97-0003901

Department of Energy

Washington, DC 20585

November 25, 1997

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The Honorable John T. Conway
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, N.W.
Suite 700
Washington, D.C. 20004

Dear Mr. Chairman:

This transmits the Fourth Quarterly Report of progress in implementing your Recommendation 94-3 about upgrades to the Rocky Flats plutonium storage facility. Progress continued during the quarter with the completion of the Basis for Interim Operations (BIO) for Building 371, resolution of review comments, submittal of an Implementation Plan for the BIO, and approval of an Authorization Agreement for Building 371. Additionally, conceptual design for a new Interim Storage Vault (ISV) was completed. Copies of the Authorization Agreement and the ISV Conceptual Design Report are enclosed.

Substantial progress was made in completing the Building 371 priority safety upgrades with eight of the fifteen projects complete, and five more on-track for a December 1997 completion. Completion of the remaining two projects will be delayed because of operational impacts with installation and redesign. A new schedule for completion of these projects is being developed. Additional detail is provided in the quarterly report.

This quarterly report was prepared before consideration of your letter of October 15, 1997, on this recommendation. The Department will respond separately to that letter.

Sincerely,

Alvin L. Alm
Assistant Secretary for
Environmental Management

Enclosures
W/O Enclosures
cc:
Mark Whitaker, S-3.1

TAB

Attachment 1
97-RF-05565
12 pages

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

DEFENSE NUCLEAR FACILITIES SAFETY BOARD RECOMMENDATION 94-3

FOURTH QUARTERLY REPORT

Classified By: [signature] (U)

Date : 10-21-97

October 1997

EXECUTIVE SUMMARY

This periodic report provides an update on progress with implementation of the Defense Nuclear Facility Safety Board (DNFSB) Recommendation 94-3. Recommendation 94-3 involves seismic and safety upgrades to the Rocky Flats plutonium storage facility. The Department of energy prepared and transmitted to the DNFSB an Integrated Program Plan (IPP) which made several commitments for future actions and decisions. Progress on those actions and results of decisions are reported in this fourth quarterly report.

DOE-RFFO and Kaiser-Hill (K-H) signed an Authorization Agreement for Building 371 on September 11, 1997, consistent with the commitment made in the recovery plan presented in the second quarterly report. This formal contractual document approves the new Authorization Basis (AB) for the facility, authorizes its implementation, and defines conditions applicable to assuring safe implementation. The new Authorization Basis is in the form of a robust Basis for Interim Operations (BIO). The Authorization Agreement is the culmination of efforts to prepare the BIO Implementation Plan (BIO-IP), the BIO itself, and the Department's Review Report for the BIO.

The BIO-IP, Revision 0, was completed and transmitted to DOE-RFFO on August 20, 1997. The BIO-IP provides for a phased implementation of the new AB. DOE-RFFO requested and K-H agreed to the BIO becoming the AB of record for all Building 371/374 Complex activity by August 1, 1998; this date is the new targeted completion for IPP milestone 3-3. The BIO-IP will be revised in October to incorporate Revision 2 of the BIO and DOE-RFFO comments, including acceleration of implementation of selected Administrative Controls judged to afford substantial improvement over current controls.

Revision 2 of the building 371/374 Complex BIO was completed and delivered to DOE-RFFO on September 10, 1997. This revision resolves the final comments from DOE-RFFO generated during preparation of their Review Report and incorporates corrections identified during finalization of the BIO-IP.

DOE-RFFO issued their Review Report for Revision 2 of the BIO on September 10, 1997. The Review Report summarized the Department's bases for approval of the BIO. There are no directed changes since comments were resolved by Revision 2. Appendix B, however, highlights issues derived from BIO-identified risk-dominant scenarios and requires evaluation of potential measures to achieve further risk reduction prior to the next annual update.

Substantial progress was made in completing the Building 371 priority safety upgrades specified in Table 3-1 of the IPP. Seven additional upgrades were completed so that eight of the fifteen are now in place. Progress on five of the remaining upgrades affords high confidence that they will be completed by December of 1997 per IPP milestone 3-2. Of the remaining two, one appears likely to be extended due to the operational impacts associated with its implementation (sequential shutdown of exhaust filter plenums is required), while the other required a new alternative study when the previously preferred option proved impractical (the supply Isolation Valve approach relied upon backdraft dampers found to be faulty). A new firm schedule for these upgrades is being developed. Additional BIO-required upgrades have been identified and their completion in FY-98 and FY-99 is scheduled in the BIO-IP, completing IPP milestone 3-4.

DOE decided in September that it would be inappropriate to defer the Safety Margin Upgrades based on the criteria specified in the IPP (i.e., to decide not to begin until FY-99 per the footnote in IPP milestone 3-5a). Additional assurance that adequate progress is being made toward early off-site shipment of Site special nuclear material was judged to be warranted to justify deferral. On the other hand, initiating work immediately was judged to entail an inappropriate impact on BIO and BIO-driven upgrade implementation. DOE-HQ is addressing the issue of the safety Margin upgrades, and will report the resolution to the DNFSB in a separate communication.

TABLE OF CONTENTS

1.0 PROGRAM ORGANIZATION

This section corresponds to section one of the IPP. It addresses key changes to the organization identified in that section as modified in subsequent quarterly reports. There have been no changes to the organization presented in the second quarterly report.

2.0 BUILDING 371

This section corresponds with Section 3 of the IPP that focusses on "Goal 1: Establish safe operation of Building 371 in conformance with an updated Authorization Basis (AB)." The following Goal 1 Objectives are specifically addressed: "Provide an updated Building 371 AB, complete definition and implementation of necessary upgrades in Building 371, and establish building operations in conformance with the updated AB."

2.1 Accomplishments and Status Summary

2.1.1 Building 371 Authorization Basis (AB)

The Rocky Flats Environmental Technology Site (Site) continued to make progress toward the achievement of milestone 3-3, "Establish and document operation of Building 371 in conformance with an updated AB by December 1996." DOE-RFFO and Kaiser-Hill (K-H) signed an Authorization Agreement for the Building 371/374 Complex on September 11, 1997, consistent with the commitment made in the recovery plan presented in the second quarterly report. This formal contractual document approves the new AB for the facilities, authorizes its implementation, and defines conditions applicable to assuring safe implementation. The new AB is in the form of a robust Basis for Interim Operation (BIO). The Authorization Agreement is the culmination of efforts to prepare the BIO Implementation Plan (BIO-IP), the BIO itself, and the Department's Review Report for the BIO.

The BIO-IP, Revision 0, was completed and transmitted to DOE-RFFO on August 20, 1997. The BIO-IP provides for implementation of the new AB in four phases, beginning with those Safety Management Programs most consistent with current practice. Subsequent phases invoke the new control set (Limiting Conditions for Operation, Administrative Controls and Design Features) in logical groupings that ensure related controls are implemented in the same phase. DOE-RFFO requested and K-H agreed to the BIO becoming the AB of record for all Building 371/374 Complex activity by August 1, 1998; this date is the new targeted completion for IPP milestone 3-3. The BIO-IP is being revised in October to incorporate Revision 2 of the BIO and DOE-RFFO comments, including acceleration of implementation of selected Administrative Controls judged to afford substantial improvement over current controls.

Revision 2 of the Building 371/374 Complex BIO was completed and delivered to DOE-RFFO on September 10, 1997. This revision resolves the final comments from DOE-RFFO generated during preparation of their Review Report and incorporates corrections identified during finalization of the BIO-IP. Comments served to clarify the control set, consistent with the previously agreed intent, while most corrections ensured that the main body of the BIO was consistent with the control set. One substantive change added an LCO for the HVAC supply isolation valves to complement the credit taken for passive backdraft dampers. Given recent evidence of actual backdraft damper capability, alternative means of limiting potential HVAC supply leakage when exhaust fans are unavailable are being assessed. The preferred concept involves new HEPA filtration in the inlet flow stream. When a concept is finalized, the BIO and BIO-IP will be updated.

The completed BIO fulfills most of the commitments made in the IPP to close the original sub-recommendations 2 and 6. Only if the decision is made to proceed with the safety margin upgrades will additional work be required to complete the Department's commitment regarding these sub-recommendations.

DOE-RFFO issued their Review Report for Revision 2 of the BIO on September 10, 1997. The Review Report summarizes the Department's bases for approval of the BIO. There are no directed changes since comments were resolved by Revision 2. Appendix B, however, highlights issues derived from BIO-identified risk-dominant scenarios and requires evaluation of potential measures to achieve further risk reduction prior to the next annual update. Included are: possible additional credit for an enhanced fire department response strategy, perhaps tied to credited riser flow alarms; evaluation of combustible scrubber tank removal; verification of HEPA filter bypass leakage surveillance sensitivity; enhancement of dock safety, such as by improving ventilation or segregating combustible materials; possible use of metal waste crates; further seismic upgrades; and verification of steps to ensure reliability of vents on the most hazardous drums.

2.1.2 Building 371 Priority Safety Upgrades

Substantial progress was made in completing the Building 371 priority safety upgrades specified in Table 3-1 of the IPP. Seven additional upgrades were completed so that eight of the fifteen are now in place. The completed upgrades include:

Filter Plenum Demister Analysis and Inspections -- a visual inspection of the demister screens in all fourteen plena in Building 371 was completed in April. Based on the inspections, the screens were replaced in plenum FP122 and the screen retaining clips were tightened in plenum FP141. The screens were shown to provide ember removal capability consistent with the requirements of DOE-STD-1066-97.

Combustible Loading Control Program -- a formal Combustible Loading Control Program based on a completed Fire Hazards Analysis (FHA) was established for the facility; the BIO-IP will adjust the control parameters as necessary for full compliance with BIO requirements and will ensure timely implementation.

Fire Doors -- fire doors in BIO-required fire barriers (both Design Features and defense-in-depth barriers) were repaired or replaced as necessary to comply with current requirements; thirteen doors were repaired and nine doors were replaced with over one hundred doors evaluated.

Subsurface Drain System -- two shallow wells were installed at the sub-basement level to provide alternate monitoring and pump-out capability; a weir was installed in each outflow to facilitate monitoring of the normal drain function and the existing cleanouts were extended and labelled for easy access. Procedures for routine monitoring and emergency operation were completed.

Egress Route Upgrades -- consensus egress routes were established and path markers in the facility were modified or repaired accordingly; egress signs were added or modified, stairway gates were repaired or modified, and an unused guard post obstructing the main facility exit was removed.

Life Safety Code Exemption Request -- one permanent and one temporary exemption request were developed, with appropriate compensatory measures, and approved to address egress features not in compliance with the Life Safety Code. The temporary exemption addresses new issues identified in the Fire Hazards Analysis; this exemption will be removed upon completion of corresponding new FY-98 projects.

Implement Stacker Retriever Load Limits -- analyses were completed to identify locations that should be maintained empty to prevent overloading of the rack structure in an earthquake; a total of fifty-four locations were emptied and the stacker/retriever software was modified to prevent future use of the positions.

Progress on five of the remaining upgrades affords high confidence that they will be completed by December of 1997 per IPP Milestone 3-2. These upgrades include: Penetrations for Room 3206 Fire Wall; Seismic HVAC Upgrades; Basement Level Fire Walls; Seismic Bracing for Attic Water Pipes; and Relocate High Risk Residues in Room 3189.

Plenum Deluge System Modifications entail operational impacts due to the need to shutdown affected filter plenums for a portion of the work that appear likely to delay their completion beyond the December of 1997 target.

The last remaining upgrade, involving the HVAC isolation valves, will be closed on an equivalent basis for the exhaust ductwork but may extend into 1998 for the supply ductwork to achieve an appropriate systems engineering solution given recently obtained evidence of the actual capability of the installed backdraft dampers. A test was performed in late August in which all ventilation in Building 371 was secured for several hours (the first time ventilation had been interrupted since the facility initiated operation); no spread of contamination occurred. The test permitted an inspection of the supply backdraft dampers which concluded, contrary to pretest expectations, that they were not suitable for the safety function they had been credited with in the BIO. A new conceptual design is being developed to provide supply HEPA filtration that would obviate reliance on either the backdraft dampers or the supply isolation valves. The design will support a decision to establish a firm course of action.

Immediately upon completion of the K-H sponsored self-assessment of upgrade project activities as reported in the previous quarterly report, DOE-RFFO reconvened their original assessment team to appraise the effectiveness of corrective actions taken. The reassessment noted improvements in the conduct of the project in all areas and identified a few areas for continued improvement, principally involving work package completion and tracking for effective project management. K-H accepted these comments and provided responses. Specific concerns were also identified regarding large fires as analyzed in the BIO; these concerns were addressed in Revision 2 of the BIO and by including an upgrade project for FY-98 to prevent seismic overturning of flammable liquid cabinets.

Additional BIO-required upgrades have been identified and their completion in FY-98 and FY-99 is scheduled in the BIO-IP, completing IPP milestone 3-4. The upgrades and current schedule are presented in Table 2-1. The schedule will be managed with the BIO-IP.

2.2 Deliverables

IPP Milestone 3-2 Report completion of priority safety upgrades specified in Table 3-1 by the end of 1997.

Progress toward upgrade project completion in this quarter makes successful completion of this milestone achievable with the exception noted for the HVAC supply isolation valves and the plenum deluge system modifications. A firm schedule for implementation of the selected alternative for the isolation valve project and for completion of the plenum deluge system modifications will be provided in the next report.

IPP Milestone 3-3 Establish and document operation of Building 371 in conformance with an updated AB by December 1996.

This milestone is now scheduled for August 1, 1998, based on the approved Authorization Agreement of September 11, 1997. The BIO-IP provides a sound roadmap for timely completion.

IPP Milestone 3-4 Issue schedule (implementation plan) for further Building 371 upgrades identified during the initial AB development by November 1996.

The implementation schedule containing all BIO-driven additional upgrades was issued on August 25, 1997, and incorporated into the BIO-IP. This milestone is considered complete.

IPP Milestone 3-5 Report completion of other Building upgrades on the following Schedule:

The schedule for these upgrades is the IPP schedule unless and until DOE determines that sufficient assurance of an early off-site option for Site SNM exists to warrant deferral of the safety margin upgrades for one year.

IPP Milestone 3-6 Reassess the need to complete the other upgrades and inform the Board by September 1998 (Milestone 3-6).

The reassessment will be an ongoing effort as decisions on the disposition of Pu and oxides are reached. The need for these upgrades is dependent upon assurance of alternative offsite shipment or resumption of ISV design and construction. If either of these conditions is met, the upgrades will not be required. Additionally, the completed BIO and the committed BIO upgrades affect the need for and benefits of some of the safety margin upgrades. These impacts will be weighed in the committed reassessment should some upgrades go forward.

2.3 Schedule of Activities

2.3.1 Building 371 Authorization Basis

The BIO and BIO-IP are complete. The BIO-IP is being updated in October to incorporate Revision 2 of the BIO and DOE-RFFO comments on the BIO-IP.

2.3.2 Building 371 Priority Safety Upgrades

The schedule of key milestones for completion of the priority upgrades, including additional upgrades identified by the BIO and its Implementation Plan, includes:

- Eight of the fifteen priority safety upgrades (IPP Table 3-1) are completed as of September 30, 1997.
- All but two of the priority safety upgrades (IPP Table 3-1) will be completed by December 31, 1997.
- Firm schedules for the remaining two priority safety upgrades (IPP Table 3-1, HVAC Isolation Valves and Plenum deluge system Modifications) will be provided in the next quarterly report.
- The BIO-IP provides the schedule for additional upgrades to be completed in FY-98 and FY-99.

TABLE 2-1: BIO-DRIVEN UPGRADES AND SCHEDULE

	UPGRADE ITEM	SCOPE	COMPLETION SCHEDULE
1	Install Emergency Lights	Provide seismically qualified egress emergency lighting (SC-3 function in Administrative Control [AC] 5.9)	JUN 98
2	Evaluate/Reinforce HVAC Ducting	Ensure ducts credited for tertiary confinement have adequate pressure capacity for tornado atmospheric pressure transient or abnormal ventilation lineups	NOV 98
3	Ensure Lightning Protection	Ensure that security systems to prevent helicopter intrusion do not compromise lightning protection for Building 371	DEC 97
4	Inspect/Repair SC-3 Fire Barriers	Apply lessons learned from Room 3206 evaluation as necessary to ensure one-hour capability of fire barriers that are SC-3 in AC 5.9	JUN 98
5	SNM Storage Rack Repairs	Ensure adequate seismic capacity for storage racks used in vault-type material storage rooms (SC-1/2 SNM Storage Racks in AC 5.9)	NOV 98
6	HVAC Interlock Modifications	Ensure safe failure mode (credited as Passive Design Feature in BIO) in EBE for the supply fan trip function and upgrade interlock to trip return fans as well as supply	SEP 98
7	Extend Roof Drains	Improve runoff during extreme weather conditions	APR 99
8	N_2 Failure Prevention Mods	Ensure nitrogen shutoff credited as Passive Design Feature in BIO to prevent Central Storage Vault pressurization after earthquake	FEB 99
9	Counterfeit Bolt Inspection	Review usage of counterfeit bolts and replace any whose capacity will not meet BIO requirements for SC-1/2 systems (94-3 low cost issue)	FEB 98
10	Redundant Zone 3 HVAC Controllers	Provide redundant ΔP controllers in Zone 3/Zone 4 areas for reliable implementation of LCO 3.1, item 6	OCT 98
11	Drain Chemical Storage Tanks	Reduce inventories of KOH and HNO_3 in outdoor storage tanks to meet requirements of AC 5.2.2, items e and f	DEC 97

	UPGRADE ITEM	SCOPE	COMPLETION SCHEDULE
12	Upgrade Vault Penetrations for Fire where Practical	Upgrade central storage vault boundaries to SC-1/2 (2-hour) fire barrier requirements where practical (BIO-IP will otherwise ensure that appropriate combustible control limits are established per AC 5.4.2, item 4c)	JUN 98
13	Repair Attic Beam	Compensate for omitted negative reinforcement at the junction of beams B55 and B56	MAR 98
14	Install Attic Leak Detection	Provide capability to detect and alarm if significant attic flooding occurs	DEC 97
15	Resolve HVAC Supply Isolation Capability	Complete evaluation of HEPA filtration option and implement HEPA filtration or alternative using isolation valve	TBD[1]
16	Miscellaneous BIO Upgrades	a) Install Dock 18T Roll-up Door Interlock b) Verify Seismic Capacity of SC-1/2 HVAC ΔP Sensor Lines c) Provide Lab Propane Tank Seismic Supports d) Complete Any Additional SQUG Walkdowns e) Determine HVAC Scrubber Disposition f) Provide Seismic Restraint for Flammable Liquid Cabinets	DEC 98
17	Life safety Code Upgrades	Correct Deficiencies in B371 (Material Access Area) per Updated Facility Fire Hazards Analysis	NOV 98

[1] A firm schedule will be established when the evaluation is completed and the alternative is selected; the objective will be to finish as close to the original December 1997 schedule for the IPP Priority Upgrade isolation valve project as possible while ensuring that the upgrade implemented is technically sound and more effective than the original isolation valve concept

3.0 INTEGRATED Pu CONSOLIDATION AND MANAGEMENT

This section corresponds with section 4 of the IPP, and follows the sequence of the Programmatic Elements in that section. The IPP states that, "The insights gained on the overall Site risk from residues and the effects of the decision to proceed with the priority Building 371 upgrades and a new ISV are to be integrated with the actions committed to the Board under Recommendation 94-1 to ensure an integrated Site plan for safe Pu management and storage. System engineering principles will be used to develop a strategic plan for residue storage and shipment that incorporates timely consideration of contingencies, such as possible delays in Waste Isolation Pilot Plant (WIPP) opening."

3.1 Accomplishments and Status Summary

As reported in the second quarterly report, the evaluation of alternatives for achieving the IPP-required risk reduction for highly dispersible residues has been completed. Conclusions were issued and incorporated into the Site's 94-1 program plan. The Site Integrated Stabilization and Management Plan (SISMP), Version 7.0, dated July 15, 1997, incorporated the 94-3 residue management recommendations originally incorporated in Revision 6. Included were: pre-stabilization drum removals from Buildings 771 and 776/777 to Building 371; utilization of the pipe overpack container for the TRU waste from dispersible residues after processing; and storage of WIPP-ready waste packages in waste management facilities as necessary outside the Protected Area. Residue storage requirements and the available capacity will be updated as Site planning evolves to ensure residue risk reduction goals can be met.

3.2 Deliverables

IPP Milestone 4-2 Incorporate selected residue alternatives into existing Site programs by April 15, 1997.

Completion of Milestone 4-2 as of March 31, 1997, was reported in the second quarterly report. This milestone is closed.

IPP Milestone 4-3 Establish and document interim storage for the Site's Pu inventory, including residues, by the end of FY-02 in a configuration that reduces Site risk due to Pu (metal, oxides and residues) to a level that is a small fraction of the risk from current Pu holdup.

This milestone is on schedule.

3.3 Schedule of Activities

All current activities related to this task are governed by the SISMP and 94-1. There are no near-term milestones for the 94-3 program.

4.0 INTERIM STORAGE MISSION

This section corresponds with Section 5 of the IPP and addresses the following mission need: "provide safe and secure interim storage of the Site's plutonium metal and oxide inventory, including pits (if still onsite) and any oxide generated due to residue and solution stabilization activities. The interim storage mission is to begin upon completion of the May 2002 commitment for plutonium metal and oxide repackaging to DOE Standard 3013 and continue until the inventory is shipped offsite (goal is no later than 2015)." Chapter 5 focusses on plans to perform an environmental impact evaluation for an Interim Storage Vault, complete predecisional activities, and base any further action (such as ISV design, construction and operation) on the NEPA outcome.

4.1 Accomplishments and Status Summary

As reported in the second quarterly report, DOE issued the Record of Decision for the Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement on January 14, 1997. In this Storage and Disposition ROD, DOE concluded that Site SNM should be shipped to Pantex and Savannah River and thus not require interim storage at Rocky Flats. The DOE elected to make early offsite shipment the preferred option for the ten-year planning that will integrate programs throughout the DOE complex. The DOE also suspended preparation of an Environmental Impact Statement for the ISV (while keeping the option open to recommit to the effort if necessary) and took other actions to prepare for early shipment of Site SNM to Pantex and Savannah River Site (SRS). Work on an ISV for Rocky Flats will not proceed beyond the conceptual design that is nearing completion.

The Conceptual Design Report (CDR) was completed and transmitted to RFFO in July as reported in the last quarterly report.

4.2 Deliverables

Specific deliverables specified by the IPP and the status of each, as related to the ISV are presented below.

IPP Milestone 5-1 Complete NEPA evaluation of alternatives for interim storage by May 1997.

The DOE has terminated efforts to pursue the ISV NEPA evaluation in view of the Record of Decision from the Programmatic Environmental Impact Statement.

IPP Milestone 5-2 Provide ISV design documents, including design criteria, as they are developed and no later than prior to the start of detailed design, including: functional design requirements; and predecisional design reports and drawings. Provide detailed design plans, calculations, drawings and specifications when developed if a decision is made to proceed.

The completed ISV Conceptual Design Report (CDR) is being provided to the DNFSB by the Department.

4.3 Schedule of Activities

The ISV conceptual design is complete.

TAB

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ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

Building 371/374 Complex Authorization Agreement

Authorization Agreement No. RFETS-005

Preamble

The purpose of this Authorization Agreement is to adopt the Building 371/374 Complex Authorization Basis, hereinafter referred to as the AB, and to authorize the performance of activities in the Complex which are enveloped by the analysis in the AB.

On July 1, 1995 Kaiser-Hill Company L.L.C. (Kaiser-Hill) became the integrating management contractor replacing EG&G Rocky Flats, Inc. It is recognized by Kaiser-Hill and DOE-RFFO that (**a**) Building 371/374 Complex facilities were over 20 years old and had system deficiencies from its original intended design capability, (**b**) there was incomplete knowledge and limited reliable/retrievable data regarding its systems and components, (**c**) some Complex systems and components required priority upgrades to perform the interim storage mission in accordance with the Implementation Program Plan for DNFSB Recommendation 94-3, (**d**) the planned Complex mission differs from its original design purpose, and (**e**) additional upgrades were expected to result from the preparation of a new authorization basis document. Based upon these conditions a new authorization basis document, the Building 371/374 Complex Basis for Interim Operation (BIO), was developed using DOE Standard 3011, *Guidance for the Preparation of DOE 5480.22 (TSR) and DOE 5480.23 (SAR) Implementation Plans and* DOE Standard 3009, *Preparation Guide for the U. S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, and is the focus of this agreement.

Agreement

With respect to Building 371/374 Complex, the Department of Energy, Rocky Flats Field Office and Kaiser-Hill agree as follows:

A. All BIO activities and operations conducted in the Complex will be accomplished in accordance with the applicable control set requirements established in the AB. These control set requirements have been demonstrated to be adequate to perform the general and current operations enveloped by the analysis in the AB. During the course of BIO implementation, any additional controls and technical safety requirements (TSRs) that may be needed to safely perform planned activities will be developed and evaluated in accordance with the Activity Control and Nuclear Safety programs described in the AB.

B. The AB contains a graded set of requirements consistent with the requirements in DOE Order 5480.23. The requirements are suitable for implementing Integrated Safety Management for the 371/374 Complex and its planned mission, including storage of special nuclear material until 2002. System Evaluation Reports support the BIO and document the means of assuring compliance with the functional requirements of Complex safety systems, structures, and components. Adherence to these requirements is required by the TSRs. Information copies of changes to the Building 371/374 Complex System Evaluation Report, Section 4.0, 5.0, and 8.0 shall be provided to DOE, RFFO.

C. Applicable federal and state law, including implementing regulations, and all contractual requirements regarding the Building 371/374 Complex remain in force. The safety management controls in Site Program Plans as referenced in Chapter 3 of the BIO, will enhance the ability of Kaiser-Hill to meet the safety management requirements contained in the Orders and Directives listed in Section J, Attachment F, of contract #DE-AC34-95RF00825.

D. The Building 371/374 Complex BIO supersedes previous authorization basis documents for the Complex. Existing Unreviewed Safety Question Determinations (USQDs) were reviewed to determine the valid compensatory measures which must be in place to meet the requirements of the proposed control set and incorporated. Open USQDs and those which may be generated during implementation of the BIO will be addressed in updates to the AB, as necessary.

E. Building 371/374 Complex TSRs and controls will be kept current by Kaiser-Hill including the performance of an annual review. The Kaiser-Hill evaluation processes (e.g., the USQDs and USQ screens) shall be used to add new activities or to make changes to existing activities identified in the AB.

F. Controls in the AB will be implemented in a phased manner as described in the BIO Implementation Plan (IP). An information copy of any changes to the BIO IP shall be provided to DOE, RFFO. The AB for BIO activities will be unambiguous at any stage during the phased implementation. For each phase, a readiness determination will be performed in accordance with established Site protocol which implements DOE Order 425.1, *Startup and Restart of Nuclear Facilities.* As of August 1, 1998, the BIO will be the AB of record for all activities conducted in the Building 371/374 Complex.

G The Department of Energy, Rocky Flats Field Office and Kaiser-Hill conclude that the Building 371/374 Complex BIO adequately documents the operating safety basis and contains controls (TSRs), that when fully implemented, will provide reasonable assurance that the work activities described in the AB can be conducted without endangering the environment or the health and safety of the workers or public. The BIO Review Report developed by the RFFO BIO Review Team using DOE-STD-1104, *Review and Approval of Final Safety Analysis Reports*, documents the technical bases for RFFO approval of the BIO and TSRs.

H. The Building 371 Safeguards and Security Plan provides specific direction for related activities and operations in Building 371.

I. This Authorization Agreement is effective for implementation as of the date of the last signature below and shall remain in effect through the life of contract #DE-AC34-95RF00825, unless extended in writing by both parties.

For Kaiser-Hill Company L. L. C.
Rocky Flats Environmental Technology Site

Robert E. Tiller 9/8/97
Robert G. Card for Date
President

For the Department of Energy
Rocky Flats Field Office

9/11/97
Jessie M. Roberson Date
Manager

TAB

97/3901

RFO F 1325.8

United States Government | Department of Energy

memorandum

Rocky Flats Field Office

DATE: OCT 28 1997

REPLY TO
ATTN OF: MSD:KJK:03745

SUBJECT: Comments on the Interim Storage Vault Conceptual Design Report

TO: Ron E. Williams
Area Project Manager
Kaiser-Hill Company, L.L.C.

Reference: Memo, Williams to Hicks, dtd 7/18/97, 97-RF-03862, subject as above

Attached are comments resulting from a review of the Interim Storage Vault (ISV) Conceptual Design Report (CDR) by the Rocky Flats Field Office (RFFO). Assistant Secretary for Environmental Management Al Alm's direction of February 13, 1997, to suspend consideration of a new storage vault at Rocky Flats is still in effect. Therefore, the RFFO recommends that Kaiser-Hill (K-H) not use resources to incorporate the attached comments into the CDR at this point. Rather, the comments should be attached to the CDR and addressed by K-H if the RFFO is directed to proceed with the ISV.

This technical direction is not intended to impact the cost, schedule, or scope of the contract. If you believe there will be such an impact, you should immediately notify the Contracting Officer's Representative and the Contracting Officer, and not implement the technical direction received.

Keith A. Klein
Deputy Manager for Technical Programs

Attachment

cc w/Att:
K. Keenan, MSD, RFFO

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Attachment

Comments Resulting from a Review of the Interim Storage Vault Conceptual Design Report Conducted by the Rocky Flats Field Office

It should be noted that since the CDR was developed only as a contingency, and will not be issued unless directed by the Assistant Secretary for Environmental Restoration and Waste Management, these comments will simply be included in the package and resolution of the comments will be achieved prior to an solicitation for bid for construction of the vault, if ever deemed necessary.

1) The Special Notice disclaimer in the front of the document would need some explicit clarification of what in the CDR is "sensitive commercial information" before the CDR could form the basis for a competitive procurement action.
2) Safeguard and Security requirements are not addressed in the CDR (purposely) and close coordination with the S&S office would be required before any further action was taken.
3) Appendix 1.12.5 identifies several issues which were considered beyond the scope of the CDR. A cost estimate, including contingency, will have to be developed for these items.
4) The lack of ability of the passive system to satisfy the 100° C maximum temperature limit required by DOE-STD-3013-96 will have to be addressed.
5) Project Scope on page 3 of 7 of the Estimate Basis section of the Cost Estimate should be revised to reflect the change in scope of the CDR that is addressed in the transmittal letter from Kaiser-Hill to the RFFO.

These comments are a result of review by Contracts, Engineering and Safeguards and Security, and were coordinated by the Nuclear Materials Group (NMG) under the Assistant Manager for Material Stabilization and Disposition. Any questions should be addressed to the NMG.

97/3901

ROCKY FLATS ENGINEERS
& CONSTRUCTORS, LLC

VOLUME 1
Revision 0
May 8, 1997

CONCEPTUAL DESIGN REPORT
INTERIM STORAGE VAULT

for the
Rocky Flats Environmental Technology Site
Golden, Colorado

Task Order 72

for the
U. S. Department of Energy
Rocky Flats Operations Office
Golden, Colorado

COLORADO REGISTERED PROFESSIONAL ENGINEER RICHARD L. SANCHEZ 20366
5/9/97

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Prepared by
Rocky Flats Engineers and Constructors, LLC
Denver, Colorado

May 1997

REVIEWED FOR CLASSIFICATION
BY J. F. Jeachum (UCNI)
DATE 5/9/97

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SPECIAL NOTICE

LIST OF SECTIONS
INTERIM STORAGE VAULT

SUMMARY

of the
Conceptual Design Report

for the
Interim Storage Vault

for the
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SUMMARY

This Conceptual Design Report is prepared to support further development of the passive storage vault option for the Integrated Program Plan of the Defense Nuclear Facility Safety Board Recommendation 94-3 for interim storage of plutonium material at the Rocky Flats Environmental Technology Site (RFETS). The Interim Storage Vault (ISV) will provide safe, secure, temporary storage for plutonium material prior to final offsite disposition beginning in 2015 at the Savannah River Site and Pantex. The ISV is being considered for the interim storage mission, primarily because of its operational reliability, security, and cost advantages over the option to upgrade Building 371 for this purpose.

The ISV is projected to offer the following benefits over other options for interim storage:

- Reduced operating costs in areas of security, confinement, repackaging, capabilities, and safeguards;
- Limited need for infrastructure, maintenance and operations staff, and training and certification requirements, which supports the objectives of the RFETS 10-Year Plan, Draft 2.0, February 27, 1997, Case 2 that calls for demolition of most site facilities before the interim storage mission is complete; and
- An operational mission of only storage of sealed special nuclear materials (SNM) containers. This will minimize the requirements for security, safeguards, support systems, such as ventilation cooling and electrical power, and operations and maintenance costs.

The ISV design concept is based on the following assumptions:

- No processing will take place at the ISV. Stored material will arrive in a sealed storage tube containing 3013 containers. If pits are stored in the vault, they will be stored in AL-R8 containers in a separate vault area (details of this area will not be discussed in this report);
- Material accountability will take place in Building 371 prior to shipment to the ISV by truck. Transfer activities will be monitored en route and during unloading operations;
- No material will be received from outside the site, with the exception of material from leaking containers, which may be returned to the ISV following container repair;
- All plutonium metal and oxides except classified material (e.g., pits) will be placed under International Atomic Energy Authority (IAEA) safeguards;
- The facility will be designed for a minimum storage duration of 15 years with a design life of 50 years;
- The temperature of the stored plutonium metal will be below 100°C, per DOE-STD-3013-96. The building will be designed to remove heat by the use of natural convection with no high-efficiency particulate air (HEPA) filtration;
- The structure will meet the Performance Category 4 (PC-4) requirements for earthquake resistance; and

- Safeguards will be based upon a strategy of denial. The ISV will be constructed with significant delay features, plus reliable and effective detection and assessment systems that will deny access to subversives.

The total life cycle costs for the ISV are estimated to be $709 million for an assumed mission to 2015. The current schedule calls for title design to begin the first quarter of Fiscal Year 1999 in order for the facility to be operational by September 2002.

DESIGN CONCEPT

of the
Conceptual Design Report

for the
Interim Storage Vault

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1.1 GENERAL DESCRIPTION OF THE PROJECT

This Conceptual Design Report (CDR) is part of the conceptualization process supporting the U.S. Department of Energy's (DOE's) decision to proceed with the design of a new Interim Storage Vault (ISV) and supporting facilities to provide temporary storage of the plutonium inventory at the Rocky Flats Environmental Technology Site (RFETS). Interim storage is needed for the current inventory of plutonium, after it has been repackaged in suitable containers (scheduled to be completed by 2002), and until offsite shipment is complete. The plutonium inventory will be shipped offsite for final disposition, with shipments beginning in 2015.

The specific mission of the ISV is to provide safe, secure storage for nuclear material for up to 15 years with a design life of 50 years. The primary activities associated with nuclear material storage include shipping and receiving, inventory, storage, and surveillance. Other design considerations of the vault are to protect the public, environment, and workers.

The ISV will be a mostly underground, two-story concrete structure with a gross area of about 78,000 square feet (sq ft). The lower level will be below grade while the upper level will be bermed and covered with 15 ft of soil over a concrete roof. The facility will consist of a truck dock loading/unloading area, a material staging area, charging rooms, a vault storage area, and all necessary support rooms.

The recommended location of the facility is between Building 131 and 460 at RFETS. This location is currently occupied by buildings, trailers, utilities, paving, and fencing, all of which will have to be removed. Buildings 110, 119, 126, and 128 will also be removed. Utilities serving these buildings and trailers will be removed and those utilities traversing the site will be relocated. The RFETS site is seismically stable. The structure will meet the highest performance category (PC-4) for earthquake resistance in accordance with DOE-STD-1020-94, with a probability of 10^{-6}/yr.

The vault will be capable of storing the site inventory of plutonium metal and oxides in type 3013 containers (DOE-STD-3013-96). Pits are a special form of metal and will be stored in a separate vault area in AL-R8 containers if they cannot be transferred to Pantex. Eight 3013 containers will be housed in a carbon steel storage tube that is 18 inches in diameter by 13 ft 9 inches in length. Containers will be placed in a steel cage within the tube with a spacing of 6 inches between containers. The 3013 containers are designed with a material container inside a boundary container so that when they are packaged in the storage tube, a triple containment is achieved.

Storage tube loading will occur in Building 371. The tubes will be trucked to the ISV where they will be lowered through penetrations in the charging room floor and stored vertically in the vault storage area (similar to a test tube rack). Removal of decay heat to satisfy plutonium metal temperature limits will be provided by passive convection cooling, without high-efficiency particulate air (HEPA) filtration, in the vault area below the charge floor, using large concrete intake and exhaust ducts. Temperature control for other areas of the building will be provided by an active ventilation system for human occupancy. Single stage HEPA filtration will be provided on the intake and exhaust of all active ventilation systems (except in the outer accessway) as a defense in depth measure.

Containers and storage tubes will be monitored by a leak detection instrumentation suite during all phases of tube packaging, transfer to the ISV, and storage for the 15-year interim storage period. The suite includes instrumentation for monitoring the containers and storage tubes in-situ, a data collection system, devices for Material Control and Accountability (MC&A), and systems for satisfying International Atomic Energy Authority (IAEA) safeguards and verification requirements. It is assumed that packaging facility management will perform a material accountability inventory of nuclear material per DOE Order 5633.3B, Control and Accountability of Nuclear Materials, as material is being loaded into the storage tubes. The control system will be designed to monitor transfer activities and detect unauthorized removal of material during transfers.

1.2 JUSTIFICATION

The Defense Nuclear Facility Safety Board (DNFSB) issued Recommendation 94-3 to address deficiencies in the ongoing effort to ensure the ability of Building 371 to perform a plutonium storage mission. Recommendation 94-3 was issued under the premise that Building 371 would be the interim storage facility, based upon the DOE position at the time. The DOE developed a two-phase approach to address the recommendation.

During Phase I, the suitability of Building 371 for the storage mission was determined, and alternatives for interim storage were explored. The Phase I studies resulted in two options being carried forward to further development. Option 1 was the construction of a new ISV, and Option 2 was the continued use of Building 371 after upgrades. The Phase I studies supported the construction of a new vault based upon reliability, security, and life-cycle costs. The capital cost estimate for the ISV was based on scaling of the capital cost estimate from the Los Alamos Conceptual Design Report for a Nuclear Materials Storage Facility Renovation Project. Operations and maintenance costs were based on current operational data from Building 371 and preliminary estimates of future reductions assuming mission simplification.

The second phase of the response to the DNFSB's Recommendation described the plans and actions necessary to support the DOE's decision on the interim storage facility. The objective of Phase II was to further develop both the new passive storage vault and the upgraded Building 371 options with emphasis on strengthening the decision basis. For the ISV, the Phase II studies provided a pre-conceptual design for a new vault, with quantities provided by the designers. The operations and maintenance costs were based on assumed processes for packaging, shipping, receiving, handling, inventorying, and security.

The Phase II reports concluded that the ISV was preferable to upgrading Building 371 because of lower life-cycle costs and significantly improved safety and security margins over an upgraded Building 371.

With DOE's decision to proceed with the design of the ISV on March 18, 1996, the Integrated Program Plan addressed the steps needed to proceed with design and construction, using a systems engineering approach. This systems engineering approach has basic elements that address the entire project life cycle. They are a mission definition, functional requirements, conceptualization execution (design, construction, and commissioning), operations, and closure (decontamination and decommissioning). Some of these elements, i.e., mission definition, functional requirements, and some conceptualization, have already been performed during Phases I and II. The CDR is part of the conceptualization process, prior to title design, in which the design is further developed to reduce the uncertainty in the cost and schedule estimates. The CDR provides the DOE with the basis to proceed with title design.

1.3 RELATIONSHIP TO OTHER PROJECTS

The ISV project will support the objectives of the RFETS 10-Year Plan, Draft 2.0, February 27, 1997, Case 2. The design of the ISV endeavors to provide systems and components that limit the need for infrastructure, maintenance, and operations staff with a corresponding reduction in training and certification requirements.

The ISV project is directly related to the Plutonium Stabilization and Packaging System (PuSPS), DOE contract DE-AC03-96SF20948. The objective of that project is to stabilize and package plutonium metals and oxides, as well as other selected isotopes in accordance with the requirements of DOE-STD-3013-96 for safe storage of these materials for 50 years. That system will support completion of a stabilization and packaging campaign of the plutonium inventory at a number of affected sites, including RFETS, by the year 2002. The storage package will be standard for all sites and will provide a minimum of two uncontaminated, organics-free confinement barriers for the packaged material. This container will be used without modification in the ISV packaging and storage concept.

1.4 ALTERNATIVES

DOE issued the Record of Decision for the Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmental Impact Statement on January 14,1997. In this Storage and Disposition ROD,DOE concluded that Site SNM should be shipped to Pantex and Savannah River and thus not require interim storage at Rocky Flats. DOE elected to make early off-site shipment the preferred option for the ten-year planning that was to integrate programs throughout the DOE complex. As a result, the Assistant Secretary for Environmental Management issued a memo in February suspending ongoing preparation of an Environmental Impact Statement for the ISV and took other actions to prepare for early shipment of Site SNM to Pantex and Savannah River Site (SRS).

Thus, the Department has taken the position that the best solution for the interim storage of Site Pu is to ship the material off-site to DOE facilities, which are expected to remain active.

The ISV will be an option should off-site shipment encounter unexpected obstacles. Work on the ISV in addition to this CDR will be placed on hold unless and until a decision is made to resume the ISV project.

1.5 DESIGN CONCEPT

1.5.1 Project Design Description

1.5.1.1 Civil/Structural

1.5.1.1.1 Civil

The ISV site is located at the southwest portion of RFETS, between Buildings 131 and 460 on the west and east, and Central Ave. and Cactus Ave. on the north and south (reference Drawings C101-C105). The site is approximately 16.5 acres and will contain an earth-covered building of 78,000 sq ft, surrounded by an 8-ft-high fence and 10-ft-high berm. Current grade slopes from west to east at 2 percent. The site was selected in accordance with requirements of DOE Order 6430.1A, Section 0200-1.1, the process and results of which are documented in the Site Selection Study, Appendix 1.12.1 of this CDR. The site currently contains buildings, trailers, utilities, and paving. The RFETS 10-Year Plan indicates all the facilities on the proposed site are to be demolished in the year 2003 or later. Since this project will be constructed in 2000, the scope will include removal of all existing facilities on this site (reference Section 1.5.9.1, Site Demolition).

The building will require fire protection water, sanitary sewer, storm sewer, electrical service, and telephone. All these utilities are currently available onsite; however, during the 15-year operational life of the ISV, the wastewater treatment facility and portions of the water system are scheduled to be dismantled. Construction of this facility will require that these utilities remain in service. Utilities are further discussed in Section 1.5.9.2, Site Preparation.

The site will be graded to take advantage of the natural slope. Site drainage will be accomplished by overland flow and culverts where required (see Section 1.5.9.2).

Fencing the site will separate this facility from the rest of RFETS. The fenced area will also include elevated and at-grade water tanks, 215A and 215B. Just south of this area, the fence will intersect Building 124, the Water Treatment Facility. The fence will be 8 ft in height with outriggers, constructed in accordance with Rocky Flats Standard SC-102. There will be one double leaf gate for vehicular traffic, and a single gate for pedestrians at the main entrance on the north side of the site.

The building will be served by a 24-ft-wide asphalt road, entering from the north, curving around the east side of the building, to the entrance on the south. Since the vehicles transporting the tubes must back into the truck accessway, a turn-around area is provided. Final design of the roadway will be completed under title design; however, this task assumes a base course thickness of 12 inches and a pavement thickness of 4 inches. The roadway will be approximately at finish grade to allow surface water to run across the road. The roadway will be striped with 4-inch white edge lines.

1.5.1.1.2 Structural

1) General Description

The building for the conceptual design is assumed to be constructed of conventionally reinforced, poured-in-place concrete. The main level will be located at existing grade. The above grade structure will then have engineered soil placed on top of and bermed against the walls and roof, providing a minimum 15-ft cover. The lower level, the tube storage vaults, will be below adjacent existing grade. Concrete intake and exhaust ducts are provided to passively cool the tubes. The intake ducts extend from the vaults 80 ft to the west to grade, and the exhaust ducts rise vertically 21 ft above the berm. Truck and personnel accesses will "tunnel" through the berm from the main facility. Concrete retaining walls will be required at entrances and at the intake ducts (reference Drawings C301-C306).

The roof and main floor structure are framed with one-way slabs and beams. The beams are supported by 5 ft x 3 ft concrete columns. Bays in the storage/vault areas are 14 ft x 32.5 ft. The support areas typically are 20 ft x 39 ft and are framed with one-way slabs and 18-inch bearing walls. Ceiling heights vary from 21 ft in the storage areas, 12.7 ft in the vaults, to 11 ft in the support areas. Foundations consist of a 6 ft-thick mat at the storage vaults, a 4 ft mat at the support areas, and a 3 ft mat at the intake ducts. All mat foundations are poured on grade. Preliminary design during this phase analyzed the building as supported by 60-inch diameter piers founded in bedrock. The dynamic analysis indicated the piers would be significantly overstressed in axial load, shear, and bending. The decision was made to use a mat foundation, as is currently reflected by this report.

Lateral loads are transferred to vertical resisting elements by diaphragms at all horizontal levels: roofs, floors, and base slabs. Lateral loads at the storage/vault areas are transferred to foundations and soil by shear walls at grids D, E, and G in the north/south direction, and shear walls at grids 2, 14, 15, and 27 in the east/west direction. The shear wall at grid G is present at the main level only; at the basement level, 5 ft by 3 ft concrete columns act with beams to transfer loads by frame action. The support areas have shear walls located in both directions to adequately transfer lateral loads. The intake duct is framed with shear walls in the east/west direction and relies on frame action between walls and slabs in the north/south direction. Diaphragms and shear walls will require boundary elements. Shears will be distributed to resisting elements in proportion to their relative stiffness.

All roofs, floors, walls, and mats exposed to the exterior will be a minimum of 36 inches thick, with five layers of reinforcement to satisfy security requirements. Additional reinforcement was added in outer layers for flexure and shear as analysis dictated.

The storage tubes, which will contain the 3013 and AL-R8 containers, will be supported vertically and laterally at the basement floor level, and laterally at the main floor level.

Main doors are 36-inch reinforced concrete, with a steel plate skin.

The structure, systems, and components are classified as PC-4 in accordance with DOE-STD-1020-94.

2) Design Loads

The conceptual design of the ISV is based on the evaluation of the following natural phenomena and man-made hazards:

- Wind (straight and tornado),
- Snow, and
- Seismic.

Per DOE-STD-1020-94, flood must also be considered; however, the Site Safety Analysis Report (SAR) states that this is not a credible event. Both straight wind and tornado loads were also considered. However, since the straight wind velocity is 180 mph and the tornado design velocity is 185 mph, only straight wind was taken into account for this effort.

The Site SAR also indicates lightning, range fires, and aircraft crash can be credible events. Because of the proposed construction materials and the fact that the facility is 95 percent buried, lightning and range fires were determined not to be a consideration in the design. The Conceptual Safety Report found the aircraft crash not to be a credible event for this facility.

