

Several comments were made regarding the approach used in the air dispersion model. Environmental emissions and dispersion models are the only way to estimate past air concentrations when air sampling data do not exist, as is the case here. Models have uncertain results because of uncertainties in the data inputs, the approximate nature of the model constructs and parameterizations, and the stochastic nature of atmospheric turbulence. To address the uncertainties, ATSDR's approach is to use a worst-case scenario. In this case, a worst-case scenario included the use of aircraft with the highest emission rates, a high number of aircraft operations, rural dispersion coefficients, and treating all the emissions as a gas (including vapors) as opposed to particulates.

ATSDR used U.S. EPA's Industrial Source Complex (ISC) model because it is a robust model recommended by EPA. The ISC model was recommended for modeling aircraft emissions based on recommendations of ATSDR's contractors who are national experts in air dispersion modeling.

ATSDR did not locate any studies of air toxic dispersion modeling at other military bases in the United States. ATSDR did find an extensive study of air toxics in the area around Midway Airport in Chicago. This study included air emission from aircraft in addition to automobile and truck emissions. ATSDR reviewed this report during the development of the modeling at Kelly AFB. ATSDR did not model automobile and truck emissions at Kelly because these types of emissions are widespread in urban areas.

Regulations, Permitting, and Compliance

Many comments related to environmental regulations, permits, and air emissions compliance. The purpose of the ATSDR public health assessment was <u>not</u> to review the regulatory compliance of Kelly AFB but to identify the type and amount of air emissions, their locations, and the time when the emissions occurred. This information can come from permit and compliance information, as well as worker safety documents, and from manufacturing design and operational documents. ATSDR used all available information.

For the air toxics ATSDR evaluated in this study, it has been ATSDR's experience that the older permitting requirements, generally before 1985, provide information on the type of operation and **indirectly** on the types of chemicals that are emitted. Because of the history of the Clean Air Act and its requirements, environmental regulations, permitting, and compliance information **do not** provide direct information on the types and emission rates of older emissions generally before 1985.

The regulations promulgated under the Clean Air Act (initially signed into law in 1963 and amended numerous times) initially focused on criteria air pollutants (beginning with the 1970 amendments[†]), which included ozone, particulate matter, carbon monoxide, nitrogen dioxide, sulfur dioxide, and lead.

The 1970 Clean Air Act Amendments enacted the first requirements for national emissions standards for hazardous air pollutants (NESHAPS). The NESHAPS in the 1970 amendment applied to new facilities emitting lead, mercury, cadmium, and asbestos. Additional air pollutants have been added through the years. For example,

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[†] The Clean Air Act and other air pollution control legislation prior to 1970 provided no pertinent regulations for hazardous air pollutants as defined by USEPA.

chromium was added in 1985. For a list of these pollutants and applicable dates see Table 1 in this Appendix and 40 CFR §61.01.‡

Aircraft engine emissions controls [40 CFR §87] were required beginning with the 1967 Clean Air Act amendments. Emission limits on hydrocarbons from aircraft engines took effect for all engines manufactured after January 1, 1984. Aircraft engine emission limits for hazardous air pollutants do not exist.

In 1990, the NESHAP standards were amended and reorganized into source categories such as dry cleaners, petroleum refineries, or vegetable oil production. The 1990 amendments specified that these sources meet emission standards based on the maximum achievable control technology (MACT) for each source category. These source categories did not replace but supplemented the pollutant-specific requirement listed in Table 1. What is achievable is based on the best-performing facilities in operation at the time and not the maximum amount of control or minimum amount of risk.

As a result of the Clean Air Act requirements, environmental regulations, permits, and compliance information for hazardous air pollutants prior to 1970 do not exist and are limited to eight hazardous air pollutants from 1970 to approximately 1984. From 1984 to 1985, regulations were added for 25 hazardous air pollutants.

When applicable, information required by the Clean Air Act requirements was reviewed for the emission inventory. This would not have included a review of all compliance events but noncompliance events that would have provided information on the emissions. Based on the different promulgation dates, the requirements were generally limited to after 1985. Before 1970, the Clean Air Act did not regulate hazardous air pollutants. As a result, the time period from 1918 to 1960 could not be studied; practically no information would exist and the uncertainty would have been too great.

Radioactive Weapons

One comment questioned whether ATSDR investigated radioactive weapons exposure such as “broken arrows”. Radioactive issues were covered in three ATSDR reports. Broken arrow is defined as an unexpected event involving nuclear weapons that result in the accidental launching, firing, detonating, theft or loss of the weapon. ATSDR has no knowledge of broken arrow incidents at Kelly AFB.

Exposures and Toxicology

Several comments were concerned with the nature of exposure, possible health outcomes, and calculated risk estimates. Consideration of each of these concerns should begin with premise that exposure does not automatically lead to disease. Contaminants that may cause cancer in some exposure scenarios do not do so with every exposure scenario. The exposure must occur to a high enough concentration of contaminant and present for a sufficient period of time to result in heritable cellular genetic abnormalities. ATSDR

‡ http://www.access.gpo.gov/cgi-bin/cfrassemble.cgi?title=200440

describes exposures that occur above levels believed to be safe from cancer and below levels believed to be a hazard by calculating an estimate of the cancer risk using the site-specific exposure. This calculated risk is an estimate of the likelihood of an exposure resulting in a cancer health effect. This risk is an estimate based on observed effects in animals or human, as available, and extrapolated below observed levels to environmental levels, with adjustments for uncertainties in scientific knowledge and in exposure populations.

Several comments addressed the available toxicological data and the need for more information. ATSDR used the best available scientific information. ATSDR agrees that more research should be conducted to better define the specific health effects expected from human exposure to specific doses of specific chemicals or to combinations of chemicals.

Several comments concerned pregnant workers and children. Issues involving worker exposure are under the authority of the Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH); thus it would not be appropriate for ATSDR to investigate worker exposures in the regulated work environment. Health effects in the fetus from on-base exposures to workers outside the regulated work environment would not be captured in a worker mortality study and may not be captured in health outcome data. As discussed earlier, ATSDR was asked to investigate potential exposures which may have resulted in the health concerns reported in the community. Health effects in the fetus due to on-base maternal exposures outside the regulated work environment would need to be addressed on a case-by-case basis involving follow-up of females working during pregnancy that may have been exposed to contaminants outside the regulated work environment. The Texas Department of State Health Services is investigating adverse birth outcomes around Kelly AFB.

The highest on-base ambient air concentration estimates of benzene and 1, 3-butadiene were approximately double that of the highest off-base concentrations expressed as an average annual concentration. While exposure to this concentration of individual chemical would not be considered a public health hazard, short-term fluctuations from the annual average are unknown, and health effects in the fetus (especially to the combination of chemicals) are unknown. Exposures may have been higher for shorter periods of time, but data are unavailable to discern the specifics. In this health consultation, ATSDR has recommended further investigation of leukemia outcomes (the most recognized health outcome from exposure to benzene and 1, 3-butadiene) in downwind zip codes which have demonstrated elevations in leukemia outcomes, and which were documented in the ATSDR 1999 Kelly Air Force Base Public Health Assessment.

Issues of children's health are addressed in every document as appropriate and as they relate to the contamination addressed in that document. In the Past Air Emissions health consultation, children's issues are contained on pages 13-14, under the heading Susceptible Populations, Children (Child Health Considerations).

One comment was concerned with the report format and questioned why the details were placed in the appendices. ATSDR has organized this report as described in the Foreward: “Information in this document is organized to improve readability by the public by placing methodology and scientific details in appendixes. The main body of the document contains the summary of the public health evaluation with supporting information contained in the appendices.”

Miscellaneous Concerns

Several questions regarded chromium emissions. The evaluation of hexavalent chromium emissions is described in the document and responses to the comments can be found in the document. The conclusions are expressed under the Conclusions section, and recommendations are made to address the indeterminate conclusions in the following Recommendations section.

There were a number of comments not related to past air emissions; they are summarized and addressed here.