Design loads used for the conceptual design are as follows:

- Dead Load - weights of materials in accordance with ASCE 7-96.
- Live Load - 100 pounds per square foot (psf) for all occupied areas and top of berm.
- Snow Load - 30 psf in accordance with Site SAR.
- Wind Load - straight wind velocity = 180 miles per hour (mph).
    - i) Tornado velocity = 185 mph.
    - ii) Missile criteria in accordance with DOE-STD-1020-94.
    - iii) Importance factor = 1.0 (Kaiser-Hill, 1996).
    - iv) Negative atmospheric pressure change was not considered.
- Seismic Load - see Item 3, Seismic Analysis (below).
- Hydrostatic Load - groundwater level at existing site grade (from RFETS, 1996, Section 3.3.4).
- Soil Load - soil unit weight = 130 pounds per cubic foot (pcf) (see Section 1.5.1.3, Geotechnical).

3) Seismic Analysis

a) General

In accordance with DOE-STD-1020-94 , the ISV conceptual design was based on a dynamic analysis approach, analyzing the main vault area bounded by column centerlines D and G. Additionally, since this is a major structure and the median soil stiffness at the foundation/base slab interface has a corresponding shear wave velocity of less than 3,500 feet per second (fps), soil-structure interaction was included.

Input for earthquake motion can be represented as a response spectrum or an acceleration time history. Attachment 3 in the ISV Statement of Work (Kaiser-Hill, 1996) directs that the conceptual design be based on a response spectrum that was prepared for Building 371. This analysis has been based on the referenced curve (see Section 1.5.1.3.7 of this CDR).

The analysis can use either of two methods: the direct method or the impedance-function approach. Because of the limited geotechnical information available at this phase and since the above referenced spectrum is to be used, the impedance-function approach was chosen.

b) Analysis

The impedance-function approach is limited to linear or equivalent linear analysis, since it is based on the principle of superposition. The approach, as applied to this project, is composed of three steps:

- Determination of foundation input motion,
- Determination of impedance functions, and
- Analysis of the coupled soil-structure system.

Determination of foundation input motion, sometimes called the kinematic interaction problem or determination of the response of a massless foundation, is obtained from the direct method with the assumptions that the foundation is rigid and the structure is massless. The seismic ground motion to be applied in the impedance-function approach should be at the embedded foundation interface. The response spectra as provided is taken at the free field surface. If this surface ground response spectrum is applied to the structure with impedance functions, the kinematic interaction effects are ignored or, in other words, the structure is a surface structure on a soil with linear elastic properties. This approach only considers the inertial interaction effects. Since this ISV building is not deeply embedded, the inertial interaction analysis, in general, will give conservative results, according to ASCE (1975).

Determination of impedance functions require defining the force-displacement characteristics of the soil. In general, the impedance functions will be composed of complex values and will be frequency dependent. They are dependent on the soil configuration and material behavior, the frequency of the seismic excitation, and the geometry of the foundation. Since the foundation shape of the ISV building is neither rectangular nor circular, the frequency dependent elastic half-space impedance for rectangular and circular footing presented in DOE-STD-1020-94 cannot be used. ASCE (1975) indicates that the results from an inertial interaction analysis with frequency independent impedance can be conservative compared with the results from the complete analysis with frequency dependent impedance. Since the bedrock at the ISV site is about 30 ft below the grade, which is relatively shallow, the elastic half-space impedance function presented in DOE-STD-1020 is not adequate to be used for this application. ASCE indicates that the results from an inertial interaction analysis with frequency independent impedance can be conservative compared with the results from the complete analysis with frequency dependent impedance. Therefore, to include the soil-structure interaction at this conceptual design stage, the linear elastic 3-D solid element will be used to model the soil foundation. In order to have a reasonable impedance function for the soil, the soil foundation will be modeled to bedrock in the vertical direction, and extends horizontally 300 ft and 200 ft outside the base of building in north/south and east/west direction, respectively.

c) Modeling

In the dynamic seismic analysis, the characteristics of the structure are represented by a mathematical model. This model describes the stiffness and mass characteristics of the structure as well as support conditions. This project used 3-D finite elements to create the mathematical model. The plate element was used to model walls and slabs, and the beam element was used for concrete beams, columns, and individual storage tubes. In general, one-half the mass of the tubes in each bay were placed at the charge floor level, and one half at the basement level. Individual tube models were placed between floors, and at four locations within the building. By combining the structure and soil model together, the ground response spectrum from the Statement of Work (RFEC, 1996) is then applied to the model to perform the analysis of coupled soil-structure system. The analysis was performed using the microcomputer-based finite element code ANSYS. This code performs linear, nonlinear, and modal dynamic analyses of mass/stiffness models of structures. The finite element analysis method is thoroughly documented in the ANSYS User's Manual. The code is qualified for use on the project in accordance with ENG-DIR 93-003.

d) Output

Output to the ANSYS analysis used the load combinations as described below in Item 4, Design Methods. The resultant loads, moments, and shears were compared with calculated member capacities.

4) Design Methods

Capacities of structural elements were calculated in accordance with ACI 349 Code Requirements for Nuclear Safety Related Concrete Structures and DOE-STD-1020-94. Load combinations used are as follows:

- U = D + L + Ess + Hd
- U = D + Lu + Ess + Hw

where D and L are dead and 100 percent of all live loads, respectively, Lu is 100 percent of live load on main floor and roof only, Ess is the safe shutdown earthquake, Hd is lateral earth pressure with no groundwater, and Hw is lateral and vertical earth/hydrostatic pressure of saturated soil. The load factor equals 1.0.

DOE-STD-1020-94 indicates loads should be combined by multiplying the inelastic seismic demand, Ds, by the scale factor, SF, divided by the inelastic energy absorption factor, Fu, to calculate Dsi, the inelastic seismic demand. Dsi is then added to the non-seismic demand, Dns, to obtain the total inelastic demand, Dti. This is noted as:

- Dsi = Ds(SF/Fu)
- Dti = Dsi + Dns

The scale factor is 1.25 for PC-4 structures, and Fu is 1.75 for concrete in flexure, 1.5 for in-plane shear, and 1.0 for out-of-plane shear. Seismic capacity, Cc, must then be greater than the total inelastic demand, Dti, or required strength, U.

Member capacities were calculated using the standard strength reduction factors, phi, for concrete. These capacities were then compared to the total demand. All members were preliminarily sized using static methods. Those found to be under-strength by the analysis were increased by dimension and/or reinforcement. Drawings C302 through C306 indicate final member sizes. Designs for retaining walls and for wind loads on exhaust ducts were evaluated using static methods only.

Title Design should include basic loads and combinations as indicated above, as well as site-specific response spectra information as indicated in ASCE 4-86 Seismic Analysis of Safety-Related Nuclear Structures and Commentary on Standard for Seismic Analysis of Safety Related Nuclear Structures.

5) Materials

The specified strength of concrete at 28 days (f'c) and the specified yield strength of reinforcement (fy) for the materials for construction shall be as follows:

- Concrete - Slabs, walls, flatwork: f'c = 4,000 psi
  Reinforcement: fy = 60,000 psi

- Steel - ASTM A36 (shapes and plates)
  ASTM A500 Grade A (tubes)

6) Construction

Quality shall be maintained in accordance with NQA-1 requirements. Sequencing will need to take into account installation of equipment prior to completing the building in certain areas and coordination of construction joint location because of the massive concrete pours.

Interior concrete doors will require special consideration for installation. Pre-cast concrete may be a consideration in Title Design for portions of the building.

Interior wall and ceiling concrete surfaces will be treated with a hardener and dust-proof penetrant. Floors will be painted with an epoxy coating in storage and staging areas to facilitate decontamination.

1.5.1.1.3 References

ANSYS User's Manual, Rev. 5.3, ANSYS Inc.

ASCE, 1975, Analysis for Soil-Structure Interaction Effects for Nuclear Power Plants, Report by the Ad Hoc Group on Soil-Structure Interaction, Nuclear Structures and Material Committee of the Structural Division of ASCE, December 5, 1975.

ENR-DIR 93-003, Software Quality Assurance Implementing Instructions, Rev.0, June 9, 1993.

Kaiser-Hill, 1996, Statement of Work for the Advanced Conceptual Design Report of the Interim Storage Vault, Rocky Flats Environmental Technology Site, Golden, Colorado, October 1996.

RFETS (Rocky Flats Environmental Technology Site), 1996, Interim Storage Vault Summary Report, Prepared by Kaiser-Hill, March 15, 1996.

1.5.1.2 Architectural

1.5.1.2.1 General Description

The ISV will be a mostly underground, windowless, multi-leveled, partially sprinklered, reinforced concrete structure that will provide safe and secure onsite interim storage for Rocky Flat's present inventory of plutonium. All special nuclear material (SNM) will arrive at the ISV in sealed, non-contaminated storage tubes.

The ISV will be a hardened building, constructed with over-berming to prevent direct access by an adversary to the structural walls. It will consist of a truck dock area, a material staging area, vault storage areas, a control room, and all necessary support facilities.

The anticipated staffing levels will change dramatically after the plutonium is loaded into the facility. The final security/monitoring/support staff will be only about 6 people, while the initial loading operations level will possibly be as high as 50.

All plutonium metals and oxides, less classified material, will be placed under IAEA safeguards.

1.5.1.2.2 <u>Function</u>

1) Operational Requirements

The primary functional activities associated with operation of the ISV include shipping, receiving, inventory, storage, and surveillance. There will be no processing or packaging of SNM within the facility.

The facility will also be designed and constructed to assure adequate protection for the general public, workers, and the environment from nuclear hazards, to properly support all required operational and maintenance functions, and to provide adequate safeguards and security measures.

The vaults will be designed for interim storage of the pre-packaged tube arrays. Each tube will be equipped with in-situ monitoring equipment to maintain surveillance for leaks and to provide safeguards accountability. The tubes will be stored vertically below the charging floor and will have tamper indicating devices (TIDs) attached to them. Temperature control for the containers will be provided by passive convective cooling below the charging floor and will not require HEPA filtration.

2) Design Requirements Matrix

The Design Requirements Matrix (Table 1.5.1.2-1) provides specific information on individual area needs.

In order to achieve the required delay times, three heavy, sliding, concrete security doors, two of which are closed and locked at all times, will be placed in exit hallways along the means of egress at a location inside each point of discharge from the building. They will be actuated remotely from the Central Alarm Station (CAS) when access into or out of the facility is required.

1.5.1.2.3 <u>Life Safety</u>

1) General

Both the Interim Storage Vault Summary Report and the Guiding Codes and Standards Document (Appendix 1.12.4) call for a facility that will assure sufficient safety to the workers and meet the requirements of National Fire Prevention Association (NFPA) 101, the Life Safety Code. The ISV will be designed so as to not require the approval of any code exemptions from the DOE Authority Having Jurisdiction. As a result, the facility is to be either in full compliance with all applicable life-safety codes or of an equivalent level of safety.

Table 1.5.1.2-1 Design Requirements Matrix

Architectural Design Requirements									
Room No. / Area	Size (l x w x h)	Net Area (sq. ft.) (note 7)	Relative Location	Staffing Levels	Equipment Housed	Security or Access Control Needs	HEPA Filtration	Hazardous Materials	Material Handling/ Work Flow
101) AL-R8 Tube Vault	172.5x59x12.7	10177		n/a	none	confined space	no	Pu	
102) HEPA Filter Room	30x59x12.7	1770	central	maintenance	HEPA filters		yes	none	cart to crane
103) 3013 Tube Vault	172.5x59x12.7	10177		n/a	none	confined space	no	Pu	
201) AL-R8 Pit Storage	172.5x59x21	10177		note 1	crane		yes	Pu	cart to crane
202) Staging Area	30x65.5x21	1965		note 1			yes	Pu	
203) 3013 Tube Storage	172.5x59x21	10177		note 1	crane		yes	Pu	cart to crane
204) Truck Accessway	179.5x24x15	4308	near dock	variable	none	roll-up door		Pu	truck access
205) Inner Truck Accessway	73x39x15	2847	near dock	variable		3 ft. conc. door	yes	Pu	truck access
206) Staging Area Hallway	30x18x11	540		transient	none	3 ft. conc. door	yes	Pu	cart access
207) Loading Dock	30x28x11	840	near staging	variable	none	3 ft. conc. door	yes	Pu	cart access
208) Emergency Exit Hallway	6x31x8	186		transient	none		yes	none	
209) Electrical Equipment Room	42.5x30.3x11	1288	central	maintenance			yes	none	maintenance
210) Mechanical Room	20x30.3x11	606	central	maintenance	HVAC		yes	none	maintenance
211) Control Room	20x30.3x11	606	near Room 203	TBD		note 5	yes	none	
212) IAEA Control Room	16x30.3x11	485		TBD		note 6	yes	none	
213) Men's Rest Rm & Shower	20x30.3x8	606		variable	RR/Shower		yes	none	
214) Women's Rest Rm & Shower	20x30.3x8	606		variable	RR/Shower		yes	none	
215) Hallway	175.5x8x8	1404		transient	I/O Cabinets		yes	none	
216) Guard Station / CAS	24x39x8	936		TBD			yes	none	
217) Emer. Exit Safe Haven	20x20x11	400	near exit	transient	door hydraul	3 ft. conc. door	yes	none	
218) Emer. Exit Hallway	17x11.5x11	195		transient	door hydraul	3 ft. conc. door	yes	none	
219) Emer. Exit Hallway	6x55x11	330		transient	door hydraul	3 ft. conc. door	yes	none	
220) Personnel Entr. Safe Haven	20x20x11	400	near exit	transient	door hydraul	3 ft. conc. door	yes	none	
221) Personnel Entr. Hallway	17x11.5x11	195		transient	door hydraul	3 ft. conc. door	yes	none	
222) Personnel Entr. Hallway	6x55x11	330		transient	door hydraul	3 ft. conc. door	yes	none	
	TOTAL =	61,551							

NOTES:
1) For Rooms 201, 202, 203, 211, and 212, same two people for a 10-hour shift. During loading, I&C people would peak at 10, and taper to 4 until the last tube is loaded.
2) Procedure for failed container:
   a) Remove tube from the storage area.
   b) Transport to the overpack station in the staging area.
   c) Place temporary enclosure.
   d) Open tube and withdraw container cage.
   e) Remove faulty container and overpack in DOT shipping container.
   f) Transport shipping container away.
   g) Replace cage in tube.
   h) Transport tube back to storage area.
   i) Lower tube into vault. (Tube is 18 inches in diameter by 13 ft 9 inches in length).
3) Control room/IAEA Room would require 10 PLC cabinets, CCTV monitor, telephone, 2 control consoles, and I&C calibration bench/workstation.
4) A temporary, movable enclosure will be required in Rooms 201 and 203 to locate over the top of the tubes for traverse monitoring, since the tertiary boundary will be breached.
5) Anyone with access rights to the control room can go anywhere in I&C areas in the building, including IAEA.
6) High security area/access limits. This room will require video surveillance in all areas, with a TV station in the security room.
7) Building footprints in 77,872 sq. ft. gross. This includes areas inhabited by intake and exhaust ducts, which are not labeled as "rooms" above.

2) Applicable Codes and Standards

- NFPA 101, The Life Safety Code - 1994 Edition.
- 1994 Uniform Building Code (UBC), Fire- and Life-Safety.
- DOE Order 6430.1A, General Design Criteria.
- Subsequent editions of the above codes shall be used if the above are not the current edition at the time of Title I Design.

3) Fundamental Code Requirements

- Free and unobstructed means of egress from all parts of the facility to an area outside the building.
- A minimum of two (2) means of egress.
- Safe and protected egress routes.
- Doors along the means of egress that are normally unlocked, swing in the direction of travel, and open readily from the inside.
- Exits that are arranged to minimize the possibility that they all may be rendered impassable by the same emergency condition.
- Exits that are separated from one another by a distance equal to but not less than half the length of the maximum overall diagonal dimension of the building or area to be served.
- Proper emergency lighting.
- Markings and illuminated signs along the means of egress.
- Appropriately safe finish materials.
- Other standard safety-related design features such as fire doors, penetration protection, etc.

4) Life-Safety Design Basis

a) Occupancy Classification

The ISV will be used for industrial operations, have a relatively low density of employee population, and be suitable only for the particular operations for which it is designed. Office and storage areas, as well as the truck bay, are incidental to the operations in the building and as such will not be considered to be separate occupancies. No vehicle maintenance or repair activities will take place in the truck bay. The following classifications apply:

- NFPA - Special Purpose Industrial Occupancy (Chapter 28).
- UBC - Group H, Division 3. (Final occupancy classification to be determined by Fire Hazards Analysis in Title I Design.)

b) Occupant Load

In an NFPA Special Purpose Industrial Occupancy, the occupant load will be the maximum number of persons to occupy the area under any probable condition. In the case of the ISV, this has been determined to be 50.

The UBC occupant load will be determined by dividing the final normally occupied space of the building by an occupant load factor that will be established by the local building official, the DOE Authority Having Jurisdiction. The intended use of this building is not listed in UBC Table 10-A.

c) Construction Type

The ISV will be a new, partially underground, windowless, cast-in-place concrete structure. The specific UBC "construction type" has not yet been determined.

d) Hazard of Contents

The following classifications apply to the contents of the ISV:

- NFPA - Ordinary Hazard.
- UBC - Health Hazard.

5) Design Approach

In order to meet the necessary perimeter security requirements and protect against a possible insider threat, all exits leading from the ISV will be strictly controlled, with access to the outside delayed until the response force has secured the area around the point of discharge. This is in direct conflict with standard life-safety requirements for free and unobstructed egress from all parts of a Special Purpose Industrial Facility.

Although the "letter-of-the-law" cannot be met, the intent of the life-safety codes will be satisfied by providing an equivalent level of protection to all occupants upon reaching an exit. This will be accomplished by providing freely accessible areas of refuge along the means of egress just before the security barriers. Occupants shall be safely detained in these normally unoccupied, smoke-proof and fire-protected, "safe havens" under tenable conditions until they can be safely evacuated to the outside without returning back through the ISV.

The occupant, upon passing through the safe haven access door, will be in the exit and, although temporarily detained, would be fully protected along the means of egress from this area to the point of discharge outside the building. Each safe haven will be sized to hold the anticipated maximum occupancy of the ISV.

The safe havens will provide an equivalent level of protection to that which is afforded to Use Condition-II as described in NFPA 101 for an area of refuge within a new Detention and Correctional Occupancies (Chapter 14). This section of the NFPA Code will be used as a guide in determining what design features are needed to reach that equivalent level of safety for occupants held in the safe havens.

The vaults and staging areas will be considered another occupancy behind a "horizontal exit". The distance to one of the two required exits would thus start at the threshold of the horizontal exit.

Exit access will be through one-hour fire-rated corridors within the operations and support areas of the ISV that connect to two separate and distinct exits. Each exit will consist of a safe haven, the discharge vestibule, the connecting corridors, and all doorways along the route.

Due to the excessive common path of travel, and the possible location of an inner security barrier between the ISV material handling and support areas and the truck bay, the primary emergency exit route from the truck bay will be by way of a separate means of egress that does not connect back through the ISV.

The vault areas and air-ventilation shafts would be considered "unoccupied/confined" spaces. Access into these areas would be through normally bolted shut metal hatches and require meeting the NFPA Code requirements for confined spaces.

6) Physical Requirements

The most restrictive requirements from the various codes will be applied to the design in the following areas.

a) Protection of Means of Egress

Exit access passageways will be 1-hour fire-resistant construction per NFPA and UBC.

Exit corridors and areas of refuge will be 2-hour fire-resistant construction per NFPA and UBC. (Requirements are subject to change based on the final occupancy classification to be determined by Title I Fire Hazards Analysis.)

b) Separation of Areas

Staging/overpack area and support area hallway separation barrier will be 2-hour fire-resistant construction per UBC.

c) Common Paths of Travel (maximum)

Per NFPA 101, Chapter 28, common travel paths of 100 ft in the building will be fully protected by an automatic sprinkler systems or will be 50 ft in areas without sprinkler protection.

d) Dead End Corridors (maximum)

The following code specifications applies to dead-end corridors:

- NFPA 101, Chapter 28 - 50 ft.
- UBC - 20 ft.

e) Egress Capacity (minimum)

The following code specifications apply to egress capacity:

- Stairs - 50 occupants times 0.3 inch per person equals 15 inches per both NFPA and UBC.
- Other - 50 occupants times 0.2 inch per person equals 10 inches per both NFPA and UBC.

f) Corridor Width (minimum)

Corridor width will be 44 inches per both NFPA and UBC.

g) Maximum Travel Distance to an Exit

The following code specifications apply to the maximum travel distance to an exit:

- NFPA 101, Chapter 28 - 400 ft in a fully sprinklered building and 300 ft in a partially sprinklered building.
- UBC - 300 ft.

h) Doors

Doors in the means of egress will be of the "swinging type" except where otherwise allowed in either NFPA or UBC.

NFPA and UBC code requirements for the direction of swing and the use of panic hardware will be complied with.

i) Areas of Refuge

A smoke-proof, 2-hour fire-resistant barrier will be placed between the main ISV area and each area of refuge. The opening in this wall will be protected by an unlocked but alarmed Class-B fire-rated door.

Each area of refuge will be sized to handle the total number of ISV occupants, in an area equal to approximately 8 sq ft per person.

Tenable conditions for the occupants are an independent positive pressure ventilation system on backup power and emergency lighting.

The area of refuge will be a "sterile" environment with only the equipment necessary to support the occupants during an emergency.

If movable security barriers are provided, they will be normally deployed, remotely controlled from the CAS, and equipped with a redundant means of manual operation from within the safe haven.

Each area of refuge will be provided with closed circuit TV (CCTV), a telephone to the CAS, and a public address speaker.

j) Emergency Lighting

This will be as required by NFPA, UBC, and DOE Order 6430.1A.

k) Finish Materials

These will be as required by NFPA, UBC, and DOE Order 6430.1A.

1.5.1.2.4 Administrative Controls

The potential problem with "trap points" being created along the path of egress by the triple security door configuration will be addressed through procedural controls.

1.5.1.2.5 Building Life

The facility will be designed for a minimum storage duration of 15 years; however, the design should not have a built-in lifetime for less than 50 years for the permanent structure.

Materials and finishes will be selected for the 15-year operating life and the 50-year design life.

1.5.1.2.6 Physical Layout

1) Physical Criteria

The ISV will be an approximately 78,000-sq ft, single-story, partially buried, reinforced concrete structure.

2) Performance Requirements

The governing factor for the facility design is to reduce the operational and maintenance costs. To achieve this, the design philosophy incorporates features to minimize occupancy and provide inherent security based upon the concept of access denial.

The design of the ISV provides systems and components that limit the need for infrastructure, maintenance and operations staff, with corresponding training and certification requirements.

The facility will be built with minimum active components and designed to meet DOE program requirements.

Safeguards will be based upon a strategy of denial. That is, a substantially constructed storage facility with significant delay features, plus reliable and effective detection and assessment systems, will be provided that will deny access by subversives. The ISV security concept is to provide physical protection features that are integrated into the design and use of the facility from the start.

A significant goal of the overall facility design is to minimize the size of the security force needed to provide protection by utilizing appropriate detection, assessment, and delay systems in the design and construction of the facility. The overall protection philosophy for the material in storage consists of five elements: detection, assessment, delay, response, and neutralization. Delay is the ability to detect an adversary act that needs to be prevented. Response is the action by the protective force. Neutralization is the ability of the responding forces to engage and defeat the adversary. The ISV will be designed to provide safe and secure emergency egress in accordance with life-safety requirements, while at the same time protect the SNM within the storage vaults from outside threats.

The truck receiving dock will be enclosed, providing unloading/loading of the delivery vehicle without exposure, and reducing the number of security officers required during the operations. All incoming shipments will enter the ISV under armed escort comprised of sufficient numbers of security personnel to meet and defeat the postulated threat.

The Primary Alarm Station (PAS) will be located within the protection provided by the storage facility in an area outside the storage vaults.

Access to the storage vault will be through a hardened entrance portal controlled by a combination of automated systems and security personnel. The location and security features of the portal will be evaluated during Title Design.

3) Overall Dimensions

The maximum overall ground level dimensions of the ISV measure approximately 400 ft wide by 200 ft deep. This does not include the safe-haven/egress route modules that are approximately 60 ft wide and extend 70 ft from the building.

4) Gross and Net Areas

The total gross area of the ISV is approximately 110,000 sq ft, with approximately 48,000 sq ft on the ground floor and approximately 62,000 sq ft at the basement level.

The total net usable, occupied, area on the ground floor of the ISV is approximately 40,000 sq ft.

5) Significant Features

Fire barriers, 2- to 3-hour, will be required between the plutonium storage vaults and the support areas as required by the Fire Hazards Analysis.

Automatic sprinklers (fire protection) will not be installed in the plutonium storage vault areas. Automatic sprinklers will be required for any support facilities or areas including: offices, maintenance areas, hallways, general support areas, shipping and receiving areas, and packing/unpacking areas. These automatic sprinklers will be required to be designed and installed in accordance with the most current NFPA codes and standards.

1.5.1.2.7 Required Studies

The actual building staffing levels for both normal and maximum anticipated will need to be determined.

1.5.1.2.8 Physically Handicapped

DOE Order 6430.1A, *General Design Criteria,* Paragraph 1300-13 Accessibility and Usability by the Physically Handicapped, requires that consideration be given to employment opportunities for physically handicapped persons within "special facilities" in administrative and support areas. The control room would be considered one of these areas; as a result, suitable handicapped accessibility provisions will be made within the building that meet the appropriate design requirements of the Americans with Disabilities Act (ADA).

1.5.1.2.9 Support Facilities

1) Building 130

The ISV will require external facilities for managerial support and parts storage areas. The actual square footage required has not been defined at this time; however, it is believed that Building 130 should remain in service for this activity and will provide adequate space. The details of these requirements shall be described in Title Design.

1.5.1.3 Geotechnical Design Criteria

1.5.1.3.1 Introduction

Geologic and geotechnical data available in RFETS files were used to characterize the proposed ISV site subsurface conditions, and to develop geotechnical design criteria for conceptual design purposes. The available data included geologic and hydrologic maps, well logs, test boring logs, laboratory test data, and geological and geotechnical reports for nearby facilities as discussed and summarized in Appendix 1.12.1 Site Selection Study. Locations of monitoring wells and boreholes in the ISV area are shown on Figure 1.5.1.3-1. A summary of the geological and geotechnical site characterization and conceptual design criteria is presented below. The RFETS geology and the ISV site geology are discussed in detail in Appendix 1.12.1.

1.5.1.3.2 ISV Site Subsurface Conditions

1) Soils

Soils beneath the ISV site consist of the late Pleistocene Rocky Flats Alluvium, which consists of sands, gravels, and scattered lenses of silt. The alluvium appears to range in thickness from 29 to 36 feet from south to north across the site, with an inferred thickness of 33 feet near the center of the proposed structure as shown on Figure 1.5.1.3-1. The sands and gravels of the Rocky Flats Alluvium are reported to be generally dense with a clayey matrix (Woodward-Clevenger, 1972; Chen and Associates, 1982). Scattered cobbles and boulders are also present. A sandy silt layer about 16 feet thick located at a depth of 12 to 28 feet was reported in monitoring well P416189 drilled within the footprint of the proposed ISV (Figure 1.5.1.3-2).

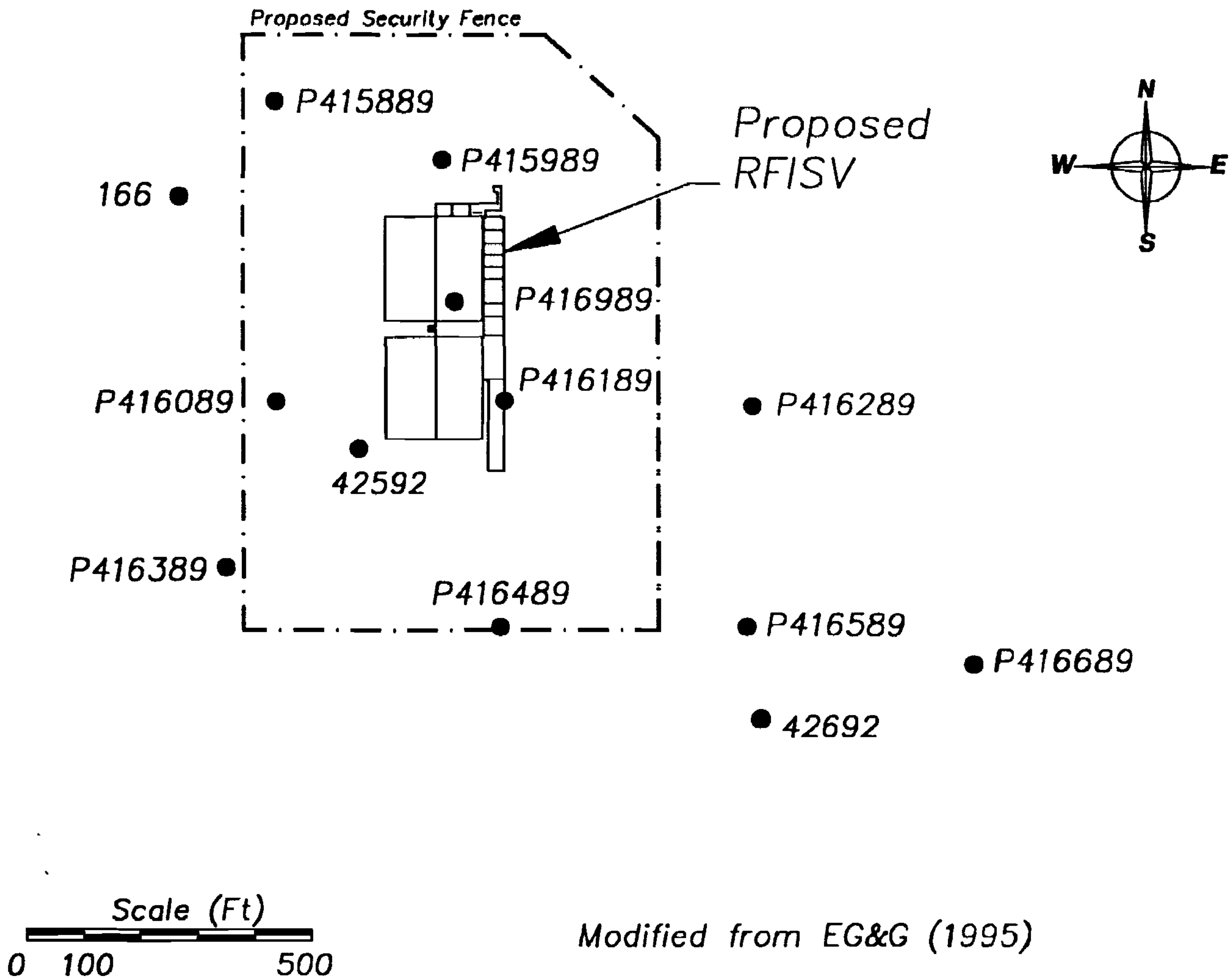
2) Bedrock

Bedrock underlying the alluvium consists of 15 to 20 feet of the Arapahoe Formation, which overlies the 600- to 800-feet thick Laramie Foundation. The bedrock strikes north 33° east and dips less than 1° to the southeast. The Arapahoe Formation contains fluvial deposits of sandstones, siltstones, and claystones and is weathered for its entire thickness. The sandstones are lenticular and less than 10 feet thick based on EG&G's interpretation (1995). The upper 15 to 25 feet of underlying Laramie claystones also are weathered. Total depth of bedrock weathering may vary nearly 20 feet across the building site from 25 feet in the northeast corner to 45 feet in the southwest corner of the proposed structure. Increased joint density in weathered bedrock results in increased permeability and reduced bearing capacity. Approximate elevations of the top of bedrock are illustrated on Figure 1.5.1.3-3.

It appears that the average elevation of the top of bedrock at the site is 6,015 feet at the center of the proposed structure. The bedrock surface slopes from south to north and varies in elevation by approximately 8 feet within the footprint of the foundation.

3) Ground Water

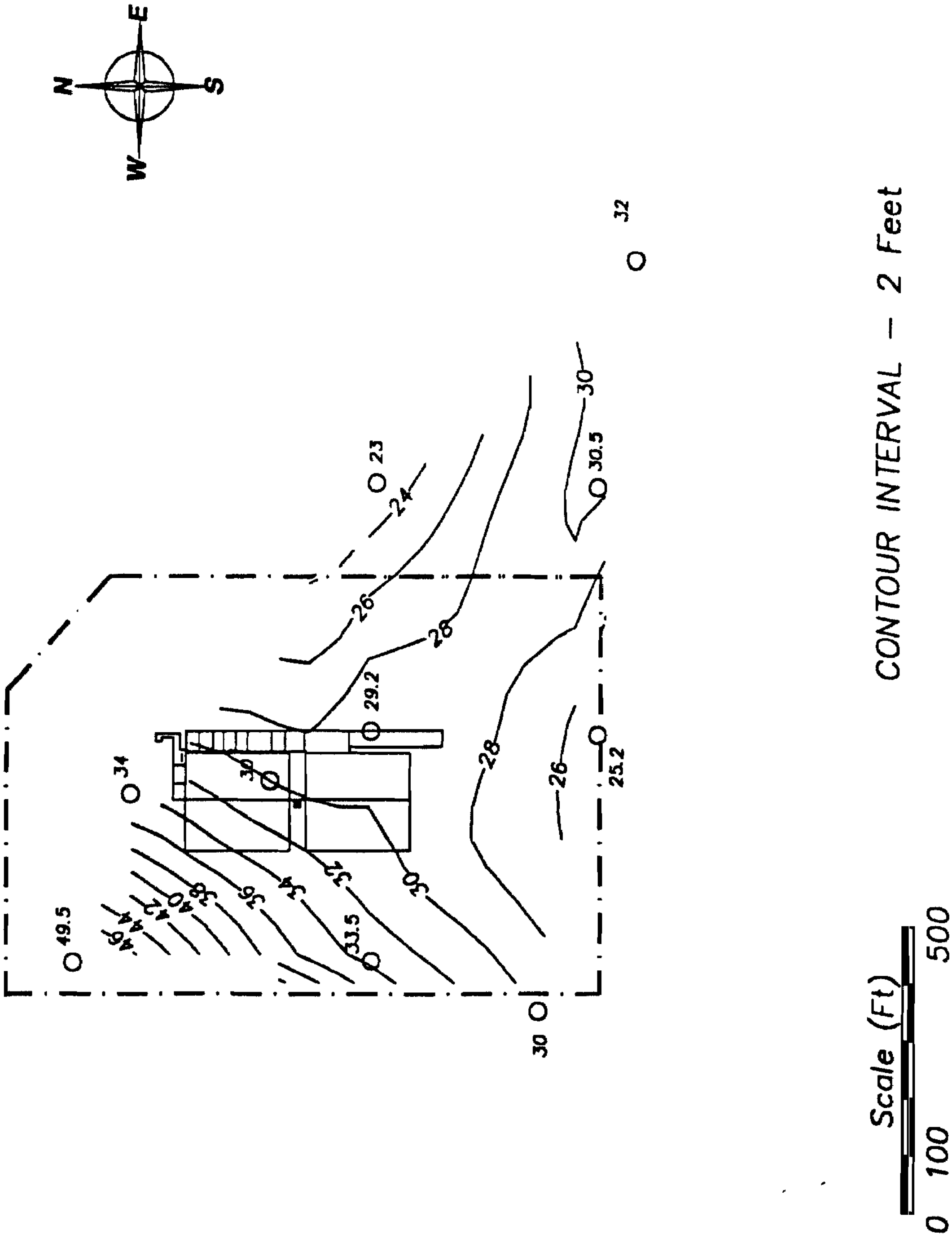
The hydrograph of monitoring well P416189, located near the center of the ISV site, indicates that groundwater is at an average (yearly) depth of 8 feet from the present ground surface. The hydrograph indicates that the water level can fluctuate up to 9 feet in one year, from a depth of 3 feet during summer months (May-June) to 12 feet during the winter months (November - January). Average groundwater surface elevations are shown on Figure 1.5.1.3-4.



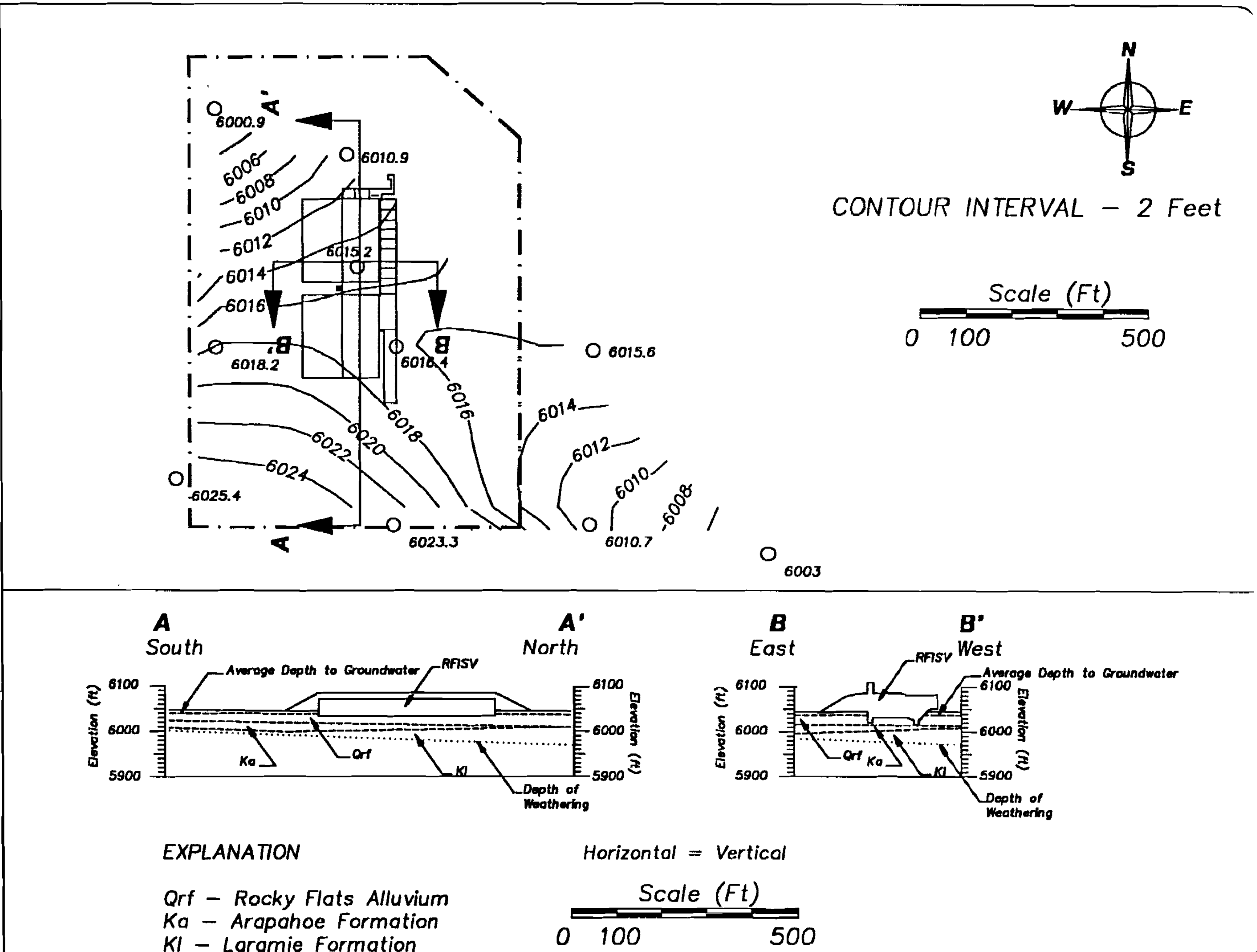
Location of Monitoring Wells and Boreholes

DATE: 4/97

FIGURE:1.5.1.3-1



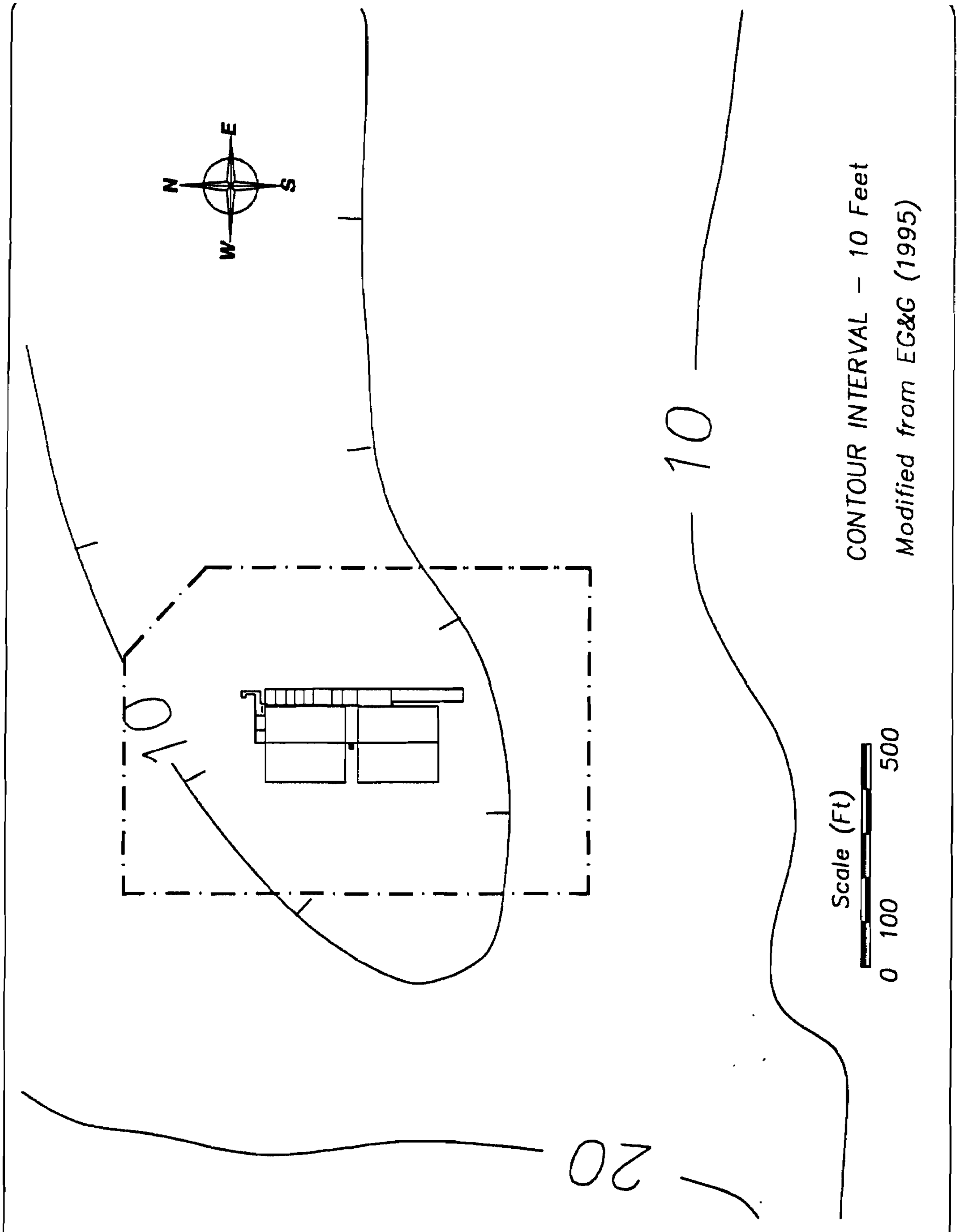
	Thickness of Surficial Soils	DATE: 4/97 FIGURE: 1.5.1.3-2



Elevation of Top of Bedrock

DATE: 4/97

FIGURE:1.5.1.3-3



	Average Depth to Water	*DATE: 4/97*
	(Yearly Average)	*FIGURE: 1.5.1.3–4*

Roy F. Weston, Inc. conducted a technical review of groundwater quality in monitoring wells in and near the ISV site. This study, attached as Appendix 1.12.7, disclosed no significant environmental problem.

4) Corrosivity of Soil

Site-specific soil corrosivity data for the proposed ISV are lacking. Corrosivity data for similar bedrock and soils from other reports at RFETS sites are summarized below:

Source	pH	percent Water Soluble Sulfates	Material
Woodward-Clevenger & Assoc., 1972	No data	0.002 or less	Soil
Woodward-Clevenger & Assoc., 1972	No data	0.002 or less	Bedrock
Aguirre Engineers, Inc., 1988	6.29-7.92	0.006 - 0.029	Soil
Aguirre Engineers, Inc., 1989	7.29-8.06	0.02 - 0.05	Soil

Using American Concrete Institute (1986) guidelines, the values rate as negligible in terms of sulfate exposure and would not warrant a special type of concrete.

1.5.1.3.3 Foundations

1) General

As indicated by the Statement of Work for the Advanced Conceptual Design (Kaiser-Hill, 1996), drilled pier foundations are currently planned for the proposed structure. Spread footing and mat foundations might also be used.

Geotechnical data pertinent to pier foundation design were compiled, and several pier foundation designs for other RFETS buildings were reviewed. Drilled piers, if used, are to be designed to fully penetrate the soils and be socketed into bedrock.

In general, the main level of the structure will be constructed at or near the existing grade elevation of 6,048 feet, the lower level is planned at elevation 6,031 feet and sumps are planned for elevations 6,021 feet and 6,017 feet.

2) Drilled Piers

For conceptual designs, an end-bearing capacity of 20,000 pounds per square foot and skin friction of 2,000 pounds per square foot both increasing by 3 percent per foot of penetration into bedrock to maximum values of 40,000 pounds per square foot and 4,000 pounds per square foot, respectively, should be assumed for that portion of the piers in bedrock. Piers should penetrate a minimum of 10 feet into bedrock, and the sides of the holes in bedrock should be grooved or artificially roughened. Skin friction should be ignored for that section of the pier within overburden soils.

A minimum pier diameter of 24 inches should be used to facilitate de-watering and cleaning of pier holes during construction. Temporary casing of the pier holes through alluvial soils overlying bedrock will be required to reduce caving and for de-watering. A large pier drilling rig, such as a Hughes LDH or larger rig, should be used to drill the pier holes.

For purposes of conceptual design, the following values should be assumed for the design of drilled piers to resist lateral foundation loads:

	Cohesion, psf	**Friction Angle degrees**	**Moist Unit Weight, pcf**
Natural Soils	0	35	135
Bedrock	4,000	0	130

The risk of total drilled pier foundation settlement exceeding 0.5 inches should be low.

3) Mats

Mat foundations bottoming on the natural, undisturbed sands and gravels (Rocky Flats Alluvium) should be designed for a maximum soil pressure of 6,000 psf. That pressure could be increased by 1/3 (to 8,000 psf) for calculating mat resistance to short-term live loads (wind, seismic, etc.).

Any loose sands and gravels and/or silts or clays found at mat foundation excavation bottoms should be removed and replaced with structural fill. The structural fill placed beneath mat foundation areas should consist of onsite or similar sands and gravels (classified in accordance with American Society for Testing and Materials (ASTM) D 2487, with no individual particles larger than 6 inches in maximum dimension. It should be placed in 8-inch or thinner loose lifts at moisture contents near optimum for compaction and should be compacted to at least 100 percent maximum density (ASTM D 698).

The risk of total foundation settlement for mats designed as discussed above exceeding 1 inch should be low.

1.5.1.3.4 Site Grading

1) Fills

The aboveground portion of the ISV is to be covered by a 5-foot-thick layer of washed rock overlain by 5 feet of clay fill. Several feet of additional fill (common fill) could be placed over the clay fill. Common fill will also be used to construct earth berms around the structure. A subsurface drainage system will be placed around the below-grade building walls.

Common fill should consist of sands, gravels, silts, or clays (all classified in accordance with ASTM D 2487), or mixtures thereof. Clay fill should consist entirely of clay soils (classified in accordance with ASTM D 2487). Common fill and clay fill should contain no individual particles larger than 6 inches in maximum dimension. Those fill materials should be placed in 8-inch or thinner loose lifts at moisture contents near optimum for compaction and should be compacted to at least 90 percent maximum density (ASTM D 698).

Structural fill used as backfill around below grade elements of the building and beneath paved areas should consist of on-site or similar sands and gravels (classified in accordance with ASTM D 2487), with no individual particles larger than 6 inches in maximum dimension. Structural fill materials should be placed in 8-inch or thinner loose lifts at moisture contents near optimum for compaction and should be compacted to at least 95 percent maximum density (ASTM D 698).

Washed rock used as fill over the above-grade portion of the building and for the subsurface drainage system should clean, rounded, washed sands and gravels containing less than 3 percent sizes smaller than the No. 200 sieve size and having a maximum particle size of 1 1/2 inches. Such materials should be placed in about 12-inch loose lifts and should be compacted to at least 70 percent of maximum relative density (ASTM D 4253 and ASTM D 4254). A non-woven, needle-punched geotextile, such as Trevira Spunbound 1120, or equivalent, should be placed between the washed rock and adjacent soils or fill materials. The washed rock layer used for the subsurface drainage system should be a minimum of 24 inches thick.

Permanent slopes constructed of common fill, structural fill, or clay fill should be graded to 2:1 (horizontal:vertical) or flatter angles.

2) Excavations

Excavations for the ISV should be into sands and gravels, and possibly some silts of the Rocky Flats Alluvium and will likely extend below groundwater levels unless de-watering is performed prior to or during construction. The sands, gravels, and silts should temporarily stand on 1-1/2:1 (horizontal:vertical) slope angles if excavations are de-watered concurrent with or prior to excavation. Excavations could be de-watered using wells or wellpoints around the perimeter of the excavation and/or by pumping from sumps or collector ditches at the bottoms of excavations.

Conceptual estimates of excavation de-watering for an excavation 460 feet long, 280 feet wide, and 21 feet deep indicate that 20 to 200 gallons per minute may flow into the excavation under steady-state conditions. Initial flow rates may be larger due to higher gradients as water is released from specific yield within the radius of influence. The estimate assumes that upward flow from bedrock induced during de-watering is negligible and that the de-watering system fully penetrates soils overlying the maximum depth of the excavation.

1.5.1.3.5 Earth Pressures

Earth materials placed as discussed above under Section 1.5.1.3.4, Site Grading - Fills, will exert vertical and lateral pressures on the structure. A moist unit weight of 130 pcf should be assumed for common fill, clay fill, and washed rock. At rest (Ko), active (Ka), and passive (Kp) coefficients of lateral earth pressure of 0.4, 0.3, and 3.7, respectively, and a moist unit weight of 140 pcf should be assumed for structure walls backfilled with structural fill. Triangular soil stress distributions should be assumed. Hydrostatic pressures and surcharge loads should be considered in earth pressure analyses.

Coefficients of lateral earth pressure should be increased by 0.3 for static analyses of walls under dynamic, earthquake conditions. That seismic coefficient increase is based on 3/4 of the design earthquake acceleration of 0.4 g at the ground surface (Department of the Navy, 1982). The ground earthquake acceleration is based on the ISV project seismic design spectrum (see Section 1.5.1.3.7, below).

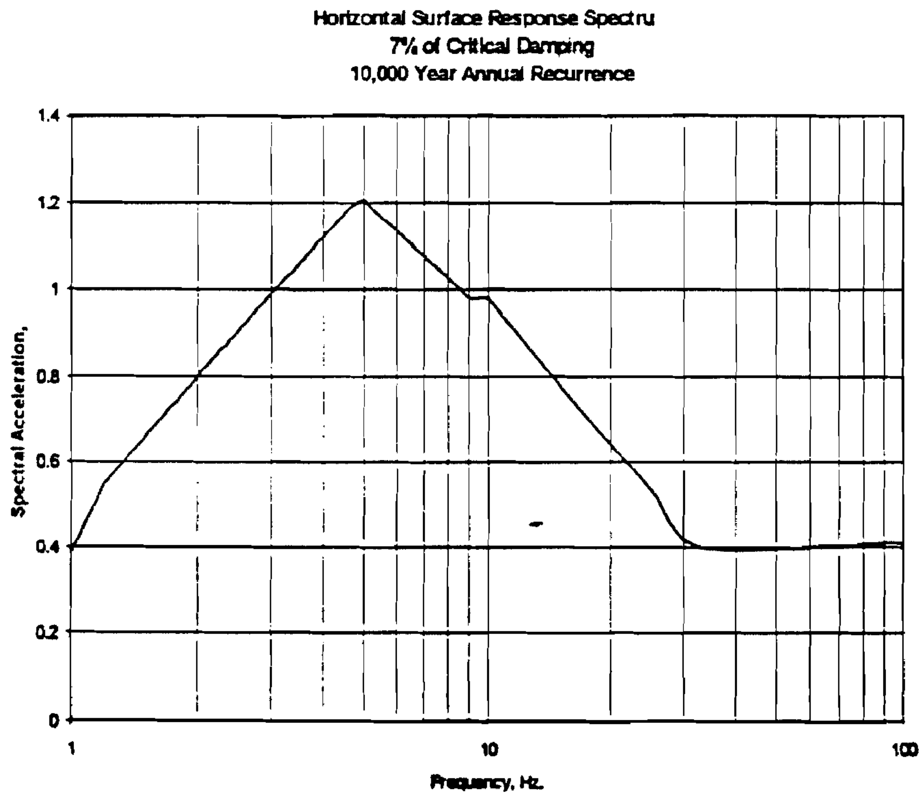
1.5.1.3.6 Roads And Pavements

Existing fill materials, if any, should be removed and replaced with structural fill beneath roads. A California Bearing Ratio (CBR) value of 10 may be used for conceptual designs of roads and pavements. A CBR of 40 could be used provided they are underlain by a minimum of 3 feet of structural fill. Structural fill should be placed as previously discussed.

1.5.1.3.7 Seismic Design

The design basis earthquake (DBE) for the site has an occurrence frequency of 1.0 x 10^{-4}/yr with a horizontal bedrock acceleration of 0.26 g at the top of bedrock at a depth of 100 ft below the ground surface. Considerable effort has been expended in evaluating soil and topographic amplification effects at Building 371, using the results of the Risk Engineering (1994) Seismic Hazard Study for RFETS. The documentation of these amplification studies is incomplete and still under review (Peregoy, 1996). An amplified PC-3 level response spectrum, however, was developed for Building 371 (Westinghouse, 1995). A preliminary response spectrum was developed for a PC-4 earthquake and provided by RFETS for use in design of the ISV (Figure 1.5.1.3-5). The response spectrum indicates an acceleration at the ground surface of 0.4 g.

The preliminary response spectrum shown on Figure 1.5.1.3.-5 was developed from the subsurface data for the Protected Area. It may not accurately reflect bedrock and surficial soil depths, thicknesses, and properties, all of which can have a pronounced effect on soil amplification. Site-specific measurements and response analyses should be made for the ISV site in subsequent studies to evaluate seismic amplification effects and to develop site response spectra.



Source: Kaiser–Hill (1996)

	Horizontal Surface Response Spectra	DATE: 4/97 FIGURE: 1.5.1.3–5

Shear modulus (G) values for the site subsurface materials were estimated for use in conceptual dynamic analyses of the structure. Published correlations for obtaining shear modulus from typical soil properties and from shear wave velocity data were used to estimate the shear modulus relationship shown on Figure 1.5.1.3-6. A Poisson's Ratio of 0.35 should be assumed for subsurface materials for conceptual designs.

The modulus values shown in Figure 1.5.1.3-6 are estimated to be for a volumetric ground strain of about 10^{-2} percent. Shear modulus varies with strain. Modulus values are larger at lower strains and smaller at larger strains. Such variations should be considered in more detailed subsequent designs of the ISV.

1.5.1.3.8 References

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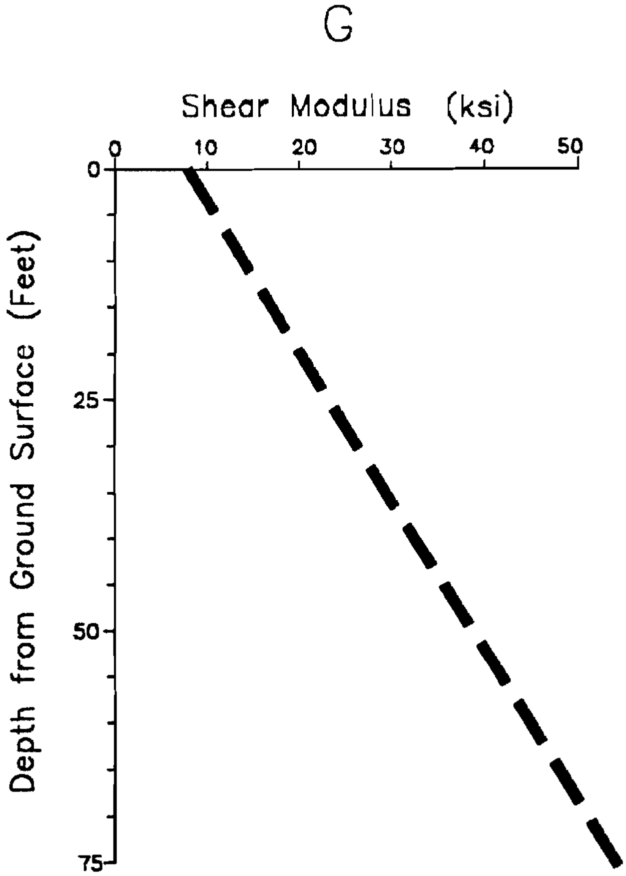

	Estimated Shear Modulus with Depth	*DATE: 4/97* *FIGURE: 1.5.1.3-6*

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1.5.1.4 Mechanical/HVAC

The ISV is designed to remove decay heat through passive cooling. The facility is designed to store plutonium in DOE standard containers stacked vertically within sealed storage tubes. The conceptual layout of the 3013 container and AL-R8 storage tubes is shown on Drawings 51493-C401 and C403.

The primary mechanical functional requirements provided by the facility and the tubes are cooling and confinement of the stored plutonium. The cooling consists of radiant, conductive, and natural convective heat transfer within the sealed storage tube and heat dissipation by passive natural convection from the tube to the outside air flowing through the lower vault area. The passive cooling system relies on air flow caused by the buoyancy of air as it is heated. Air enters the vault area through horizontal tunnels, flows through the storage tube array, and exits through vertical chimneys. The storage tubes provide tertiary confinement for the plutonium and maintain vertical spacing between containers during normal, seismic, and accidental drop scenarios and are therefore system category 1 components.

In addition, mechanical support systems including heating, ventilation, and air conditioning (HVAC), fire protection, floor drainage, and plumbing are required in the facility. These support systems are not credited with any nuclear safety functions in the Conceptual Safety Report (CSR) and are therefore not classified as system category 1 or 2.

1.5.1.4.1 Passive Decay Heat Removal

Passive removal of decay heat from the stored plutonium is the paramount design concept for the ISV. The feasibility of passive heat removal from plutonium metals and oxides stored within three levels of confinement was investigated by General Atomics (GA). The investigation consisted of conceptual design thermal and air flow analyses of the 3013 container, the storage tube, and the ISV physical layout for normal design ambient conditions and for partial and fully blocked flow conditions. The analyses are documented in GA's Calculation Report.

The thermal analyses consisted of a 3013 container steady-state calculation, various storage tube steady state heat transfer calculations, and natural convection air flow calculations to determine air flow rates and velocities through the storage vault. The 3013 container calculation benchmarked the finite difference model against previous, more detailed models. The storage tube steady-state calculations concluded that the significant modes of heat transfer from the container to the storage tube wall were by radiation and convection and that container temperatures could be reduced by increasing the emissivity of the exterior of the 3013 outer container. Conduction was not considered to be a viable heat transfer mode because of inherent air gaps (resistances) between the containers, the support cage components, and the storage tube wall. Therefore, the support cage structural components were not included in the storage tube finite difference model. The air flow calculations determined the flow rates and velocities through the storage vault inlet ducts, through the storage tube arrays, and up the chimneys for chimney heights of 50 ft and 60 ft.

The main results of the heat transfer analyses are presented here along with pertinent inputs and assumptions. The detailed calculation inputs, assumptions, methodology, and results are documented in the GA Calculation Report.

- With 95°F inlet air and 20 watts/container heat generation rate, the highest outer container temperature was 177°F with an outer container emissivity for clean stainless steel of 0.3, and 150°F with an outer container emissivity of 0.8 (coated, prepared or painted). The average air flow velocity through the storage tube array was 1.5 ft/sec and the maximum exit air temperature from the 60-ft chimney was 100.5°F.
- For the same conditions with 50% of the natural draft air flow rate, the highest outer container temperatures increased to 181°F and 153°F with container emissivities of 0.3 and 0.8, respectively. Steady state was reached in about 10 hours.
- With full blockage of the air flow, outer container temperatures increased to 210°F in 200 hours with a container emissivity of 0.3 and 188°F in 200 hours with a container emissivity of 0.8. With a container emissivity of 0.3, a steady state temperature of 217°F is reached in several hundred hours. With a container emissivity of 0.8, a steady state temperature of 194°F is reached in several hundred hours.

In addition to increasing the emissivity of the 3013 outer container, a recommendation in the Calculation Report was that the support cage should provide minimum obstruction to thermal radiation from the containers to the tube with narrow bands surrounding the containers and large cutouts in the radial webs.

1.5.1.4.2 <u>3013 Can Storage Tube Design</u>

The tertiary confinement for plutonium metals and oxides stored in the 3013 containers is provided by the storage tube. The storage tube is an 18-inch outer diameter (OD)13-ft, 9-inch-long cylinder fabricated from extra strong, low carbon steel piping and is shown in

Drawings 51493-C401 and C404. Each storage tube is designed to hold eight 3013 containers in its lower (bottom 11 ft) portion. The storage tube assembly is estimated to weigh 3,000 lb when fully loaded. The tube bottom consists of a 1-inch flat plate circumferentially welded to the piping. The top of the tube contains an instrument well, space for instrument wiring transitions, thick steel plates for radiation shielding, and the closure flanges. The instrument well is fabricated from 16-inch OD standard wall pipe and plate similar to the tube. The instrument well bottom and wall are part of the tertiary confinement boundary. The instrument well details are shown in Drawings 51493-C402, C406, and C407. The closure flange pair consists of a standard 18-inch, 150-lb slip-on flange double fillet welded to the tube and an 18-inch, 125 lb lightweight slip-on flange with a special 16-inch bore size. The lightweight flange is double fillet welded to the instrument well. All weld details are consistent with American Society of Mechanical Engineers (ASME) VIII, Division 1, pressure vessel construction requirements. The flange seal is provided by a metallic spacer ring or ring gasket.

The instrument well bottom includes instrument wiring penetrations, inspection and surveillance access ports, and leak detection tubing penetrations through the tertiary boundary. The wiring penetrations are filled with Chico X fiber and Chico A sealing compound. The 2-inch and 4-inch access ports are tapered and internally threaded to accept a screwed plug. A suitable thread sealant will be required for these access ports. The tubing penetration is a seal welded coupling. The tubing between the penetration coupling and the tubing isolation valve is socket welded. The tubing and leak detection components within the instrument well also comprise part of the tertiary boundary.

The 3013 containers are in a support cage suspended from the bottom of the instrument well within the tube. The support cage structural details are shown on Drawings 51493-C408 and C409. The cage consists of structural angles, structural tubing, and bent plates welded together to form a support system with hinged doors for loading containers. Each container location has its own door. The doors are closed and prevent radial movement of the containers once the loaded cage is placed within the tube. The structural angles run the length of the tube and provide the backbone of the cage. Four-inch by 2-inch structural tubing spans between the angles provide weight support for the containers when the tubes are upright in their storage position. Bent plates in the cage structure and doors are formed as clamps and center the containers within the cage. These clamps provide horizontal support and were originally intended as radial cooling fins, facilitating heat dissipation from the containers by conduction. However, as stated in the passive cooling section above, the primary heat transfer modes are radiation and convection and minimizing the obstructions provided by the clamps and fins was recommended.

The proposed storage tube and support cage materials are low carbon steel for all components except for those components in physical contact with the 3013 containers. The container support plate and the container clamp, doors, and radial fins are stainless steel. When placed in storage, the exterior surfaces will be exposed to air at ambient conditions of temperature and moisture. The only identifiable source of corrosion once the tubes are stored in the vault area is excessive moisture from groundwater infiltration. A study of coating options (including no coating) for interior and exterior surfaces is proposed for further study. Any coating, cladding, or finish must enhance heat transfer out of the tube, must be highly radiation tolerant and corrosion resistant, and must have acceptable durability and scratch resistance for loading, handling, and emplacement operations.

The instrumentation, wiring, and security provisions associated with the 3013 container storage tube, instrument well, and support cage are shown on Drawings 51493-C402 and C753. The intention is to have the tube, instrument well, and support cage totally prefabricated, pre-instrumented, prewired, and pretested to minimize exposure times during container loading operations. The sequence of loading operations is discussed in CDR Section 1.5.1.5.

The following is a list of functional requirements considered during the development and conceptual design of the storage tube and support cage. Not all of these requirements have been fully addressed during the conceptual design phase.

- For a tube in the vertical position, the tube and internal support cage shall support the weight of the 3013 containers considering the following loading conditions: deadweight and seismic.
- For a tube in the horizontal position, the internal cage shall support itself and the weight of the 3013 containers considering the following loading conditions: deadweight (including independent cage handling, tube loading and unloading, and storage conditions), and transportation on both a cart and government vehicle.
- For a vertical drop of 15 ft or a fall from a vertical to a horizontal position, the acceptance criteria for the cage shall be:

    1) No leakage of the 3013 containers,
    2) No loss of structural support capability,
    3) No violation of internal spacing requirements, and
    4) No loss of retrieval ability from the tube.

- The tube, instrument well, and flange seal shall provide tertiary confinement.
- The cage shall facilitate or promote heat transfer from the 3013 container to the storage tube.
- The cage shall provide wireways for adequately protecting, shielding, and supporting all required instrumentation wiring and cable bundles. Plug connections are restricted to outside the confinement boundary. There shall not be loose or excess wiring.
- The cage shall allow or facilitate all required surveillance and inspection requirements, which may include remote video and ultrasonic inspections, bar code scanning, etc. of all 3013 cans.
- The cage shall facilitate the loading and removal of containers from the storage tube without damage to the containers, the cage, wiring, instrumentation, the storage tube, or the storage tube coating. The loading time, including application of instrumentation shall be minimized to obtain as low as reasonably achievable (ALARA) exposure.

- The cage and instrument well shall provide acceptable shielding above the containers for the electronic instrumentation and for required or expected occupancy levels on the charging floor.
- In order to reproduce material signatures, neither the cage nor the containers shall be capable of rotation within the tube.
- Material selection shall be compatible with the 3013 containers, the storage tubes, the storage tube coatings.
- The cage details shall facilitate/minimize fabrication, and fabrication inspection and examination requirements.
- The weight of the cage shall be minimized by optimizing components, component thicknesses, materials, etc.

Table 1.5.1.4-1 presents the various requirements and some of the major design options considered during this phase and includes the relative or qualitative evaluation results for each option. The results identify "Good (G), Acceptable (A), or Poor (P)" options for each applicable requirement. A "good" option easily satisfies the requirement, an "acceptable" option satisfies the requirement acceptably, and a "poor" option does not readily satisfy the requirement.

Pressure capacity was determined and used as a correlation for confinement capability of the storage tube and instrument well. The pressure capacity of the tube and well confinement system components excluding the wiring penetrations and the flange gasket is limited to about 80 psi by the flat plate bottoms on the tube and the instrument well. The maximum internal pressure expected within the tube with a 150°F temperature rise above ambient is less than 5 pounds per square inch gauge (psig).

The cage is horizontal during the loading operation and is designed as a self-supporting structure to hold the weight of the containers while in this position. In the upright storage position, the cage and tube are designed for weight loadings combined with and horizontal and vertical seismic loads corresponding to a PC-4 component. The resultant horizontal acceleration at the tube center of gravity was determined in the seismic analysis of the ISV building (SWEC Calculation 06489.72-SD-01) to be about 5 g's. The tube provides lateral restraint to the cage structure during horizontal seismic loadings by limiting displacements to the cage-to-tube fabrication tolerances. The tube is qualified as a pinned-pinned beam for the horizontal seismic loading. The charging floor provides horizontal restraint at the top of the tube and the tube base support provides horizontal restraint at the tube base. The structural analysis of the storage tube and internal support cage considering weight, pressure capability, seismic, and accidental drop loadings as discussed below is documented in SWEC Calculation 06489.72-NM-001.

In addition to seismic qualification, two drop accident scenarios have been considered. The first is a 15-ft vertical drop of a fully loaded tube through the charging floor. The second drop accident considered is a tube falling from an upright position while sitting on a floor to a horizontal position laying on a floor. All other drop accidents are assumed to be bounded by these two cases.

Table 1.5.1.4.-1
Storage Tube and Support Cage Conceptual Design Evaluation Matrix

Component or Operation	Tube Closure		No. Fins (Columns)		Loading		Cage Units		No. Cage Doors	
Option:	Head	Well	3-Fin	4-Fin	Above	End	Multiple	Single	Multiple	Single
MECHANICAL										
Cage										
Promotes Heat Transfer			A	A						
Maintains Acceptable Temperatures										
Facilitates Can Loading			A	G	G	A	P	G	G	G
Facilitates Can Unloading			A	G	G	P	P	G	G	G
Material Compatibility										
Quick Closure and Lock					G	A			A	G
Nonmanual Open/Close					A	P			G	G
Tube										
Provide Tertiary Confinement	G	G								
Provide Confinement Seal	G	G								
Provide Floor Seal	A	A								
Quick Head Closure	G	A								
Accommodate Lifting Mechanism	A	A								
STRUCTURES										
Cage										
Support Cans Vertically			G	G						
Support Horizontally for Loading			A	G						
Self Support for Handling			A	G					A	G
Withstand Vertical Drop			G	A					A	G
Withstand Horizontal Drop			G	G					G	G
Withdrawal After Drop										
Withstand Seismic			G	G					G	G
Minimize Weight			G	A						
Attachment to Well			G	G					A	A
Tube										
Withstand Seismic	G	G	A	G			A	A	A	G
ELECTRICAL										
Provide Wireways	A	A	A	A			P	G	A	A
Facilitate Prewiring	A	G	A	G			P	G	A	A
Minimize Plug Connections	P	G	A	A			P	G	A	G
No Loose Cable Bundles	P	G	A	A			P	G	A	G
Confinement Wiring Seal	A	A								
Shield Electronics	P	G								
INSTRUMENTATION										
Accommodate RTD's										
Provide Integral Can Contact										
Facilitate Visual Code Scan										
Facilitate Bar Code Scan										
Facilitate External RTR Scan										
ACCIDENT										
Criticality										
Provide Vertical Spacing					G	A			G	A
Maintain Spacing After Drop					G	P			A	G
Drop										
No Loss of Primary Confinement										
No Loss of Secondary Confinement										
No Can Punctures										
ALARA										
Provide Vertical Shielding	A	A								
Minimize Loading Time					G	G	P	G	A	A
Minimize Unloading Time					G	P	P	G	A	A
FABRICATION										
Ease of Assembly	G	A	G	A					A	G
Design for Production										
Standard Components	G	G	A	G						
Standard Shapes										
Standard Materials										
Optimize Welding										
Minimize Tolerances										
Design for Prewiring										
Minimize Cost										
Code:	A	Acceptable								
	G	Good								
	P	Poor								

For the 15-ft vertical drop accident, tube failure and three modes of container failure - container failure due to a puncture, container rupture due to the impact loading, and a criticality failure due to support collapse with loss of required container spacing - have been addressed in the conceptual design. An energy absorption system has been designed into the storage tube base support (Drawing C405 and Section 1.5.1.4.3) on the vault floor to minimize the damage to the tube and the concrete slab. The possibility of container punctures has been minimized by avoiding or eliminating sharp corners or point contacts against the container, and by assuring that there are no plausible loose or free objects within the tube. The containers themselves are required to "remain leak-tight as defined by American National Standards Institute (ANSI) N14.5 after a free drop of 30 ft onto a flat, essentially unyielding, horizontal surface." Since this 30-ft free drop bounds the postulated tube drop accident, a can rupture is considered improbable. Each 3013 container support platform within the cage has also been designed for energy absorption to reduce the impact loadings from the containers on the cage structural members along with absorption of elastically stored energy in the rebounding cage. The container support beams and cage structural members have been designed for the expected impact loads and maintain an acceptable spacing between containers. Therefore, the probability of a breech of all three confinements resulting in a leak after such a drop is extremely unlikely.

For the second drop or fall accident, 3013 container failures from puncture or rupture are addressed with similar arguments to those above. The containers are securely held and partially protected within the cage by the relatively thin can clamps and fins. These clamps and fins deform slightly and absorb the energy of the containers during this fall accident but the relative position of the containers does not change. The effect of this fall on the tube closure flanges and floor slab has not been determined during the conceptual design phase.

1.5.1.4.3 Storage Tube Base Support

The storage tube base support was designed to hold the weight of the storage tube during normal storage conditions, provide horizontal seismic restraint to the tube bottom, and absorb the energy of the tube following an accidental drop during emplacement operations. The base support is shown on Drawing 51493-C405. There are four vertical guide columns designed for the horizontal seismic loads. These columns are tapered at the top so that the tube bottom is properly positioned on the base as it is lowered for storage. There are four 8-inch-long sections of piping that are designed to absorb the energy of a tube drop by crushing. The pipes are 6-inch diameter and are sized to crush 3 inches for the worst case drop of 15 ft. For a 3,000-lb tube dropped from 15 ft, the maximum vertical load from the base onto the vault floor is estimated to be 285,000 lb. I-beam sections are interspaced with the pipe sections to prevent total collapse of the pipe that would result in impact of the closure flanges at the top of the tube with the shelf of the floor penetration. The base support materials are all standard low carbon steel except for the lower baseplate and anchor bolts, which are type 304 stainless steel.

1.5.1.4.4 Facility Ventilation

The forced ventilation systems for this facility will include HEPA filters in all fresh air intake, pressurization, re-circulation, and exhaust airstreams except the exhaust system serving the outer truck accessway that opens to the outdoors. The HEPA filters and ventilation systems are not safety class items. They are not required as confinement ventilation per the CSR but are provided for defense-in-depth. Heat removal from the area below the charging deck is by natural convection. Plutonium storage with three passive barriers makes release incredible, and thus, filtration is not required.

1.5.1.4.5 Support Area HVAC

Natural convection is used for removing heat from the tube storage vaults below the charging rooms. Plutonium storage with three passive barriers makes a release incredible, therefore, filtration is not required. The support area is served by AHU-1, supplying approximately 8,180 cubic feet per minute (cfm) of which 1,300 cfm is fresh air discharged into the return air duct to AHU-1 by supply fan SF-1. An air-cooled chiller CH-1 (located on the pad with the electrical transformers) in conjunction with pumps, P-1A&B, will provide a chilled propylene glycol/water brine to the coil in AHU-1 capable of producing a 55°F design supply air temperature. Duct-mounted electric heating coils, HC-1 through HC-8, will be controlled by room thermostats modulating silicon controlled rectifier (SCR) controllers. Signals from selected room thermostats to the AHU controller will reset the supply air temperature to match the requirement of the zone with the greatest cooling head.

A requirement of the pitot tube array airflow station will provide a signal to a controller to reposition the inlet vane damperson the fan in AHU-1 to maintain a constant airflow from clean filter conditions to fully loaded conditions.

Exhaust fan, EF-1, will extract a total of 1,500 cfm from the men's and women's toilet/shower rooms. Approximately 45 percent of the air will be supplied into these rooms, with the balance consisting of air supplied to the hallway and air infiltrating from the pressurized safe havens into the hallway. Door grilles will be used for the transfer air.

The safe havens will be pressurized in accordance with NFPA 92A by supply fans, SF-2 A&B, each providing approximately 200 cfm. Approximately 100 cfm will infiltrate into the facility and 100 cfm will exfiltrate to the outdoors from each safe haven. A wall-mounted electric convector, CV-1G or CV-1H, will provide 3 kilowatts (kW) of heat in each safe haven.

The hallway is heated by six convectors, CV-1A thru 1F, at 3 kW each.

1.5.1.4.6 Charging Areas Ventilation

The charging areas will not be provided with heating or mechanical cooling. A two-fan (supply and return/exhaust) air handling unit, AHU-2, circulates 14,400 cfm total to provide approximately two air changes per hour in each charging room. A temperature sensor in

Room 203 and in the outside air intake duct will provide signals to a controller to reposition the outside air, recirculation, and exhaust dampers to maintain a space temperature between 50°F and 90°F. A minimum outside air setting of 10 percent will provide 720 cfm of fresh air to each charging room (720 cfm/20 cfm/person = adequate for 36 people per ASHRAE 62). A "smart" controller will optimize the fresh air/recirculated air mix for maximum advantage of the normal range of 30°F between the daily high and low outdoor air temperatures and the inherent thermal stability provided by the massive structure and earth cover.

Pitot tube array airflow stations in the supply and return air ducts will provide signals to a controller to reposition the inlet vane dampers on the supply and return fans, respectively. This will keep the airflows constant and in balance for the full service life of the filters.

A portable HEPA air mover, HAM-1, consisting of a 1,000-cfm fan and testable two-stage HEPA filter housing mounted on a dolly will be provided.

The HAM-1 will be connected by flexible duct to a portable contamination control hood, CCH-1, located inside the portable contamination control cell, CCC-1. This system will be used only if it is necessary to breach the tertiary confinement provided by the storage tubes. This would occur only if the monitoring system detected a suspected leak requiring a traverse inspection of the containers and removal for repackaging offsite shipping containers for disposition.

1.5.1.4.7 Shipping and Receiving Area Ventilation and Heating

A two-fan (supply and return/exhaust) air handling unit circulates a total of 5,750 cfm through the HEPA filter room, loading dock, staging area hallway, and staging area, producing a ventilation rate of approximately four air changes per hour in each room. Temperature sensors in the staging area and in the outside air intake duct provide signals to a controller to reposition the outside air, recirculation, and exhaust dampers to maintain the space temperature between 50°F and 90°F. This system will also optimize the use of fresh air/recirculated air and the structures' thermal characteristics as described above for the charging area ventilation system. A minimum outside air setting of 10 percent provides adequate ventilation for approximately 29 people at 20 cfm per person.

Pitot tube array airflow stations in the supply and return air ducts will provide signals to a controller to reposition the inlet vane dampers on their respective fans. This will maintain constant air volumes and keep the system in balance for the full service life of the filters.

Electric unit heaters are provided in the HEPA filter room to offset the heat loss through the walls into the storage vaults. A ceiling-mounted electric radiant heater is provided in the dock.

A supply fan and exhaust fan, SF-3 and EF-3, each rated at 4,300 cfm, will be used to provide a ventilation rate of 1.5 cfm/ft^2 in the inner truck accessway. This ventilation rate complies with the UBC requirement for garages.

An exhaust fan, EF-2, will ventilate the outer truck accessway using 6,500 cfm to produce the required 1.5 cfm/ft^2 rate. Air is drawn into the space through the open doorway or a wall-mounted louver and motorized damper interlocked to the fan. This fan will be interlocked to stop when the door between the inner and outer truck accessways is opened to minimize the transfer of air from the HEPA filtered area to the unfiltered airstream.

1.5.1.4.8 Storage Tube Cooling

The storage tube cooling is performed by a passive system relying on the buoyancy of the air as it is heated. Air enters the vault area through horizontal tunnels, passes over the storage tubes, and exits through vertical chimneys. Details of this passive ventilation system are included in General Atomic's Calculation Report, Heat Transfer Analysis of Passively Cooled Plutonium Storage Vault, included with the calculations.

1.5.1.4.9 Fire Protection

All areas of this facility except the tube storage vaults and the charging rooms will be protected by fire sprinklers in accordance with NFPA 13. The fire sprinkler system will be filled with a propylene glycol/water solution to avoid the possibility of freezing in unheated areas. A standpipe and hose system in combination with the sprinkler system will provide Class I hose stations per NFPA 14. Portable fire extinguishers complying with the distribution and application requirements of NFPA 10 will be provided throughout the facility.

Portable fire extinguishers complying with the distribution and application requirements of NFPA 10 will be provided throughout the facility.

The standby generator will be installed with appropriate fire protection, as determined during preparation of a Fire Hazards Analysis during title design.

1.5.1.4.10 Floor Drainage and Sumps

A floor drain system with gravity flow to a holding tank will be provided to collect the sprinkler discharge. A sump with duplex submersible pumps will be located in the HEPA filter room to collect the sprinkler discharge in this room and the inner truck accessway as well as the drainage of rainwater entering the outlet stacks from the tube storage vaults. The sump pump will discharge into the gravity drain line to the holding tank. Duplex submersible pumps will be located in the holding tank for use after the collected water solution is sampled and disposition is determined.

1.5.1.4.11 Plumbing

Potable water is supplied to the fixtures from the new water service to the facility from the existing main. An electric water heater will be used to provide hot water to the men's and women's toilet/locker rooms. An electric water cooler will be located in the hallway. The sanitary drain line from the facility will connect to the new sanitary sewer extended to the facility from the existing sewer line.

1.5.1.5 Mechanical Handling Systems and Equipment

Mechanical handling systems and equipment for the ISV include provisions for storage tube handling and transfer within the packaging facility; DOE-STD-3013 and AL-R8 container handling; storage tube loading system, with support cage handling and storage tube sealing and inspection; transport systems for shipment to the ISV; receipt, overhead handling, emplacement, and inspection systems within the ISV; and a portable contamination control cell for retrieval of storage containers from the ISV. Process flow operations associated with ISV mechanical handling systems and equipment are depicted on Drawing 51493-C001. The three major stages involved are in the ISV Packaging Facility, where sealed plutonium-bearing shipping containers are loaded and sealed into storage tubes; transport of the storage tube from the packaging facility to the ISV; and emplacement of the storage tube at the ISV.

A governing factor in the design of the ISV is that operation and maintenance (O&M) costs are minimized by restricting the function of the facility to that of storage only, with all processing activities performed in separate head-end facilities. All forms of plutonium to be stored at the ISV are stabilized and isolated in container systems that provide two layers of confinement prior to their transfer to the ISV Packaging Facility. Defense classified assemblies and components are sealed in AL-R8 shipping containers that provide a containment boundary layer around the primary boundary inherent in the assemblies. Plutonium metals and oxides are prepared by the PuSPS Project and provided in 3013 container systems. The 3013 container system consists of an inner, convenience container sealed in a material container that is in turn sealed in a boundary container; the material and boundary containers are welded closed, evacuated, and backfilled with inert gas that serves as a heat transfer medium and a source for leak detection. Sealed containers are kept in PuSPS lag storage for at least 30 days for characterization of contents through non-destructive assay, verification of leak-tight integrity, and verification of heat load generation rates, prior to their transfer.

Plutonium metals and oxides are received by the Packaging Facility in a shielded transfer basket transported on a lag storage dolly. The lag storage dolly is a manually operated wheeled vehicle that transports one transfer basket. The transfer basket has an integral top-mounted bail for handling, has a vertically opening latched door, and supports two 3013 containers in a horizontal orientation on an internal frame. The outer boundary container is approximately 5 inches in diameter by 10 inches long, with a design basis maximum weight of 50 lb; the top head contains an integrally formed pintle for handling. AL-R8 containers are received singly and handled with standard barrel-handling equipment. As the containers are sealed systems, radioactive contamination is not a concern in their handling, although radiation shielding concerns are applicable. Functionally, ISV packaging operations are similar for all expected forms of plutonium, and only the packaging, handling, and emplacement of the 3013 containers is discussed below for illustrative purposes.

1.5.1.5.1 ISV Packaging Facility

The 3013 containers received from PuSPS are loaded and sealed into storage tubes in the ISV Packaging Facility, providing a tertiary boundary for the packages. Pressure boundary integrity of the storage tube is provided by a gasketed bolted closure. Containers are received two at a time from PuSPS, and eight are loaded per storage tube. With a total design basis population of approximately 5,000 containers to be emplaced in the ISV during a 12-month loading cycle, the packaging facility is designed to handle two to three storage tubes per day, or two to three containers per hour.

The ISV Packaging Facility is located in Room 3206 of Building 371 on the RFETS site. Building 371 ground floor layout, with identifying room numbers, is shown on Drawing 30371-3-M. Layout of existing equipment in Room 3206 is depicted on Drawing 51493-C002, which also defines the items requiring removal to provide space for storage tube loading. Drawing 51493-C003 depicts the equipment layout for the storage tube packaging train, including the personnel barrier wall for radiation shielding.

As an existing plutonium processing facility, Building 371 SAR accidents envelope the potential risks and consequences to operating personnel and the public posed by the ISV Packaging Facility. Existing accident mitigating systems for confinement, support systems such as emergency power, air, etc., and fire detection and suppression systems are required to be maintained in support of the Packaging Facility. Additionally, existing safety systems required in excess of the accident mitigation systems include those for inadvertent radiation exposure, alpha air monitors, health physics, and criticality alarms. Building utilities required to support the packaging facility include building ventilation and 120 volt (V)/240 V power.

To minimize the impact on the existing Building 371 structure, all handling activities associated with the ISV Packaging Facility maintain the 3013 containers, the storage tube, and its internal support cage in a horizontal configuration, thus limiting headroom requirements within the facility. The axial centerline of the storage tube is supported 42 inches above the floor. A single level, straight through material flow path is provided for simplicity of operation, and to facilitate material accountability and control activities. Operating personnel and 3013 transfer baskets on a lag storage trolley enter the Packaging Facility through the existing doorway from hallway 3031A; storage tubes enter (empty) and leave (loaded) the facility through the existing doorway from hallway 3034. The process train is located behind a barrier wall providing the equivalent radiation shielding of 2 inches of steel. Packaging facility operators monitor and control operations from the north side of the barrier wall. Transfer to truck dock 18T for shipment to the ISV is on the same building floor level and does not require any overhead handling systems or elevator type mechanisms.

Staging of the storage tubes in preparation for loading involves mounting a storage tube containing a support cage onto the storage tube transport cart. Storage tubes and support cages are provided as an assembly with matched sets of unique identifiers to facilitate material accountability and control activities. Receipt storage and assembly of support cages into storage tubes in Building 371 requires the use of additional building space, such as

Room 3513, to function as a lag storage and assembly staging area. Handling of the storage tubes is accomplished with a jib crane or A-frame gantry with a 2-ton capacity chain hoist and standard rigging. Azimuthal orientation of the support cage in the storage tube is not required by the design. Visual cues on the instrumentation package define the orientation of the support cage loading doors when installing a storage tube onto a transport cart.

The storage tube transport cart is a welded steel, wheeled vehicle based on a scissors lift table with holding and positioning brackets to support the horizontal storage tube during loading and transport. No supplemental radiation shielding of the storage tube is provided by the transport cart, but may be added in the form of removable panel assemblies if deemed necessary or prudent. The platform is based on a commercially available scissors lift table mounted on a welded structural steel frame to allow loading operations with the storage tube centerline elevation at 42 inches, upending of the storage tube (in the ISV) at a lower elevation for stability, and limitation of the headroom requirements in the ISV storage area. For safety, the table is staked in position at both elevations with quick release ball detent pins. Storage cart wheels allow locking in position to stabilize the assembly during loading and truck shipment. Positioning and support of the storage tube is provided by V-shaped blocks, which also function as anchor points for storage tube securing straps and transport cart shipping tie-downs. The support block at the flanged end of the storage tube is fixed to the bed of the transport cart; the lower support block pivots to allow upending of the storage tube in the ISV. Load capacity of the transport cart is based on an estimated maximum loaded storage tube weight of 3,000 lb.

Motive power for the storage tube transport cart is provided by a 4,000-lb capacity motorized hand pallet truck. The tines of the pallet truck engage the lower frame of the transport cart from either end, as required by handling requirements. No radiation shielding for the pallet truck operator is provided as the distance between the operating handle and the load provides adequate distance. However, the geometry of the hand pallet truck easily lends itself to the addition of local shielding to further protect the operator should it be deemed necessary or prudent. Administrative controls are utilized to preclude exposing other workers in Building 371 to excess radiation levels during transfers of the loaded storage tubes.

The hand pallet truck is used to transfer the cart-mounted storage tube from the staging area into Room 3206, position it in line with the cage handling fixture, and transfer it to the shipping dock at Building 371 truck dock 18T. A duplicate component at the ISV is used for receipt and positioning of the storage tube in the staging area and in the upending areas.

In the Packaging Facility, the transport cart is manually secured in position by engaging the wheel locks, and the face plate of the cage handling fixture is fastened to the cage closure flange. The support cage is retracted from the storage tube by the cage handling fixture, ready for loading of the 3013 containers. In the fully retracted support cage position, the coupled system design of the transport cart and cage handling fixture is adequate to withstand the design basis seismic event without loss of dimensional stability.

The cage handling fixture indexes the support cage under the overhead electromechanical manipulator during loading of the 3013 containers. The fixture attaches to and supports the closure flange end of the support cage and withdraws/inserts the cage in discrete steps controlled by a linear ball screw drive system. Each container location is situated in turn at the loading station by the drive system. Positioning is provided by multi-turn rotary switches and indicated by an integral resolver. All operations are observed by the operator and capable of manual intervention for fine tuning of position, as required. The loading station is located adjacent to the closure flange of the storage tube, and initial positioning of the support cage is fully retracted to expose the lowest container location. Sufficient support cage structure remains in the storage tube to provide positioning and support for the cage in the retracted position. Over retraction of the support cage to the point of full removal from the storage tube is physically precluded by the design of the handling fixture: the linear ball screw drive assemblies are physically shorter than the support cage. The support cage is designed for its full loaded weight in the fully retracted position, supported only at each end.

Attachment of the fixture to the support cage is at the closure flange, utilizing three of the closure bolt hole locations for a clamped (bolted) attachment and three bolt hole locations for tapered alignment pins. This leaves provision for 10 closure bolts for sealing the storage tube, which is sufficient to satisfy the storage tube design conditions, although all 16 of the bolt locations remain available for use after the handling fixture is withdrawn. The bolted connections are made through a 1-$^{3}/_{8}$-inch tap in three of the flange bolt holes. The attachment bolts are captured in the handling fixture face plate and provided with conic heads to facilitate wrench locating. When fully threaded in, the bolts do not protrude through the support cage closure flange. The alignment pins are three different lengths, all of which are long enough to engage the storage tube closure flange. On full insertion of the support cage into the support tube, the longest pin provides general alignment between the two closure flanges, the next pin provides rotational alignment, and the final pin ensures full registration of the bolt hole patterns. The face frame and clamping bolts are carbon steel, the alignment pins are hardened stainless steel.

The face frame assembly is positioned by two ball screw drive systems mounted in parallel on a structural steel frame. Positioners on the motion controllers for the ball drives are preset for locating each of the eight 3013 container locations in the support cage at the loading station. Drivers, motion controllers and ball drive assemblies are sized to withdraw and insert the carbon steel support cage in the coated carbon steel storage tube with no lubrication of the sliding surfaces. The support cage is indexed in one cage location, based on a 16-inch pitch between containers, after each 3013 container is loaded.

The ball screw drive-face frame assembly is set on a floor-mounted structural steel frame that supports the system and positions it such that the centerline elevation of the support cage is at 42 inches above the Packaging Facility floor.

Operation of the cage handling fixture is operator controlled from the workstation behind the barrier shielding wall (optionally, in Room 3208). Motion initiation automatically indexes 16 inches to bring the next 3013 container location to the loading position, with operator override permitted for fine tuning as required. Motion controls are minimal, with no zero correction circuitry necessary due to the direct operator involvement.

Prior to closing the support cage locking door on an installed 3013 container, final material accountability and control activities are performed, including verification and recording of the container unique identifier in conjunction with its location within the support cage/storage tube.

Actuation of the support cage locking doors is manually controlled by operator action, using a simple ball joint ("castle") manipulator mounted through the barrier wall. This manual manipulator is essentially a grasping tong on the end of an extension wand located in the barrier wall through a universal joint type of penetration.

Loading of the 3013 containers into the support cage at the loading station is performed by a 150-lb capacity overhead monorail hoist carrying an electromechanical manipulator with a grasping end-effector. Controls for the hoist include load swing and cushioned stop and start. Hoist and manipulator actions are operator controlled. The monorail traverses between the transfer basket lag storage location where the 3013 containers are picked up, and the support cage loading station where the containers are placed in the cage structure. The containers are handled in a horizontal orientation, in-line with the axis of the storage tube with no rotation required of the containers. Thus, the loading is essentially a "pick and place" operation between two fixed points. Elevations of both points are equal, to simplify the vertical travel requirements of the manipulator.

The 3013 containers are retrieved from the shielded transfer basket by a fixed-position electromechanical manipulator with a three-pronged end effector used for grasping the integral pintle in the closure head of the container. The 3013 containers are stored horizontally in the transfer basket and are retrieved by the manipulator in the same orientation. Each container is retracted from the transfer basket by the manipulator arm onto a horizontal support surface. The manipulator rotates about its vertical axis after retrieving a 3013 container to position it under the overhead manipulator for transfer to the support cage.

The transfer basket for the 3013 containers is supported on the lag storage dolly, providing an elevation that is compatible with the centerline of the storage tube. Additional transfer baskets, up to a maximum of three, are located on a surge storage platform at a fixed spacing, separated from each other by the equivalent of 2 inches of Jabroc neutron shielding material. On the lag storage dolly, in line with the fixed manipulator, transfer basket closures are manually operator actuated by a second ball joint manipulator mounted through the barrier wall.

After eight 3013 containers are loaded into the support cage, it is fully inserted into the storage tube by the cage handling fixture, and the closure bolts installed. At this stage, TIDs are also installed and recorded. One of the closure bolts carries a unique ultrasonic signature; other closures on the instrumentation package carry TID tapes and/or wire locks. The scissors table is adjusted to the lower position, staked, and the transport cart is transferred to truck dock 18T with the motorized hand pallet truck. Administrative controls are invoked to ensure that passage through Building 371 hallways will not inadvertently expose other occupants of the building to elevated radiation levels during the transfer.

1.5.1.5.2 Transport

At the truck dock, the storage tube and transport cart are loaded onto an SST carrier for shipment to the ISV. Transport tie-downs are attached to the carrier, and a portable instrumentation and monitoring package is connected to the storage tube for in-transit monitoring. At this stage, custody of the plutonium material is transferred from the ISV Packaging Facility to the transport personnel, and subsequently to the ISV.