Several comments were concerned about omissions from the Past Air Emission health consultation. However, these omissions do not involve past air emissions and were addressed in previous public health assessments and health consultations or will be addressed in the East Kelly public health assessment.

One comment concerned questions raised in response to a presentation by Dr. Warner Reeser to the RAB. ATSDR is not familiar with the presentation by Dr. Reeser, thus it would not be appropriate for ATSDR to comment on questions and comments addressed to Dr. Reeser concerning a presentation he made to the Kelly AFB RAB.

Several comments addressed soil and water issues. Specifically, there were concerns about benzo(a)pyrene concentrations in Zone 3 and the Edwards Aquifer. These concerns have been addressed in the ATSDR 1999 Kelly Air Force Base Public Health Assessment.

A number of comments concerned the use of Agent Orange used on- and off-base as an herbicide. As part of the original public health assessment, ATSDR reviewed on-site soil data for chemicals that comprise Agent Orange, and exposure to those chemicals was not found to be a threat to public health. Off-base use of Agent Orange as an herbicide is beyond the scope of the work related to the Kelly AFB petition.

One comment concerned the use of transformer oils and past studies on them. Any identified spills of transformer oils would have been investigated as part of the environmental restoration program. Research on the health studies of transformer oils is outside the scope of this work. In the past, transformer oils were contaminated with PCBs. The scientific literature is replete with toxicological evaluations of PCBs. The ATSDR toxicological profile provides a summary of this work (the reader is referred to http://www.atsdr.cdc.gov/toxprofiles/tp17.html).

Comments regarding the provision of medical exams and investigation of medical records to clarify the health status of the community are best addressed by health outcome data investigations. ATSDR has made appropriate recommendations for health outcome data investigations.

Comments regarding health education were previously addressed in the General Comments section of this appendix.

Comments made to the RAB by the contractor under the TAPP grant.

Comment: There was no attempt to model exposure concentrations of metals other than Cr off-base.
Response: On page 8, ATSDR states: Contaminants whose past use was similar to current use were not modeled during Phase II if the Phase I modeling did not suggest a public health concern, and if the source location or stack height were also similar.

Comment:. The comparison of residential exposures with occupational exposure values (Table B-8) has critical limitations.
Response: ATSDR was not comparing residential exposures with occupational exposures. ATSDR is providing scientific information in the document for the perspective of the reader, as ATSDR seeks to be unbiased and transparent in the reporting of potential health effects from environmental exposures. To avoid such misunderstandings, ATSDR qualifies occupational exposures on page 50 and on page 68.

Comment: Due to the fact that the data available for this study were not comprehensive (e.g. lack of information on metals, lack of speciation of JP-4 fuel, lack of small particulate matter)…. It would be more appropriate to conclude that individual contaminants present an indeterminate health hazard.
Response: Metals are addressed in the response to the first comment. The speciation assumptions, calculations and sources of information for JP-4 fuel are contained in Appendix B. ATSDR assumed all contamination was available for inhalation regardless of whether it was in a particulate, gas, or vapor phase. ATSDR's conclusions are based on the assumptions specified.

Comment: An <u>indeterminate health hazard</u> conclusion is also warranted based on the fact that apparent chronic non-cancer health hazards have not been acknowledged.
Response: Exceeding a comparison value does not indicate that health effects are likely, but does suggest further evaluation. ATSDR considered chronic non-cancer health hazards and found no apparent health hazard. ATSDR has included additional information in the final report to make the criteria for evaluation more transparent. In addition, an error was made in the comparison value listing for 1,3-butadiene and has been corrected in the final release.

Comment: The cancer risk level for ATSDR CREG values has not been specified.

Response: ATSDR had added this value (1E-06) for continuous lifetime exposures in the final report.

Comment: It is unclear why the chemicals of concern for stationary emissions…were not included in the summary table for both stationary and aircraft emissions (Table B-8).
Response: Because aircraft emissions represented the greatest risk, contributions of the same chemical from industrial emissions were included in the table with aircraft emissions. Other industrial emissions were insignificant compared to aircraft emissions and were not included.