Transport to the ISV is by over-the-road carrier under escort in specially designed and designated safe, secure transport (SST) vehicles. Receipt at the ISV is a reverse order activity, with the storage tube transport cart(s) removed by a motorized hand pallet truck to the ISV staging area, where receipt inspection and material accountability checks are performed.

1.5.1.5.3 Emplacement

With the motorized hand pallet truck, the storage tube is located in the upending area on the ISV charging floor with the scissors table mechanism lowered to minimize headroom requirements. Lift rig attachments are made and the storage tube is upended using the 5-ton capacity overhead bridge crane. The bridge crane is an industry standard 35-ft span top running bridge crane with an electric hoist and trolley with 25- to 30-ft lift capacity. Crane controls are provided with variable frequency alternating current (AC) modulation for controlled acceleration/deceleration and load swing control. For security purposes, the bridge crane and hoist will incorporate design features which permit effective disabling of their operation when loading/unloading operations are not in progress.

The storage tube, suspended vertically from the overhead crane, is traversed to its specified storage location and lowered into place. Final spotting and position feedback is operator-verified either by direct visual observation if the crane is under pendant control, or by CCTV if it is under Control Room operation.

During lowering into position, and as required, final non-intrusive baseline measurements are taken of the storage tube and its contents. These activities consist of any or all of the following:

- Installation, verification, and recording of TIDs,
- Verification and recording of storage tube unique identifiers, e.g., bar codes,
- Temperature measurement at discrete locations along tube (container locations),
- Real time radiography (RTR) of containers to determine fill level of contents and/or shape of primary boundary top head for internal pressure assessment, and
- Radiation profiling of each container to define material content in terms of emitted energy spectrum.

These measurements are taken by an instrumentation suite mounted in a module that locates over and around a storage location. Discrete measurements correlated to a specific 3013 location in the storage tube are taken with the tube suspended from the overhead crane at the appropriate distance into the storage location.

Subsequent to emplacement of the storage tube, final TIDs and/or security locks are installed and the instrumentation wiring harness connections are made.

1.5.1.5.4 Final Disposition

At the end of the ISV storage period, storage tubes are removed in the reverse sequence in which they were loaded, up to placement on SST vehicles. The possibility of 3013 containers failing during the storage period has been considered. Options for handling these containers include both repackaging for shipment offsite, or doing onsite inspection, assessment, and reloading into a storage tube. If it becomes necessary to remove a storage tube prior to this time because of suspected or detected degradation of 3013 containers, the storage tube will be moved to the staging area for attachment to the portable HEPA air mover (HAM-1) for removal of the containers. The same, or similar, equipment train from the (now decommissioned) Packaging Facility may be used to retrieve the 3013 containers.

If the suspected damage to a 3013 container is of such a magnitude that the double confinement boundaries are breached, retrieval of the storage tube from its well may require a method that provides another controlled leakage boundary. This involves raising the storage tube into another container that would provide a boundary, downending the package at the ISV upending station, and transporting it to the HAM-1 located in the ISV staging area. This container is shown schematically in Drawing 51493-C004. The capacities of the original handling equipment, including the storage tube transport cart are sufficient to handle the additional weight of such a retreat system, but the requirements for personnel radiation shielding may very well require modifications based on the specifics of the incident.

1.5.1.6 Electrical

1.5.1.6.1 General-Basic Materials and Methods

1) General

All systems will be designed to comply with the latest edition of the National Electrical Code (NEC), NFPA 70. Standard voltages to be used for this facility will be 480-V, 3-phase, and 208Y/120-V, as stated in ANSI C84.1.

Electrical materials and equipment will be Underwriters' Laboratory (UL) or Factory Mutual (FM) tested. Installation methods will be in accordance with manufacturer instructions, NFPA 70, and the design drawings and specifications.

2) Wiring Systems

a) Raceways

The following types of raceway systems will be used in the ISV:

- Electrical Metallic Tubing (EMT) - EMT will be used to enclose circuit power conductors for alarm and signal circuits in non-hazardous and non-corrosive locations. It will not be used where subject to physical damage. EMT will not be installed underground or encased in concrete.

- Flexible Steel Conduit - This conduit will be used for connections to equipment subject to vibration, such as filtration fans and connection between junction boxes to light fixtures.

- Rigid Steel Conduit - This conduit will be used in a majority of locations within the ISV. Rigid conduit will be used within storage areas and for main runs within concealed areas.

- Cable Tray and Wireways - These raceways may be used in areas where multiple cable runs are necessary, such as in the corridors above ceiling tiles. Open tray will not be used within the storage areas.

b) Conductors

Conductors used in the interior electrical system will be copper. Conductors for power and lighting branch circuits will not be smaller than No. 12 American wire gauge (AWG). No. 10 and 12 AWG conductors for power and lighting branch circuits will be solid. No. 8 AWG and larger cables will be stranded.

c) Receptacles

Receptacles will comply with general grade as defined in Federal Specifications FS W-C-596, General for Connector, Power.

All office areas, corridors, and the charging rooms to be used for testing purposes will be provided with 120-V receptacles.

1.5.1.6.2 Normal and Alternate Power Sources

1) General Description

Normal and alternate power supplies for the ISV will originate at existing onsite substations. Specifically, new Substation 679/680 has been selected as the primary source. Two 13.8-kV circuits from the substation to the service entrance site near the ISV will be provided. At the terminus of the double circuit line, the voltage will be stepped down to utilization voltage with two pad-mounted transformers located outside the ISV's electrical room. The sizing of the transformers will assume that each would be capable of supplying power to the entire ISV loads, which will be established in Title I conceptual design. Conservatively sized 500-kVA units were selected based on availability. In the event of loss of normal power to the facility the alternate source breaker can be closed to re-establish facility power. The secondary of each transformer will be connected to two 480-V 3-phase buses that will be interconnected through a pair of tie breakers to provide diverse switching capability. The larger cooling loads for the facility will be assigned to these busses. These two switchgear busses will also provide a power supply to a normal and emergency power Motor Control Centers (MCC) during normal operations. Loads assigned to these MCC's are shown on Drawing 51493-0701, One Line diagram - Power distribution.

2) New Poleline Construction - 13.8-kV System

The purpose of the new double circuit line is twofold. One function is to provide adequate power to the new ISV. The second purpose is to supplement existing feeders for loads to the southwest quadrant of the site. Most structures in this area are currently fed from a Public Service Transformer T132. Existing alternate lines to this area are suspect with regard to loading of the installed conductors. The new line would resolve these potential loading problems and provide a reliable source to the ISV.

The new poleline route proposed will be as shown on the Drawing 51493-0707. The line is routed south from Substation 679/680 to Central Ave. The line will then run due west along Central Ave. to Third St. The line will then turn south then west again to the ISV.

The line will be of wood pole construction using 50-ft, class 2 Douglas Fir. The line will require approximately 12 double circuit structures, 7 double circuit dead-end (corner) structures, and 2 dead-end (riser) structures. The riser structure will provide a transition outside the perimeter fence to an underground concrete encased system to the ISV transformer primaries.

1.5.1.6.3 <u>Emergency and Standby Power</u>

1) Standby Generator

The standby generator for the ISV will be located on the east side within the Protected Area. It will be positioned adjacent to the normal power transformers in the ISV service entrance substation. The diesel will be designated as a standby unit and has been rated at 500 kW, which is sufficient to supply power to the full load rating of the emergency MCC. Upon loss of normal power the unit will automatically start after a 5-second delay. When the unit reaches full speed within 10 to 15 seconds, it will connect automatically to the emergency bus. Equipment on the emergency bus then can be sequenced, if necessary, and power can be restored to designated loads.

The generator will be a 480-V, 3-phase, 500-kW, diesel-driven unit. Once the unit is supplying power to emergency loads, it will remain on until the load is manually transferred back to normal power by resetting the Automatic Transfer Switch (ATS).

The emergency generator has a day tank that has approximately one hour of fuel supply. Should the unit fail to start during a normal power outage, utility operators would take immediate action to start and load it manually.

If a failure of the emergency generator and both normal power supplies occur simultaneously, the Uninterruptible Power Supply (UPS) would remain in operation to service loads connected to it for a limited time. All normal operations in the ISV would be suspended.

The emergency power system will be capable of maintaining full operation of emergency loads for the full time period of at least 24 hours. Refueling will allow indefinite operation. This power source will have features to facilitate operational testing on a periodic basis.

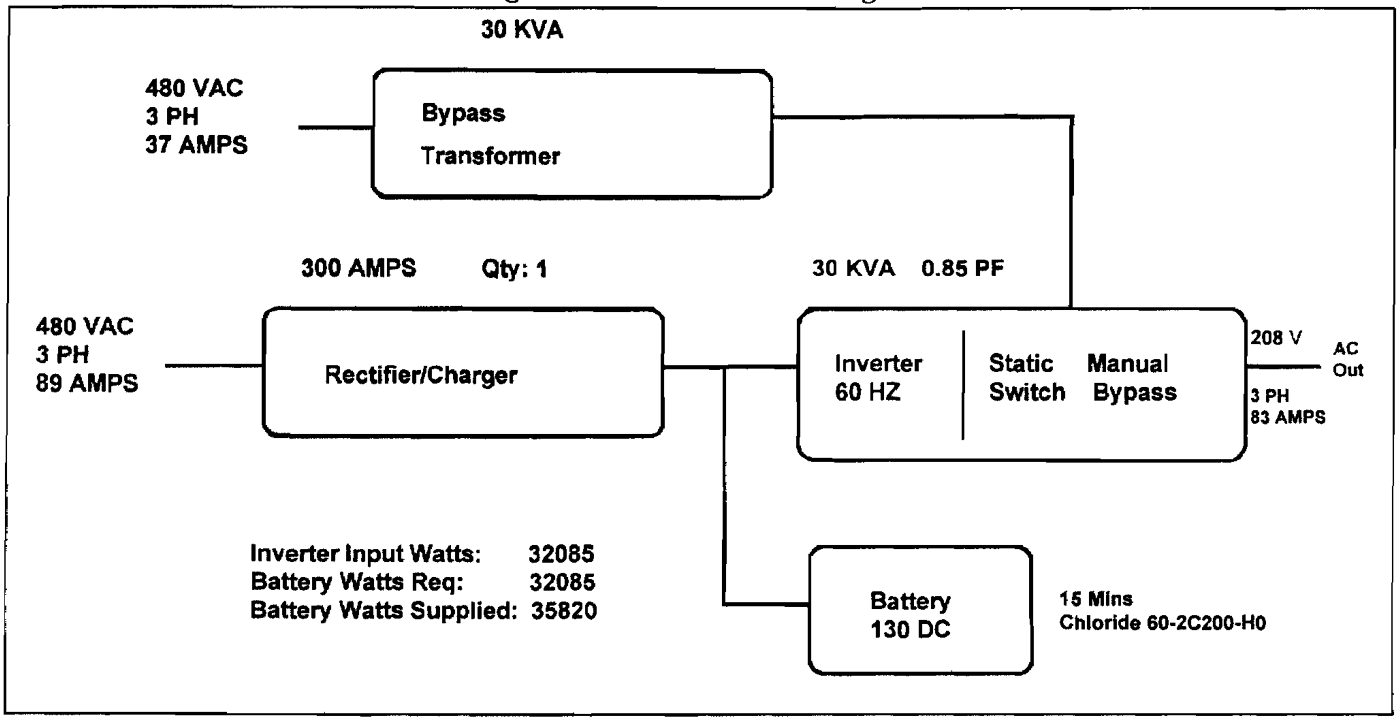
2) Uninterruptible Power Supplies

The UPS will be the float configuration. During any interruption of AC power input to the UPS, the battery bank will continue to provide input direct current (DC) power to the inverter with no interruption in inverter output AC power. Each UPS to be furnished will consist of the following major components:

- AC rectifier/charger,
- Static inverter,
- Static transfer switch,
- Manual bypass switch,
- Bypass transformer, and
- Battery bank.

Two separate UPSs will be installed in the Electrical Equipment Room. Loads on one unit will consist of instrument monitoring and associated terminals. The other will be for security. The UPSs will be provided as packaged systems consisting of inverter, storage batteries, charger, and distribution panelboards. This power source will only be used for loads that cannot tolerate the transient or momentary power losses that occur in the utility power supply. The UPSs will have a rechargeable battery power supply backup that, in the event of loss of normal and emergency power, will run the UPS for 15 minutes. This is a typical duration for other buildings at RFETS. All required UPS loads have not been established in this phase of the design. Two 30-kVA units have been included for estimate purposes. Figure 1.5.1.6-1 shows a block diagram depicting the system(s) ratings.

Figure 1.5.1.6-1 Block Diagram



There are two modes of failure for a UPS: (1) an internal failure of the electrical or electronic system and (2) complete discharge of the battery system. If normal or emergency power is available during an internal failure of the UPS, the alternate feed circuit breaker can be closed to supply power. In the second mode of failure, if normal or emergency power is not available, a loss of power to the UPS loads will occur. In this case it will not be possible to monitor the leak detection system or alarm building functions until power is restored.

1.5.1.6.4 Lighting Systems

Both interior and exterior lighting will conform to the Illuminating Engineering Society (IES) Lighting handbook. Exit and emergency lighting will comply with NFPA 101 and NFPA 110.

Maximum use will be made of fluorescent and high intensity discharge (HID) lamps. Light fixtures will have diffusers and lenses constructed of noncombustible materials.

1.5.1.6.5 Grounding System

The Grounding System will be designed to comply with NFPA 70 and Institute of Electrical and Electronics Engineers (IEEE) 142. A separate ground conductor will be installed in raceways. The raceway will not be used as a ground path.

Fence grounding will comply with ANSI C2.

Isolated ground systems may be required to meet special instrument requirements.

1.5.1.6.6 CCTV Requirements

This system will be provided as part of the security system. Cameras are proposed within vault areas, manned areas, loading areas, and external to the ISV. Monitoring will be provided in the CAS and Secondary Alarm Station (SAS) areas, as well as selective monitoring in the Control Room and IAEA room.

1.5.1.6.7 Communications and Alarms

Interior communications and alarm systems will be designed to use standard, commercially available equipment. The initial and projected requirements for telecommunications systems will comply with DOE Order 5300.1B. Secure communications systems will comply with DOE Order 5300.3B. Data communications facilities, services, and equipment will comply with DOE Order 5300.1B.

1) Joint Use

Telephone circuits will be used for other communications and alarm services to the maximum extent possible. If separate conductors are required, they will be routed through the main telecommunications and signal raceway system. Joint use lines are anticipated from the ISV to the SAS location, as a minimum.

Telecommunications and alarm equipment and conductors will be located outside areas subject to radiation, vibration, and excessive noise levels. Where communications equipment must be placed in these areas, the equipment installed must be suitable for the hazard.

1.5.1.6.8 Service Equipment

1) General

Interior systems will comply with NFPA 70. Switchgear will comply with IEEE C37, Circuit Breakers, Switchgear, Relays Substations, and Fuses.

2) Metering

Energy metering requirements for new facilities will use conventional kilowatt-hour meters for measuring and recording electric energy use at the incoming power service.

3) Transformers

Interior service transformer installations will comply with NFPA 70. The minimum number of transformers necessary to satisfy initial and projected facility loads will be used. These units will be provided to supply power at 480-V and 120-V to internal building emergency and normal loads.

4) Motors

Motors will comply with National Electrical Manufacturer's Association (NEMA) MG-1. In general, motors for use in HVAC systems will be furnished with the driven equipment.

Motor enclosures will be drip-proof for indoor dry locations. Except where special conditions require otherwise, motors 1 hp or less will be single-phase, 115-V rated. Motors greater than 1 hp will be specified as 3-phase, 200- or 460-V rated.

5) Motor Control

Control equipment will comply with NEMA Industrial Controls and Systems (ICS) standards. Motors, as well as other loads, will be controlled from the electrical room where both emergency and normal power centers are provided.

1.5.1.7 Leak Detection Instrumentation Suite

The recommended instrument suite for container leak detection, discussed in detail in Appendix 1.12.3, is based on requirements in the Kaiser-Hill Request for Proposal/Statement of Work. The suite includes equipment for monitoring the containers and storage tubes, a data collection system, devices for MC&A, and systems for satisfying IAEA verification requirements. The suite does not include facility security systems, such as video monitoring and surveillance systems; radiation safety systems, such as alpha air monitors and criticality monitors; or other safety systems, such as fire protection.

Plutonium waste material will pass through three stages: packaging, transfer to the storage facility, and 15-year interim storage in the ISV. Because of different physical constraints, each stage requires separate sets of leak detection instrumentation.

During the packaging stage, material will be encapsulated in containers that will be certified for leak tightness, observed for problems during a short "soak-in" period, and placed into storage tubes. There are three categories of data that must be collected for each container during packaging: certification data, soak-in data, and MC&A data.

Package certification data are required to verify that containers are properly sealed leak tight and include the following as a minimum:

- Leak test results for inner and outer containers,
- Exterior surface contamination test results for inner and outer containers, and
- Radiographs of all welds.

Soak-in data are required to detect short-term packaging failures and include the following as a minimum:

- Temperature of the outer container, and
- Internal pressure of the inner container.

MC&A data are required for record keeping and inventory and include the following as a minimum:

- Content type, weight, and thermal output,
- Container weight and dimensions,
- Reference gamma and neutron "signatures",
- Unique identification of storage tubes and containers, and
- TID identification.

For the transfer stage, storage tubes will be loaded onto vehicles and transported to the ISV. The following transfer data shall be collected immediately before loading the storage tubes on the vehicle and immediately after unloading the tubes at their destination:

- Storage tube identification,
- Storage tube TIDs,
- Temperature of the outer container, and
- Internal pressure of the inner container.

During the 15-year storage stage, storage tubes will be placed in the ISV and monitored for problem conditions. The following data will be collected during the storage period:

- Temperature of the outer container,
- Internal pressure of the inner container,
- Air temperature inside the storage tube,
- Air temperature of the ISV,
- Leak detection by sensing helium gas in the tube atmosphere,
- Storage tube identification,
- Storage tube TIDs, and
- Inspection of storage tube and container condition.

1.5.1.7.1 Recommendations for Packaging Instrumentation

1) Storage Tube Identification

Storage tubes will be individually identified with bar codes. The bar code system will be identical to the system used by the packaging program for 3013 container bar codes.

2) Storage Tube TIDs

In order to eliminate the requirement for IAEA material audits on the storage tubes, there must be at least two independent TIDs sealing each opening. For the current tube design, there are four openings that could be used to remove material:

- The main lid, flanged and bolted shut,

- A 4-inch threadolet port, closed with a screw plug,
- An air supply connection for a helium detector, and
- A 2-inch threadolet port, closed with a screw plug.

For the main lid, one of the two TIDs will be an ultrasonic sealing bolt incorporating an ultrasonically verifiable "fingerprint" and an internal "integrity" device that breaks when the bolt is unscrewed. The other TID on the main lid shall be a tape seal incorporating a bar code.

For the threadolet ports, one of the TIDs will be a tape seal similar to the one described above for the main lid. The other TID will be a cable barrier seal consisting of a high strength steel wire secured with a special clamp that collapses upon a tampering attempt. The clamp will have a bar code to scan to determine if the original seal has been replaced.

The seals on the air supply port for the helium detector will be tape seals and cable barrier seals similar to the ones described above.

3) Temperature of Outer Container

During the soak-in period, the outer container surface temperature will be manually measured with radiation pyrometers. Pyrometers will be in the 8-14 micron wavelength range, which will monitor object temperatures from 0 to 540°C.

4) Internal Pressure of the Inner Container

During the soak in period, the inner container pressure will be periodically checked using a custom designed radioscopy system. The radioscopy system will consist of an isotopic fan source with shielding, a shutter, a linear array detector, and a digital imaging system. The source, shutter, and detector shall be designed as a collar-shaped device with two halves hinged together. The radioscopy system will be designed to detect at least a 0.15 inch deflection of the inner container lid. This amount of deflection occurs when the internal container pressure is 100 psi.

1.5.1.7.2 <u>Recommendations for Transfer Instrumentation</u>

1) Storage Tube Identification

Storage tubes will be identified with bar codes as discussed in Section 1.5.1.7.1.

2) Storage Tube TIDs

TIDs for storage tubes are discussed in Section 1.5.1.7.1.

3) Temperature of the Outer Container

Container surface temperature will be continuously measured with 10-ohm platinum two-wire Resistance Temperature Detectors (RTDs) attached with high temperature, radiation resistant epoxy or room temperature vulcanizing (RTV) silicone adhesive. The RTDs will be wired to a portable datalogger for the duration of the transport period.

4) Internal Pressure of the Inner Container

Container pressure will be determined using a radioscopy system as described in Section 1.5.1.7.1. The radioscopy system will be located in the ISV on the charging deck positioned above and around the storage tube floor entry hole. Containers will be inspected without opening the storage tube, as the tube is lowered into its well.

1.5.1.7.3 Recommendations for Storage Instrumentation

1) Storage Tube Identification

Storage tubes will be identified with bar codes as discussed in Section 1.5.1.7.1.

2) Storage Tube TIDs

TIDs for storage tubes are discussed in Section 1.5.1.7.1.

3) Temperature Monitoring

Temperature of the containers, of the air inside the storage tube, and of the ISV ambient air will be continuously measured with 100-ohm platinum two-wire RTDs. The RTDs will be wired to a programmable logic controller (PLC) data acquisition system as described below.

4) Continuous Monitoring for Inert Gas Leakage

The atmosphere inside the storage tube will be continuously sampled and analyzed with a helium gas detector to detect container leaks. The helium gas detector will be located in the tube instrument well and will generate an analog output signal proportional to the helium content of the tube atmosphere. This signal will be wired to a PLC analog input module mounted in the tube instrument well. The detector will be able to detect helium concentrations of 1 ppm or greater.

5) Automatic Data Collection System

The recommended data collection system is a combination of PLC and personal computer (PC) systems. The PLC portion of the system will perform data acquisition, trending and alarm generation and will forward the data to a PC-based operator workstation for storage and further analysis.

6) Internal Pressure of Inner Container

Container pressure will be checked on a regular schedule using a radioscopy system as described in Section 1.5.1.7.1 above.

7) Visual Inspection of Container

A fiber optic video system will be used to check container bar codes for MC&A audits; to inspect the condition of the containers, support cage, and sensors; and to find broken wires, supports, tubing, or other components. The system will have the following features:

- Long flexible probe with small diameter,
- Smooth coating on probe, allowing easy decontamination,
- High intensity light source,
- Field of view, real time imaging with monitor and TV camera, and
- Retrieval tool accessory to convert scope to working channel type.

8) Location of Leaks with Inert Gas Detector

If a container leak is suspected, a sensitive helium detector with a long flexible air intake hose will be used to pinpoint the location of the leak, since the concentration of helium gas in the storage tube atmosphere would be highest near the leak. The inspection could be performed without opening the storage tube or removing the storage tube from the ISV.

1.5.1.8 Monitoring, Alarm, and Display Systems

1.5.1.8.1 Overview

Monitoring, alarm, and display equipment will be provided for the following systems:

- Criticality Accident Alarm System,
- Fire Alarm System,
- Life Safety/Disaster Warning (LS/DW) System,
- Portable Continuous Air Monitoring System,
- 3013 and AL-R8 Container Monitoring Systems, and
- Building Utilities Monitoring and Control.

The primary location for monitoring, alarm, and display systems will be the ISV Control Room. Hardwired alarm panels, control consoles, and cathode ray tube (CRT) monitors will be installed for each system. The Control Room will be manned by operations personnel at all times.

Security system monitoring equipment, including closed circuit TV (CCTV) monitors and communications systems, will be located in the CAS/Guard Station.

The SAS will be located away from the ISV site in Building 121. The SAS will have communications with the CAS via a redundant network communication bus. CAS operations will be monitored through full CCTV coverage, relayed and supervised by the SAS.

The IAEA Room will be used for non-intrusive monitoring of non-classified material/parts in 3013 containers. This will include an operator workstation for the 3013 Can Leak Detection Monitoring System.

In general, all critical alarms will enunciate in the Control Room and the SAS. All safety alarm systems, such as fire alarms, criticality accident alarms, and evacuation alarms will actuate audible signals inside the ISV in all occupied spaces and outside the ISV near egress points.

Alarms will be prioritized so that precedence can be assigned to more critical events.

Alarms associated with support equipment may be enunciated with a "Common Trouble" alarm in the SAS.

1.5.1.8.2 <u>Criticality Accident Alarm System</u>

The Criticality Accident Alarm System will be designed to meet the requirements of the site Nuclear Criticality Safety Manual and ANSI/ANS-8.3, Criticality Alarm System.

The system will consist of neutron criticality detectors, located in the two charging rooms, which are connected to a central criticality alarm and display panel in the Control Room. Additional alarm panels will be located in the SAS.

The criticality alarm panel in the Control Room will contain the following equipment:

- Individual detector status indicators,
- Beacon activation indicator,
- "Trouble" audible alarm,
- AC power status indicator,
- DC power supply, batteries, and battery charging circuits, and
- Coincidence circuitry for alarm actuation.

Criticality detectors will be positioned in the charging rooms so that each area where a criticality could occur is covered by at least three detectors to insure redundant coverage. Detector locations and quantities will be determined during title engineering. The detectors operate on the principle of sensitivity to high neutron flux associated with a nuclear criticality.

A criticality accident alarm is triggered by coincident actuation of at least two detectors. Audible alarms will be transmitted via the LS/DW System within all occupied rooms of the ISV, and alarm displays on the Criticality Alarm Panels in the SAS will be actuated. Strobe beacons outside each egress point will be actuated. If only one detector trips, a "Trouble" audible alarm and light are actuated on the panel and in the CAS.

The Criticality Alarm Panel and beacon circuits are powered from the ISV Emergency Power System. Internal batteries in the panel serve as an interruptible power supply for the panel and detectors in the event emergency power is momentarily lost. The batteries will provide power for a minimum of 4 hours. Loss of AC power or trouble with the charging system or batteries will actuate a "Trouble" alarm.

1.5.1.8.3 Fire Alarm System

Fire Alarm Systems will be installed in accordance with NFPA 72, National Fire Alarm Code.

Automatic smoke detectors will be installed in occupied areas without automatic sprinkler protection. This includes the two charging rooms, Rooms 201 and 212. Placement and number of detectors is dependent on the final room configuration. In addition, smoke detectors will be installed in each of the air handling units. Manual fire alarm pull stations will be installed in areas required by NFPA 101 and 72.

The automatic sprinkler system will designed to include one alarm, which is actuated when water flow to the system is initiated.

Manual fire alarm pull stations will be installed in occupied areas.

All alarm initiating devices will actuate alarms in the following areas:

- Main fire alarm panel in the Control Room,
- Local alarms in the facility,
- SAS, and
- Site Central Fire Station.

Fully-trained fire department personnel from the Site Central Fire Station will respond to fire alarms at the ISV.

1.5.1.8.4 Life Safety/ Disaster Warning System

The LS/DW System is a multiple-input public address system used to provide annunciation to building workers for criticality alarms, emergency response actions, and general building announcements. The criticality alarm will override and block out all other alarms or announcements on a priority basis. Speakers will be located in all rooms of the facility.

The LS/DW System will be powered by uninterruptible power from the monitoring and alarm UPS.

The integrity of the LS/DW System will be monitored by continuously playing music through the system. If a speaker is silent, a failure is presumed to have occurred somewhere in the system.

The system includes an equipment cabinet in the Control Room that houses an amplification system, criticality tone generator, and microphone inputs. Microphones will be located in the Control Room and the CAS/Guard Station.

1.5.1.8.5 Air Monitoring System

The ISV installation is not required to meet requirements for effluent monitoring or record effluent sampling systems for Clean Air Act permit surveillance because of the nature of the triple containment container packaging system. Portable continuous air monitors (CAMs) will be used to allow workers in the vicinity to take appropriate action in the unlikely event of an alarm to minimize the immediate worker's potential for exposure to airborne radioactivity.

Portable CAMs will be placed at appropriate locations in the truck accessway, staging area, and charging rooms when tube handling operations are in progress. The portable CAMs are self-contained units that include a small vacuum pump, audible alarm, and rotating beacon mounted on a wheeled cart. They provide real-time detection of airborne plutonium releases. The CAMs will be powered from receptacles on the emergency power system.

The CAMs will be RADECO Model 452, as currently used onsite, or the latest available model. Sampled ambient air is drawn though the CAM by the portable vacuum pump. Particulates up to 10 microns are collected by the sampling system and deposited on a filter inside the unit. An ion implanted detector mounted in close proximity to the filter surface responds to the alpha activity of the particles deposited on the filter.

1.5.1.8.6 Container Leak Detection System

A detailed description of the instrumentation that will be used for monitoring for leakage in the containers and storage tubes is included in Section 1.5.1.7 and Appendix 1.12.3. Two separate and isolated Automatic Data Collection Systems will be used for monitoring container leakage. The 3013 container system will be monitored independently of the AL-R8 container system because of the presence of SNM in the AL-R8 containers.

The equipment configuration for each of the Automatic Data Collection Systems will be similar. Instrumentation on the containers and storage tubes will be connected by remote input/output (I/O) link to a group of PLCs located in the hallways outside the charging rooms. The PLCs will be connected by a redundant network communication link to PC-based operator workstations. The PC-based operator workstations for each system will be used for data acquisition, trending, alarms, and report generation of storage container parameters.

Workstations will be located in the following areas for each system:

3013 Container System

- Control Room,
- IAEA Control Room, and
- SAS.

AL-R8 Container System

- Control Room, and
- SAS.

1.5.1.8.7 Utility Control and Monitoring Panel

The Utility Control and Monitoring Panel will be located in the Control Room. It will be the central location for control and monitoring of the ISV utility systems, including the following systems:

- HVAC System,
- Primary and Alternate Power System,
- Emergency Power System,
- Emergency Generator,
- UPS - Monitoring systems, and
- UPS - Security System.

The panel will include control switches, indicating lights, enunciators, meters, etc., as required for monitoring, alarm, and remote control of the ISV support systems.

1.5.2 Energy Conservation

The heavy concrete construction and earth cover of this facility protect most of the occupied areas from the normal climatic forces affecting a building's HVAC energy consumption.

The charging rooms above the storage vaults are ventilated with a variable mix of recirculated and fresh air without heating or mechanical cooling to normally maintain the room temperature between 50°F to 90°F. These areas will have a low watts/ft^2 requirement for lighting.

The shipping and receiving area is ventilated in the same manner as described above. Electric unit heaters in the HEPA filter room can normally be shut off and used only when servicing the air handling units located in this room.

The discharge air temperature from the support area air handling unit cooling coil will be reset to provide air only cool enough to meet the requirement of the zone with the greatest cooling demand. This will minimize the chiller running time and reduce energy consumption resulting from overcooling and re-heating in the other zones.

1.5.3 Environmental Considerations

1.5.3.1 General

Under the Atomic Energy Act of 1954 (42 USC 2011 et seq.), DOE has established policies, regulations, and standards, through a series of DOE Orders, to protect the environment, health and safety of workers and the general public surrounding the DOE sites. For environmental considerations, there are major federal and state statutes and regulations that are applicable to DOE sites. Some federal regulations include: National Environmental Policy Act of 1969 (42 USC 4321- 4370c); Clean Air Act of 1970 (42 USC 7401 - 7671q); Clean Water Act of 1972 (33 USC 1251 - 1387); Safe Drinking Water Act of 1974 (42 USC 300f - 300j-11); Resource Conservation and Recovery Act of 1976 (42 USC 6901 - 6992k); Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (USC 9601 - 9675); and the Federal Facility Compliance Act of 1992 (42 USC 6921 et seq.). The statutes and the regulations are examined briefly to see if they are applicable to the ISV for the storage of plutonium.

1.5.3.2 National Environmental Policy Act (NEPA)

NEPA (5 CFR, Part 1500.1 - 1517.7) requires detailed statements on policy, plans, programs, projects, and permits on all aspects of the environmental effects that may significantly affect the quality of the human activities and to balance environmental considerations positively and fairly against other mission considerations. NEPA requires that for a major federal action, a federal agency such as DOE must follow one of the three alternatives for compliance: 1) Environmental Impact Statement (EIS), 2) Environmental Assessment (EA), or 3) Exclusion or other exemption. For "significant impacts" on the environment such as the construction of the ISV, an EIS is required in accordance with Counsel on Environmental Quality (40 CFR 1500 - 1508) and DOE regulations (DOE Order 5440) for implementing the procedural provisions of NEPA (10 CFR 1021). A Draft Environmental Impact Statement (DEIS, November 1996) was written for the proposed construction of the ISV. It discussed reasonable alternatives, including a "No Action" alternative, and their potential environmental consequences and strongly favored the construction of the ISV.

1.5.3.3 Clean Air Act (CAA)

Under 40 CFR, Section 109, the U.S. Environmental Protection Agency (EPA) has established National Ambient Air Quality Standards (NAAQS) for pollutants - ozone, carbon monoxide, oxides of nitrogen, particulate matter less than 10 microns, sulfur dioxide, and lead. Under the Interagency Agreement between DOE, EPA, the Colorado Department of Health (CDH) signed in January 1991, an air emission permit was issued to RFETS. EPA regulates hazardous air pollutants, including radionuclides, under the National Emission Standard of Hazardous Air Pollutants (NESHAPs), 42 USC 7470. Ozone falls under non-attainment area (NAA) because of the "Greenhouse effect" or "Global warming". RFETS is in an NAA for ozone and in class II for the other five pollutants. The radionuclide emissions are regulated under NESHAPs (40 CFR Part 61).

EPA issued an administrative compliance order for radionuclide emission to RFETS in March 1992. Under DOE Orders 5400.1, 5400.5, and 5480.1, the site has a radioactive ambient air monitoring program (RAAMP) to monitor for plutonium, americium, uranium, and tritium. The monitoring is performed through manual-check samplers onsite and in surrounding communities to ensure that the levels are below the regulatory limits. This practice will continue during the construction of the ISV, transfer of the 3013 containers in tubes from Building 371 to the ISV, and operation of the ISV.

As such, the CAA is not applicable to the ISV. However, if there is any operation involving the opening of a container or a storage tube, this will be done in a confined contamination control glove box that will be equipped with a HEPA filter. During this time, air stack sampling will be performed to monitor for any radioactivity release into the environment. DOE had a dose limit of 25 mrem/year. Under 40 CFR, Part 61, EPA has lowered this limit to 10 mrem/year effective dose in 1990 for radionuclide emissions for RFETS. The 10 mrem/year dose limit will be applicable to the ISV.

1.5.3.4 Clean Water Act (CWA) and Safe Drinking Water Act (SDWA)

EPA has established guidelines for the effluent limitations from point-source discharges based on the applicable technologies available and provides guidelines for the National Pollutant Discharge Elimination System (NPDES) for permitting programs. States usually administer the NPDES permitting programs. EPA also has the responsibility to set guidelines for stormwater discharges that are associated with industrial activity. Any stormwater discharges associated with industrial activity require an NPDES permit (40 CFR 122, Section 402p). RFETS has an NPDES permit for stormwater discharge, which will be applicable during construction of the ISV.

Under the SDWA, EPA has promulgated regulations under 40 CFR Parts 100 to 149 for various pollutants. States administer the program through water quality certification and standards. For radionuclides, the regulations require that the average annual dose from radionuclides in drinking water shall not exceed the total body dose of 4 mrem/year beta activity (Draft Environmental Impact Statement, November 1996).

Like any large industrial plant, RFETS surface waters consist of base flows in creeks, ponds, and irrigation ditches, treated sanitary sewage effluent, storm water runoff, spray irrigation, and groundwater flows. A significant portion of these waters run into Walnut and Woman Creeks that naturally drain downstream into two major suburban drinking water supplies - Great Western Reservoir (serving Broomfield) and Stanley Lake (serving Westminster, Thornton and Northglenn). Air-dispersed radioactive and hazardous substances, outside the contained wastewater streams, can migrate to surface waters, groundwater, stormwater flows, etc., as nonpoint source pollution. There are six monitoring locations installed offsite to monitor streams for radionuclides, inorganic, and organic pollutants.

Radionuclides are not regulated by the NPDES permit or NPDES Federal Facility Compliance Act (FFCA) because DOE has a "self-policing" position, but they are monitored in the sewage treatment plant and terminal ponds. DOE (under DOE Order 5400.5) has adopted the ALARA concept, using the best available technology. Based on the Interagency Agreement, the ALARA values for radionuclides at RFETS are: 15 pCi/l for gross alpha, 50 pCi/l for gross beta, 5 pCi/l for uranium (U-238), 0.05 pCi/l for plutonium (Pu-239+240), and 0.05 pCi/l for americium (Am-241).

The ISV shall have underground water systems for fire protection and drinking water, which do not require the CWA and SDWA permit; however, if the radioactivity levels exceed the ALARA values, monitoring is required. The berm around the ISV will have stormwater runoff, so an NPDES permit will be required.

1.5.3.5 Resource Conservation and Recovery Act (RCRA)

RCRA was enacted to deal with disposal of hazardous waste. The ISV is for storage of plutonium, and radionuclides or radioactive waste such as plutonium. SNM, or byproduct material is exempt from RCRA, Part 1004,27, under the Atomic Energy Act of 1954 (42 USC 2011, et seq.). However, "mixed" waste, where the radioactive waste is mixed with hazardous waste, is hazardous and subject to RCRA. If the radioactive component (e.g., plutonium, americium, etc.) is separated out, the remaining waste would be regulated as hazardous, whereas the component is no longer subject to RCRA requirements. A waste generator with a treatment, storage, and disposal (TSD) facility requires a RCRA permit - Part A for "interim status" and Part B for a permanent permit. Rocky Flats is a permitted treatment and storage facility, but not a disposal facility. As long as there is no hazardous or mixed (radioactive and hazardous) waste, RCRA does not apply to the ISV.

Solely transuranic waste (TRU) (plutonium, americium, or byproducts, <100 nCi/gram) and low-level waste (LLW) (plutonium, americium, or byproducts, <100 nCi/gram) are regulated by DOE (DOE Orders 5400.1, 5820.2A). LLW in 55-gallon drums is shipped to the Nevada Test Site, whereas the TRU material or waste is expected to be shipped to DOE's Waste Isolation Pilot Plant, near Carlsbad, New Mexico, or Savannah River in South Carolina. In the interim, plutonium will be stored in the ISV. However, under the Interagency Agreement and FFCA agreement, EPA and the state need to give concurrence of the RCRA exemption for the ISV.

1.5.3.6 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund)

CERCLA was enacted to clean up hazardous sites that are inactive, ignored, or abandoned; therefore, this regulation is not applicable to the ISV for plutonium storage. If there is any radioactive release by a potential accident scenario into the environment, the health and safety concerns are dealt with under DOE Orders 5400.1 and 5400.4 as required by the Atomic Energy Act of 1954 (42 USC, 2011 et seq.).

1.5.3.7 Federal Facility Compliance Act (FFCA)

There have been several FFCA agreements signed under the Interagency Agreement between DOE, EPA, and the state pertaining to the mixed waste (hazardous and radioactive). FFCA I was signed on September 19, 1989, and FFCA II was signed on May 11, 1991. The latest FFCA was signed on October 6, 1992, in which the FFCA waives sovereign immunity for fines and penalties for RCRA violations at federal facilities. The FFCA further provides relief to DOE in that it will not be subject to fines and penalties for violation of federal hazardous waste regulations pertaining to the land disposal restriction storage prohibition for mixed waste, as long as the facility is in compliance with an approved plan and consent order, and meets all other applicable regulations. The FFCA would also apply to nuclear material (TRU, LLW) if RCRA would apply to storage and treatment of such material. If RCRA does not apply, which seems to be the case, then FFCA would not apply.

1.5.3.8 Summary

Of the major federal statutes discussed, CAA, SDWA, CERCLA, and FFCA are not applicable for the ISV. RCRA would apply for mixed waste, and the CWA regulations pertaining to stormwater runoff would apply during construction and failure operation of the ISV. As defined in the Interagency Agreements, EPA and the state will need to give concurrence on these exemptions.

1.5.4 Facility and Equipment Maintainability

The expected life of the ISV is 15 years, however, the design life is specified as 50 years. The facility and equipment maintainability design concepts for the design life of the facility are discussed in this section.

1.5.4.1 Facility

The ISV will be a poured-in-place concrete structure that will have hardeners and dust-proof penetrants applied to walls and ceilings, and epoxy coatings on floors. Since the facility will use loading carts during the storage phase, and foot traffic for the remainder of its life, no maintenance is anticipated after the facility is constructed.

The 3-ft-thick concrete security doors ride on a series of steel bearings on a steel plate. Normal maintenance may be required to clean the tracks, and keep them relatively free of rust, dirt, and gravel. Hydraulic systems for the doors will require periodic maintenance to keep the systems operating properly. This will consist of periodic inspection of mechanical linkages and quarterly testing of the fire-resistant hydraulic fluid with a refractometer and subsequent correction as required (i.e., addition of distilled water with morpholine additive). Fluid filters should be inspected quarterly and replaced annually while systems are in use. All systems should be monitored continually for leakage and repaired immediately upon detection.

1.5.4.2 Cranes and Material Handling Equipment

The proposed material handling equipment required to load cans in the storage tubes is commercially available and contains standard industrial components. Maintainability of the loading equipment will consist of replacement of failed components. Contamination of the equipment was not a design consideration because of the confinement provided by the 3013 cans. Components requiring periodic maintenance can be serviced while no storage cans are in the area or with radiation sources moved to a remote location of the room. An equipment failure during in-process loading may require operator intervention with local shielding provisions.

The bridge crane in the ISV is also commercially available and may require infrequent maintenance such as cable inspections, lubrication, etc. The crane will see light duty in the non-corrosive atmosphere of the facility. Major maintenance can be accomplished while the crane is positioned above the upending bay, away from any significant radiation levels. Additional local shielding could be used if necessary.

1.5.4.3 Support Systems

The mechanical rooms containing the HVAC equipment and sump pumps are located in fully accessible areas of the facility. The HVAC equipment and pumps are standard commercial equipment and will require normal inspection and service such as examination of belt drives, lubrication of fan bearings, and replacement of filters and belts. Major maintenance or replacement of bearings, seals, and motors will be required as the life of the facility is extended.

1.5.4.4 Electrical

Output voltage and frequency for the UPS's are verified on a monthly basis. Annually, operation with the electrical loads is verified by simulation of loss of AC or normal power to the UPS.

The following battery surveillances are performed:

- Verify float voltage on a monthly basis,
- Verify the float voltage of each cell, battery, and battery system on a quarterly basis,
- Verify the battery system capacity is greater than 90 percent of supplier's specifications on a 5-year interval by performance testing, and
- Periodically replace the cell as necessary.

The engine heaters are verified as operable on a daily basis. Surveillances of the Fuel System and starting battery are performed daily.

The generator is checked that it meets nameplate rating every 10 years. The diesel generator will be demonstrated operable by verification of the following on a monthly basis:

- The lube oil level is adequate,
- Standby power is supplied to the ATS in less than 20 seconds from loss of power to the emergency bus,

- Loads are energized on simulation of loss of power to the connected bus,
- Voltage is maintained on the bus,
- Loads are supplied for at least 60 minutes,
- Frequency is maintained,
- Generator coolant temperature is maintained, and
- Starting air pressure is adequate.

1.5.4.5 Storage Tube

The storage tube confinement boundary and internal support cage components are mostly welded carbon steel and stainless steel parts. The flange seal is metallic. The only exception is the sealing compound and insulation material integral with the wiring penetration seals. The structural and confinement components are designed to preclude maintenance over the design storage life of the ISV. Some additional study or testing is required to verify a design life for the wiring seals.

1.5.4.6 Storage Tube Monitoring System

Instrumentation inside the storage tube has been designed with either installed spares or a traversing probe concept that will permit maintenance without removing the storage tube cover. Insulation for the instrumentation wiring within the storage tube has been selected that tolerates the expected radiation levels within the tube and the instrument well. Storage tube instrumentation requiring maintenance has been located outside the tertiary confinement boundary in the instrument well for access from the charging deck floor. The data acquisition PLC processors have been located in the hallway outside the charging deck floor minimizing the need to enter the space above the storage tubes . The control consoles are located in areas designed for continuous habitation. Industry standard components have been recommended to complement spare parts availability and utilize proven maintainability measures. Periodic calibration and maintenance will be required for the tube monitoring instrumentation. The large quantity of instrumentation will require a more or less continuous maintenance activity in the ISV.

1.5.4.7 Facility Alarms

The neutron criticality detectors, air handling smoke detectors, fire detectors, and criticality accident alarm systems operator interface panels are located in areas designed for continuous habitation. The detectors will be placed in areas that will accommodate functionality and maintainability. Industry standard components have been recommended to complement spare parts availability and utilize proven maintainability measures.

1.5.4.8 Radiation Levels

Radiation levels in the facility are acceptable for full-time occupancy in all areas except the storage vault area and directly above the vault area on the charging floor. The vault area is inaccessible by design for security purposes and most of the equipment in the vault does not require maintenance. The radiation levels on the charging floor can be reduced to acceptable full-time occupancy levels (around 0.25 mrem/hr) with the equivalent of 7 inches of steel above the containers. The current design includes only 4 inches of steel shielding above the containers resulting in an estimated dose rate of 0.51 mrem/hr at the charging floor surface. It is feasible to increase the thickness of the 1-inch floor cover plates.

Radiation levels within the instrument well are quite significant (between 1 and 2 mrem/hr). Therefore, instrument components within the well are designed to be unplugged and replaced if faulty or if maintenance is needed. This level of radiation will degrade instrument performance over time. Depending on the actual instruments selected and the final tube and building design, it may be possible to reduce the instrument failure rate by increasing the amount of well shielding or by relocating the instruments outside the well.

1.5.4.9 Security Systems

Active systems for monitoring and response, including cameras, intrusion detectors, security lighting, and alarms will require periodic maintenance and calibration procedures.

1.5.5 Safety Considerations

1.5.5.1 Nuclear Safety

DOE Orders require that facility workers and the general public be protected from hazardous activities associated with the use of radioactive and hazardous materials. Hazardous and potential accident analyses have been performed to document scenarios deemed hazardous to the public and to the facility worker. Certain features (safety items) are incorporated into the facility design to assure that the health and safety of the public are protected in the event of any postulated accident or design basis natural phenomena event (e.g., earthquake). Surveillance requirements are specified to ensure that safety systems are capable of performing required functions. Safety systems will be designed in accordance with special criteria documented in DOE Order 6430.1A and site-specific standards.

For storing SNM, a 3013 container has two credited layers of stainless steel containment. The containers are 4.9 inches (12.5 cm) OD and 10 inches (25.4 cm) high. They are designed to withstand a 30-ft drop, a lid internal pressure of 750 psig, and an external pressure of 21 psig, per 49 CFR 178. Eight 3013 containers will be placed vertically (with at least a 6-inch separation between each container) in a 0.5-inch-thick carbon steel storage tube that is 18 inches in diameter and 13 ft, 9 inches long. Both the 3013 container and the tube are safety class items.

1.5.5.2 Potential Hazards and Doses

The ISV is a nuclear hazard Category 2, based on the storage capacity of SNM. Potential hazards are spills, fires, explosion, and nuclear criticalities. Accident scenarios can be internal, external, or natural events. Internal events can be spill, human error, sabotage, electrical short circuit, heat, fire, nuclear criticality, explosion, or failure of a canister.

External events can be man-made hazards, intra-site movement, loading/unloading, shipping, transportation, or an airplane crash. Natural events can be meteorite impact, high wind, snow storm, flooding, lightning, tornado, or earthquake.

The probability of occurrence of each hazard is evaluated for safety considerations. If the frequency of occurrence is below $1x10^{-6}$/year, the event is considered not credible. A frequency between 10^{-4} to 10^{-6}/year is an extremely unlikely event. A frequency between 10^{-2} to 10^{-4}/year is an unlikely event. A frequency greater than 10^{-2}/year is an anticipated event. From the results of the hazards evaluation, breach of a canister, spill, small fire (non-lofted), criticality, high wind, tornado, snow, lightning, and earthquake are extremely unlikely, but credible events with a frequency of 10^{-4} to 10^{-6}/year. High wind, tornado, snow, or lightning events are enveloped within the ISV design (PC-4).

Release of a SNM from a sealed tube (safety class item) is considered not credible in an earthquake scenario. Accident analysis and radiological doses (non-criticality) for the other accidents are calculated for the collocated worker (CW) at 100 meters and the maximum offsite individual (MOI) at 1,040 meters (site boundary). The dose value for the CW will be the dose for the MOI since the boundary fence is 100 meters from the ISV. The doses range from 0.05 to 4.6 rem at 100 meters, which meets the 5 rem recommended maximum value by the DNSFB.

1.5.5.3 Risk and Consequence

The risk matrix of consequence versus frequency is shown in Table 1.5.5.3-1. Consequences are classed into high, medium, and low categories, whereas frequency is divided into extremely unlikely (EU; 10^{-6} to 10^{-4}/year), unlikely (UN; 10^{-4} to 10^{-2}/year), and anticipated (AN; > 10^{-2}/year). Consequence evaluation falls into four risk classes. Class I risks are major, Class II are serious, Class III are marginal, and Class IV are negligible. From the accident analysis, high consequences with any frequency event are Class I or II dominant risk scenarios and thus are not acceptable. A medium consequence with any frequency event is also unacceptable. Low consequences in any frequency event are acceptable to marginal accidents. These accidents can result from a spill from handling or corrosion, breach of a container from pressure or temperature, criticality because of stacking or configuration, and minor fire from electric wiring, heat, etc.

Table 1.5.5.3-1 ISV Accident Scenarios - Consequence Vs. Frequency

Consequence	Frequency (per year)		
	10^{-6} to 10^{-4}/year (Extremely Unlikely)	10^{-4} to 10^{-2}/year (Unlikely)	> 10^{-2}/year (Anticipated)
HIGH	Unacceptable None Class II	Unacceptable None Class I	Unacceptable None Class I
MEDIUM	Unacceptable None Class III	Unacceptable None Class II	Unacceptable None Class I
LOW	Acceptable Spill Breach of a canister Criticality Fire (minor) Class IV	Marginal Spill Breach of a canister Criticality Fire (minor) Class III	Marginal None Class III

1.5.5.4 Facility Worker

DOE-STD-3009-94 requires a qualitative discussion of hazard identification with analysis, prevention, and mitigation. Facility workers can be subject to injury or serious incidents such as fire, explosion, spill, and criticalities that may cause a fatality if appropriate emergency response actions are not initiated. Before construction of a new facility or modification of an existing facility, DOE Orders require detailed safety analyses to assure that facility design and operating procedures limit the number of workers in hazardous areas and minimize the risk of injury or fatality in the event of an accident.

The potential for a significant radiological uptake exists from airborne contamination. Use of personnel protective equipment will reduce the potential for immediate uptake. Worker awareness of the events and administrative programs such as training and emergency response should reduce the immediate consequences.

The consequences can be categorized into high, medium, and low with and without mitigation. A high dose greater than 25 rem can cause a worker an acute injury or death. With mitigation, the consequences can be reduced. A moderate dose between 5 and 25 rem can cause a serious injury and require hospitalization. A moderate dose can result from a small fire or loss of containment. A low dose between 0.5 to 5 rem can cause minor injury. A low dose can result from spill or contamination scenarios. A dose below 0.5 rem is negligible.

Risk classes are identified in Table 1.5.5.3-1. Accident scenarios associated with Class I and Class II risk are considered the dominant risk scenarios and are examined in more detail in the Conceptual Safety Report (Chapter 3, Section 3.6). Mitigation and preventive features must be identified for Class I and II risks.

Radiological impacts are compared with applicable regulatory compliance and guidance requirements. Regulation 10 CFR 835 defines a radiation protection program to limit a worker's dose exposure to an ALARA level (0.50 mr/hr), although the RFETS Radiological Control Guidelines Manual (June 1996) recommends a lower ALARA value of 0.25 mr/hr. Should criticality occur, workers should adhere to the Site's nuclear criticality safety program and immediately vacate the building following a criticality alarm.

1.5.5.5 Occupational Safety

A combination of design features and administrative procedures are used to reduce risks to acceptable levels. Design features will include safety criteria such as mitigation of radiological hazards through shielding, confinement, fire protection, portable alpha air monitors, and a criticality alarm system.

The ISV will also meet the health and safety guidelines set by the Occupational Safety and Health Administration (OSHA) regulations 29 CFR 1900 to 1910 and general industry standards. The DOE has voluntarily accepted OSHA and has endorsed OSHA through DOE Order 5483.1A.

1.5.6 Security Requirements

Security systems for the ISV include passive provisions built into the design, active provisions provided for monitoring and response, secondary response facilities, a trained guard force, provisions for support from offsite organizations, and training of the support staff.

Passive provisions built into the design include access control points, security fences, berms, detaining facilities for emergency egress, restrictions and inconveniences in the ventilation inlet and outlet ducts, heavily reinforced concrete walls, floors, ceilings, earth mounded over the facility, and labyrinth accesses.

Active provisions for monitoring and response include interior and exterior cameras, a manned guard station inside the ISV, a manned alarm station, security lighting, and intrusion detection.

Secondary response facilities, the trained guard force, support from offsite organizations, and training of the support staff are included as part of the site response plans, training organizations, and site facilities. The existing CAS in Building 121 will be maintained and tied into the ISV to be used as the SAS and armory.

Details of the security measures will be developed as part of the title design.

1.5.7 Radiological Shielding Considerations

1.5.7.1 Radiation and Health Effects

Weapons grade (WG) plutonium consists primarily of Pu-239, although it contains other isotopes as well (Pu-238, Pu-240, Pu-241, and Pu-242). Except for Pu-241, which is a beta emitter and decays to Am-241, the remaining plutonium isotopes emit alphas (He-4), which are highly charged particles, and gamma rays that range in energy mostly from 0.1 to 2 Mev. Alphas produce an internal hazard when their source is inhaled, ingested, or injected into the human body.

Being a fissile material, plutonium isotopes also emit neutrons as a result of their decay by spontaneous fission and by the (α, n) reaction with light elements such as oxygen. Thus, gammas and neutrons are the main source of radiation. Health hazards associated with plutonium are from radiation and its high toxicity. These hazards can be managed or minimized by using radiation shielding and confinement systems (containers, controlled ventilation) between the SNM and worker and the public. Plutonium or its compounds also exhibit reactive hazards such as pyrophoricity, chemical reactivity with air, corrosivity, dispersibility, and the potential for degradation of containers.

Radiation dose is expressed in a unit of rem (1 rem = 1,000 mrem or 1,000 mr). The higher the dose rate, the more damaging it is to a human body. Living organisms exposed to a high dose undergo chemical changes that can lead to serious illness or death. Low doses produce chemical changes in cells that can damage cellular deoxyribonucleic acid, leading to cancerous growth of the cells or to genetic mutations. High dose over a short period is more damaging than low dose over long time. From a health and safety point of view, it is important to keep the dose exposure ALARA, which is 0.25 mr/hr as a whole body for a full-time occupancy, per RFETS Radiological Control Guidelines Manual (June 1996). This is based on 500 mr per year exposure assuming 2,000 work hours annually.

1.5.7.2 Doses and Shielding Effect

Gamma and neutron dose rates for plutonium isotopes and daughter products are calculated using QADCGGP Code for gammas and MORSE Code for neutrons in the SCALE 4.3 program. A quantity of 4.5 kg of plutonium metal or oxide, when encased in a 3013 stainless steel container with three layers of containment, exhibits a surface dose rate of 270 mr/hr (150 mr/hr for gamma and 120 mr/hr for neutron) in air. This total dose rate drops near exponentially to 1.7 mr/hr at a distance of 3 ft and to 0.62 mr/hr at 5 ft. When a container is placed in a 0.5-inch-thick carbon steel tube, the total dose rate drops again by a factor of about 2 (e.g., 0.9 mr/hr at 3 ft).

When eight containers are placed in a stainless steel cage with a 6-inch spacing in a 13-ft, 9-inch long tube, the radial (horizontally) dose is 5.7 mr/hr at 3 ft and 3.2 mr/hr at 5 ft. These dose values suggest that containers or tubes should be handled remotely and behind 2 to 3 inches equivalent of carbon steel shield, to reduce dose to the worker.

Different materials were used to investigate the shielding effect for gammas and neutrons. Table 1.5.7.2-1 shows the shielding results of 2-inch materials of polyethylene, paraffin, Jabroc, and carbon steel.

Table 1.5.7.2-1 Shielding Factor (SF) of 2-Inch Materials for Gamma and Neutron

	Polyethylene	Paraffin	Jabroc*	Carbon Steel**
Density (g/cm^3)	0.92	0.90	1.3	7.82
Gamma (SF)	2.3	2.3	2.5	20.7
Neutron (SF)	4.0	5.4	2.0	3.2

* = H 6 wt%; C 48.9wt% ; N 0.15wt%; O 43.9 wt%; Na 0.84 wt%; Ca 0.20 wt%
**= Fe 99 wt%; C 1 wt%

Carbon steel is clearly very effective for reducing gamma dose. For neutron, paraffin is effective; but from a combustibility consideration in the ISV, polyethylene, paraffin, and Jabroc are ruled out. Only carbon steel was chosen for both gammas and neutrons.

1.5.7.2.1 Dose in the ISV

In the ISV, tubes will be stored vertically through holes on the main floor, where they will be air cooled through large concrete intake and exhaust ducts. Two tubes will be separated by 30 inches of concrete which reduces the dose rate from the side tubes to the charging floor. Refer to Drawing No. 51493-C401.

Doses from the lower containers are mostly shielded by the upper containers. There will be a 4-ft spacing and 7 inches of carbon steel between the top container and the charging floor. From density comparison, 7 inches of carbon steel is equivalent to 24 inches of concrete shielding, which is a considerable shielding for both gammas and neutrons. For a symmetrical contribution from other tubes to a worker, a combination of seven tubes is assumed to constitute an array for a cumulative dose to a worker on the charging floor. These results are shown are shown in Table 1.5.7.2-2. The gamma dose rate has virtually vanished. Neutrons contribute the major dose; since they are neutral and have a longer penetrating range. The total dose is 0.21 mr/hr, which is below the ALARA dose of 0.25 mr/hr.

In summary, 7-inch carbon steel shielding is required as a minimum to reduce the total dose rate from 270 mr/hr from the surface of a 3013 container in a tube, in an array of 8 x 7 (56 canisters) to below 0.25 mr/hr at the charging floor for a facility worker.

Table 1.5.7.2-2 Total Dose Rate (mr/hr) at the Charging Floor*
(7-inch Carbon Steel Shielding and 30-inch Concrete)

Canister	Radiation	Dose Rate (mr/hr)
S-1	neutron	0.069
	gamma	0.0036
S-2	neutron	0.033
	gamma	0.0020
S-3	neutron	0.029
	gamma	0.0013
S-4 to S-8	neutron	0.071
	gamma	0.0033
Total	neutron	0.20
	gamma	0.01

* Cumulative dose from 7 tubes on the charging floor.
Distance is 4 ft from the top of container to the charging floor.

1.5.8 Criticality Considerations

Special nuclear material such as plutonium is subject to criticality when k-eff (neutron production rate/neutron loss rate) approaches or exceeds one and causes a chain reaction. For sub-criticality, the k-eff should be below 0.95 as a limiting control. Criticality depends on various parameters, which are (in order of emphasis): geometry, mass, density, concentration limitations, volume, enrichment, moderation, reflection, poisons, and temperature. Combinations of these parameters can lead to criticality due to improper stacking, configuration (system design), flooding, failure to comply with Criticality Safety Operating Limit, fire, and collapse of a building. Although criticality in the ISV is an extremely unlikely event (10^{-5} to 10^{-6} /yr), nuclear safety criteria are addressed in accordance with DOE Orders 5480.24, and 6430.1A, ANS 8 Standard Series and the NRC Regulatory Guide 3.35.

1.5.8.1 Mitigation of Criticality

Methods for preventing criticality are based on engineering design features: 1) Seismic and other design features that will protect the plutonium inventory from natural phenomena hazards; 2) The DOE 3013 container design that is based on DOE STD-3013-94; 3) Double confinement provided by the DOE 3013 container that provides material separation and prevents in-leakage of moisture; 4) Storage tubes that provide tertiary confinement and that also preclude moisture in-leakage; and (5) Cage assembly design that provides positive vertical and horizontal positioning of the DOE 3013 containers; and (6) A passive vertical storage tube array design that provides 3-ft nominal center-to-center spacing.

Once the tubes are stored in the ISV, they will be monitored for temperature and pressure changes, helium (alpha) leak detection, and RTR to detect any abnormal changes sensitive to criticality.

Potential for criticality during loading of 3013 container in a tube in Building 371, transfer to the ISV, and unloading of the tubes in the ISV are also considered. These and other potential scenarios, which are very unlikely, are listed below.

- Failure of a storage tube cage assembly resulting in the elimination of both horizontal and vertical spacing of 3013 containers within the storage tubes. Currently the spacing is 6 inches between two containers.
- Moisture, cage assembly, electrical cabling, and instrumentation within the ISV storage tube in addition to the 3013 containers containing fissile material.
- Flooding of the storage vaults (called the vault area).
- Moisture (1-3%) inside the 3013 container at the time of sealing or at some subsequent time.
- Spacing violation of two or more staged storage tubes.
- Unloading dock accident due to mass overloading of 3013 containers or the AL-R8 containers.
- Plutonium metal (powder) overbatching.

These events are described in detail and have been modeled using the Program SCALE 4.3 KENO Code to evaluate reactivity by its k-eff value for any criticality. These results are summarized in Table 1.5.8.1-1 below.

Table 1.5.8.1-1. Summary of Reactivity Analysis of Normal Storage Configuration and Potential Criticality Hazards

Description	Reactivity k-eff	Criticality Potential
Normal storage configuration	0.90131± 0.002144	no
Storage tube cage assembly failure	0.92643± 0.00190	no
Moisture within storage tube	<0.91	no
Moisture (1-3%) within 3013 container	0.90190 ± 0.00295	no
Flooding of ISV storage vault area	<0.91	no
Spacing violation of two storage tubes	0.82547± 0.00192	no
PuO_2 overbatching	11 kg_{mcm}*vs. 8.6 kg	no
Pu metal overbatching	5.9 kg_{mcm}	yes

*The mcm subscript denotes single parameter minimum critical mass (ANSI/ANS 8.1 - 1983).

All criticality analyses are required to provide a margin below critical for acceptable calculation results. This margin is generally about 0.05, which implies that calculated k-eff values should be ≤ 0.95.

1.5.8.2 Criticality Alarm System Requirements

DOE Order 6430.1A indicates that a criticality monitoring and alarm system (gamma and/or neutron) be provided where necessary to meet the requirements of DOE Order 5480.5 and ANSI/ANS 8.3.

The largest probability of a criticality will be during the storage tube loading and unloading operations. Therefore, as a minimum, a criticality alarm system that provides coverage during these operations is required.

ANS 8.3 also requires, "the need for an alarm system shall be evaluated for all activities in which the inventory of fissionable material... exceeds... 450g of Pu-239." Additional guidance of ANSI/ANS 8.3 is that alarm systems shall be provided wherever it is deemed that they will result in a reduction in total risk. Where alarm systems are installed, emergency plans should be maintained. Thus, it is recommended that criticality alarm system detectors be installed to provide sufficient coverage by a minimum of three detectors for a criticality anywhere within the storage vault or anywhere on the charging floor. These detectors should be installed on the walls of the charging floor room at height of about 8 ft and a separation distance of at least 20 ft to cover a wide area.

Real-time reactivity (k-eff) instrumentation should be considered for loading and unloading operations. Such instrumentation will provide verification of proper mass loading as well as a measure of reactivity. The Oak Ridge National Laboratory Instrument and Control Division has developed such an instrument, and it might be available for practical demonstration. Both the portable and fixed criticality alarm system(s) shall be tested and calibrated according to ANSI/ANS 8.3 Standard (1983).

1.5.8.3 Radiological Doses (Criticality)

Radiological doses from four criticality scenarios are considered: bare metal with one spike, oxide coated (2%) metal with one spike, and water moderated with one or multiple spikes. A spike may last for milliseconds. Many spikes are considered as 48 spikes with 10-minute interval for each spike. In all cases, no plutonium is assumed to escape from the canister, only fission products are released; thus most of the dose stems from gamma radiation. The number of fissions assumed in calculations are 10^{+17} fissions (1.0E+17) for one spike and 10^{+18} fissions for many spikes. In these four cases, the doses are extremely low at the 100-meter site boundary and range from 8×10^{-4} rem to 0.05 rem. If the number of fissions were to increase from 10^{+17} to 10^{+18}, the corresponding doses would increase by an order of magnitude, but the dose values would be still very low and remain below the 5 rem recommended limit at 100 meters by the DNFSB (June 1996).

The fission prompt doses due to gammas and neutrons are quite high for an immediate worker. The dose is 13 rem (unshielded) at 25 meters. However, there will be 7 inches of stainless shielding vertically between the top canister and the charging floor, which is equivalent to 24 inches of concrete shielding. The 13 rem (unshielded) dose at 25 meters drops to 0.22 rem. The distance between the top canister and the charging floor is 4 ft (1.3 meters). The unshielded dose at a 1-meter distance is 9,100 rem, which is a lethal dose, while it drops to 150 rem with 24-inch concrete shielding. This dose level falls into a serious injury category. As discussed earlier, the probability of criticality is an extremely unlikely event - 1×10^{-5}/yr to 1×10^{-6}/yr.

1.5.9 Site Development Plant Coordination

1.5.9.1 Site Demolition

The site at which the ISV is to be located is currently occupied by buildings, trailers, utilities, paving, and fencing, all of which will have to be removed. Demolition plan, schedule, and approximate quantities are shown on Drawing C106.

Buildings to be demolished are 110, 119, 126, and 128. They range in square footage from 500 to 5,500 sq ft. Demolition will require removal of foundations, floors, walls, and roofs.

All materials will be properly disposed of offsite.

Trailers to be removed are T119A, T119B, T121A, and T124A. They range in square footage from 1,000 to 13,000 sq ft. Trailers will be dismantled and salvaged. Foundations will be removed and disposed of offsite.

Utilities serving buildings and trailers to be removed will be removed to the main service and capped. Utilities serving Buildings 130 and 131 that traverse the ISV site will be removed and relocated. This includes several 13.8-kV lines tying into the grid, and a 10-inch and 12-inch raw water line serving Building 124, the water treatment facility.

Earthwork for demolition will consist mostly of shallow excavations to remove foundations, paving, and utilities. According to site data, there are no Individual Hazardous Substance Sites (IHSS) within the project boundaries. Existing pavement will be removed and disposed of offsite. Erosion control in the form of silt fences and wind erosion fences will be placed and remain until completion of construction.

There are three major 13.8-kV lines crossing the proposed site for the ISV in an east/west direction. Two of the lines are at N35,856 and the other is at N35,575 in accordance with site utility plans.

The two lines at N35,856 are part of the 13.8-kV system that serves multiple structures. One line is underground and the other is on overhead wood structures. These lines provide power to Building 130 as well as other loads.

It is currently anticipated that these three lines will require rerouting to allow excavation of the ISV. A detailed study should be performed in conjunction with the approved 10-year plan to determine loading conditions during decommissioning of structures in this area. Line rerouting is detailed below.

1.5.9.1.1 Line N35,575

This line currently runs in an east/west direction through the southern portion of the proposed site. The line is underground and passes through Manhole No. 38 located at N35,575/E17,935. This line should be eliminated from service and a new single circuit installed to Building 124. The location of transition points (structures) will require more detailed analysis. Refer to Dawing 51493-C707 for conceptual routing of the replacement line to Building 124.

1.5.9.1.2 Lines at N35,856

These two lines will require rerouting to avoid the construction site. It is anticipated that Buildings 130, 131, and other loads in the southwest sector must remain in service. These buildings can be fed from Line 661-3 originating at new Substation 679/680. An alternate source currently available would be Line 518-2/555-2. Both of these lines would require a load study to determine the adequacy of existing conductors to carry additional load. It is assumed that the existing Public Service transformer would not be available for service when the ISV is constructed.

A new single circuit line north of the ISV site is proposed to serve existing loads and provide a normal power supply to the ISV. The best location and number of circuits on this line is to be determined upon completion of load studies.

A double circuit line will be constructed as shown on Drawing 51493-0707 and be routed west from new Substation 679/680. Installation of this line will provide 13.8-kV power to the new ISV as well as service loads currently supplied by Public Service Transformer T132. Existing circuits to this southwest area may not be able to accommodate all loads that are anticipated to remain in place after the vault is operational.

1.5.9.1.3 Additional Lines Within the ISV Site Boundary

Power supplies for structures that will be removed from service because of construction of the ISV have been identified as follows:

- Building 126 — Isolate at service entrance and source bus.
- Building 128 — Isolate at service entrance and source bus.
- Building 119 — Isolate building at Switch 25T. Load reduction includes elimination of one 1,300 kVa Transformer 119-1.
- Building T121 — Isolate building at Switch 25K. Load reduction includes elimination of one 300 kVa Transformer 121-1.
- Building 100 — Isolate building at Switch 10T. Load reduction includes elimination of three 37.5 kVa Transformers 100-1, in accordance with Drawing 3500-0004-02A.

There are no other 13.8-kV lines identified that cross the ISV footprint, however there are a variety of power, local area network, plant fire, and security alarm circuits that require careful consideration. There are a number of 277-V circuits within the perimeter boundary that may be reused for exterior lighting of the ISV. These circuits are currently located within the Building 460 parking areas.

Power lines west of First Street may remain since they are on the extreme perimeter of the proposed site boundary or perimeter fence.

1.5.9.2 Site Preparation

1.5.9.2.1 Grading/Drainage/Foundation Drain

1) Grading

From available site topographical information, the center of the site is at approximately elevation 6,048 ft. This elevation was used as a basis for the main floor elevation. All earthwork calculations were based on this. Final design should adjust this elevation once a site survey is complete, which will also allow excavation and embankment volumes to be balanced.

Earthwork will require excavation to a depth of 20 ft for the main excavation, with areas for the sumps at the intake and exhaust ducts at 33 ft. The bottom of excavation will cover an area of 200 ft by 400 ft, not including the entrance areas. Side slopes and groundwater control during construction shall be in accordance with Section 1.5.1.3, Geotechnical.

2) Drainage Design

a) General

The "Rocky Flats Drainage Master Plan" (WWE, 1991) was reviewed. It provided a good overview of the stormwater drainage in the vicinity of the Rocky Flats area. It did not include site-specific information for the proposed ISV location.

Field investigation on March 13, 1997, identified the general drainage characteristics of the site. Runoff from the existing site flows to the north and east. Approximately 50 ft to the north of Central Avenue there is a large drainage ditch that is the most probable outfall for stormwater runoff from the new site. This ditch is approximately 6 to 8 ft deep and 20 to 30 ft wide running generally to the east. No other likely outfall location was identified.

b) Design Bases

The stormwater management plan for the site is based on the 25-year event with a potential flood hazard analysis using the 100-year flood as required in the DOE "General Design Criteria", DOE Order 6430.1A. Since the proposed stormwater management plan for the site does not include storage, the Hydrocad routing model (recommended for use at this facility) was not used, and the more conservative Rational Formula was utilized to determine design values for peak discharges. Rocky Flats Plant Standard SC-109, "Standard for Storm Sewer Design Criteria" dated June 22, 1992, provided Intensity-Duration-Frequency Curves for obtaining rainfall intensities. Stormwater conveyances are designed in accordance with normal depth and culvert calculation procedures found in U.S. Army Corps of Engineers TM 5-820-4, "Drainage for Areas Other than Airfields," dated October 1983.

c) Stormwater Management Plan

The site grading plan places the facility itself in the center of a rectangular, bermed area. The finished grade of the building is elevated so that surface runoff drains away from it with an overland slope of approximately three percent. At the toe of the berm, runoff is intercepted by a triangular swale (with 3:1 side slopes) along the east and west interior boundaries and is conveyed to a catch basin on the north interior boundary near its center. These swales slope at a mild 0.25 percent toward the catch basin. Flow will exit the catch basin (5 ft deep) via a 30-inch reinforced concrete culvert, which outfalls to the ditch identified during the site walkdown. Runoff from the exterior slopes of the berm will be intercepted by roadside drainage ditches and conveyed to the north and east boundaries of the site.

d) Results

The drainage swale conveys the 25-year design runoff at a maximum depth of 1.9 ft and a velocity of 2.7 fps. The culvert carries this flow with a maximum headwater of 3.1 ft and a velocity of 5.8 fps. The 100-year flood flows 2.0 ft deep at 2.9 fps in the swale and with 3.8 ft headwater at 7.0 fps in the culvert. These design parameters do not indicate a significant constraint on the stormwater system design.

3) Foundation

A foundation drain system will also be provided under the main lower level slab to collect groundwater, which will alleviate hydrostatic forces on the slab and walls. This is in accordance with the ISV Summary Report (RFETS, 1996). It is composed of a 4-inch perforated pipe network laid in a 24-inch-thick layer of gravel under the slab. The walls will also have a layer of gravel adjacent to them, which will channel water to the drains below. A 6-inch solid polyvinyl chloride (PVC) drain pipe will then route the water by gravity to the Woman Creek Drainage on the south. The installation of the solid drain pipe will require approximately 1,000 ft of trench 30 ft deep.

1.5.9.2.2 Electrical

Normal power for the vault and associated area will be provided by the 13.8-kV power system. A minimum of two 13.8-kV power sources, normal and alternate, will provide power to the facility. The sources will be circuits from Substation 679/680.

The normal power system will consist of two fully-rated transformers, each fed from a different source. Existing 500-kVA transformers that currently service other buildings that will be removed may be used for this new facility. During design, calculations will be performed to determine electrical loading. The number of transformers to be used and the electrical system configuration will be determined from the loading information. The loads will be split between the two incoming sources. Automatic transfer schemes between the buses will be used to provide continuous power during the loss of one of the 13.8-kV sources.

A new double circuit 13.8-kV overhead line is currently proposed to service the ISV. The line will originate at Substation 679/680 and terminate outside the ISV perimeter fence. At this point, a deadend riser structure will be installed to make a transition to underground installation. This underground run will terminate at the ISV service entrance transformers. Two single circuit lines will also be constructed to serve Building 124 and other loads that must remain in service. Since it is assumed that existing Transformer T132, currently feeding loads in this area, will not be available, a single circuit tap and line will be installed around and north of the ISV. This line will intercept existing 13.8-kV lines on the west side of the ISV.

1.5.9.2.3 Potable/Fire Water

Water will be provided by a 6-inch ductile iron water line, supplied by the site domestic cold water system. The site system can provide adequate pressure and volume to service fire suppression (sprinkler) systems and potable water requirements for showers and restrooms. The service line will connect to an existing 10-inch domestic cold water line 40 ft east of the ISV building line.

1.5.9.2.4 Sanitary Sewer

A sanitary sewer will route sanitary waste from the restrooms via a 6-inch PVC gravity sewer line to the site sanitary collection system and treatment facilities. The proposed tie-in is Manhole R2-1, located 35 ft east of the ISV building line.

1.5.9.2.5 Telephone

Interior communications and alarm systems will be designed to use standard, commercially available equipment. The initial and projected requirements for telecommunications systems will comply with DOE Order 5300.1B. Secure communications systems will comply with DOE Order 5300.3B. Data communications facilities, services, and equipment will comply with DOE Order 5300.1B.

Joint Use Telephone circuits will be used for other communications and alarm services to the maximum extent practical. If separate conductors are required, they will be routed through the main telecommunications and signal raceway system. Joint use lines are anticipated from the ISV to the SAS location, as a minimum.

Telecommunications and alarm equipment and conductors will be located outside areas subject to radiation, vibration, and excessive noise levels. Where communications equipment must be placed in these areas, the equipment installed will be suitable for the hazard.

1.5.9.3 Secondary Alarm Station

A SAS is required to support the ISV security system denial concept. The SAS will serve as a functional backup for the CAS, which is located within the ISV structure.

The CAS and SAS will be connected by redundant, protected communications and data links. Response forces will be dispatched from either of the alarm stations.

The SAS will be designed to meet the following functional requirements:

- Alarm monitoring for criticality safety, fire, and environmental/effluent monitoring systems,
- Alarm monitoring for security systems,
- Communications with CAS and emergency response forces,
- Personnel access and truck dock security doors operation, and
- CCTV security monitors.

The SAS will be located in Building 121, outside the ISV perimeter fence. Building 121 is currently used as the site CAS. Therefore, many of the design requirements for a SAS facility will be in place.

1.5.9.4 Support Facilities

The ISV will require external facilities for managerial support and parts storage areas. The actual square footage required has not been defined at this time; however, it is believed that Building 130 should remain in service for this activity and will provide adequate space.

The Central Fire Station, or a smaller functional equivalent, will be required to provide fire protection for the ISV. Both the water and the sewer treatment facilities must also remain in service to support the ISV.

1.5.9.5 References

RFETS (Rocky Flats Environmental Technology Site), 1996, Interim Storage Vault Summary Report, Prepared by Kaiser-Hill, March 15, 1996.

WWE (Wright Water Engineers, Inc.), 1991, Rocky Flats Drainage Master Plan, Prepared for EG&G Rocky Flats Plant, December 1991.

1.6 QUALITY ASSURANCE

1.6.1 Quality Assurance Plan

Title design and construction of the ISV shall be accomplished under the provisions of the RFETS Interim Storage Vault Quality Assurance Program Plan (QAPP).

Work on the project performed by the Managing and Integrating Contractor and designated subcontractors shall be subject to the QA Program documented in the following:

- RFETS Rocky Flats Quality Assurance Manual, and
- RFETS Rocky Flats Quality Assurance Procedures Manual.

Work on the project may also be performed by subcontractors under their own QA programs, provided that the program meets the requirements of the referenced DOE Orders, federal regulations, and ASME NQA-1 and has been approved by the Managing and Integrating Contractor's QA Division.

1.6.2 Classification Approach

In general, DOE projects incorporate a graded approach to specifying quality requirements. This approach ensures that structures, systems, and components (SSCs) important to safety or critical to meeting program objectives are subject to commensurately higher design, testing, and verification standards. The documents governing the design and construction of the ISV require classification of project elements under several different schemes identified below. These classifications determine specific design criteria, natural phenomena loading, and evaluation procedures applicable to each element, all of which affect quality objectives.

1.6.2.1 DOE Order 6430.1A

DOE Order 6430.1A, General Design Criteria, requires that SSCs be classified as either safety class or non-safety class, as follows.

1.6.2.1.1 Safety Class

SSCs include portions of process systems whose failure could adversely affect the environment or the health and safety of the public. Specifically, safety class items are:

- Those whose failure would produce exposure consequences that would exceed the guidelines in Section 1300-1.4, Guidance on Limiting Exposure of the Public, at the site boundary or nearest point of public access,
- Those required to maintain operating parameters within the safety limits specified in Operational Safety Requirements during normal operations and anticipated operational occurrences,

APPENDIX 1.12.1
Site Selection Study

of the
Conceptual Design Report

for the
Interim Storage Vault

for the
Rocky Flats Environmental Technology Site

Task Order 72

for the

U. S. Department of Energy
Rocky Flats Operations Office
Golden, Colorado

Prepared by
Rocky Flats Engineers and Constructors, LLC
Denver, Colorado

May 1997

Authorization No. E32CD100

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APPENDIX 1.12.1 SITE SELECTION STUDY

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1.0 INTRODUCTION

A site selection study was performed to identify advantages and disadvantages of potential Interim Storage Vault (ISV) sites at Rocky Flats Environmental Technology Site (RFETS). Based, in part, on the results of the site selection study, Kaiser-Hill Company selected one of the candidate sites as the location of the ISV for advanced conceptual designs.

The following six sites, illustrated on Figure 1.12.1.-1, were included as candidate ISV locations:

- Site 1 - West of the T-130 temporary buildings.
- Site 2 - Southeast corner of the Industrial Area west of Building 460.
- Site 3 - West of Building 371 outside of the Protected Area (PA).
- Site 4 - Solar ponds area in the northeast part of the PA.
- Site 5 - North of the T-130 temporary buildings.
- Site 6 - Northeast of the Industrial Area near the new landfill.

Four of the sites (1, 2, 3 and 5) were those suggested by previous work (Kaiser-Hill, 1996). The other sites (4 and 6) were selected as they are in reasonably flat areas that might not be affected by known topographic features (slopes, etc.). Site 4 was also included in the study as it is generally the only reasonably flat area within the RFETS PA.

The sites were evaluated using facility siting criteria of DOE Order 6430.1A (1989) as the governing criteria. Those siting criteria were labeled as A through Q and are listed in Table 1.12.1-1. The site selection study was a qualitative evaluation of the sites relative to those criteria based on information available in RFETS files. No site-specific investigations (borings, pits, sampling, etc.) were included in the work.

The results of the site selection study were presented to a Review Panel comprised of the following technical experts:

- Kathryn Hanson, Geomatrix Consultants
- Mohammad Mozumder, Department of Energy
- Matthew Maryak, Westinghouse/SavannahRiver
- James Meisenheimer, Stone & Webster Engineering Company

The Review Panel reviewed and concurred with the methodology and results of the study.

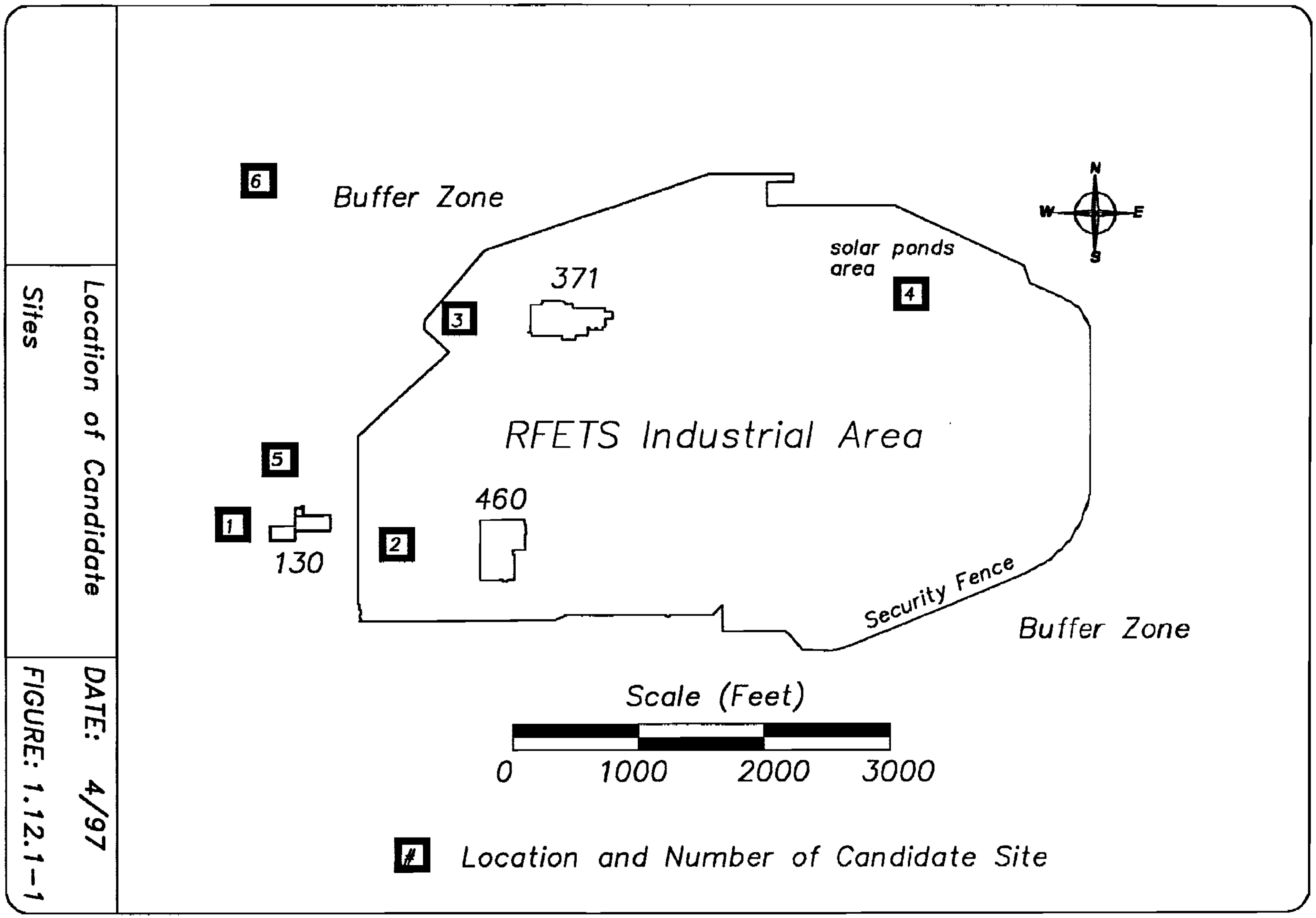

Location of Candidate Sites
DATE: 4/97
FIGURE: 1.12.1-1
Buffer Zone
RFETS Industrial Area
solar ponds area
371
460
130
1
2
3
4
5
6
N
S
E
W
Security Fence
Buffer Zone
Scale (Feet)
0
1000
2000
3000
Location and Number of Candidate Site

Table 1.12.1-1
RFETS INTERIM STORAGE VAULT SITE SELECTION CRITERIA

A.	Programmatic/Operating Efficiency
B.	Natural Topographic and Geologic Conditions
C.	Existing Cultural/Historic/Arch. Resources
D.	Endemic Plants and Animals
E.	RCRA and CERCLA Sites
F.	Special Siting Requirements
G.	Health, Safety and Environmental Protection
H.	Indoor Air Quality Impacts (Radon)
I.	Hazardous Operations and Consequences
J.	Natural Hazards
K.	Wave Action
L.	Physical Protection
M.	Security and Safeguards
N.	Support Facilities
O.	Aesthetic Compatibility
P.	Energy Conversion
Q.	Impact of Site Selection

2.0 METHODOLOGY

Following selection of the six sites, the project team ranked each site based on the siting criteria of DOE Order 6430.1A. The siting criteria exhibit a wide range of importance in siting and design of the ISV. Accordingly, weighting factors were subjectively assigned to each individual criterion as a means of assessing relative importance. Weighting factors were assigned integer values of 1, 2 and 3 with greater weight or importance reflected by increasingly higher numbers.

After establishing major siting issues and individual siting criteria, a simplified scoring system was devised:

- 0 = Unacceptable (i.e., a fatal flaw)
- 1 = Minimally acceptable
- 2 = Acceptable
- 3 = Exceeds requirements

The project team scored each criterion for each site under consideration. The site scores multiplied by the weighting factor determined the score of that site for the specified criterion. Summation of the scores produced a total score for each site with higher scores indicating generally more favorable sites. Site 4, located within a known Individual Hazards Substance Site (IHSS), was considered to be fatally flawed and was eliminated from further consideration. Each site was scored in this manner, and the sites were ranked in order of preference based on their total scores.

3.0 ENGINEERING, DESIGN, AND CONSTRUCTABILITY CONSIDERATIONS

Several of the siting criteria of DOE Order 6430.1A can be classified as those involving engineering and design issues. The siting criteria labeled as A, F, G, I, L, M, N, O, P, and Q fall into that classification.

The physical configuration of the ISV at any of the candidate sites of the RFETS would be essentially the same. All of the candidate sites are located within a single, relatively small area (the RFETS) and are essentially the same distance from existing site facilities. Therefore, the above-listed criterion, all of which are essentially the same for each location and can be addressed equally by engineering and design of the ISV, did not have a significant impact on the site selection, as indicated in Table 1.12.1-2. Moreover, because all of the sites are similar, differences in constructability are small and do not unduly influence site selection. Constructability was considered in the context of each of the appropriate siting criteria but is not discussed separately as a siting issue.

Criteria K-Wave Action does not apply to the RFETS as there are no large bodies of water there.

4.0 EXISTING SITE CONDITIONS

4.1 INTRODUCTION

After identification of the six alternative sites, geological, hydrological, and ecological conditions and natural hazards were assessed at each site using existing data supplied by RFETS. No new data collection or field engineering studies were performed. The siting criteria of DOE Order 6430.1A considered as "Existing Site Condition" issues are as follows:

- B. Natural topographic and geologic conditions.
- C. Cultural, historic and archaeological resources.
- D. Endemic plant and animal species.
- E. Known RCRA and/or CERCLA sites.
- H. Indoor air quality impacts.
- J. Natural hazards.

From these major issues, subsidiary siting criteria were identified as shown in Table 1.12.1-3.

The following sections outline: (1) existing data used to define siting criteria and to assign weighting factors and scores, and (2) brief descriptions of each site. Site conditions are summarized in Table 1.12.1-4. The scoring for the siting criteria is summarized on Table 1.12.1-5.