Comment: On page 36, the report specifies that six chemicals from Table B-5 were selected for modeling based on emission rates and toxicity. Additional information regarding the selection process is needed. Were screening criteria applied? If so, which criteria were used and why?
Response: ATSDR selected the individual contaminants with the greatest potential for toxic effects by considering the highest emissions with the most sensitive toxic endpoint for each chemical. These results were obtained during the screening air dispersion model using a single discharge point on the runway for all emissions. As the results of the screening model indicated that a more detailed model was needed and that model subsequently completed, inclusion of the screening information was unnecessary and not included.

Comment: Based on the comparisons presented in Figures B-6 and B-7, it seems as if the levels of benzene and 1,3-butadiene are unacceptably close to "levels in a smoke-filled bar".
Response: ATSDR reported the levels from scientific literature for the reader's perspective. ATSDR is not assessing the health risk in a "smoke-filled bar."

Comment: Data from past hexavalent chromium air emissions (i.e., before 1980) were insufficient to assess public health implications and represent an <u>indeterminate health hazard.</u> This is a very appropriate conclusion. It isn't clear, however, why the data that were available after 1980 weren't used to assess risk to off-base populations during this time period.
Response: On page 8, ATSDR states: Contaminants whose past use was similar to current use were not modeled during Phase II if the Phase I modeling did not suggest a public health concern, and if the source location or stack height were also similar.

Comment: In most risk assessments, a default value of additivity is assumed if specific information is not known about the interactions of the chemicals present in mixtures. Since leukemia is the cancer of concern for benzene, 1,3 butadiene and formaldehyde, it would be appropriate to at least make a calculation of the combined effects of exposure to these three chemicals (based on data presented in Table B-8). …This should be included in the text of the document to emphasize the importance of considering the cumulative effects of multiple chemicals.

Response: ATSDR provided the information both in a table (Table C-1, page 70) and in a discussion, pages 66-69.

Comment: Several comments were made about the meaning of the ATSDR indeterminate health hazard category.
Response: Clarification is provided from ATSDR's Public Health Hazard Categories -

> **CATEGORY C: INDETERMINATE PUBLIC HEALTH HAZARD**
>
> This category is used for sites when a professional judgment on the level of health hazard cannot be made because information critical to such a decision is lacking.
>
> Criteria:
>
> This category is used for sites in which "*critical*" data are *insufficient* with regard to extent of exposure and/or toxicologic properties at estimated exposure levels. The health assessor must determine, using professional judgment, the "criticality" of such data and the **likelihood that the data can be obtained and will be obtained in a timely manner.** Where some data are available, even limited data, the health assessor is encouraged to the extent possible to select other hazard categories and to support their decision with clear narrative that explains the limits of the data and the rationale for the decision.

The rationale used by the health assessor was while individual contaminant levels would not indicate a public health concern, the effect that multiple chemicals (benzene, 1, 3-butadiene, and formaldehyde) may have via the inhalation pathway is unknown. While additivity of the risk estimates of these chemicals does not indicate a public health hazard, the uncertainty in the representative nature of the data as well as potential interactions of these chemicals (benzene, 1,3-butadiene, and formaldehyde have been associated with leukemia outcomes) preclude considering this exposure as no apparent health hazard. In light of the uncertainties and previously published ATSDR reporting of elevated leukemia outcomes in downwind zipcodes, ATSDR considers the exposures as indeterminate because additional activities could be performed to clarify the existence of a public health hazard. Following this rationale, ATSDR recommended further investigation of leukemia outcomes in elevated downwind zipcodes.