Table 1.12.1-2
RFETS INTERIM STORAGE VAULT SITE SELECTION MATRIX

Siting Criteria	Weight Factor	Site 1 Score	Site 1 Total	Site 2 Score	Site 2 Total	Site 3 Score	Site 3 Total	Site 4 Score	Site 4 Total	Site 5 Score	Site 5 Total	Site 6 Score	Site 6 Total
A. Programmatic/Operating Efficiency	1	3	3	3	3	2	2	1	1	2	2	2	2
B. Natural Topographic and Geologic Conditions	2	2	4	2	4	2	4	1	2	2	4	2	4
C. Existing Cultural/Historic/Arch. Resources	1	2	2	2	2	2	2	2	2	1	1	1	1
D. Endemic Plants and Animals	2	2	4	2	4	2	4	2	4	1	2	1	2
E. RCRA and CERCLA Sites	3	2	6	2	6	2	6	0	0	2	6	2	6
F. Special Siting Requirements	2	2	4	2	4	2	4	2	4	2	4	2	4
G. Health, Safety and Environmental Protection	2	2	4	2	4	2	4	2	4	2	4	2	4
H. Indoor Air Quality Impacts (Radon)	1	2	2	2	2	2	2	1	1	2	2	2	2
I. Hazardous Operations and Consequences	1	2	2	2	2	2	2	2	2	2	2	2	2
J. Natural Hazards	3	2	6	2	6	2	6	3	9	2	6	2	6
K. Wave Action	1	2	2	2	2	2	2	2	2	2	2	2	2
L. Physical Protection	1	2	2	2	2	2	2	2	2	2	2	2	2
M. Security and Safeguards	3	2	6	2	6	2	6	3	9	2	6	1	3
N. Support Facilities	2	2	4	3	6	2	4	2	4	2	4	1	2
O. Aesthetic Compatibility	1	2	2	2	2	2	2	2	2	2	2	2	2
P. Energy Conversion	1	2	2	2	2	2	2	2	2	2	2	2	2
Q. Impact of Site Selection	1	2	2	2	2	2	2	2	2	2	2	1	1
TOTALS:		57		59		56		0		53		47	
SITE RANK:		2		1		2		5		3		4	

Scoring Criteria
0= Unacceptable (any siting issue)
1= Less acceptable
2= Acceptable
3 = More acceptable

Table 1.12.1-3
INDIVIDUAL SITING ISSUES

SITING ISSUES	DESCRIPTION	WEIGHT FACTOR
Natural topographic and geologic conditions		
1. Surface conditions/present use.	Considers location of the proposed ISV site with respect to present surface conditions and land use. In general, undisturbed sites are more favorable; disturbed sites containing existing facilities and/or artificial fill are less favorable.	2
2. Surficial deposits.	Considers the type of surficial deposits at the ground surface. Undisturbed Rocky Flats Alluvium is considered more favorable than uncontrolled or structural fill.	2
3. Thickness of surficial deposits/ depth to bedrock	Considers thickness of surficial deposits for design of drilled pier foundation system. Unusually thick (>50 feet) or thin (<10 feet) surficial deposits (Rocky Flats Alluvium, artificial fill) overlying bedrock is considered less favorable than thickness in the range of 10 to 50 feet.	3
4. Bedrock formation/lithology.	Considers bedrock formation (Arapahoe and/or Laramie) and lithology (bedrock type, i.e. claystone, siltstone, sandstone, etc.).	2
5. Depth to ground water.	Considers annual average depth to ground water. In general, deeper ground water is more favorable for ease of construction (dewatering) and long-term operation (foundation drainage).	3
6. Inferred faults.	Considers whether inferred faults pass beneath the ISV footprint. Although previous studies have shown inferred faults to be uncertain in interpretation and not capable by NRC criteria, the traces of inferred faults are to be avoided in siting the ISV.	3
7. Mineral resource potential.	Considers whether economically-exploitable mineral resources are present.	2
8. Continuity of quaternary age datum.	Considers whether quartnary deposits and resident soils are intact to allow assessments of the presence or absence of fault displacements and/or other geologic events.	2
Cultural, historic, and archaeological resources		
1. General.	Considers whether cultural, historic and archaeological resources will be impacted by the ISV. No known significant resources are present at RFETS.	2
Endemic plant and animal species		
1. Outside wetlands.	Considers whether ISV site or access to the site will adversely impact known wetlands.	3
2. Outside xeric tallgrass prairie habitat.	Considers whether ISV site will adversely impact xeric tallgrass prairie habitat.	2
3. Outside Preble's meadow jumping mouse habitat.	Considers whether ISV site will adversely impact Preble's meadow jumping mouse habitat.	2
4. Outside raptor habitat.	Considers whether ISV site will adversely impact raptor habitat.	2
Known RCRA and/or CERCLA sites		
1. Outside IHSS.	Considers whether site is outside known Individual Hazardous Substance Site (IHSS). Location of site within an IHSS is a fatal flaw.	3
2. Outside contaminant plume.	Considers whether site is outside known contaminant plume.	3
3. Down-gradient of IHSS.	Considers whether site is down-gradient of Individual Hazardous Substance Site (IHSS) and potential for contamination may occur during the life of the structure.	1
4. Down-gradient of contaminant plume.	Considers whether site is down-gradient of contaminant plume and potential for contamination may occur during the life of the structure.	1
Indoor air quality impacts.		
1. Radon gas.	Considers the potential for accumulation of radon gas in an enclosed structure. Little reliable information related to RFETS is available on this siting issue.	1
Natural hazards		
1. Distance from fault sources.	Considers the distance of site from known fault sources defined in the REI (1994) and Geomatrix (1995a) studies. All sites are in close proximity and minor variations in distance from identified fault sources are considered negligible.	2
2. Distance from steeply-dipping bedrock along Front Range.	Considers possible amplification of ground motion resulting from proximity to steeply dipping bedrock west of RFETS. Subjectively, sites located farther away (east) from the zone of steeply-dipping bedrock are less likely to be affected by amplification, but this interpretation is uncertain.	2
3. Soil column amplification effects.	Considers the effects of soil column amplification from inferred top of rock at 100 feet depth to ISV near surface. All of the sites are subjectively similar.	2
4. Topographic amplification effects.	Considers the effects of ground motion amplification due to topographic variations at or near ISV sites. Location of site near edge of incised drainage is less favorable. Location of site on Rocky Flats surface away from incised drainages is considered more favorable.	3
5. Flood/hydrologic effects.	Considers the effects for flood or extreme hydrologic events. Location of site near drainage (stream channel) is less favorable. Location of site on Rocky Flats surface away from drainage (stream channel) is considered more favorable.	2
6. Wind/tornado effects.	Considers the effects of wind and tornado. All of the sites are similar in regard to exposure to wind/tornado effects.	1

Table 1.12.1-4
SUMMARY OF SITE CONDITIONS

	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6
TOPOGRAPHY	On pediment surface between Woman creek and N, Waiunt Creek, >1000 feet from nearest edge.	On south edge of pediment, 800 feet north of Woman Creek.	On north edge of pediment, 300 feet south of N. Walnut Creek.	On pediment surface between S. Walnunt Cr. and N. Walnut Cr., 500 feet south of N. Walnut Cr.	On pediment surface between Woman creek and N. WalNUt Creek. 1000 feet south of N. Walnut Cr.	On pediment surface, 1000 feet north of N. Walnut Creek.
GROUND ELEVATION (FEET) [TO THE NEAREST 5 FOOT]	6070	6045	6025	5965	6060	6050
SURFACE CONDITIONS/ PRESENT USE	Flat ground near T130 trailers.	Flat ground, parking lot.	Flat ground, vacant?	Flat ground, Solar Ponds area.	Flat ground, vacant land.	Flat ground, vacant land.
SURFICIAL SOILS	ROCKY FLATS ALLUVIUM	ROCKY FLATS ALLUVIUM	ROCKY FLATS ALLUVIUM	ARTIFICIAL FILL	ROCKY FLATS ALLUVIUM	ROCKY FLATS ALLUVIUM
APPROXIMATE DEPTH OF SURFICIAL SOILS	50-55 FEET	30-35 FEET	30-40 FEET	10 FEET	50-55 FEET	65 FEET
TYPE OF BEDROCK	CLAYSTONE	CLAYSTONE, SILTY CLAYSTONE, SANDY CLAYSTONE	CLAYSTONE	CLAYSTONE, SILTY CLAYSTONE, SANDY CLAYSTONE	CLAYSTONE	CLAYSTONE
AVERAGE DEPTH TO WATER	30 FEET	8 FEET	10 FEET	10 FEET	20-25 FEET	45 FEET
WITHIN IHSS?	NO	NO	NO	YES	NO	NO
WITHIN CONTAMINANT PLUME?	NO	NO	NO	YES	NO	NO
NEARBY BOREHOLES	NO	42592, 42692	00593, 01293, 42492, 43992, 44092,	54294, 40893, SP0687, 42293, SP0787, 43493, SP0487, 42593, SP0587	NO	TH-4, TH-7, TH-9
INFERRED FAULTS? DISTANCE/FAULT #	1,270 FEET / 2A	750 FEET / 2A	320 FEET / 2A	0 FEET / 4	780 FEET / 2A	2220 FEET / 2A
DISTANCE FROM STEEPLY DIPPING STRATA	4250 FEET	5750 FEET	6000 FEET	9750 FEET	4625 FEET	4250 FEET

TABLE 1.12.1-5
RFETS INTERIM STORAGE VAULT SITING CRITERIA

Scoring Criteria:
- 0 = Unacceptable
- 1 = Less Acceptable
- 2 = Acceptable
- 3 = More Acceptable

SITING ISSUES	WEIGHT FACTOR	SITE 1		SITE 2		SITE 3		SITE 4		SITE 5		SITE 6	
		Score	Total	Score	Total	Score	Total	Score	Total	Score	Total	Score	Total
B Natural topographic and geologic conditions													
1. Surface conditions/present use	2	3	6	3	6	2	4	0	0	1	2	1	2
2. Surficial deposits	2	2	4	2	4	2	4	1	2	2	4	2	4
3 Thickness of surficial deposits/Depth to bedrock	3	2	6	3	9	2	6	1	3	2	6	2	6
4 Bedrock formation/Lithology	2	2	4	2	4	2	4	2	4	2	4	2	4
5. Depth to groundwater	3	2	6	1	3	1	3	1	3	2	6	2	6
6. Inferred faults	3	2	6	1	3	2	6	1	3	2	6	3	9
7 Mineral resource potential	2	1	2	2	4	2	4	2	4	1	2	1	2
8 Continuity of age datum	2	2	4	2	4	2	4	1	2	3	6	3	6
		Sub-Total	38	Sub-Total	37	Sub-Total	35	Sub-Total	21	Sub-Total	36	Sub-Total	39
C Cultural, historic and archaeological resources													
1 General	2	2	4	2	4	2	4	2	4	1	2	1	2
		Sub-Total	4	Sub-Total	4	Sub-Total	4	Sub-Total	4	Sub-Total	2	Sub-Total	2
D. Endemic plant and animal species													
1 Outside wetlands	3	2	6	2	6	2	6	2	6	2	6	2	6
2. Outside xeric tall grass prairie habitat	2	2	4	2	4	2	4	2	4	0	0	0	0
3. Outside Preble's meadow jumping mouse habitat	2	2	4	2	4	2	4	2	4	2	4	2	4
4. Raptor habitat	2	1	2	2	4	2	4	1	2	2	4	1	2
		Sub-Total	16	Sub-Total	18	Sub-Total	18	Sub-Total	16	Sub-Total	14	Sub-Total	12
E. Known RCRA and/or CERCLA sites													
1. Outside IHSS	3	2	6	2	6	2	6	0	0	2	6	2	6
2. Outside contaminant plume	3	2	6	2	6	2	6	0	0	2	6	2	6
3. Down gradient of IHSS	1	2	2	2	2	2	2	0	0	2	2	2	2
4. Down gradient of contaminant plume	1	2	2	2	2	2	2	0	0	2	2	2	2
		Sub-Total	16	Sub-Total	16	Sub-Total	16	Sub-Total	0	Sub-Total	16	Sub-Total	16
H. Indoor air quality impacts													
1. Radon gas	1	2	2	2	2	2	2	1	1	2	2	2	2
		Sub-Total	2	Sub-Total	2	Sub-Total	2	Sub-Total	1	Sub-Total	2	Sub-Total	2
J. Natural hazards													
1. Distance from fault sources.	2	1	2	2	4	2	4	3	6	1	2	1	2
2 Distance from steeply-dipping bedrock	2	1	2	2	4	2	4	3	6	1	2	1	2
3 Soil column amplification effects	2	1	2	2	4	2	4	3	6	1	2	1	2
4 Topographic amplification effects	3	2	6	2	6	2	6	2	6	2	6	2	6
5 Flood/hydrologic effects	2	2	4	2	4	1	2	1	2	2	4	2	4
6. Wind/Tornado effects	1	2	2	2	2	2	2	2	2	2	2	2	2
		Sub-Total	18	Sub-Total	24	Sub-Total	22	Sub-Total	28	Sub-Total	18	Sub-Total	18

4.2 NATURAL TOPOGRAPHIC AND GEOLOGIC CONDITIONS

4.2.1 TOPOGRAPHY

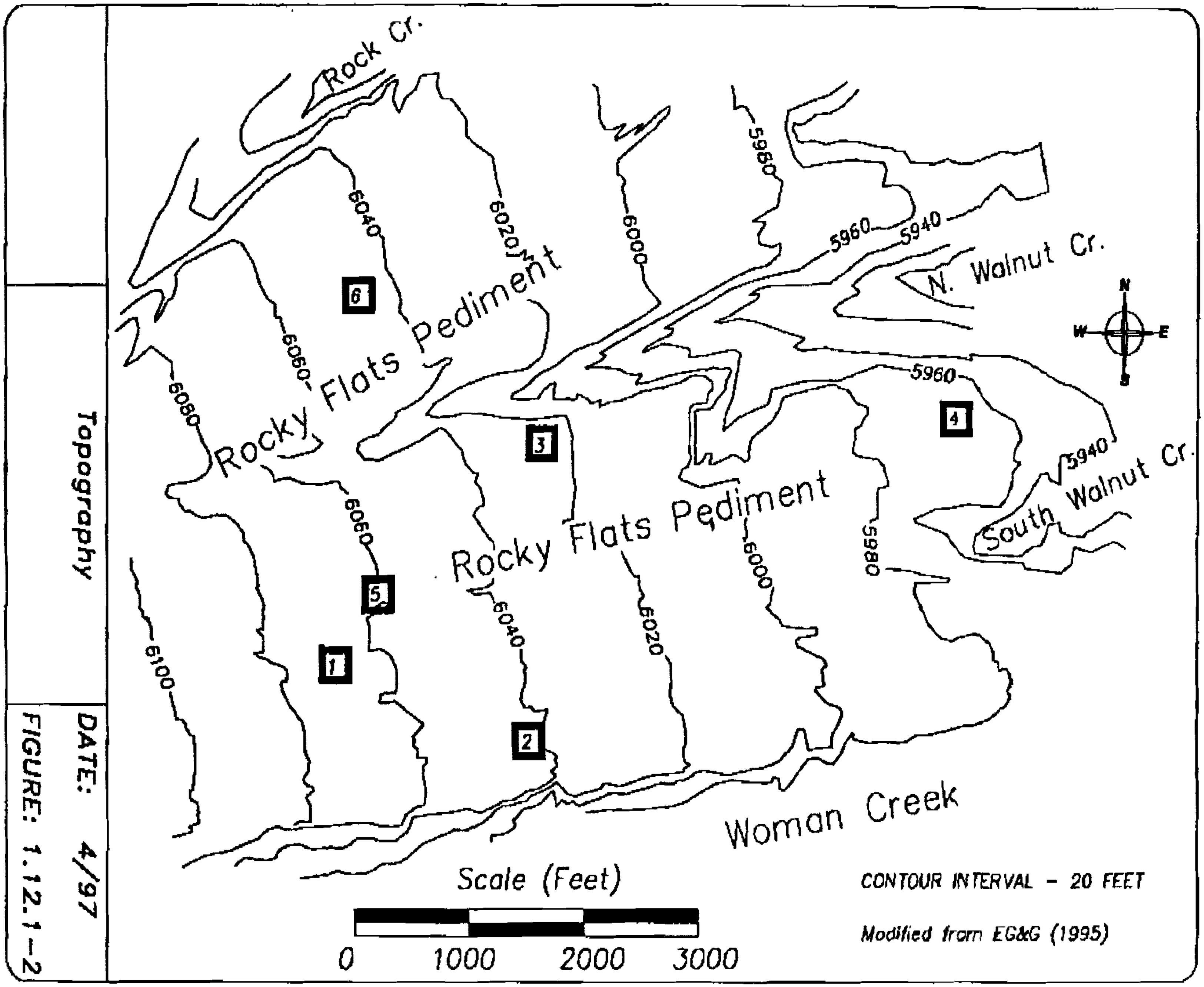
RFETS is located on a broad, mountain front erosional surface termed the Rocky Flats pediment in the Colorado Piedmont of the Great Plains Physiographic Province. The Front Range of the Rocky Mountains lies a few miles west of the site, and the Continental Divide is about 26 miles west. The RFETS topography is broadly rolling and slopes gently to the east with a drop of about 450 ft and a slope of approximately 1.5 degrees from the west to east edges of the buffer zone (Figure 1.12.1-2). Major stream valleys originating in the mountains of the Front Range cross the pediment generally from west to northeast. Small tributaries to these major streams have developed locally. Moderately steep hillsides are common adjacent to the stream drainages.

RFETS covers approximately 11 square miles (about 6,550 acres) of federally owned land, occupying Sections 1 through 4 and 9 through 15 of Township 2 South, Range 70 West, 6th Principal Meridian in Jefferson County, Colorado. RFETS is centered at 105° 11' 30" west longitude, 39° 53' 30" north latitude, about 16 miles northwest of downtown Denver, and 9 to 12 miles from the communities of Boulder, Broomfield, Golden, Arvada, and Westminster. The area surrounding the site is located in Adams, Boulder, and Jefferson counties. Adams County, east of the site, includes portions of the cities of Arvada, Broomfield, and Westminster. The area north of the site is in Boulder County.

Four miles west of RFETS, the eastern margin of the Front Range is characterized by a narrow zone of hogback ridges formed by steeply east-dipping Paleozoic and Mesozoic strata (the Fountain Formation and the Dakota Group, respectively). Fifteen miles west of the eastern margin of the Front Range, along the Continental Divide, the mountains reach elevations of 12,000 to nearly 14,000 ft above mean sea level. The core of the Front Range is composed of Precambrian basement (igneous and metamorphic assemblages). East of RFETS, the Rocky Flats pediment merges with the High Plains section of the Great Plains Physiographic Province.

RFETS consists of an industrial area and surrounding buffer zone. The major facilities are all located in the Industrial Area, which is enclosed by a security fence. Two access roads, one from State Highway 93 to the west and one from County Highway 17 (Indiana Street) to the east, pass through the security fence. Land between the site boundary and the Industrial Area serves as a buffer zone between the site and the public.

The buffer zone is a protected environmental "preserve" for plant and animal life, some of which is endangered. Development in the buffer zone is limited to firebreaks, access roads, holding ponds and ditches, environmental sampling and monitoring stations, old and new sanitary landfills, a firing range, radio towers, a salvage yard, power lines, contaminated water holding tanks, a gravel pit, and a raw-water reservoir. The only permanent buildings in the buffer zone are unoccupied farm buildings of the Lindsay Ranch, which operated before the site came into existence, and buildings associated with the new landfill.


Rock Cr.
6040
6020
6000
5980
5960
5940
N. Walnut Cr.
N
W
E
S
Rocky Flats Pediment
6060
6080
Rocky Flats Pediment
5960
4
3
6
5940
South Walnut Cr.
6060
5
1
6100
6040
6020
6000
5980
2
Woman Creek
Scale (Feet)
0
1000
2000
3000
CONTOUR INTERVAL - 20 FEET
Modified from EG&G (1995)
Topography
DATE: 4/97
FIGURE: 1.12.1-2

4.2.2 GEOLOGY

4.2.2.1 General Description

The six ISV sites are geologically similar and are underlain by bedrock of the Laramie and Arapahoe Formations and 0 to 65 ft of unconsolidated surficial deposits. These include man-made artificial fill and terrace alluvium (Figure 1.12.1.-3). The Rocky Flats pediment and associated alluvial deposits are part of a 10-square-mile alluvial fan extending to the east from the mouth of Coal Creek. Modern stream channels have locally dissected the alluvium and expose Cretaceous bedrock. The six ISV sites, however, are located on alluvium-capped uplands, between the incised drainages. The uplands exhibit relatively "flat" topography and slope gently towards the east.

Colluvial deposits (rock detritus and soil) cover the steep hillsides in the incised stream drainages. Landslide deposits are present along the steep hillsides in the drainages (Hurr, 1976). Alluvial deposits occur in flood plains, stream channels, and terraces along drainages across the site. The characteristics of the surficial deposits are briefly described below and more thoroughly discussed in EG&G (1995) and USGS (1994).

The total Paleozoic and Mesozoic stratigraphic section in RFETS area is estimated to be roughly 13,000 ft thick. The Laramie and Arapahoe Formations are the uppermost bedrock units across RFETS. The Arapahoe Formation unconformably overlies the Laramie Formation and is preserved as eroded, isolated remnants beneath the Rocky Flats Alluvium.

A fluctuating, perched, unconfined water table occurs within surficial materials and upper few ft of weathered bedrock.

4.2.2.2 Bedrock Stratigraphy

1) Laramie Formation

The Upper Cretaceous Laramie Formation consists of claystones, siltstones, sandstones, and coal beds and is approximately 600 to 800 ft thick. The formation was deposited in a fresh to brackish water delta-plain environment (EG&G, 1995). Palynological evidence suggests an age of late Campanian to mid-Maestrichtian (74.5 million years to 66.4 million years) for the Laramie Formation.

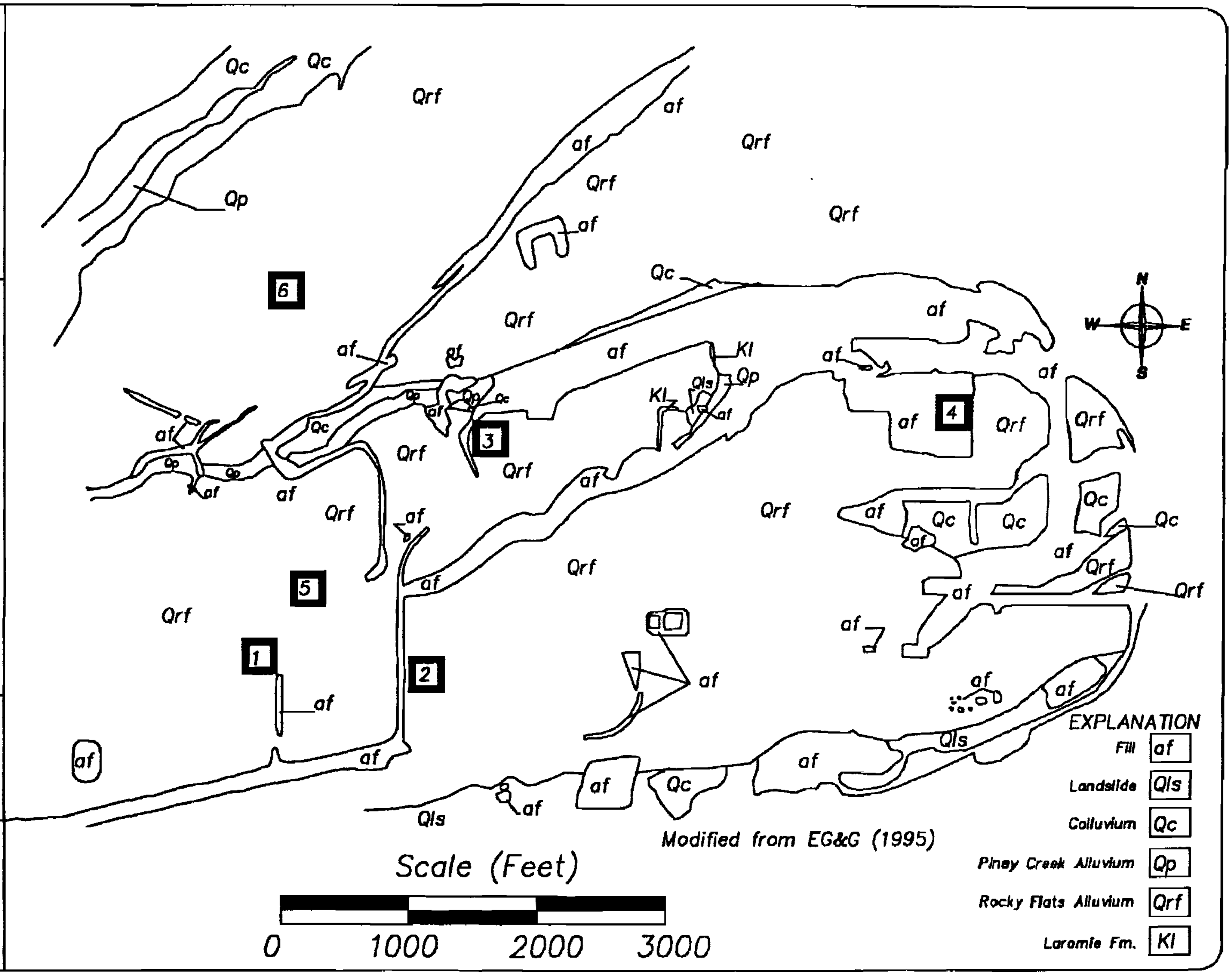
2) Arapahoe Formation

The Upper Cretaceous Arapahoe Formation consists of fluvial lithologies includes: sandstones, overbank siltstones, and claystones. Most of the Arapahoe Formation has been removed by erosion at Rocky Flats, however, thin sections (0 to 50 ft) of basal Arapahoe locally occur within channels eroded into the top of the Laramie Formation. This unconformable relationship can result in Arapahoe Formation bedrock occurring laterally adjacent to Laramie Formation Bedrock (EG&G, 1995). Basal sandstones of the Arapahoe Formation are interpreted as being late Maestrichtian to early Paleocene (66.4 million years to 63.6 million years) in age.

Surficial Geology

DATE: 4/97

FIGURE: 1.12.1-3



4.2.2.3 <u>Bedrock Structure</u>

The structural geology of RFETS and the surrounding area is complex and dominated by structural features that formed during the uplift of the Rocky Mountains approximately 65 million years ago and subsequent Neogene modification beginning about 17 million years ago. These features include north-northwest trending mountain ranges bounded by low-angle thrust faults. A structure contour map prepared by EG&G (1995) indicates that on a site-wide scale, the bedrock generally strikes in a north-south direction and dips 1° to 3° to the east, towards the center of the Denver Basin. Locally, however, minor bedrock faults and folds result in deviations from this general trend. Along the western boundary of the Rocky Flats site, some 4,250 to 9,750 ft west of the ISV candidate sites, lies a zone of steeply eastward-dipping bedrock associated with folding and reverse faulting related to the Laramide Orogeny.

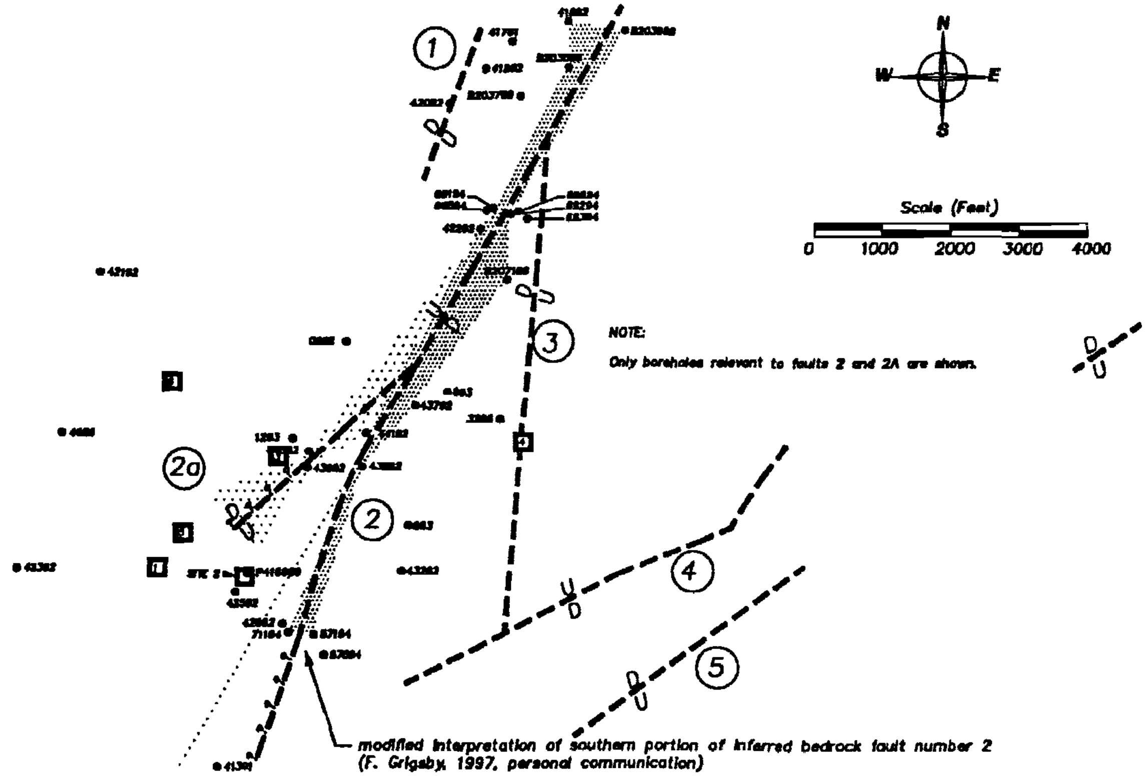
Based on structural data developed from limited deep drilling, EG&G (1995) inferred several faults in the bedrock beneath Rocky Flats (Figure 1.12.1-4). A deep reflection seismic line also indicates the presence of faults in bedrock beneath RFETS; however, limited resolution precludes association of geophysically interpreted faults with either specific building sites or faults inferred from drilling. The inferred faults are assumed to be high-angle-reverse faults with displacements estimated to range from 10 to 120 ft. To date, however, none of these inferred faults have been shown to displace the overlying surficial soils, which brackets the age of the faulting at older than 900 ± 300 kilo annum (ka) (Geomatrix, 1995b). Geomatrix (1995b) postulates a syndepositional, nontectonic origin for faults observed in a trench excavated across excavated across Fault 2 (Geomatrix, 1995b).

1) Bedrock Weathering

Data obtained from the drilling at Rocky Flats indicates that weathering of bedrock may extend from 0 to 60 ft below the top of rock (EG&G, 1995). Elevations of top of bedrock are illustrated on Figure 1.12.1.-5. Weathered bedrock is identified as having increased jointing and softening, deposition of iron oxides along joints, and orange to yellow color mottling. Due to joint density in weathered bedrock, increased permeability and reduced bearing capacity may result.

4.2.2.4 <u>Surficial Stratigraphy</u>

Surficial materials at the proposed candidate ISV sites typically consist of the unconsolidated Rocky Flats Alluvium and local areas of artificial fill material.



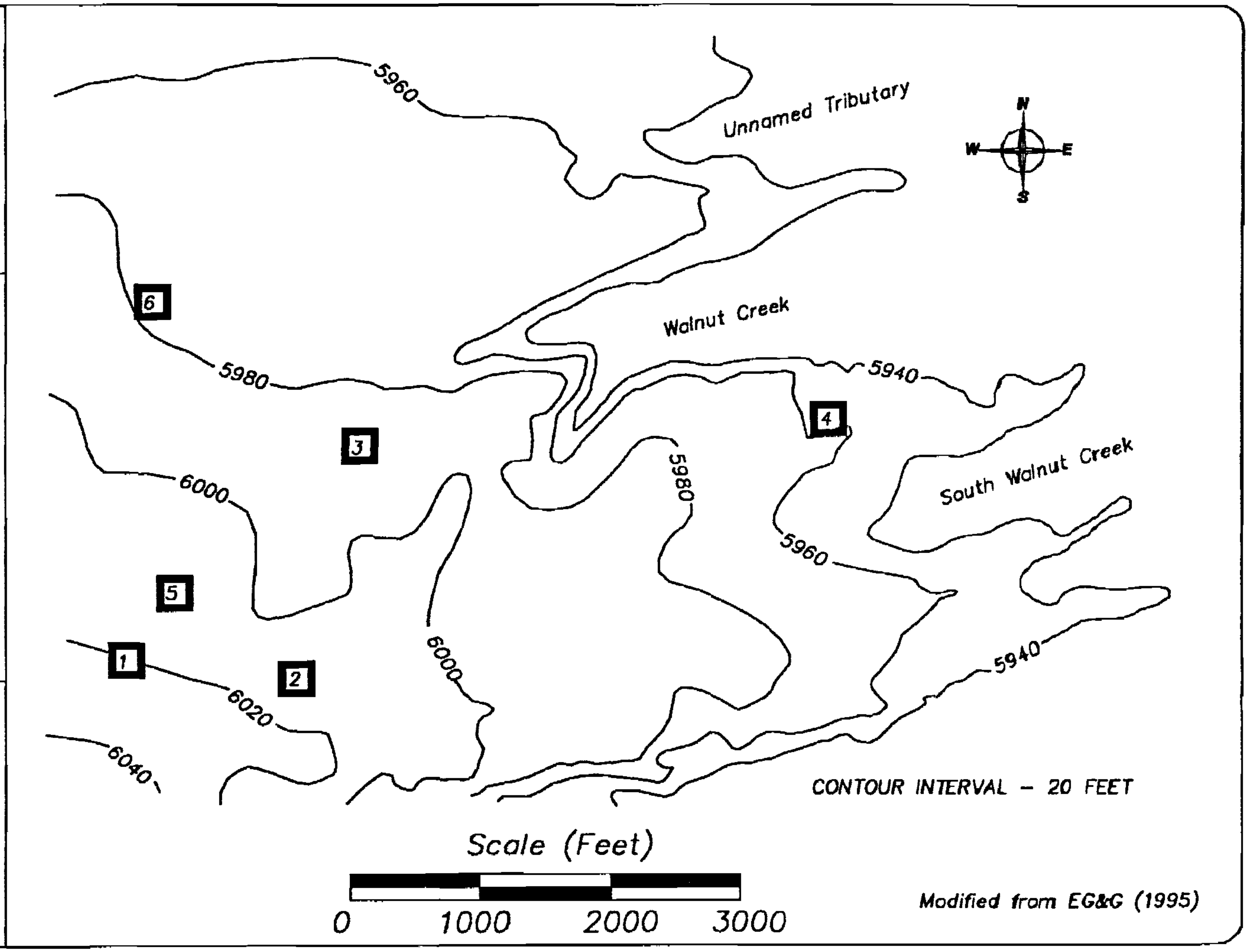
INFERRED BEDROCK FAULTS

- Location of Control Borehole
- Inferred bedrock fault (EG&G,1995, F. Grigsby, personal communication, 1997) constrained by control boreholes
- Possible extension of inferred bedrock fault (poorly constrained by control boreholes)
- Previous interpretation of location of inferred bedrock fault number 2 (EG&G, 1995 plate 7-1)
- Area within which location of inferred bedrock fault number 2 is interpreted to be constrained by control boreholes (modified from Geomatrix, 1995)
- Area within which location of inferred bedrock fault number 2A is interpreted to be constrained by control boreholes

Inferred Bedrock Faults

DATE: 4/97

FIGURE: 1.12.1-4



Elevation of Top of Bedrock

DATE: 4/97

FIGURE: 1.12.1–5

1) Rocky Flats Alluvium

The early Pleistocene Rocky Flats Alluvium is the most laterally extensive alluvial deposit at Rocky Flats. USGS (1994) describes the alluvium as consisting of a poorly sorted, clast supported, slightly bouldery, cobbly gravel in a light-brown to light-red, clayey sand matrix with beds and lenses of sandy gravel, gravelly, silty sand, and cobbly and gravelly sandy clay in the western portion of Rocky Flats. In the eastern portion of Rocky Flats, the authors report the alluvium contains thin (5 to 90 cm) beds and lenses of poorly sorted, clast and matrix supported, white to pink, sandy gravel, gravelly sand, and silty sand. The alluvium was deposited in an alluvial fan environment on a pediment surface eroded into bedrock. The age of the Rocky Flats Alluvium is inferred to be a minimum of 900 $\pm$ 300 ka based on relative topographic position to other dated alluviums and the degree of soil development. The thickness of the Rocky Flats Alluvium at the candidate sites ranges from 25 to 65 ft (Figure 1.12.1-6).

2) Artificial Fill Material

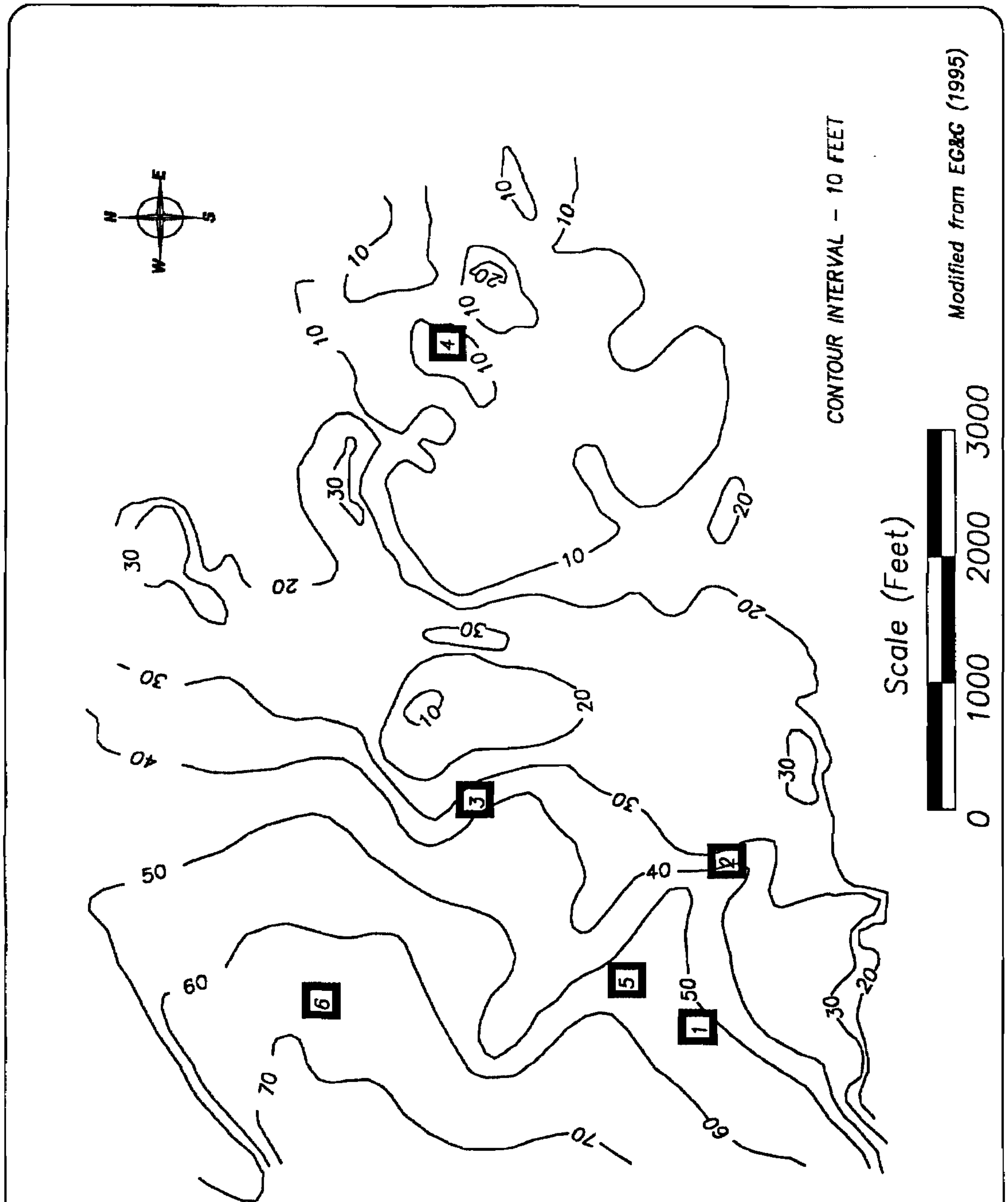
Two of the candidate sites, Site 3 located just west of Building 371 and Site 4 in the solar ponds area, are interpreted to be underlain by artificial fill. The composition and thickness of the fill at Site 3 is unknown. Depth to the top of bedrock in this area is shown by EG&G (1995) as being approximately 30 to 40 ft. Depth to the top of bedrock at Site 4 in the solar ponds area is about 10 ft.

4.2.2.5 Groundwater

Groundwater is present in the shallow, unconsolidated sediments and subcropping bedrock throughout the site (Figure 1.12.1-7). Shallow groundwater flows through two distinct layers, each exhibiting specific hydrologic and geochemical characteristics, which allow for grouping into two hydrostratigraphic units. These units are generally referred to as the upper hydrostratigraphic unit and the lower hydrostratigraphic unit.

The upper hydrostratigraphic unit is the predominant water-bearing unit of concern at RFETS. It consists of unconsolidated, sandy, and gravelly materials mixed with clay (i.e., alluvium, colluvium, and artificial fill), weathered bedrock, claystones, and minor bedrock sandstones hydraulically connected to the alluvium. The site experiences significant seasonal fluctuations of groundwater levels in the upper hydrostratigraphic unit. The lower hydrostratigraphic unit consists of unweathered claystone, with some interbedded siltstones and sandstones. A significant difference exists in hydraulic conductivity of each unit.

Groundwater at the site has both horizontal and vertical components of flow. Groundwater in the upper hydrostratigraphic unit preferentially flows along preexisting channels cut into the bedrock. These channels are known to occur in the Industrial Area, Solar Ponds, 881 Hillside, 903 Pad, East Trenches Areas, and possibly in the West Spray Field. In addition, groundwater in the Industrial Area may preferentially flow along buried sewer lines and process-waste lines (RFETS, 1996). Other hydrogeologic controls for groundwater flow and contaminant transport are hydraulic gradient, distribution of subcropping sandstones and claystones, and topography.

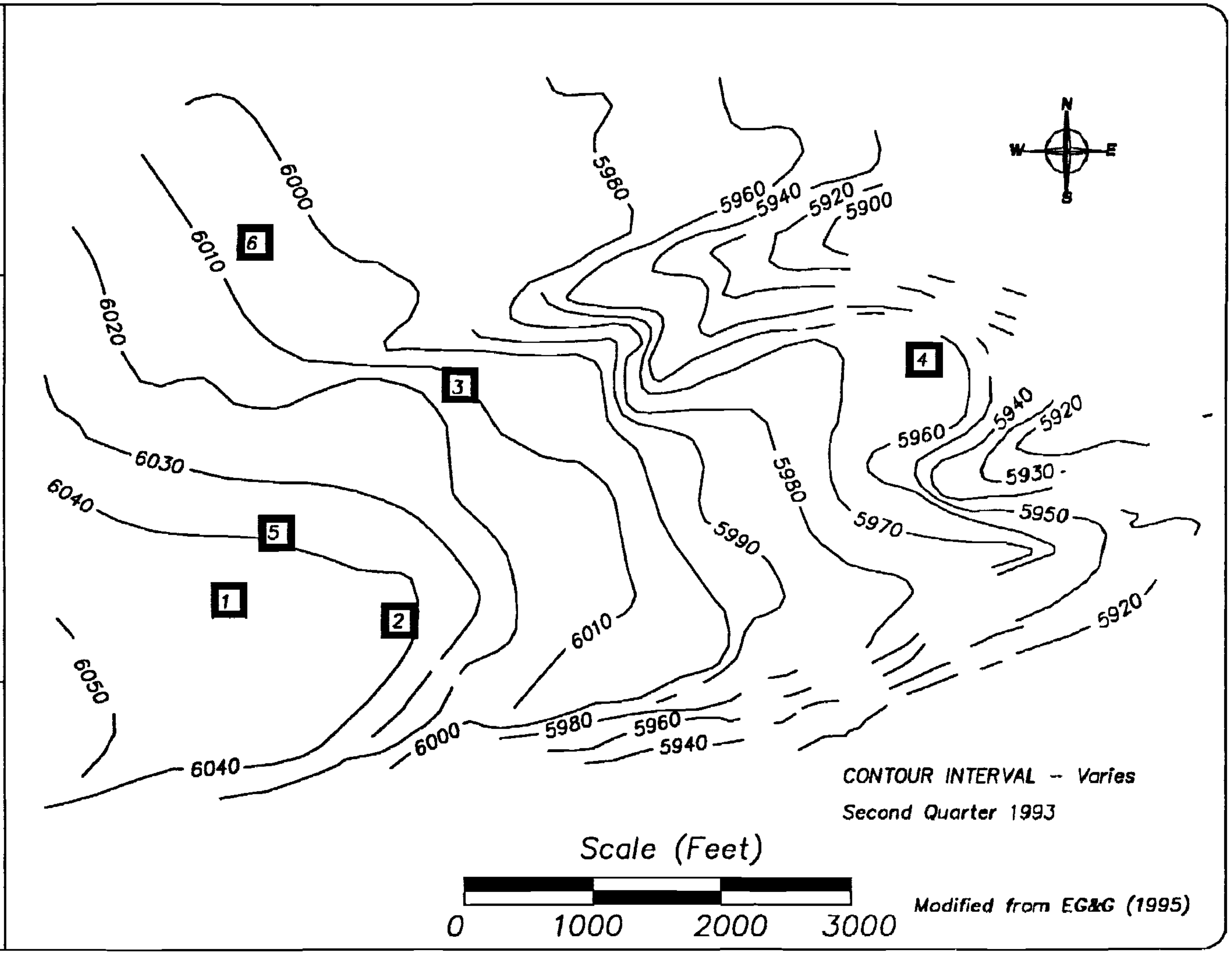


	Isopach Map of Surficial Soils	DATE: 4/97 FIGURE: 1.12.1-6

Water Table in Surficial Soils

DATE: 4/97

FIGURE: 1.12.1-7



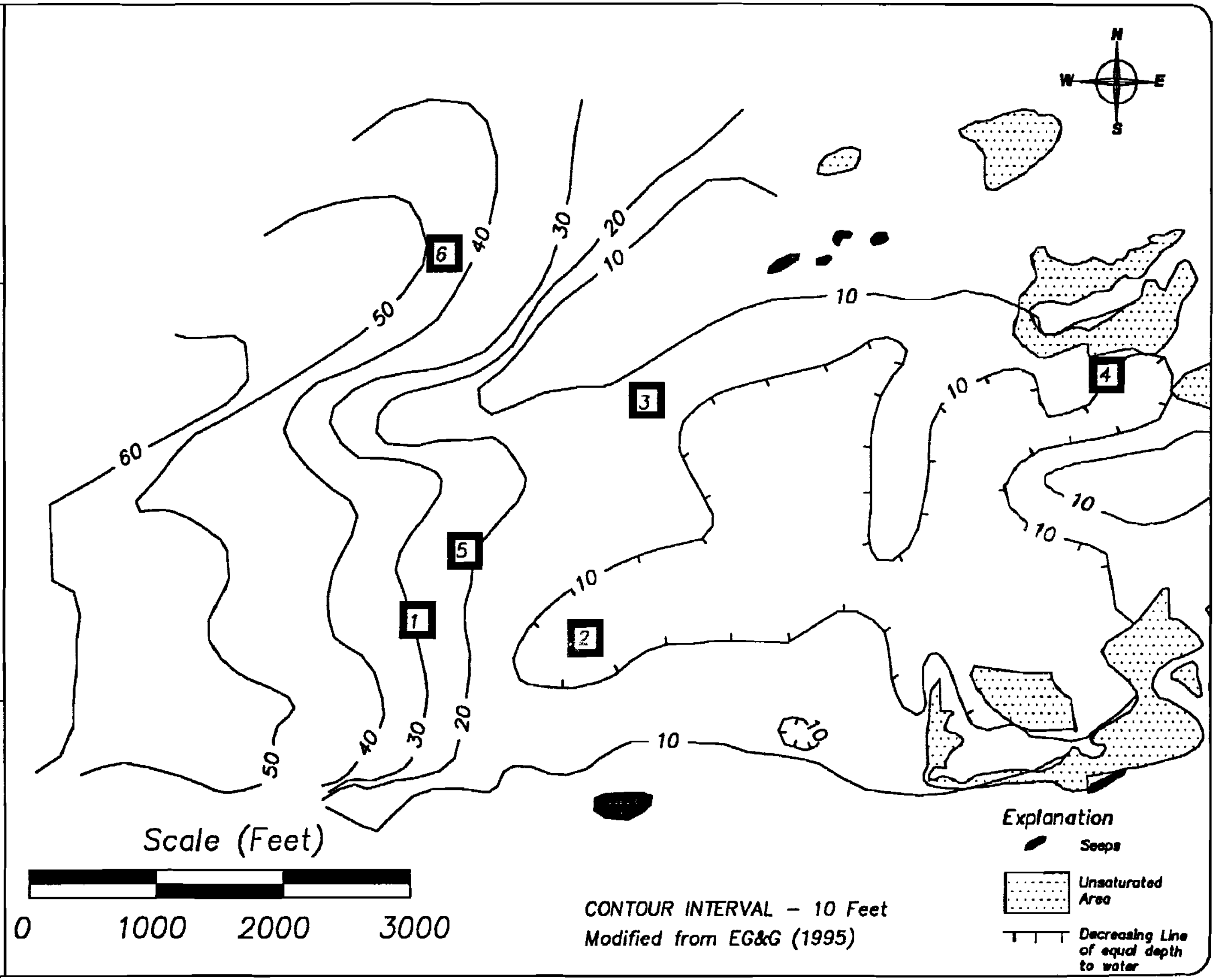
Groundwater in the surficial deposits of the upper hydrostratigraphic unit generally flows to the east, following bedrock and surface topography, and discharges to the surface water drainages at springs, seeps, and associated wetlands on the hillsides of the Industrial Area at the contact between the alluvium and bedrock and where shallow sandstones crop out in the drainages. Water in springs and seeps is either consumed by evapotranspiration or flows downslope as surface water or through colluvial deposits to South Walnut Creek or Woman Creek.

Both downward and upward vertical hydraulic gradients have been documented at RFETS. Vertical hydraulic gradient values, on the order of 0.79 to 1.05 ft per foot, have been estimated between the colluvium and bedrock sandstones at Operable Unit 1. Regional water-level elevations indicate that a strong downward vertical gradient also exists locally between the upper hydrostratigraphic unit and the Laramie-Fox Hills aquifer. At RFETS, the potentiometric surface in the Laramie-Fox Hills aquifer is 50 to 100 ft lower than the water level in the overlying alluvium. Upward hydraulic gradients were identified in well clusters located in topographically low areas near the bottoms of drainages, suggesting that groundwater in the bedrock may recharge unconsolidated surficial deposits in stream drainages.

Most well cluster hydrographs, however, show poor hydraulic connection between the bedrock and unconsolidated surficial deposits. The Well Evaluation Report (RFETS, 1993) concluded that the deeper hydrostratigraphic units at the site, typically greater than 100 ft deep, are generally not in direct hydraulic connection with the upper hydrostratigraphic unit. This limited hydraulic connection indicates that groundwater from the upper hydrostratigraphic unit will not quickly nor easily migrate downward to the lower hydrostratigraphic unit, despite vertical gradients. Further, the low vertical hydraulic conductivities and the adsorptive properties of clay materials are expected to retard the downward movement of chemical constituents. The low-permeability claystones of the lower hydrostratigraphic unit form a barrier at least 500 ft in thickness to diminish contaminated groundwater from migrating vertically downward to the Laramie-Fox Hills aquifer.

Available hydrogeologic and isotopic data suggest that faults are not significant conduits for downward vertical groundwater flow to deep aquifers (RFETS, 1994). Evidence of limited hydraulic communication between groundwater from the upper hydrostratigraphic unit to the lower hydrostratigraphic unit was found to exist in some wells, but these occurrences do not present a pattern consistent with known fault locations. Isolated fractures in unfaulted bedrock, as opposed to fault-zone fractures, are the most likely mode of transport for the upper hydrostratigraphic unit groundwater to reach unweathered bedrock. However, the thick Laramie Formation claystone and siltstone prevent direct connection between surficial groundwater and the Laramie-Fox Hills aquifer.

The perched groundwater fluctuates significantly in response to local climatic variations such as rainfall, surface-water runoff, and snow melt. The average depth (yearly) to the groundwater at the candidate sites ranges from 10 to 45 ft (Figure 1.12.1-8). Seasonal fluctuations in the level of the water table are commonly 5 to 10 ft.