Figure A:

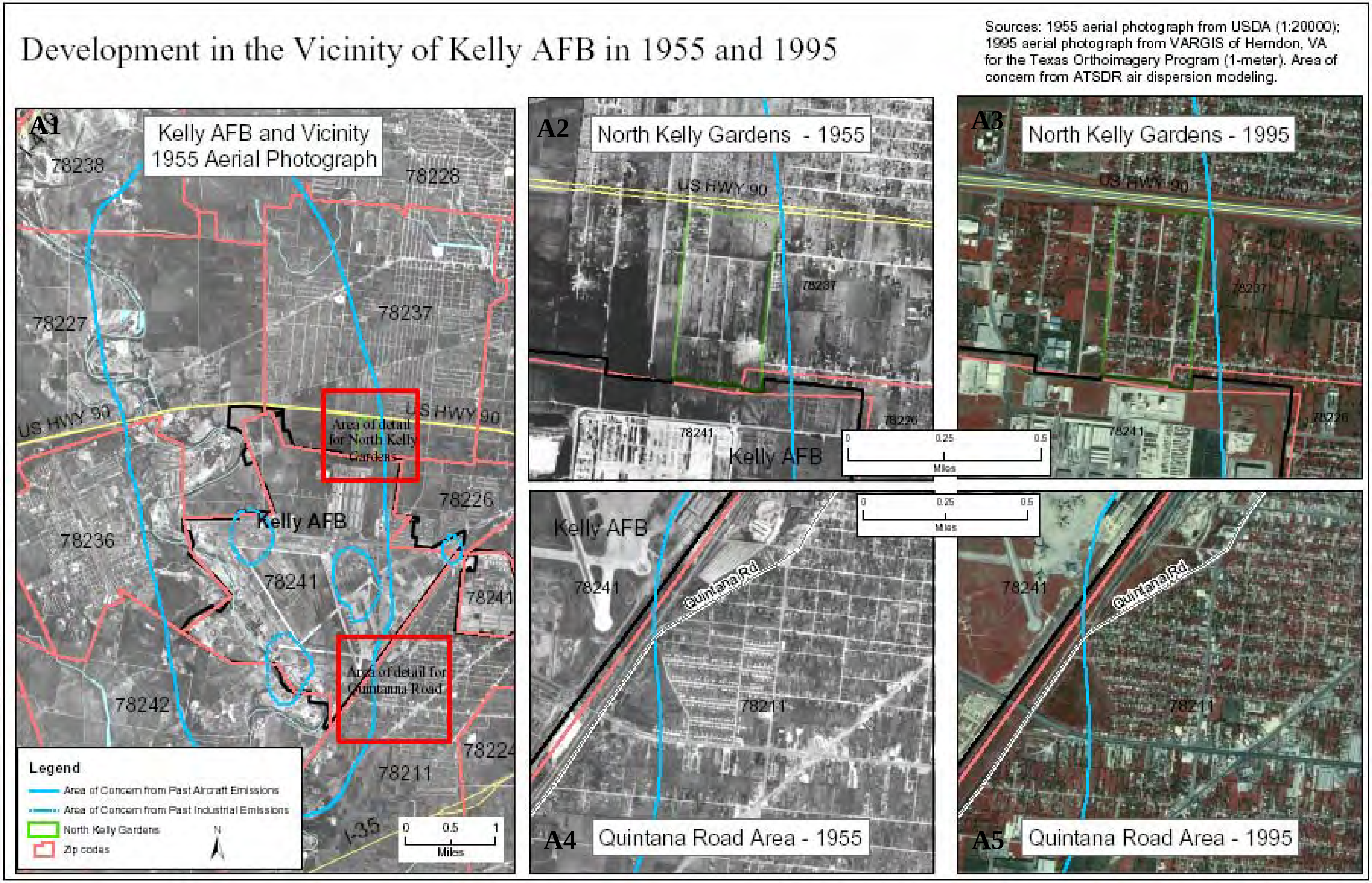
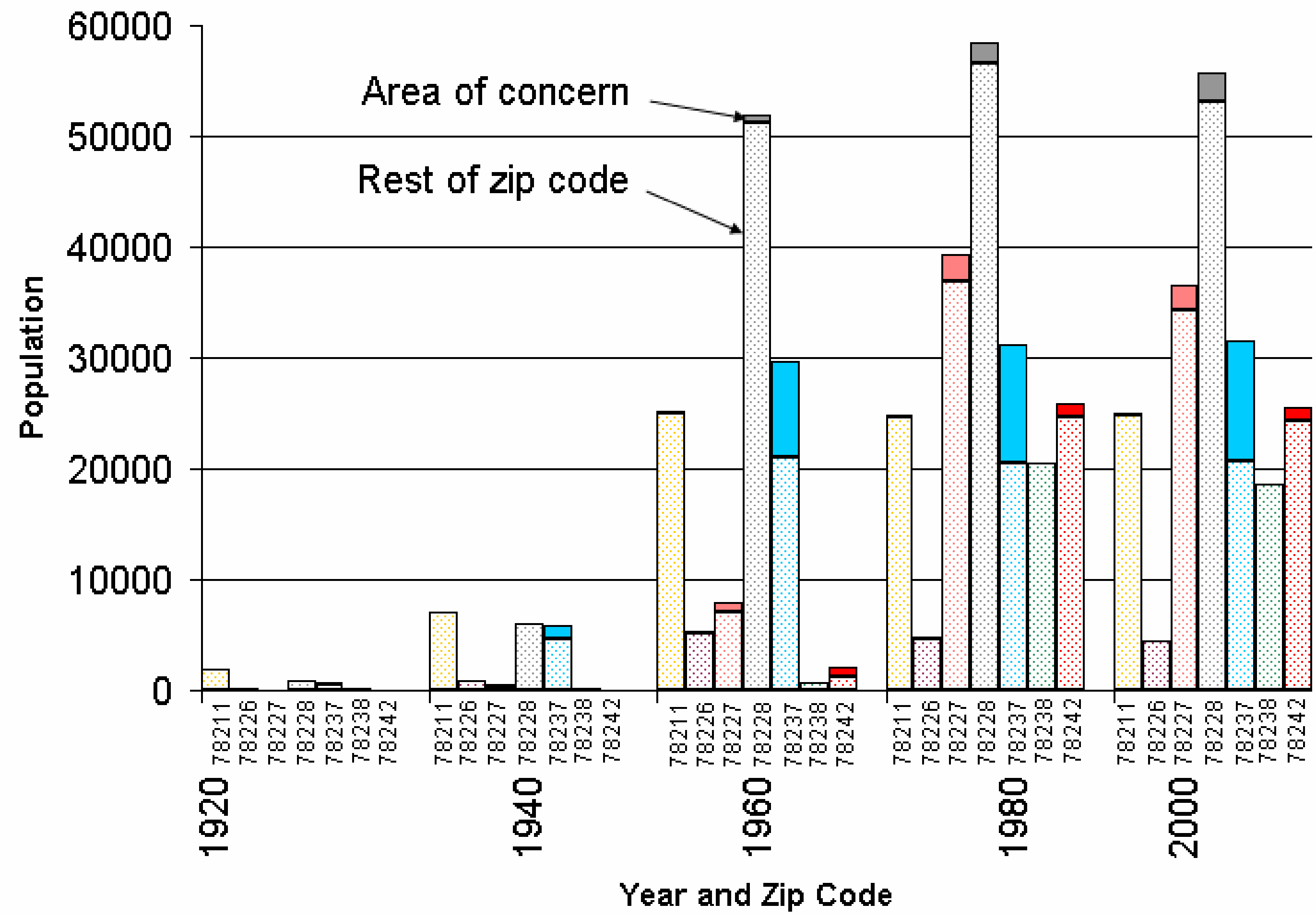