Average Depth to Water (yearly average)

DATE: 4/97

FIGURE: 1.12.1-8

The geometric mean of the permeability in the heterogeneous Rocky Flats Alluvium is reported to be 2 x 10^{-4} cm/s. Weathered bedrock values are generally an order of magnitude lower at 10^{-5} cm/s and unweathered bedrock values indicate very low permeability of 10^{-7} cm/s (EG&G, 1995).

4.2.2.6 Mineral Resources

Sands and gravels comprising the Rocky Flats Alluvium are an economically exploitable mineral resource in the Denver-Boulder metropolitan area. Sand and gravel are currently being mined west of the Industrial Area and T-130 Building and north of the west access road from Highway 93. Although no detailed studies have been conducted, sand and gravel deposits across the entire Rocky Flats pediment surface, except in developed areas and where contaminated by past activities at the site, may be economically exploitable and are considered in siting studies.

4.2.2.7 Surface Water

Surface water flows from RFETS via five ephemeral streams that flow through or are adjacent to the site: North Walnut Creek, South Walnut Creek, Rock Creek, Smart Ditch, and Woman Creek. These drainages generally traverse the site from west to east. North and South Walnut Creek combine to form Walnut Creek on-site and the combined stream flows off-site where it is diverted by the Broomfield Diversion Ditch just east of Indiana Street. The Broomfield Diversion Ditch routes Walnut Creek around Great Western Reservoir to Walnut Creek below the reservoir. Walnut Creek eventually discharges to Big Dry Creek. Rock Creek headwaters just west of RFETS and flows through the northeast section of the site. Rock Creek is not impacted by site operations. Smart Ditch flows from Rocky Flats Lake just west of the site, across the southernmost quarter of the buffer zone, and into two detention ponds. In addition to the natural drainages, there are several ditches that route surface water through or around RFETS. Woman Creek traverses along the south of the site to eventually discharge into Woman Creek Reservoir.

Water detention ponds with earthen dams have been constructed to serve various purposes including containment of surface water runoff, groundwater interception, containment of wastewater treatment plant effluent to allow for sample collection and analysis, and emergency spill containment.

4.3 CULTURAL, HISTORIC, AND ARCHAEOLOGICAL RESOURCES

With the exception of abandoned farm and ranch buildings (Lindsay Ranch) north of the Industrial Area, no significant cultural, historic, and archaeological resources are known to exist within the RFETS boundary.

4.4 ENDEMIC PLANT AND ANIMAL SPECIES

RFETS is located in an area with several unique ecological factors. These factors are important to siting the proposed ISV.

4.4.1 Ecological Resources

RFETS provides a unique refuge for a large number of bird and mammal species as a result of more than two decades of protection from grazing, development, and other disturbances. The exclusion of grazing and development has allowed the native prairie/montane ecotonal system to rebound.

4.4.2 Wildlife

Data from the past several years show an abundance and diversity of species that demonstrate the excellent ecological health of RFETS. The protection and isolation of the buffer zone has provided essential habitat for rare species such as the American peregrine falcon, bald eagle, eastern short horned lizard, burrowing owl, loggerhead shrike, black swift, Baird's sparrow, American white pelican, grasshopper sparrow, water shrew, and Preble's meadow jumping mouse. Many are sensitive species or indicator organisms that by their presence or, more significantly, by their absence indicate the ecological health of an area.

RFETS supports a great diversity of bird species (over 180 species), including 19 avian predators. There are 37 mammal species (including 10 carnivores), 8 reptiles, and 7 amphibians, as well as numerous arthropods and other invertebrates (RMRS, 1996). This species diversity is another indicator of the high quality of the habitats at RFETS.

4.4.3 Wildlife Habitat and Plant Communities

A large unit of relic xeric tallgrass prairie, a grassland classified by the Colorado Natural Heritage Program (CNHP, 1995a, 1995b) as a rare and imperiled plant community occupies the western third of RFETS. Xeric mixed grasslands are important fall breeding and winter foraging habitat for the resident mule deer herd. Additionally, xeric and mesic mixed grasslands are important breeding habitats for grasshopper sparrows (a declining prairie species) and other grassland bird species.

The Great Plains riparian community, a stream channel and a woodland and shrubland plant community, is found along streams at RFETS. Cottonwood trees and willows predominate in this community. Another unusual shrub community, dominated by leadplant, also is commonly found in association with the Great Plains riparian community. This community provides important habitat for many bird and mammal species, including the Preble's meadow jumping mouse.

4.4.4 Threatened and Endangered Species

At RFETS, special monitoring before, during, and after a project may be required by the U.S. Fish and Wildlife Service (FWS) if the critical habitat for threatened and endangered species might be impacted. Threatened and endangered species are those plant or animal species listed in the Endangered Species Act (ESA) as threatened by extinction or in danger of immediate extinction, respectively. These species receive stringent protection from harm under the ESA and therefore any actions by Department of Energy (DOE) or its contractors that may affect threatened or endangered species are of concern. This regulation protects threatened and endangered fish, wildlife, and plants from injury, harassment, and death ("take"). The FWS also enforces the Fish and Wildlife Coordination Act of 1958, which requires consultation whenever the waters of any stream or other water body are altered by a federal agency. The Colorado Division of Wildlife administers the Colorado Nongame, Threatened, and Endangered Species Act, which protects state listed species in addition to all federally listed species.

1) Migratory Birds

For RFETS projects, all work sites must be evaluated by a qualified ecologist for potential to impact migratory birds or their nests prior to the start of work. Migratory birds include songbirds, raptors, waterfowl, shorebirds, game birds, and others (magpies, crows, ravens, and jays) as listed in the federal Migratory Bird Treaty Act (MBTA). The FWS administers the MBTA, which is based on treaties with Canada, Mexico, Japan, and Russia.

2) Wetlands

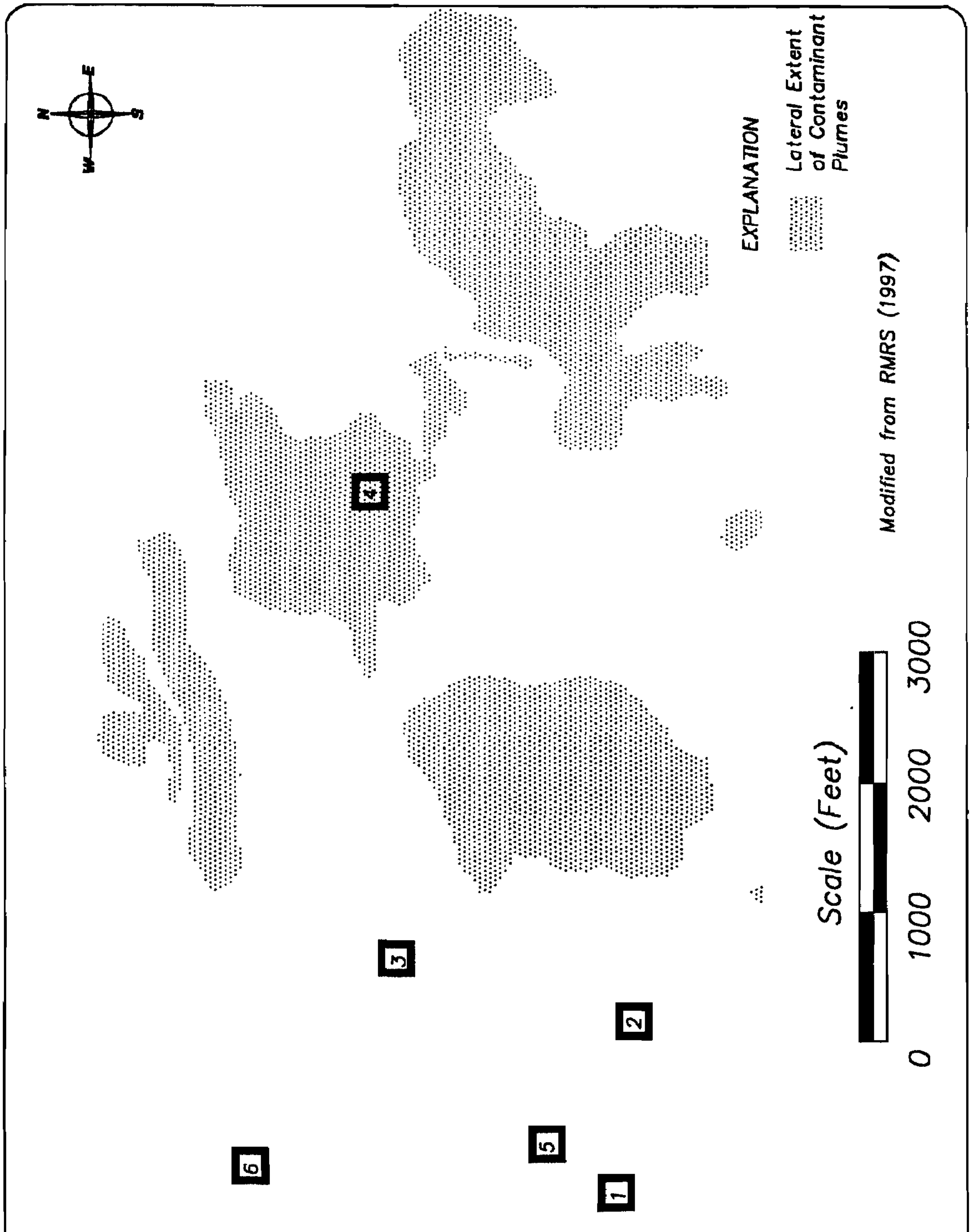
The U. S. Army Corps of Engineers (Corps) has surveyed and mapped the wetlands of RFETS (USACE, 1994). Wetlands are common on north-facing hillsides. One of the largest wetlands is Antelope Springs, which lies south of the Industrial Area. Although these wetlands are not unique, the role they serve in terms of retaining nutrients, sediments, and metals, purifying water, and providing forage, cover, and nesting habitat for wildlife is important.

Both the Environmental Protection Agency (EPA) and the Corps have jurisdiction over activities that affect wetlands on the RFETS under the Clean Water Act. Generally, EPA has jurisdiction over Comprehensive Environmental Response Compensation and Liability Act (CERCLA) activities, and the Corps has jurisdiction over non-CERCLA activities. EPA reserves the right to make all jurisdictional determinations. Wetland protection requirements do not prohibit all activities in wetlands, but they do require avoiding wetlands where practicable, minimizing impacts to wetlands, and providing appropriate compensatory mitigation for unavoidable impacts.

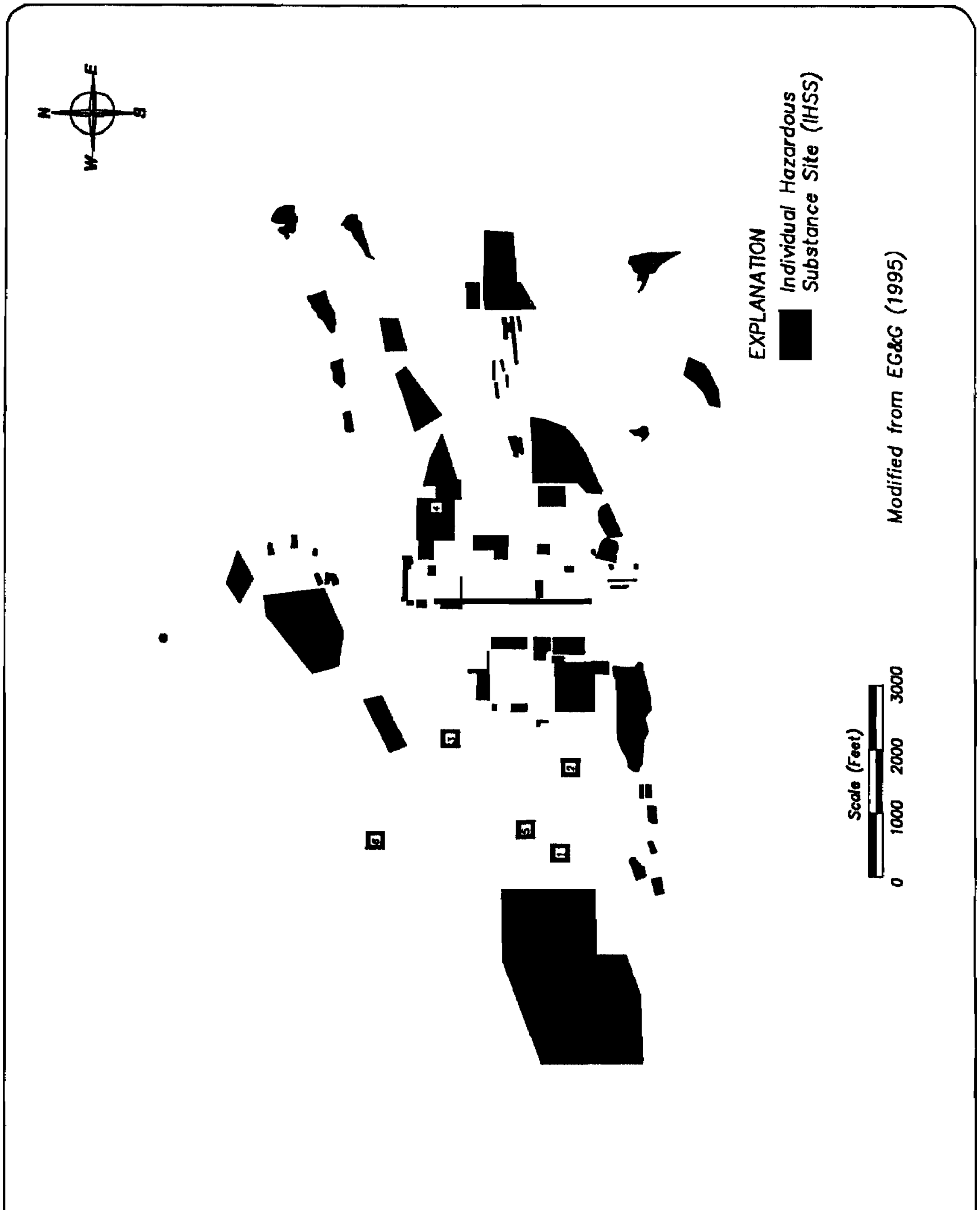
5.0 KNOWN RCRA AND CERCLA SITES

Known Resource Conservation and Recovery Act (RCRA) and CERCLA sites have been identified as IHSS and compiled on the RFETS geographic information system. In general, information is available on each IHSS including dates and types of contamination and causes of contamination. In some areas, contamination has been detected in the alluvial aquifer within the Rocky Flats Alluvium or in the vadose zone as a contaminant plume. Contaminant plumes also are compiled on the RFETS geographic information system.

Locations of both IHSSs and contaminant plumes were compiled from the RFETS geographic information system for use in the ISV siting study (Figure 1.12.1-9 and 1.12.1-10). For the purposes of the ISV siting study, location of a site within an IHSS or a contaminant plume is considered a fatal flaw. Because of the potential of downgradient migration of contaminant plumes, the siting of the ISV with respect to location of any known contaminant plume also was evaluated.



	Location of Contaminant Plumes	DATE: 4/97 FIGURE: 1.12.1–9



	Individual Hazardous Substance Sites (IHSS)	DATE: 4/97 FIGURE: 1.12.1-10

6.0 INDOOR AIR QUALITY IMPACTS

Indoor air quality impacts are limited to natural geologic conditions that would produce radon gas in an enclosed structure. In general, indoor radon gas is produced by Precambrian rock and uranium-bearing sedimentary rock. The surficial deposits and bedrock underlying RFETS are not typically associated with production of radon gas and no significant radon gas occurrences have been reported at RFETS.

7.0 NATURAL HAZARDS

7.1 SEISMIC HAZARDS

RFETS is located in an area of low seismic activity (REI, 1994). Numerous seismic studies have been performed to develop a seismic hazard curve addressing the potential intensity of earthquakes at the site. Review of these studies was performed to arrive at a basis for recommending a seismic hazard curve for use in site accident analysis.

The historical records of earthquakes that have occurred in Colorado were investigated by REI (1994). A specific study was conducted on the 1882 Colorado earthquake because it represents the largest seismic event recorded in Colorado history. The location of the 1882 earthquake was also evaluated as part of REI's 1994 studies. Using historical accounts, the epicenter was estimated to be most probably located in the northern Front Range. The magnitude was estimated to be between 4.6 and 7.1 with the most likely predicted value to be 6.4 (REI, 1994).

The current seismic hazard analysis for the site (REI, 1994) presents a map of geological features near the site and describes the nearest active and potentially active faults. The Walnut Creek fault traverses the east side of the site and has about a 3-km length. The Rock Creek fault is near the north boundary of the site strikes northeast, and has about a 4-km length. The Valmont fault is about 11-km north of the site and strikes north-northeast with about a 4-km length. The Golden-Boulder segment of the Front Range fault is about 4-km west of the site and strikes north-northwest about 55-km. The Rocky Mountain Arsenal (RMA)/Derby source is located about 16-km east of the site trending southeast with about a 22-km length. These faults were studied in the seismic hazard analysis (REI, 1994) for seismic capability, estimated magnitude capacity, closest distance to the site, and estimated recurrence. All of these factors were probabilistically weighted in a logic tree analysis to arrive at the probabilistic seismic hazard for the site.

An additional review for Building 371 (Geomatrix, 1995b) studied the capability of inferred northeast-striking faults, interpreted from borehole data, to pass beneath or near Building 371. . Figure 1.12.1-4 illustrates the estimated locations of the inferred faults on the Rocky Flats site. Investigation of these faults was performed by review of available subsurface data in the vicinity of Building 371 and by excavation and detailed logging of a trench across Fault 2, projected to pass beneath Building 371. The trench exposed the erosional unconformity between bedrock and the overlying Rocky Flats Alluvium (minimum age 900±300 ka). The conclusion of the investigation was that these faults were not capable as defined by Nuclear Regulatory Commission (NRC) criteria (i.e., no tectonic movement has occurred in the past 500,000 years). Therefore, these faults are categorized as inactive.

7.1.1 Evaluation Parameters

7.1.1.1 Seismic Design Criteria

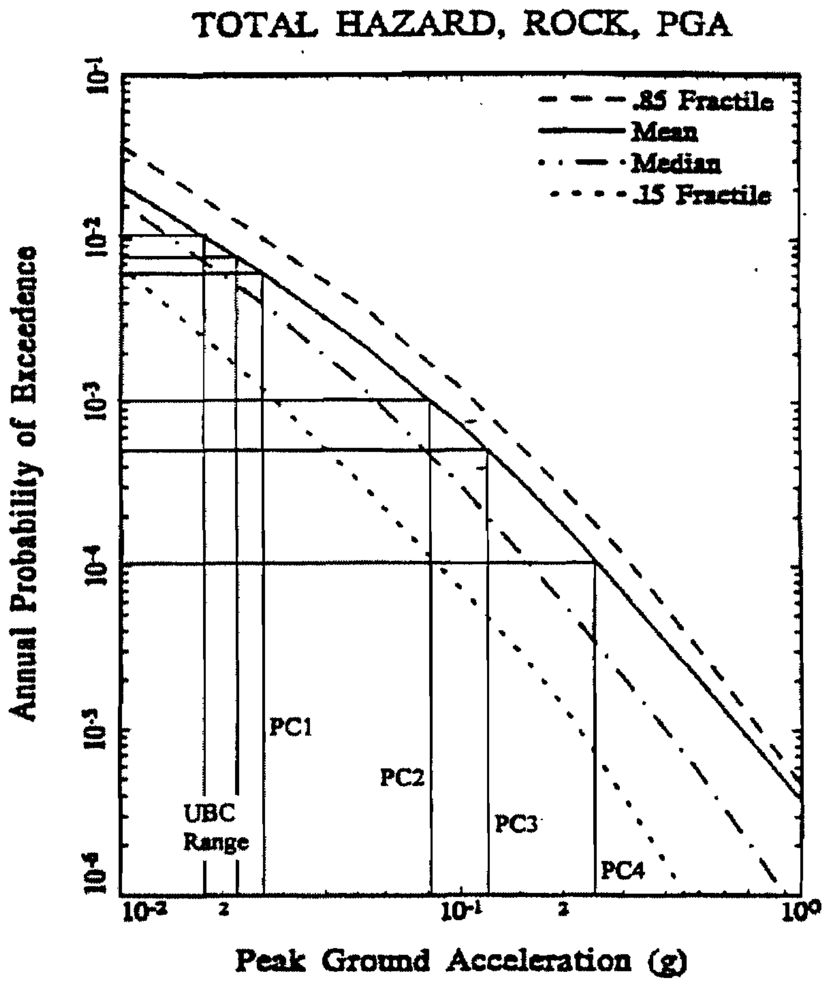
Facility levels are determined using Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports (DOE, 1992) which provides guidance to determine hazard classifications, used in DOE-STD-1020-94 (DOE, 1994a), Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities. The hazard classifications are used to define Performance Categories.

The RMA/Derby source is the major contributor to site seismic hazard for probabilities of interest for PC-3 design. For hazards requiring a PC-4 design, the Golden-Boulder portion of the Front Range source has more significance due to its proximity to the site and potential for a large earthquake.

Defense Nuclear Facility Safety Board (DNFSB) Recommendation 94-3 (1994) made a request that information be developed on seismic resistance capabilities of Building 371. As part of the Implementation Plan to address DNFSB Recommendation 94-3, a study (Geomatrix,1995c) was performed to reconcile the probabilistic seismic hazard analysis with a deterministic assessment performed to 10 CFR 100 Appendix A criteria. The results of that study showed that for a reactor facility designed as PC-4, the seismic hazard analysis and deterministic assessment would result in the same ground motion levels. A reconciliation and consolidation of site seismic issues was performed and documented (Geomatrix,1995c). Once a facility has been characterized into a specific Performance Category, the recurrence frequency and intensity can be derived from the hazard curve.

7.1.1.2 Hazard Curve

The Seismic Hazard Analysis (REI,1994) presents the calculated annual probability of occurrence versus ground motion level for several response frequencies. The results of the Seismic Hazard Analysis for peak ground acceleration are shown on Figure 1.12.1-11. The acceleration values are for bedrock at approximately 100 ft below the site and must be adjusted for the specific location of the facility to which they are applied as well as the applicable soil column amplification. The Seismic Hazard Analysis also addressed soil liquefaction and slope stability for the site; the conclusion was that these parameters are not a concern for typical ground motion levels for the site.



Source: Risk Engineering (1994)

	Seismic Hazard Curves	DATE: 4/97 FIGURE: 1.12.1-11

7.1.2 CONCLUSION

The design basis earthquake (DBE) for the site has an occurrence frequency of 1.0 x 10^{-4}/yr with a horizontal bedrock acceleration of 0.26g at the top of bedrock at a depth of 100 ft below the ground surface. Considerable effort has been expended in evaluation of soil and topographic amplification effects at Building 371, using the results of the REI (1994) Seismic Hazard Analysis for RFETS. The documentation of these amplification studies is incomplete and under review (Peregoy, 1996). An amplified PC-3 level response spectrum, however, was developed for Building 371. A preliminary response spectrum was developed for PC-4 earthquake and provided by RFETS for use in design of the ISV.

7.2 WIND/TORNADO EFFECTS

The wind statistics provided are based on data from a height of 10 m (33 ft) for data (from 1984 through 1993) taken from the meteorological tower, or from a height of 7.6 m (25 ft) in the case of the period from 1953 through 1975. The mean annual wind is about 4.4 m/s (9.8 mph). Although mean wind speed is often considered "typical," it is biased by the few high winds. A better measure for "typical" is the median (50th percentile); by definition, winds are less than the median 50 percent of the time and greater for the other 50 percent. The measure for "unfavorable" wind speeds is the 95th percentile wind; only 5 percent of the time is the wind greater than this value. The median wind speed for the period February 1989 through December 1992 is 3.1 m/s, somewhat lower than the mean, 3.8 m/s, as expected.

Daytime winds are infrequent from the southwestern sectors but are common from the southeastern sectors as well as the west-northwest and northern sectors. At night the winds are predominantly from one of the western sectors. The preponderance of winds are from the west. This dominance of westerly winds is season-dependent, being more striking in the winter and spring and less striking in the summer and fall.

8.0 <u>GENERAL DESCRIPTION OF SIX ALTERNATIVE ISV SITES</u>

The characteristics of the six alternative ISV sites are summarized in Table 1.12.1-4 and outlined briefly in the following sections.

8.1 SITE 1- WEST OF T-130 TEMPORARY BUILDINGS

Site 1 is located approximately 1000 ft north of the edge of an upland surface overlooking Woman Creek, to the south, at an elevation of 6,070 ft. Presently, the T130 series of trailers occupy this proposed site. The surficial soils consist of Rocky Flats Alluvium to depths of approximately 50 to 55 ft. Subcropping bedrock lithology is mapped as claystone (EG&G, 1995). Bedrock beneath Site 1 should be the Laramie Formation based on review of existing mapping (EG&G, 1995). The annual average depth to water is reported to be approximately 30 ft (EG&G, 1995). The building site is approximately 1,270 ft west of the nearest inferred fault, Fault 2A (EG&G, 1995) and 4,250 ft east of the zone of steeply dipping rock bordering the western edge of RFETS.

8.2 SITE 2-SOUTHEAST CORNER OF THE INDUSTRIAL AREA WEST OF BUILDING 460

Site 2 is located approximately 400 ft north of the edge of an upland surface overlooking Woman Creek, to the south, at an elevation of 6045 ft. Presently, the building site is undeveloped. The surficial soils consist of Rocky Flats Alluvium to depths of approximately 30 to 35 ft. Subcropping bedrock lithology is mapped as claystone, silty claystone, and sandy claystone (EG&G, 1995). Bedrock beneath Site 2 should be the Arapahoe Formation based on review of existing mapping (EG&G, 1995). The Arapahoe Formation is approximately 15 to 20 foot thick at this site and overlies Laramie Formation claystones. The annual average depth to water is reported to be approximately 10 ft (EG&G, 1995). The building site is approximately 750 ft west of the nearest inferred fault, Fault 2A, as interpreted from recent boreholes. (Grigsby, personal communication, 1997) and 5,750 ft east of the zone of steeply dipping rock bordering the western edge of the RFETS.

8.3 SITE 3 - WEST OF BUILDING 371 OUTSIDE PROTECTED AREA (PA)

Site 3 is located approximately 300 ft south of the edge of an upland surface overlooking North Walnut Creek, to the north, at an elevation of 6,025 ft. The site is about 500 ft west of Building 371 and sits in an area near a large gravel pile. The surficial soils consist of Rocky Flats Alluvium to depths of approximately 30 to 40 ft. Subcropping bedrock lithology is mapped as claystone (EG&G, 1995). We interpret the bedrock beneath site 3 to be the Laramie Formation based on review of existing mapping (EG&G, 1995). The annual average depth to water is reported to be approximately 30 to 40 ft (EG&G, 1995). The building site is approximately 320 ft west of the nearest inferred fault, Fault 2A (EG&G, 1995), and 9,750 ft east of the zone of steeply dipping rock bordering the western edge of the RFETS.

8.4 SITE 4 - SOLAR PONDS AREA, NORTHEAST PART OF THE PA

Site 4 is located approximately 500 ft south of the edge of an upland surface overlooking North Walnut Creek, to the north, at an elevation of 5965 ft. Presently, the Solar Ponds occupy this proposed site. The surficial soils consist of artificial fill material to depths of approximately 10 ft. Subcropping bedrock lithology is mapped as claystone, silty claystone, and sandy claystone (EG&G, 1995). Bedrock units beneath Site 4 should be both the Arapahoe and Laramie Formations based on review of existing mapping (EG&G, 1995). The annual average depth to water is reported to be approximately 10 ft (EG&G, 1995). The building site is directly on top of inferred Fault 3 (EG&G, 1995) and 9,750 ft east of the zone of steeply dipping rock bordering the western edge of the RFETS.

8.5 SITE 5 - NORTH OF T-130 TEMPORARY BUILDINGS

Site 5 is located approximately 1,000 ft south of the edge of an upland surface overlooking North Walnut Creek, to the north, at an elevation of 6,060 ft. Presently, the site is undeveloped. The surficial soils consist of Rocky Flats Alluvium to depths of approximately 50 to 55 ft. Subcropping bedrock lithology is mapped as claystone (EG&G, 1995). Bedrock beneath Site 5 should be the Laramie Formation based on review of existing mapping (EG&G, 1995). The annual average depth to water is reported to be approximately 20-25 ft (EG&G, 1995). The building site is approximately 780 ft west of the nearest inferred fault, Fault 2A (EG&G, 1995), and 4,625 ft east of the zone of steeply dipping rock bordering the western edge of the RFETS.

8.6 SITE 6 - NORTHEAST OF INDUSTRIAL AREA NEAR NEW LANDFILL

Site 6 is located approximately 1,000 ft north of the edge of an upland surface overlooking North Walnut Creek, to the south, at an elevation of 6,050 ft. Presently, the site is undeveloped. The surficial soils consist of Rocky Flats Alluvium to depths of approximately 65 ft. Subcropping bedrock lithology is mapped as claystone (EG&G, 1995). Bedrock beneath Site 6 should be the Laramie Formation based on review of existing mapping (EG&G, 1995). The average (yearly) depth to water is reported to be approximately 45 ft (EG&G, 1995). The building site is approximately 2,220 ft west of the nearest inferred fault, Fault 2A (EG&G, 1995), and 4,250 ft east of the zone of steeply dipping rock bordering the western edge of the RFETS.

9.0 SCORING AND SITE SELECTION

Final scoring and site selection are tabulated in Table 1.12.1-2. Site 2 received the highest score. The results of the siting study were presented to the ISV Review Panel. They concluded, based on the site information presented, that the ISV could be constructed at Sites 1, 2, 3, 5, or 6, and that other concerns, such as security, safety, etc., might be the deciding issues relative to selection of the final sites. They also concluded that Sites 1 and 5, or a combined site near those locations, Site 2, or Site 6 were the preferred sites.

The Review Panel also requested that a site visit/walkover be made of Sites 1, 2, 3, 5, and 6 to observe the sites for any conditions that might affect the site selection process. That walkover was made by members of the project team and anticipated conditions that influence the site selection were observed.

After the Review Panel meeting and the site walkover, the results of the study were discussed with Kaiser-Hill Company and RFETS security personnel. Based on those discussions, Site 2 was selected by Kaiser-Hill as the site for ISV advanced conceptual designs.

10.0 REFERENCES

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APPENDIX 1.12.2
Geotechnical Investigation Plan

of the
Conceptual Design Report

for the
Interim Storage Vault

for the
Rocky Flats Environmental Technology Site
Golden, Colorado

Task Order 72

for the

U. S. Department of Energy
Rocky Flats Operations Office
Golden, Colorado

Prepared by
Rocky Flats Engineers and Constructors, LLC
Denver, Colorado

May 1997

Authorization No. E32CD100

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APPENDIX 1.12.2 GEOTECHNICAL INVESTIGATION PLAN

LIST OF FIGURES

1.0 INTRODUCTION

Additional geological, geotechnical, and seismological data, which will be required for completion of design-level studies of the Interim Storage Vault (ISV), have been identified during the advanced conceptual design studies for the ISV. This section discusses geological, geotechnical, and seismological issues requiring field investigation and outlines a scope of work to be followed in obtaining the necessary additional data.

The selected ISV site will require site-specific evaluation in the context of normal geotechnical conditions and loadings associated with postulated natural phenomena events, mainly seismic hazards. All soil, rock, and included fluids that directly support, apply loads to, or contribute to the integrity of the ISV as the result of normal loading or a natural phenomenon event will be subject to this investigation.

2.0 GENERAL DESIGN CRITERIA AND GUIDANCE

Current design criteria for subsurface investigations and foundations at U. S. Department of Energy (DOE) facilities are identified in Section 0201, *Subsurface Investigations,* of DOE Order 6430.1A. Procedures and guidance outlined in Naval Facilities Engineering Command Design Manual 7.1 *Soil Mechanics*, (1982), and American Society of Civil Engineers (ASCE) Standard 1-82, *Guideline for Design and Analysis of Nuclear Safety-Related Earth Structures* to augment DOE Order 6430.1A (1989). Further guidance is provided by DOE's *Guidance for Geotechnical Studies*, Systematic Evaluation Program, Department of Energy Non-Reactor Facilities. Drilling, sampling, and laboratory testing programs will be designed in accordance with the American Society for Testing and Materials (ASTM) or other accepted standards should also be followed. Nuclear Regulatory Commission regulatory guides will also be reviewed for applicable siting and design criteria.

3.0 GENERAL REQUIREMENTS FOR SUBSURFACE, LABORATORY, AND GEOTECHNICAL EVALUATIONS

For permanent structures, subsurface conditions will be determined by borings or other methods that adequately define soil and groundwater conditions. Subsurface investigations will be conducted under the direction of the geotechnical engineer and will comply with applicable American Society for Testing and Materials (ASTM) standards including ASTM D1586, ASTM D1587, and ASTM D2113. Soil samples will be obtained at each change in soil stratification or soil consistency with maximum sampling interval not to exceed 5 ft. The minimum depth of investigation will be determined by the design geotechnical engineer in cooperation with other project design professionals. Soil samples will be preserved until the subsurface investigation has been approved by the cognizant DOE authority.

4.0 DEFINITION OF SITE INVESTIGATION PROGRAM ELEMENTS

Existing geological, geotechnical, and seismological data have been reviewed in the context of the chosen ISV site and have resulted in identification of necessary elements for further site-specific field investigations. The geologic formations and groundwater regimes are fairly well defined by existing bore holes and monitoring wells. However, past drilling at RFETS is generally not adequate for geotechnical design. For example, penetration resistance tests were not performed and samples were not obtained for density or strength testing. For this reason, geotechnical design data are lacking. Site-specific seismological design properties, established or assumed for Building 371, do not directly relate to the ISV site.

4.1 ISSUES FOR SITE INVESTIGATION PROGRAM

Geological, geotechnical, and seismological issues to be addressed with site-specific investigations are discussed in the following paragraphs. The scope and logic of the investigations will follow the development of the issues.

4.2 GEOLOGICAL ISSUES

The Geologic Characterization Report (EG&G, 1995) presents a comprehensive characterization of the geologic formations at the ISV site. Examination of geologic well logs within the local vicinity of the chosen site has led to an understanding of the distribution of the various geologic units. Spacing of existing wells, however, is not considered to be dense enough for building design. Existing data will need to be supplemented with building-site-specific data to confirm and more fully define the following geological issues:

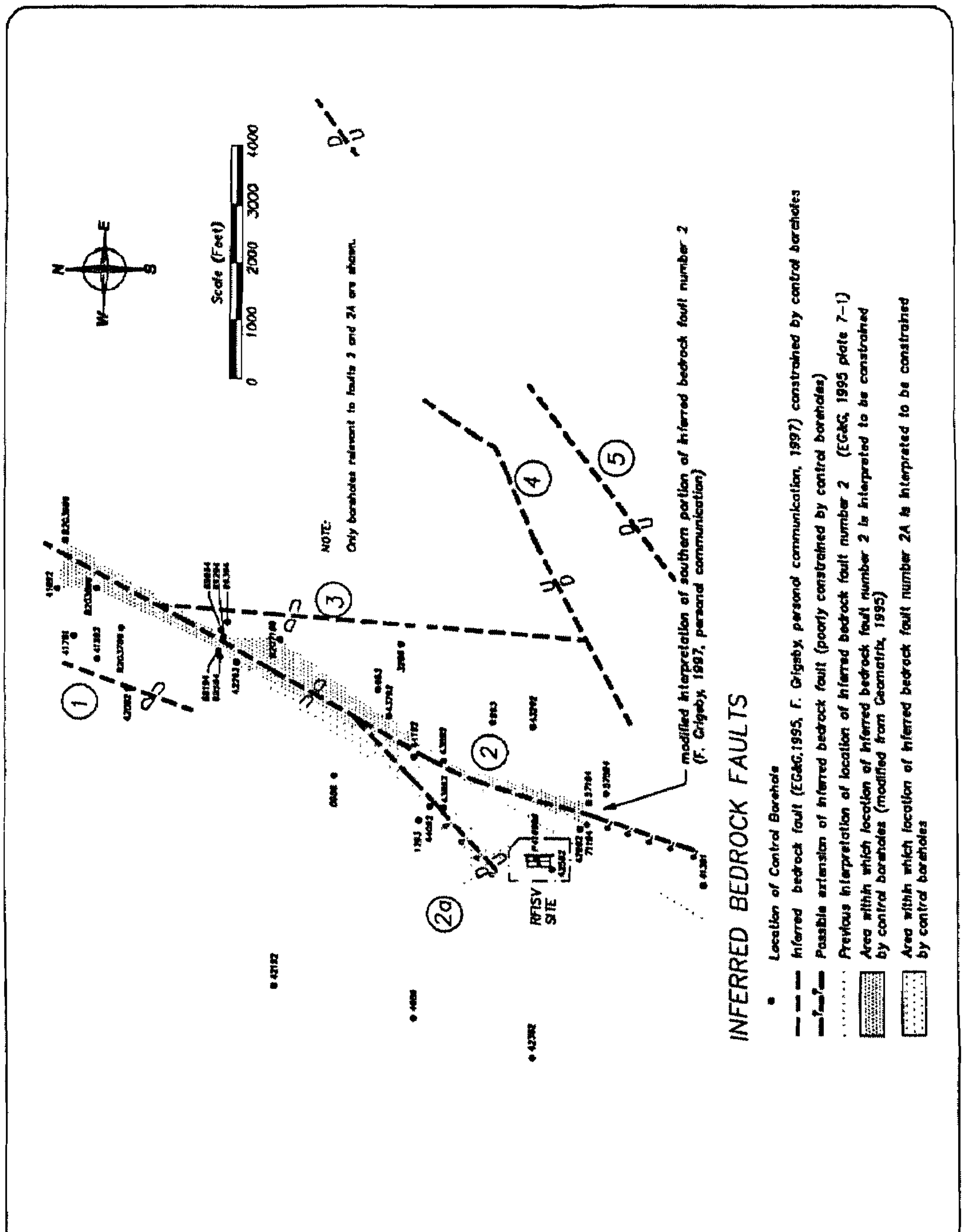
4.2.1 Elevation and Topography of the Contact Between the Surficial Soils and Bedrock

The elevation of the top of bedrock will be a controlling factor in drilled pier foundation design. Since the piers will be socketed into bedrock, the elevation of top of rock is necessary prior to construction. Bedrock elevation is less important in design of a mat foundation, but is a potentially critical parameter in soil column amplification. Topography of the bedrock contact also influences preferential flow direction of groundwater, thus requiring a thorough understanding, so that potential subsurface drainage problems with the ISV can be mitigated through design. To evaluate the top of bedrock elevation, drilling, sampling, and geologic logging will be required.

4.2.2 Uncertainty of Inferred Bedrock Fault Locations

Inferred faults in bedrock have been the subject of drilling and detailed trenching investigations for Building 371. These studies (Geomatrix, 1995a) indicate that inferred faults near Building 371 are not active or capable. Nevertheless, avoidance of inferred bedrock faults was considered prudent in the site selection process.

Interpretations and uncertainty in the locations of inferred fault traces were incorporated into site selection for the ISV. Figure 1.12.2-1 shows the uncertainty in the locations of inferred faults (faults 2 and 2a) that lie closest to the proposed ISV site. Constraints in the location of these faults, in particular fault 2a, provided by limited borehole data are not sufficient to preclude the presence of significant bedrock faults at the site. Drilling and geophysical logging of additional deep boreholes at the proposed ISV site will provide data to better constrain the location of inferred faults. Data on the elevation of the bedrock/Rocky Flats Alluvium unconformity



	Inferred Bedrock Faults	DATE: 4/97
		FIGURE: 1.12.2-1

(contact) from all test holes proposed in this investigation, in addition to data collected in previous site characterization (EG&G, 1995) and fault capability studies (Geomatrix, 1995a), will be used to assess fault activity, if required. Deep boreholes used for inferred fault locations also will be used for shear wave velocity measurements related to ground motion amplification issues discussed below.

4.2.3 Groundwater Occurrence

Construction of the ISV at the selected site will require excavations below groundwater levels. Accordingly some of the drill holes proposed for this investigation will be completed as monitoring wells so that static water levels can be measured and slug-type permeability tests can be performed. Permeability tests will be used to estimate the requirements for dewatering of the excavation either prior to and/or during construction. In addition, construction dewatering for the ISV will induce local changes in gradients that conceivably could cause potential contamination of the site. The potential for dewatering-induced contamination will be addressed during data collection, interpretation, and analysis.

4.3 GEOTECHNICAL ISSUES

Standard drilling procedures for monitoring wells and bore holes at RFETS typically do not include standard geotechnical testing or sampling. Most of the wells drilled for groundwater monitoring purposes were advanced using augers equipped with continuous sampling devices. This type of drilling does not provide information on penetration resistance (blow-count, N value) or generally samples appropriate for geotechnical testing and foundation design. For this reason, it will be necessary to conduct standardized geotechnical drilling and sampling to obtain the data required for foundation design. Geotechnical issues which will be the target of ensuing investigations are discussed below.

4.3.1 Foundation Design

The foundation systems currently considered for the ISV include either drilled piers with structural grade beams and structural floors or a mat foundation. In the drilled pier alternative, piers will be socketed into argillaceous (claystone) bedrock underlying surficial soils beneath the building. Load-carrying capacity of piers constructed in this geologic environment rely principally on skin friction developed along the sides of the piers and, to a lesser degree, end-bearing capacity. Skin friction is also required to evaluate uplift resistance to swelling in the overburden soils and bedrock within the zone of active moisture fluctuation.

Current state-of-the-art pier foundation design relies mainly on the evaluation of the skin friction component of total load carrying capacity. The shear strength of the material surrounding the pier socket is the principal geotechnical parameter used in evaluating skin friction (Turner, Sandberg and Chou, 1993, Kulhawy and Phoon, 1993, and Hassan and O'Neill, 1997).

Alternatively, pier foundations in the Denver metropolitan area have been designed successfully in flat-lying argillaceous bedrock for several decades using rational pier formulas developed by

Chen (1975) and Jubenville and Hepworth (1981). These empirical formulas rely on data from penetration resistance tests to calculate end-bearing capacity; the skin friction is then assumed to be 10 percent of the end-bearing value. Turner, Sandberg and Chou (1993) caution, however, that the factors of safety implied when using the empirical formulas is sometimes less than that considered to be adequate.

It is anticipated that both of the methods of analysis will be performed for the ISV site and the most conservative result chosen for design. For this reason, both blow-count data from penetration resistance tests and undisturbed samples for shear strength testing will be required.

Geotechnical design criteria of primary interest for mat foundation designs are allowable bearing pressures and associated settlements. The currently available data for the ISV site indicates the structure should bottom in sands and gravels of the Rocky Flats Alluvium. It also appears the thickness of the alluvium between the lower level floors except for that of the intake duct slab, and the top of bedrock, should be at least 15 feet. The intake duct slab is expected to bottom near the bedrock surface.

Most geotechnical design parameters and criteria will be based on the characteristics of the alluvium beneath the structure. Expansive characteristics of the bedrock may influence foundation treatment and design of the intake duct slab. Excavation of some of the bedrock beneath that slab and replacement with non-expansive fill may be indicated should the slab bottom in the bedrock. Clay or silt layers in the alluvium may also require excavation and replacement with compacted sands and gravels.

Mat foundation design criteria will be developed, in part, based on soil descriptions and penetration resistance data from the test holes, and the results of laboratory tests.

4.3.2 Liquefaction

Construction of a mat foundation on sands and gravels of the Rocky Flats Alluvium will require analysis of liquefaction potential. Risk Engineering, Inc. (1994) concluded that negligible probability of liquefaction exists at RFETS based on penetration resistance values, material properties, and age of the deposits. This conclusion will be revisited based on analysis of site-specific conditions at the proposed ISV site.

4.4 SEISMOLOGICAL ISSUES

The Seismic Hazard Study for RFETS (REI, 1994) and reconciliation and consolidation of ground motion for the Evaluation Basis Earthquake for Building 371 (Geomatrix, 1995b) are considered applicable to the proposed ISV at the present time without extensive reevaluation. The proposed scope of work, however, requires review and reconciliation of the Seismic Hazard Study (REI, 1994) and subsequent ground motion consolidation studies (Geomatrix, 1995b) with the current state-of-the art in seismic hazard assessment and knowledge of seismic hazards in north-central Colorado at the time geological and geotechnical design studies commence.

Uncertainty exists in shear wave velocity profile at the proposed ISV site and amplification of ground motions from the top of bedrock (100 ft deep; REI, 1994) to various structural levels of the storage vault.

Profiles of shear wave velocity will be required to evaluate ground motion amplification/deamplification potential in soils and bedrock at the site. Four of the drill holes proposed as part of the field investigation will be drilled for shear wave velocity testing. It is anticipated that core drilling to depths of approximately 200 to 500 ft will be required to adequately characterize shear wave velocities. These holes will be cored and geophysically logged to aid in geological evaluation of inferred faults and to provide additional geotechnical information.

5.0 SCOPE OF WORK

The objective of the proposed geological and geotechnical studies is to provide sufficient data, interpretation, analyses and design criteria leading to Title 1 design. The proposed scope of work is divided into four major tasks: (1) Data Collection; (2) Interpretation and Analysis; (3) Reconciliation; and (4) Design Criteria. Each of the major tasks and subtasks are described below.

5.1 TASK 1 - DATA COLLECTION

Subtask 1.1 - Preparations For Site Investigations

The layout and procedures for the proposed site investigation will be presented to RFETS for review. Required pre-investigation site screening (by RFETS) will be requested and disturbance permits will be obtained. A health and safety plan will be prepared for the drilling operations. Readiness reviews for proposed field work will be completed. The building site will be surveyed and locations of proposed drill holes will be staked.

Subtask 1.2 - Specifications

Specifications for subtasks involving acquisition of field data by subcontrcator forces (principally drilling and sampling, shear wave velocity measurements, and laboratory testing) will be prepared outlining methodologies and specific technical requirements. As part of this subtask, technical requirements for data acquisition will be finalized. We anticipate that standard procedures, especially for drilling and sampling developed at Rocky Flats will require substantial modification to meet the requirements for design of the ISV.

Subtask 1.3 - Subcontractor Qualification

A list of qualified subcontractors will be compiled from industry and DOE sources. Potential qualified subcontractors will be required to submit a Statement of Qualifications outlining general experience, specific experience in the specific requested technical service, DOE-related experience, Rocky Flats-related experience, and list of equipment proposed for use on the project. Price and cost proposals will be solicited from three to five firms for each required subcontract service.

Subtask 1.4 - Site Drilling

Test Holes will be drilled at an approximate 100-ft spacing along the building perimeter and within the footprint of the structure. The drilling program will require approximately 15 drill holes advanced to depths of approximately 85 ft. Actual depths will depend on the elevation of the top of bedrock and the purpose of the drill hole. Four test holes will be advanced by rotary coring methods to minimum depths of 200 ft and maximum depths of 600 ft for geophysical logging and shear wave velocity testing. At least two of the core holes will be drilled to depths of 500-600 ft to define shear wave velocity "basement" for use in soil column amplification studies. Four shallow (<85 ft) test holes will be completed as monitoring wells so that static water levels can be monitored and slug-type permeability tests can be performed. The remaining seven shallow test holes can be drilled using standard auger methods and focused on obtaining penetration resistance (blow-count) data for foundation design and samples of soil and bedrock materials for laboratory testing.