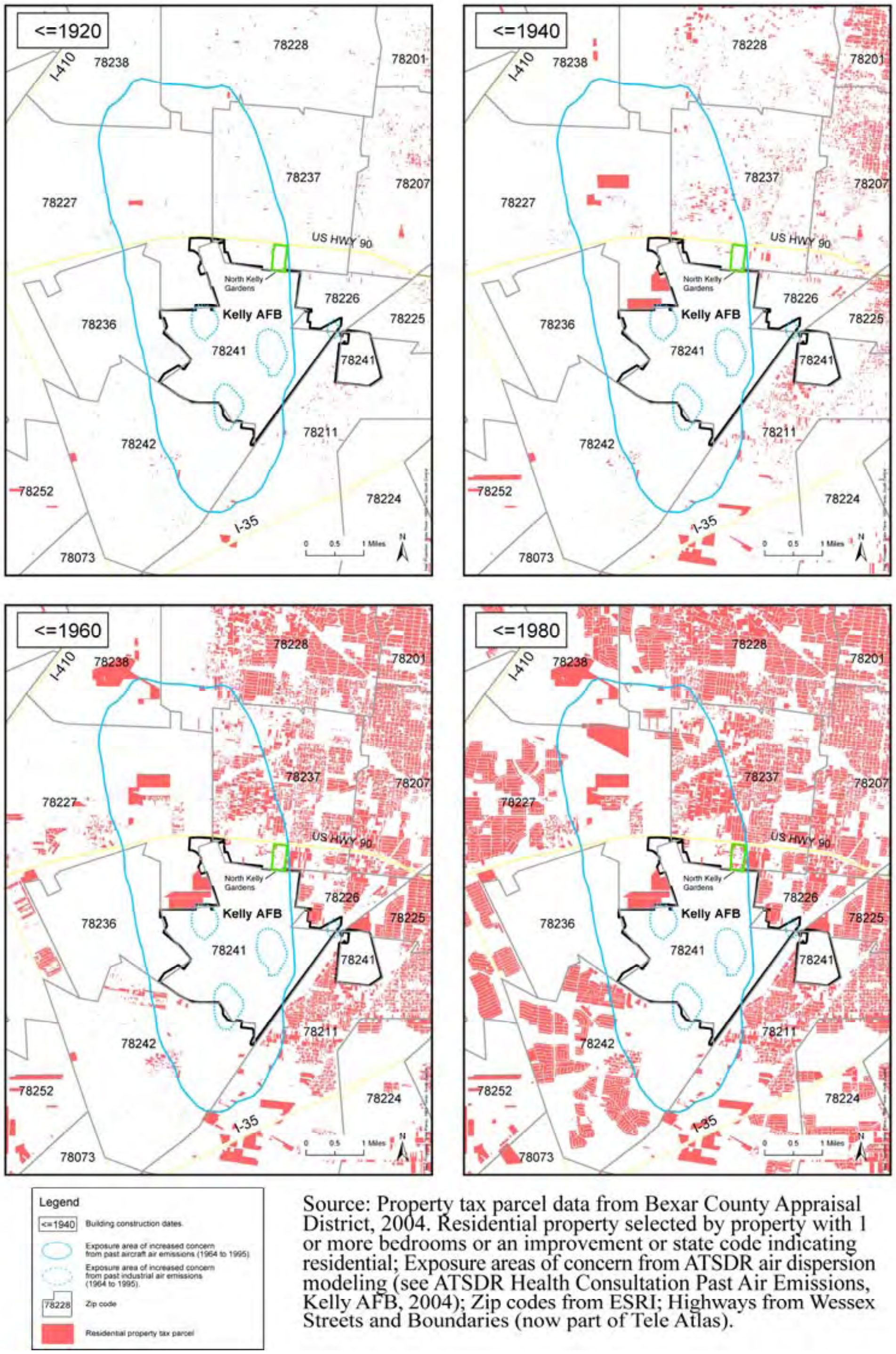

Development in the Vicinity of Kelly AFB in 1955 and 1995
Sources: 1955 aerial photograph from USDA (1:20000); 1995 aerial photograph from VARGIS of Herndon, VA for the Texas Orthoimagery Program (1-meter). Area of concern from ATSDR air dispersion modeling.
A1
Kelly AFB and Vicinity 1955 Aerial Photograph
78238
78228
78227
78237
US HWY 90
US HWY 90
Area of detail for North Kelly Gardens
78226
Kelly AFB
78236
78241
78241
Area of detail for Quintana Road
78242
78224
78211
I-35
Legend
Area of Concern from Past Aircraft Emissions
Area of Concern from Past Industrial Emissions
North Kelly Gardens
Zip codes
N
0 0.5 1
Miles
A2
North Kelly Gardens - 1955
US HWY 90
78237
78241
78226
Kelly AFB
0 0.25 0.5
Miles
A3
North Kelly Gardens - 1995
US HWY 90
78237
78241
78226
0 0.25 0.5
Miles
A4
Kelly AFB
78241
Quintana Rd
78211
Quintana Road Area - 1955
A5
78241
Quintana Rd
78211
Quintana Road Area - 1995

Figure B: Population residing in and outside the area of concern in each zip code.



Note: The population is based on property tax parcel data and the ratio of the number of bedrooms in the zip codes and areas of concern compared to the census population of Bexar County. Zip codes encompassing Lackland AFB (78236) and Kelly AFB (78241) are not included because the tax parcel data does not include military housing. The tax parcel data does not include bedrooms in multiunit buildings. This means that the total number of bedrooms are underestimated. Because the populations are based on the relative number of bedrooms in the county, zip code populations are underestimated and the area of concern populations slightly overestimated.

Figure C: Historical Development of Residential Property Near Kelly AFB



Source: Property tax parcel data from Bexar County Appraisal District, 2004. Residential property selected by property with 1 or more bedrooms or an improvement or state code indicating residential; Exposure areas of concern from ATSDR air dispersion modeling (see ATSDR Health Consultation Past Air Emissions, Kelly AFB, 2004); Zip codes from ESRI; Highways from Wessex Streets and Boundaries (now part of Tele Atlas).

Table 1:

List of Pollutants in 40 CFR Part 61--National Emission Standards For Hazardous Air Pollutants

40 CFR §61.01 (a)
Asbestos (36 FR 5931; Mar. 31, 1971)
Benzene (42 FR 29332; June 8, 1977)
Beryllium (36 FR 5931; Mar. 31, 1971)
Coke Oven Emissions (49 FR 36560; Sept. 18, 1984)
Inorganic Arsenic (45 FR 37886; June 5, 1980)
Mercury (36 FR 5931; Mar. 31, 1971)
Radionuclides (44 FR 76738; Dec. 27, 1979)
Vinyl Chloride (40 FR 59532; Dec. 24, 1975)

40 CFR §61.01 (b)
Acrylonitrile (50 FR 24319; June 10, 1985)
1,3-Butadiene (50 FR 41466; Oct. 10, 1985)
Cadmium (50 FR 42000; Oct. 16, 1985)
Carbon Tetrachloride (50 FR 32621; Aug. 13, 1985)
Chlorinated Benzenes (50 FR 32628; Aug. 13, 1985)
Chlorofluorocarbon--113 (50 FR 24313; June 10, 1985)
Chloroform (50 FR 39626; Sept. 27, 1985)
Chloroprene (50 FR 39632; Sept. 27, 1985)
Chromium (50 FR 24317; June 10, 1985)
Copper (52 FR 5496; Feb. 23, 1987)
Epichlorohydrin (50 FR 24575; June 11, 1985)
Ethylene Dichloride (50 FR 41994; Oct. 16, 1985)
Ethylene Oxide (50 FR 40286; Oct. 2, 1985)
Hexachlorocyclopentadiene (50 FR 40154; Oct. 1, 1985)
Manganese (50 FR 32627; Aug. 13, 1985)
Methyl Chloroform (50 FR 24314; June 10, 1985)
Methylene Chloride (50 FR 42037; Oct. 17, 1985)
Nickel (51 FR 34135; Sept. 25, 1986)
Perchloroethylene (50 FR 52800; Dec. 26, 1985)
Phenol (51 FR 22854; June 23, 1986)
Polycyclic Organic Matter (49 FR 31680; Aug. 8, 1984)
Toluene (49 FR 22195; May 25, 1984)
Trichloroethylene (50 FR 52422; Dec. 23, 1985)
Vinylidene Chloride (50 FR 32632; Aug. 13, 1985)
Zinc and Zinc Oxide (52 FR 32597, Aug. 28, 1987)

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