Geotechnical data derived from subsurface investigations will be recorded in the field and referenced to borings according to ASTM or other accepted methods. Soils/rock shall be visually classified in the field in accordance with ASTM D2488. Final classification, however, will be based on examination of the samples by a geotechnical engineer and appropriate laboratory index tests. Disturbed and undisturbed samples will be preserved to maintain natural moisture contents. Undisturbed samples will be protected to maintain in situ properties. All laboratory samples will be transported to the laboratory within 12 hours of recovery using approved transportation methods. Sample storage in the laboratory will be in accordance with applicable standards. All holes except the monitoring wells will be plugged and abandoned using standard operating procedures applicable to RFETS. A summary table of the drilling is presented below:

	Number/ Type Of Holes	Soil Drilling	Bedrock Drilling	Total Depth	Purpose
	4deep holes	Auger	Core	200-600 feet	Penetration resistance, geotechnical samples; geophysical logging, shear wave velocity measurements
	4 monitoring wells	Auger	Auger	85 feet	Penetration resistance, geotechnical samples; Installation of piezometers for monitoring and slug testing
	7 geotechnical holes	Auger	Auger	85 feet	Penetration resistance, geotechnical samples
TOTALS:	**15 holes**			**1735-3335 -feet**	

Subtask 1.5 - Geophysical Logging

The four deep core holes will be subjected to geophysical logging immediately after drilling. Geophysical logging will include: gamma-ray, neutron-density, electrical resistance and spontaneous potential (SP). Geophysical logging will be performed in accordance with procedures in SOP GT.15, Geophysical Borehole Logging (EG&G, 1992) and will be supervised by a geologist. All equipment will be calibrated before and after the logging runs. Reruns may be included to confirm depth data. Field prints and tapes or disks containing all portions of the logging runs will be produced at the time of logging.

Subtask 1.6 - Shear Wave Velocity Testing

Cross-hole, down-hole, and uphole shear wave velocity measurements will be obtained in the deep core holes at the corners of the proposed ISV site and selected shallow test holes during drilling or immediately after geophysical logging. Cross-hole shear wave velocity measurements will be obtained in accordance with ASTM D 4428/D 4428M and a recently published paper on large-strain cross-hole testing (Salgado an others, 1997).

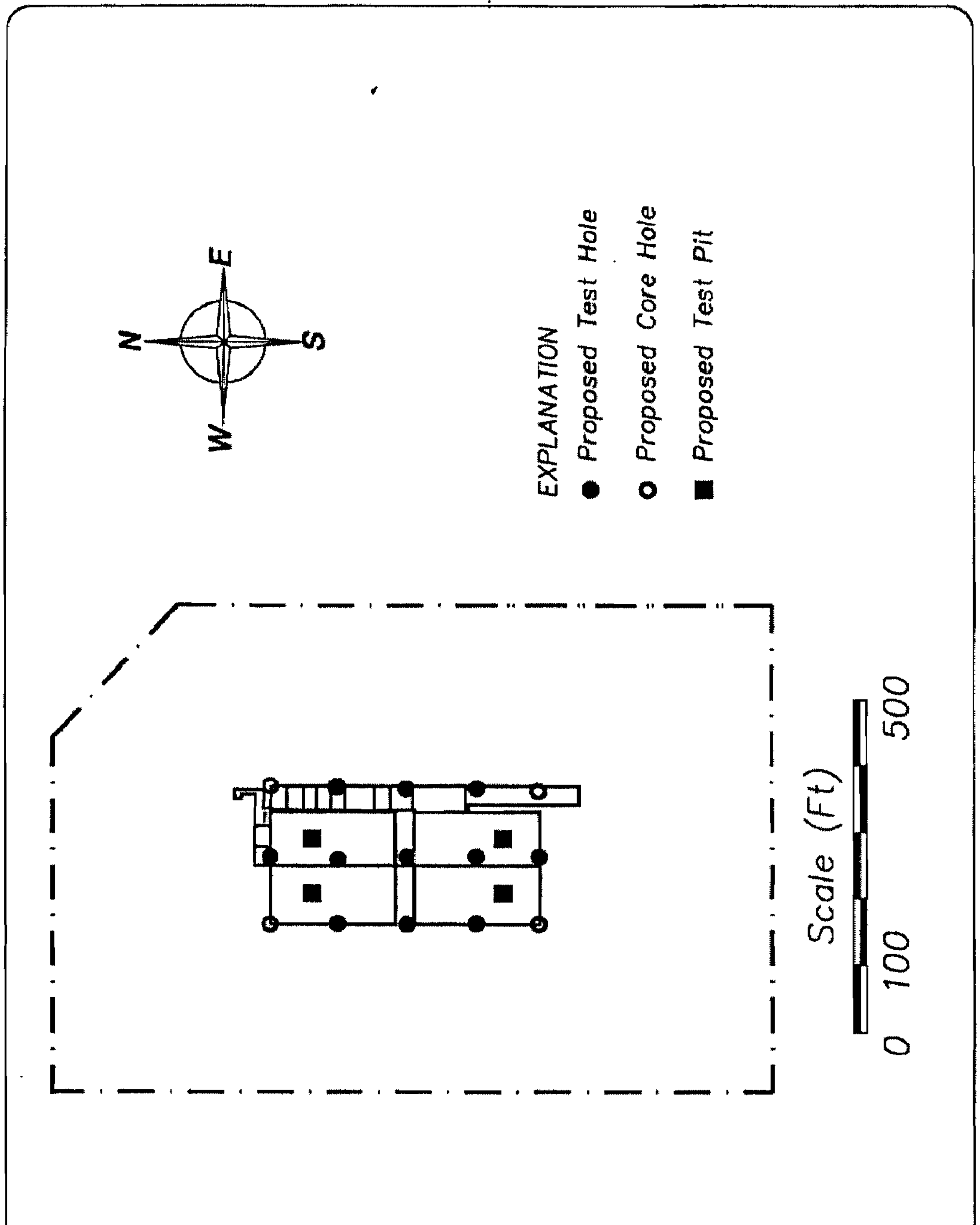
The equipment will be calibrated before and after each run. Shear wave velocities will be measured at approximately 5- to 10- ft intervals from the bottom of the surface casing to the total depth of the hole. Shear waves will be generated using a heavy sledgehammer striking the end of a railroad tie anchored by the front tires of a truck parked on top of it. Shear waves of both polarities will be generated at each test depth in order to distinguish s-wave arrivals from p-wave train. Field prints and tape or disk copies of the data will be produced at the time of testing. Preliminary picks of the first shear wave arrival will be completed before going to the next interval.

Subtask 1.7 - Ground Water Monitoring And Slug Testing

Four of the shallow test holes will be completed as monitoring wells to obtain data on seasonal ground water fluctuations prior to construction. Once the groundwater levels in the wells have stabilized, permeability slug tests will be performed. Slug tests consist of instantaneously raising the water level in the hole and monitoring the response with time. The piezometers and data logger (if used) will be calibrated before and after each test. Forms containing the real-time data and tapes or disks of data logger output will produced at the time of testing.

Subtask 1.8 - Test Pit Excavation

Approximately four test pits will be excavated within the footprint of the proposed structure (Figure 1.12.2-2) to provide additional information on stratigraphy and engineering properties of the Rocky Flats Alluvium and to provide bulk samples for laboratory testing. The test pits will be logged by a geologist at the time of excavation. As an alternative to test pit excavation, a bucket auger or caisson drilling rig may be used to define alluvial stratigraphy and to provide bulk samples.



	Proposed Test Hole and Test Pit Location	DATE: 4/97 FIGURE: 1.12.2-2

Subtask 1.9 - Drill Hole Abandonment

All holes except for the monitoring wells will be abandoned immediately after drilling. Standard operating procedures applicable to RFETS will be followed. It is anticipated that the monitoring wells will be abandoned in the same manner immediately before foundation excavation.

Subtask 1.10 - Laboratory Testing

Conventional and dynamic laboratory testing will be performed on samples obtained from the drill holes and test pits. Tests will be used to confirm classifications of soil and bedrock materials performed at the time of drilling and to produce static and dynamic data suitable for design of the structure. Conventional testing will generally include but not be limited to the following:

- Gradations and Atterberg limits,
- Moisture-density of in-situ samples,
- Shear strength testing (unconfined compression, unconsolidated undrained, consolidated drained),
- Swell/consolidation tests,
- Soil-suction measurements on samples for swelling characteristics,
- Corrosivity (pH, sulfates, chlorides),
- Compaction tests on soils,
- Thermal resistivity, and
- Electrical resistivity.

Dynamic laboratory testing will depend on the ability to obtain representative samples from both the Rocky Flats Alluvium and soil-like bedrock. It is anticipated that it will be difficult to obtain undisturbed, representative samples from the Rocky Flats Alluvium. In general, dynamic testing may include resonant column, cyclic triaxial, and cyclic simple shear, and/or centrifuge testing. The actual scope and types of dynamic tests, however, will depend on the results of shear wave measurements in alluvium and bedrock and the ability to obtain undisturbed, representative samples.

5.2 TASK 2 - INTERPRETATION AND ANALYSIS

The data obtained under Task 1 will be compiled, interpreted, and synthesized into a detailed geological and geotechnical characterization of the proposed ISV site. The interpretation and analyses will include as a minimum:

- Summary of surface and subsurface site conditions.
- Soil classification chart, terminology and symbology used on boring logs.
- ASTM or other standard sampling and testing procedures used in the investigation.
- Dimensioned plot plan showing locations of structures and borings.
- Detailed logs of each boring showing graphical representation of subsurface conditions, soil descriptions, date of start and finish, method of boring, sample depths

and types, blow counts (N-value), hydraulic pressures, loss of drilling fluid, depth to groundwater at time of drilling, variation of groundwater depth/elevation with time, depth of caving, presence of gases, and other information as appropriate.

- Graphical summary logs of test holes presented in sections across the site showing elevations of test holes and soils; soil classifications; depths/thicknesses of soils; sample depths, types, and blow counts; and occurrence of ground water with time.
- Summary of ground water levels, gradients and permeabilities for use in assessing foundation dewatering requirements, resulting gradients, and potential for dewatering-induced contamination.
- Summary of all laboratory tests performed presented in tabular format according to boring and depth.
- Supporting laboratory data.

5.3 TASK 3 - RECONCILIATION

As part of this task, the collected data will be reviewed in the context of previous geological, geotechnical, and ground water investigations at RFETS to reconcile any discrepancies in interpretation and/or to bring previous interpretations into line with current knowledge and/or standards of practice. Special emphasis will be placed on review of the Risk Engineering, Inc. (1994) Seismic Hazard Study for RFETS and the subsequent ground motion consolidation and reconciliation (Geomatrix 1995b). Any discrepancies identified as part of this task will be documented and resolved through appropriate data collection and analyses. Uncertainties will be identified, quantified, and incorporated into analyses and development of design criteria.

5.4 TASK 4 - DESIGN CRITERIA

The final report will summarize methodologies employed, the data collected, interpretations, analyses, and design criteria leading to Title 1 design, specifically including:

1. Characterization/description of ISV site subsurface conditions:

    a. Soils
    b. Bedrock
    c. Groundwater
    d. Corrositivity of soil (concrete type)

2. Drilled Pier Foundations

    a. Depth/elevation of bedrock
    b. Bearing capacity of bedrock (end bearing, side shear, uplift resistance)
    c. Soil and bedrock parameters for lateral resistance designs (cohesion, friction angle, unit weight)
    d. Settlement estimates
    e. Construction considerations

        - Drill rig size

- Casing
- Groundwater
- Minimum pier diameter

3. Mat Foundations

    a. Foundation treatments (subgrade preparation, over-excavation, structural fill requirements)
    b. Allowable bearing pressures
    c. Coefficients of sliding friction between mat and subgrade
    d. Settlement estimates

4. Floors/Walls/Roof

    a. Drainage system recommendations (fill/geocomposite materials, soil permeability, etc.)
    b. Lateral earth pressure coefficients (active, at-rest, passive)
    c. Soil/fill unit weights
    d. Compaction requirements

5. Site Grading

    a. Excavation and fill slope angles (temporary construction and final)
    b. Fill materials and compaction requirements
    c. Groundwater/dewatering during construction
    d. Roads and pavements (either follow RFETS standards or provide CBR/modulus values for designs)

6. Seismic/Dynamic Analyses

    a. Seismic response spectrum
    b. Shear modulus
    c. Poisson's Ratio
    d. Seismic wall pressures, including those for saturated sands and gravels.
    e. Liquefaction potential of soils based on design earthquake

Recommendations concerning additional studies and work to confirm and/or to upgrade the geotechnical design parameters and criteria will be provided.

6.0 REFERENCES

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APPENDIX 1.12.3
Leak Detection Instrumentation and Controls Tradeoff Study

of the
Conceptual Design Report

for the
Interim Storage Vault

for the
Rocky Flats Environmental Technology Site
Golden, Colorado

Task Order 72

for the

U. S. Department of Energy
Rocky Flats Operations Office
Golden, Colorado

Prepared by
Rocky Flats Engineers and Constructors, LLC
Denver, Colorado

May 1997

Authorization No. E32CD100

J.O. NO. 06489.72

INSTRUMENTATION AND CONTROLS TRADE-OFF STUDY REPORT

FOR

INTERIM STORAGE VAULT (ISV)

AT THE

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

GOLDEN, COLORADO

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COLORADO REGISTERED PROFESSIONAL ENGINEER SUSAN E. HOBBIE 29833 Susan E Hobbie 4-27-97

DESIGN BASIS DOCUMENT
REVISION RECORD

ISSUE	DESCRIPTION	ISSUE DATE	TASK MANAGER
A	for Kaiser Hill review	2/18/97	R. Sanchez
1	Final	2/28/97	R. Sanchez
2	Incorp. K-H comments	4/25/97	R. Sanchez

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ATTACHMENTS

1.0 SCOPE

1.1 Purpose of Facility

The mission of the Interim Storage Vault (ISV) is safe and secure interim storage of Plutonium inventory at the Rocky Flats Environmental Technology Site (RFETS). Plutonium inventory at RFETS is approximately 12.9 metric tons.

The ISV program timeline has the ISV ready to begin accepting inventory from Building 371 by the year 2001, and to be fully loaded by 2002. The ISV will store the inventory for at least 15 years, and will have a design life of 50 years.

1.2 Location of Work

The Interim Storage Vault will be located on the RFETS site.

1.3 Description of Project

Plutonium waste from building 371 will pass through three stages of processing before eventual disposal. These stages are packaging, transfer or transportation, and interim storage. Waste material is first packaged in appropriate containers at its current location, transported to the Interim Storage Vault site, then stored in the vault for 15 years before relocation to another facility.

1.3.1 Packaging Phase

The packaging phase includes the following activities: encapsulation of Plutonium material in containers; certification of containers for leak tightness and other criteria; "soak in" or observation period to identify containers with potential pressurization problem; placement of containers into storage tubes; and loading of storage tubes onto vehicles for transport to the Interim Storage Vault.

There are three categories of data which must be collected for each container during packaging: package certification data, soak in data, and Materials Control and Accountability (MC&A) data. Attachment A-1 lists tests to be performed on containers during this phase.

The first category of data, container certification information, must be gathered to verify the leak tightness and cleanliness of the container. This data is collected during sealing of the containers, and includes the following:

- leak test results for material container, in accordance with ANSI N14.5
- leak test results for boundary container, in accordance with ANSI N14.5
- exterior surface contamination test results for material container, in accordance with 10 CFR 835 Appendix D
- exterior surface contamination test results for boundary container, in accordance with 10 CFR 835 Appendix D
- ~~weld radiograph signature~~

The second category of packaging information, soak in data, is required to verify that the container contents are stable. The intent of the soak in period is detection of short term packaging failures. Soak in data includes the following:

- temperature of outer (boundary) container
- internal pressure of inner (material) container

As a minimum, the soak in data must be collected 30 days after the containers are sealed in the packaging facility. If the containers are kept at the packaging facility longer than 30 days prior to transport to the Interim Storage Vault, the containers should be inspected once per month.

The third category of data, MC&A data, is information for record keeping and inventory. This data includes the following as a minimum:

- unique container identification
- content type
- mass of contents
- reference gamma signature taken at the outer container surface and at 30 cm from the container surface
- reference neutron signature taken at the outer container surface and at 30 cm from the container surface
- thermal output
- container weight
- container dimensions
- tamper indicating device identification (for storage tube)

All information in this category will be stored in a database to comply with existing Materials Control and Accountability, safeguards and security, and audit and surveillance directives. The information will be used for inventory, tracking, and reporting during transportation, interim storage, and eventual relocation to another site~~disposal~~.

1.3.2 Transfer Phase

The transfer phase includes the following activities: loading of storage tubes onto vehicles for transport from the packaging facility to the Interim Storage Vault and non-invasive monitoring of containers inside tubes to detect possible problems. Attachment A-2 lists tests to be performed on containers during this phase.

The following tests are required for Materials Control and Accountability, and are to be performed immediately before loading the storage tubes on the vehicle, and immediately after unloading the tubes at their destination.

- inspection of storage tube identification
- inspection of storage tube tamper indicating devices
- check of surface temperature of containers inside storage tube
- non-invasive inspection of storage tube and containers as tubes are placed in vault

1.3.3 Interim Storage Phase

The interim storage phase includes the following activities: placement of tubes in the Interim Storage Vault, and monitoring and inspection of tubes and. Storage period design basis is 15 years. Attachment A-3 lists tests to be performed on containers during this phase.

As a minimum, the following tests and checks are to be performed on the containers at regular intervals during the 15 year storage period.

- measurement of container surface temperature (non-invasive measurement)
- measurement of internal pressure of container (non-invasive measurement)
- measurement of air temperature inside storage tube (non-invasive measurement)
- detection of leaks by sensing helium gas in tube atmosphere (non-invasive measurement)
- inspection of storage tube identification (non-invasive measurement)
- inspection of tamper indicating devices (non-invasive measurement)
- inspection of storage tube and container condition (invasive measurement)
- measurement of vault air temperature

1.4 Study Scope and Format

The instrument suite recommended in this study is based on the requirements in the Kaiser-Hill Request for Proposal/Statement of Work, dated October 25, 1996, and amended November 8, 1996 (see Section 10.1). The scope of the study includes instruments for monitoring the containers and storage tubes, a data collection system for monitoring instruments, systems for Material Control and Accountability (MC&A), and systems for satisfying IAEA verification requirements.

The study scope does not include determination of safety classification for the instrument suite.

The study scope does not include facility security systems, such as video monitoring and surveillance systems; radiation safety systems, such as alpha air monitors and criticality monitors; or other safety systems such as fire protection systems.

Section 2 describes storage tube design to provide background information on how the instruments, containers and tubes will fit together. Section 3 lists and briefly describes most technologies that may be useful for container monitoring. Sections 4, 5 and 6 recommend a suite of instruments for the packaging, transfer and storage phases from the technologies described in Section 3; these sections also discuss why the chosen technologies are the most suitable. Attachment A lists technical, legal and contractual requirements which define the parameters to be measured by the instrument suite. Attachment B contains storage tube and instrumentation conceptual design drawings. Attachment C summarizes the instrumentation recommended to satisfy each requirement. Attachment D provides a Bill of Materials with costs. Attachment E discusses system reliability.

1.5 Assumptions

In addition to plutonium metal and oxides in 3013 containers, AL-R8 containers may be stored in the Interim Storage Vault. It is assumed that the AL-R8 containers will have the same technical requirements and instrumentation suite as 3013 containers.

2.0 STORAGE TUBE CONSTRUCTION

2.1 Storage Tubes for 3013 Containers

Storage tubes constitute tertiary confinement for Plutonium inventory as defined in the Statement of Work (reference 10.1.1). Drawings in Attachment B show the construction of the storage tube for 3013 containers.

Each storage tube for 3013 containers will hold eight 3013 containers. The main body of the tube will be cylindrical, and will be fabricated from pipe. The tube bottom will be a blank plate welded to the cylinder. The top section of the tube will consist of an instrumentation well outside the tertiary confinement boundary. This well will contain electrical connectors, miscellaneous process instruments, and interface electronics for a data acquisition system. The instrument well may have radiation shielding for protection of instruments and personnel.

The lid of each storage tube will have two ports to allow invasive inspection of containers without opening the storage tube lid or removing the storage tube from the vault. Each port will be closed with a screw plug. Each lid will also have connections for air supply and return lines for detection of helium in the tube atmosphere.

Inside the storage tube, the 3013 containers will be supported in a cage with four cooling fins and hinged sections for loading. The cooling fins will extend radially outward at 90° angles from the container to the inside wall of the storage tube. The fin surfaces will be anodized black, which will improve heat transfer and aid cooling. The outermost section of the cooling fins consists of structural angles which provide the support structure for the cage and also serve as a wireway. Sensor cables will be threaded through three fixed fin wireways; the fourth fin will be part of the hinged door section. All cables will be wired to connectors potted into the tube lid.

2.2 Storage Tubes for AL-R8 Containers

Storage tubes constitute tertiary confinement as defined in the Statement of Work (reference 10.1.1) for Plutonium inventory.

General tube construction for AL-R8 containers will be similar to that for 3013 containers, with appropriate modifications to take into account the different dimensions of 3013 and AL-R8 containers. Each tube will hold two AL-R8 containers.

2.3 Storage Tube Design Considerations

The following factors were considered and balanced during storage tube design:

- number of 3013 or AL-R8 containers per storage tube
- storage tube dimensions
- instrument well depth
- number of instruments on each container
- number of instruments inside storage tube
- number of instruments in instrument well

The number of containers per tube was optimized to limit the amount of wiring inside the tube, to limit the amount of heat generated inside a tube, to limit the number of connectors on the top of the tube, and to limit the amount of instrumentation needed inside the tube. The number of containers per tube was balanced against the need to minimize the floor space of the vault. Reducing the number of 3013 containers to six per tube made the facility much larger. Increasing the number of containers per tube made the amount of wiring inside the tube excessive and limited heat transfer because of the space that would be occupied by wiring.

The instrument well depth was minimized to limit the length and weight of the tube and containers while maintaining enough free space to house and keep instrumentation from protruding above the charging deck floor. Minimizing the well depth also makes access to instruments easier.

The 3013 storage tube diameter was determined through criticality studies (see reference 10.1.3) that considered scenarios with the vault area partially and fully flooded.

The number and types of instrumentation located permanently inside the tube were determined by considering their tolerance to high temperatures and radiation, and by balancing available space for mounting instruments and running wires with the need to maximize free air space for convection cooling. ALARA (As Low As Reasonably Achievable personnel radiation exposure) principles were also considered. Since some instruments may need to be serviced occasionally, fewer devices inside the tube means less radiation exposure to service personnel. Redundancy of instrumentation was incorporated where practical.

3.0 AVAILABLE TECHNOLOGIES

This section describes various technologies that may be suitable for monitoring, package certification, and Material Control and Accounting (MC&A) for containers and storage tubes. Sections 4, 5 and 6 recommend the most suitable instrumentation for packaging, transport and storage.

3.1 Temperature Sensors

Per DOE-STD-3013-96 Section 3.4.1.2.b, the steady state temperature of Plutonium metal must not exceed 100°C. Container instrumentation must therefore be able to monitor temperature and alarm on high temperature. Container surface temperature can be measured with the following technologies:

- thermocouples
- resistance temperature detectors (RTD)
- thermistors
- radiation pyrometers
- fiber optic temperature sensors
- surface temperature thermometer decals
- ultrasonic temperature detection
- filled thermal systems

The distribution of material inside the container may not be uniform, so hot spots may develop on the container. To detect any localized overheating, containers should be constructed with multiple temperature sensors attached to the container surface where the contents are most likely to rest. Sensors should have large, pad style sensing areas for better thermal contact.

Storage tube internal air temperature will affect heat transfer from the containers, and may provide some indication of a container leak; thus, the storage tube internal air temperature should be continuously monitored. Storage tube internal air temperature can be measured with temperature sensors mounted at various locations inside the tube.

The ambient air temperature outside the storage tubes will also affect container cooling, and should be continuously monitored. Vault ambient air temperature can be measured with averaging temperature sensors mounted at various locations in the vault.

3.1.1 Thermocouples

A thermocouple is a transducer constructed of two dissimilar metal wires joined at one end. The other end of each wire is connected to a specialized measuring circuit. Thermocouples will cause an electric current to flow in the attached measuring circuit when subjected to changes in temperature. Thermocouples have an extremely wide useful temperature range, depending on the thermocouple type; for example, type K thermocouples (chromel-alumel) are suitable for use in the range -200°C to 1250°C.

3.1.2 Resistance Temperature Detectors (RTDs)

An RTD is an electrical transducer constructed of a material, such as Platinum, that increases and decreases in resistance linearly with a temperature change. Platinum RTDs have a wide temperature range and high accuracy. Typical RTD probes have two, three or four wires that are connected to specialized interface electronics which drive the

RTD and convert the voltage thereby generated into a signal the monitoring system can use. RTDs can be used for temperature ranges of -270°C to +850°C, depending on the RTD type.

3.1.3 Thermistors

A thermistor, which is a variety of RTD, is a semiconductor device with a resistance varying exponentially with temperature. Thermistors are highly sensitive to temperature changes but have smaller useful temperature ranges than thermocouples and Platinum RTDs. Typical thermistor probes have two wires that are connected to specialized interface electronics which drive the thermistor and convert the voltage thereby generated into a signal the monitoring system can use. Thermistors have a maximum useful range of -80°C to +150°C, depending on the thermistor type.

3.1.4 Radiation Pyrometers

Pyrometers are non-contacting sensors that determine an object's temperature by measuring the amount of infrared or optical energy emitted by the object. The temperature is related to the quantity and peak wavelength of electromagnetic radiation emitted by the object; heating the object will cause it to radiate greater quantities of energy at shorter wavelengths. The optical sensor focuses the emitted energy onto a detector, which compares the incoming signal to an internal reference signal and generates an output signal proportional to the difference between the input and reference signals. Pyrometers are available as remote mounted sensors, or as manually operated devices with telescopic sights or lasers for precise targeting.

3.1.5 Fiber Optic Temperature Sensors

There are a number of related technologies which use fiber optic materials for temperature measurement. The sensor typically consists of a single fiber optic cable with a specially treated tip. The amount and wavelength of infrared light emitted by an object is related by Planck's radiation equation to the object's surface temperature. The emitted light is gathered by the cable tip and conducted through the fiber optic cable to a photo detector, which converts the light into an electrical signal. The electrical signal is then digitized and conditioned to provide a standard electrical temperature signal such as 0-10V, 4-20 mA or a thermocouple type millivolt signal.

Fiber optic temperature sensors are non-contacting and can be highly resistant to radiation and electromagnetic interference if materials are chosen properly to construct the sensor. Photo detectors, junctions and optical multiplexers must be used to conduct the signal to the processing instrument.

3.1.6 Surface Temperature Thermometer Decals

Thermometer decals are heat sensitive strips made of materials which change color at a specific temperature. The strips attach to a surface with adhesive, and are available for a range of temperatures. The strips are inspected visually.

3.1.7 Acoustic Time Domain Reflectometers (ATDR)

This method of temperature measurement operates on the principle that the speed of sound through an object varies with the object temperature. An acoustic temperature sensor consists of a special transducer placed in direct contact with the object. The transducer sends an acoustic pulse through the object; the pulse travels through the object and is reflected back from the opposite side. Special electronics are used to measure the time of travel of the pulse, and to generate a standard electrical signal proportional to temperature.

3.1.8 Filled Systems

This method of temperature measurement uses a fluid filled bulb attached by capillary tubing to sensing electronics. The bulb is placed in contact with the object whose temperature is to be measured. The fluid in the bulb and capillary expands with an increase in temperature; the expansion is measured by the sensing electronics and converted to a standard electrical signal proportional to temperature. The maximum practical distance between bulb and sensing electronics is approximately twenty feet because of the properties of standard fill fluids. Filled systems have a wide useful temperature range, depending on the construction materials; for example, United Electric offers a system with copper bulb and capillary tube rated +10°C to +340°C.

3.2 Pressure Sensors

Per DOE-STD-3013-96 Section 4.2.2.b, the material container shall "contain features to allow for a non-destructive indication of a buildup of internal pressure...such as a pressure deflectable lid or bellows which would be observable by radiography." It is not possible to measure pressure directly via conventional means such as a bourdon tube or diaphragm, because incorporating or retrofitting such devices that are commercially available would compromise the integrity of the container walls. However, there are a number of techniques which may provide an indirect indication of a pressure change:

- Radioscopy
- Acoustic Resonance Spectroscopy (ARS)
- Magnetic Field Sensors

3.2.1 Radioscopy

Radioscopy is a non-invasive imaging technology which uses x-rays to examine objects. The object to be inspected is placed between a scanning x-ray source and a linear detector array. The x-rays pass through the object and are selectively absorbed by its internal structure; x-rays which pass through the object hit the detector array, which converts the received pattern of x-rays into an image.

The 3013 boundary container lid deforms a predictable amount with an increase in internal pressure. For example, tests on the lid show that the lid bulges upward by approximately 0.150 inches for an internal pressure of 100 psi; this amount of deformation can be easily detected with radioscopy. If a record of radiograph images is kept for each container lid, periodic inspection and comparison of previous images current images will reveal any internal pressure changes.

3.2.2 Acoustic Resonance Spectroscopy (ARS)

Acoustic Resonance Spectroscopy (ARS) is a non-invasive evaluation technology, developed at Los Alamos National Laboratory, that identifies the contents of sealed containers from their acoustic resonance signature. The ARS transducer obtains a container's resonance spectrum, or "acoustic signature," by vibrating the container over a wide frequency range and measuring the container's response.

Each container will have a unique acoustic "signature" that will change if the container is disturbed in any way, such as by tampering, leakage, or shifting of contents during transport. If a record of acoustic signatures is kept for each container, periodic inspection of a container's signature and comparison of previous signatures with current signatures will reveal any changes to the container or its contents. However, no studies have been performed to date to correlate pressure change to a change in acoustic signature. Extensive research will have to be performed if this technology is chosen as a method of pressure indication.

3.2.3 Magnetic Field Sensors

The 3013 boundary container lid deforms a predictable amount with an increase in internal pressure. For example, tests on the lid show that the lid bulges upward by approximately 0.150 inches for an internal pressure of 100 psi. These circumstances may provide a means of pressure sensing by measuring changes in magnetic flux. If a permanent magnet were attached to the lid of the inner container, a magnetic flux sensor (such as a Hall effect sensor) mounted on the exterior of the outer container would be able to react to the magnetic field of the permanent magnet on the inner container lid. As long as the inner lid remains flat (in other words, no pressure change inside the container), the magnetic flux at the sensor would not change. As the container pressure changed, the lid would deform, moving the permanent magnet and changing the magnetic flux detected by the sensor.

It is important to note that this method of pressure sensing requires a great deal of research and development to determine its feasibility, to select suitable magnets and sensors, and to characterize the change in magnetic flux with pressure changes. Other concerns which must be addressed include (but are not limited to) the magnetic behavior of the stainless steel container; temperature effects, especially temperature cycling, on the permanent magnet and the magnetic flux sensors; the overall sensitivity of the method (can lid deformation be measured to the desired accuracy); radiation hardness of the magnetic flux sensors; long term stability of the magnetic flux sensors, reliability and repeatability of this method; and calibration requirements while operating in the harsh storage tube environment.

3.3 Other Methods of Leak Detection

Leaks in the boundary or material containers may allow fill gases, radiation, or radioactive material to escape into the storage tube. Monitoring for this escaped material provides a method of leak detection. There are several technologies which may allow leak detection in this manner:

- Long Range Alpha Detection (LRAD)
- Gamma Radiation Detection
- Neutron Radiation Detection
- Beta Particle Detection
- Inert Gas Detection
- <u>Weight Sensors</u>

3.3.1 Long Range Alpha Detection (LRAD)

~~Alpha decay is a radioactive process in which a particle with two neutrons and two protons is ejected from the nucleus of a radioactive atom. The particle is identical to the nucleus of a helium atom. Alpha decay occurs only in very heavy elements such as Plutonium, Uranium, Thorium and Radium. The nuclei of these atoms are very "neutron rich" (i.e. have a lot more neutrons in their nucleus than they do protons) which makes emission of the alpha particle possible.~~

~~Because alpha particles contain two protons, they have a positive charge of two. Further, alpha particles are very heavy and very energetic compared to other common types of radiation. These characteristics allow alpha particles to interact readily with materials they encounter, including air, causing many ionizations in a very short distance. Typical alpha particles will travel no more than a few centimeters in air and are stopped by a sheet of paper.~~

Long Range Alpha Detection (LRAD) is a method of alpha radiation detection based on ion transport technology, and was first developed at Los Alamos National Laboratory. An LRAD detector consists of an electrode in an enclosed space containing an alpha emitting material. The electrode collects the ions created in ambient air as the emitted particles lose kinetic energy. The collected charge is proportional to the number of ions created, which is proportional to the amount of alpha emitting material in the space.

If both the inner and outer containers develop a small leak, emitted alpha particles may escape through the leaks into the storage tube. If both containers develop a massive leak, Plutonium may escape into the storage tube. Ionized air from alpha particles from these sources may be detected with an LRAD sensor.

Typical alpha particles will travel no more than a few centimeters in air, and can be stopped by a sheet of paper. Also, d~~D~~epending on airflow patterns, the ionized air particles created by the emitted alpha particles may travel only a few~~several~~ feet before recombining. Therefore, because the tube is approximately twelve feet long, the electrode must be carefully positioned to ensure that leaks from any container will be detected.

3.3.2 Gamma Detectors

Gamma radiation is high energy electromagnetic radiation originating from the nucleus of a radioactive atom. Gamma radiation is emitted in the form of photons, which are discrete bundles of energy having both wave and particle properties. Often a daughter nuclide is left in an excited state after a radioactive parent nucleus undergoes a transformation by alpha decay, beta decay, or electron capture. The daughter nuclide will drop to the ground state by the emission of gamma radiation. Gamma radiation detectors are commercially available; a typical detector consists of a scintillation sensor such as a sodium iodide (NaI) crystal connected to an electronic counter.

In principle~~Theoretically~~, gamma ray sensors could be used for leak detection in the following manner. Gamma ray flux from the container would be monitored using a commercial gamma ray sensor such as a small NaI crystal detector. If a crack developed in the container wall, the detector would sense an increased gamma ray flux outside the container at the crack because of the reducedlack of attenuation at that point.

However, there are a number of factors that would argue against this method of leak detection. First, the average thickness of the can wall may not be sufficiently uniform for the precision required. Secondly, the density distribution of the contents may not be uniform enough to allow measurements to the required precision. Additionally, the suggested method may suffer from geometrical effects near the top and bottom of the containers.

One way to make the technique much more sensitive would be to use a smaller detector. If the detector size is reduced., the detector signal increases correspondingly. In the limit as the detector elements become smaller and smaller, one could imagine a linear array of gamma detectors positioned along the side of the container to produce an easily interpreted two dimensional image showing cracks of the sizes assumed above. However, considerable research would have to be done to develop a unit to be used in the field.

3.3.3 Neutron Detectors

Neutron radiation consists of high energy neutrons emitted by Plutonium and by its daughter products during radioactive decay. Neutrons have much greater penetrating power than gamma rays and will easily pass through steel walls, limiting the usefulness of neutron detectors for container leak detection.

3.3.4 Beta Detectors

Beta decay is the emission of electrons of nuclear rather than orbital origin. These particles are electrons that have been expelled by excited nuclei. Beta particles have a very short lifetime and mean free path; also, they can be blocked by a few thicknesses of paper. For these reasons, Beta detectors are not practical for container leak detection inside the storage tube.

3.3.5 Inert Gas Detection

DOE-STD-3013-96 Section 4.2.1.b requires that both the material and boundary containers shall contain an inert atmosphere, such as helium gas. In addition, Plutonium emits alpha particles during radioactive decay; the alpha particles, which are essentially helium nuclei, pick up electrons combinein air to form helium gas. These circumstances provide a means of detecting leaks by using a dedicated helium gas detector to analyze the storage tube atmosphere. The presence of helium in the storage tube atmosphere will indicate that one or more containers has developed a leak. Self contained helium gas detectors are commercially available in a range of sensitivities, and with a number of different methods of gas analysis.

It is important to note that this method of leak detection will only be able to show that one or more containers has leaked. This method will not tell which of the multiple containers in a storage tube is leaking. Also, since both the inner and outer cans of a 3013 container will be backfilled with inert gas, this method will not show which can (inner or outer) has leaked unless the inner and outer containers are filled with different inert gases.

3.3.6 Weight Sensors

Commercially available weight sensors such as load cells or strain gauges could be used for simple leak detection if the weight of each filled container is recorded after packaging. If material leaks out of a container into the storage tube, the container weight will decrease. Material leakage can be detected by comparing the current weight with the original weight.

However, it is important to note that weight sensing is a crude way of detecting leaks, since a relatively large amount of material must escape a container before the weight sensor shows a noticeable decrease. Also, weight sensors typically require frequent calibration, which is not possible unless the storage tube is opened. Therefore, weight sensing is not recommended as a leak detection method.

3.4 Tamper Indicating Devices (TID)

Per DOE Order 5633.3B Section III, tamper indicating devices (TIDs) must be installed on nuclear material containers. In addition, IAEA guidelinesSafeguards Criteria 1991-1995 require two functionally independent TIDs plus active surveillance to be applied to nuclear material containment areas so that reverification of nuclear material in the storage vault is unnecessary. Active surveillance is defined as continuous monitoring (visual or otherwise) of a containment area, and forms part of the facility security system; as such, surveillance technologies are not in the scope of this study.

There are several available technologies for tamper indication:

- Passive Mechanical Seal
- Plastic Casting
- Bolt Seal
- Active Fiber Optic Seal
- Active Radio Frequency (RF) Seal
- Acoustic Resonance Spectroscopy
- Motion Sensors
- Radiation Sensors
- Weight Sensors

3.4.1 Passive Mechanical Seal

Passive mechanical seals are the simplest type of TID. Passive seals consist of paper, metal or plastic strips, tape, wire, or locks. The seals are attached to a container such that opening the container destroys or visibly damages the seal. The tamper indicating devices are inspected visually. If the seals are missing or damaged, the container has been disturbed. Passive mechanical seals may incorporate unique identification, such as a bar code or electronic serial number; comparison of the current seal with records for the original seal will show if the current seal is the original or a counterfeit.

3.4.2 Plastic Casting

This type of TID consists of a simple plastic casting of a container. An original casting of the container lid is taken when the container is first sealed. This casting is stored for future reference. If tampering is suspected, a new casting of the container is taken and compared to the original casting.

3.4.3 Bolt Seal

Each storage tube is sealed with a flanged lid, which is bolted shut. To provide indication of tampering or lid removal and replacement, one of the sealing bolts is replaced with a special bolt incorporating a verifiable "fingerprint" and an internal "integrity" device which breaks when the bolt is unscrewed. The finger print is a unique bar code, ultrasonic wave reflector, fiber optic pattern, scratch pattern, or engraved identification number. The tamper seal is inspected manually with an instrument capable of reading the fingerprint.

3.4.4 Active Fiber Optic Seal

Active fiber optic seals use a loop of fiber optic cable, one end of which is connected to the container to be protected, and the other end of which is driven by a light source transceiver. The transceiver pulses a light source through one end of the fiber optic loop and looks for the same pulse at the other end of the loop. If the pulse is not detected, the seal has been disturbed. Multiple containers can be protected on a single fiber optic loop.

3.4.5 Radio Frequency (RF) Seal

RF seals use a length of coax cable, one end of which is connected to the container to be protected, and the other end of which is driven by a microwave source. The source sends pulses of varying frequencies through the cable. An analyzer compares the expected and actual response characteristics of the cable. If the actual response is significantly different from the expected characteristics, the seal has been disturbed.

3.4.6 Acoustic Resonance Spectroscopy (ARS)

Use of Acoustic Resonance Spectroscopy to detect removal and replacement of a storage tube lid is a technique currently being developed at Los Alamos National Laboratory. Each tube has a unique response to vibration, or acoustic spectrum, which is recorded when the tube is first sealed. To determine if the tube has been disturbed in any way, a new acoustic spectrum of the suspect container is taken and compared with the original recorded spectrum. If the new spectrum is substantially different than the original spectrum, the tube has been opened and resealed, or the contents have shifted due to transport or leakage.

3.4.7 Motion Sensors

Motion sensors are typically used for building security systems for intruder detection. Simple motion sensors consist of an infrared, ultrasonic or microwave transmitter and receiver pair; objects passing between the pair block reception of the transmitted signal, generating an alarm. More sophisticated motion detectors use wide angle radar, video cameras, and image analysis to sense movement. Motion sensors installed in the charging deck, the vault, or the storage tube instrument well could be used as tamper indicating devices by alerting security forces of an unauthorized presence.

3.4.8 Radiation Sensors

Commercially available gamma or neutron radiation sensors can be used for gross tamper detection without opening the storage tube, because the filled containers and storage tube will have a characteristic radiation field. If material is removed, the radiation field will change. Removal of material can be detected by comparing the radiation field of the suspect tube with its original radiation field.

Radiation sensors are described in detail in Sections 3.3.1 through 3.3.4 above.

3.4.9 Weight Sensors

Commercially available weight sensors such as load cells or strain gauges could be used for simple tamper detection if the weight of the filled containers and storage tube is recorded. If containers are removed from a storage tube, or if material is removed from a container, the total weight of the tube or container will decrease. Removal of material can be easily detected by comparing the current weight with the original weight.

3.5 Inventory Systems

DOE-STD-3013-96 states in various sections that containers shall be inspected for safety reasons, and for Material Control and Accountability. To accomplish this, an inventory system and records database must be implemented for all containers and tubes. There following technologies are commonly used for inventory management:

- Bar Code Identification System
- Magnetic Strip Identification System

3.5.1 Bar Code Identification System

Bar coding is an automatic identification technology which translates human readable symbols such as letters and numerals into a pattern, called a "bar code." The bar code consists of a sequence of dark and light bands of varying widths and spacing. Coding variables include the number of dark bars, the relative positions of dark bars within a code structure, the variable widths of the dark bars, the variable widths of the light bars, and their relative positions. The bar code is read with a scanner that electro-optically converts bars and spaces to electrical signals, and communicates the encoded information to a remote records system. Communication between the scanner and the remote system may be wireless, using radio transmitters and receivers, or may be hardwired, using telephone lines, electrical cables, or fiber optics. Bar code technology is well developed and is commercially available from a number of manufacturers.

3.5.2 Magnetic Strip Identification System

A magnetic strip identification system is an automatic identification technology which translates human readable symbols such as letters and numerals into a pattern of variably aligned magnetic fields in a strip of magnetic material. The strip is read with a scanner that converts the magnetic fields to electrical signals, and communicates the encoded information to a remote records system. Communication between the scanner and the remote system may be wireless, using radio transmitters and receivers, or may be hardwired, using telephone lines, electrical cables, or fiber optics. Magnetic strip technology is widely available and relatively inexpensive; however, the information encoded in the strip may be corrupted by external magnetic fields, radiation, or high temperatures.

3.6 Inspection Systems

DOE-STD-3013-96 states in various sections that containers shall be inspected for safety reasons, and for Material Control and Accountability. These inspections should be performed after packaging, before and after any material is transported, and periodically during the 15 year interim storage period. The following invasive and non-invasive technologies are suitable for inspecting containers:

- Fiber Optic Video
- Radioscopy
- Inert Gas Detection
- Radiation Sensors

3.6.1 Fiber Optic Video

Fiber optic video systems are devices used to visually inspect areas that are difficult or dangerous to access. A basic fiber optic video system consists of a lens, fiber optic cable, light source, and imaging system. The light source, which can be visible, infrared or ultraviolet, illuminates a target which reflects the light. The lens focuses the reflected light into the fiber optic cable, which conducts the light back to the imaging system. The imaging system converts the optical signal from the cable to a viewable picture. There are several different types of fiber optic video systems: borescopes, fiberscopes, and videoimagescopes. Each type has various advantages and disadvantages in different applications.

A borescope typically has a rigid probe, and is a combination of fiber optics and lenses; illumination of the target is supplied through a fiber optic light guide, and the image is relayed back to the imaging system through a miniature lens system in the probe. Borescopes can usually tolerate higher temperatures and harsher environments than fiberscopes and videoimagescopes.

Fiberscopes typically have flexible probes constructed entirely from fiber optic materials. Illumination of the target is supplied by a fiber optic light guide connected to a light source. The image is relayed back to the imaging system through a coherent bundle of optical fibers; each fiber contributes a pixel of light to form the image at the viewing end.

Videoimagescopes are similar to fiberscopes, but with a miniature charge coupled device (CCD) sensor built into the working end of the probe. An objective lens focuses light from the target onto the CCD sensor, which converts the light into an electrical signal. Illumination of the target is supplied by a fiber optic light guide connected to a light source. Videoimagescopes typically have higher resolution than borescopes and fiberscopes because of the characteristics of the CCD sensor.

Fiber optic video systems can be used with video cameras or digitizers to capture the image seen through the lens. Software can be used to magnify, enhance, and analyze the digitized image. Various gripping tools can be put on the probe tip to allow retrieval of small objects or to help maneuver the probe through constricted spaces.

3.6.2 Radioscopy

Radioscopy is a non-invasive imaging technology which uses x-rays to examine the internal structure of objects. This technology is described in Section 3.2.1 above, and is suitable for use in general inspections as well as for detection of specific problems. If problems are suspected with a storage tube or container, the storage tube could be removed from its support structure, exposing the tube shaft without violating the tertiary seal. A portable radioscopy system could be designed to fit around the exposed tube shaft and used to examine the containers inside.

3.6.3 Inert Gas Detection

Inert gas detection ~~This~~ technology is described in Section 3.3.5. This technology could be used for inspection of individual containers inside a storage tube. A helium detector gas intake would be fitted with a long sample hose that would be moved slowly around inside the storage tube. Since leaking containers would have a greater concentration of helium around the leak, the helium detector would show a sudden jump in helium concentration as the probe passes over the leak.

3.6.4 Radiation Sensors

Radiation sensors could be used for inspection of individual containers inside a storage tube, as described in section 3.3.2 above. However, because of the drawbacks discussed in section 3.3.2, radiation sensors are not recommended as an inspection technique.

3.7 Automatic Data Collection System

DOE-STD-3013-96 states in various sections that containers shall be continuously monitored. In order that personnel exposure be kept to a minimum, instrumentation should be automatically monitored to allow remote detection of possible problems. There are several types of systems commercially available for automatic retrieval, analysis and storage of large quantities of data:

- PC based Data Acquisition System
- Programmable Logic Controller (PLC)
- Distributed Control Systems (DCS)
- Supervisory Control and Data Acquisition Systems (SCADA)

All of the above systems basically consist of a central processing computer communicating with sensors and control devices via input and output (I/O) hardware. Historically, PC, PLC, DCS, and SCADA systems differed in the number of processors, the amount and type of I/O that could be addressed, data storage capacity, processor instruction sets, communication hardware, sophistication of operator interfaces, reliability, and other features. However, the different types of systems are becoming more alike because of advances in operating system software, MMI (man-machine interface) software, networks, data storage technologies, and hardware miniaturization.

3.7.1 PC based Data Acquisition System

A personal computer (PC) based data acquisition system (DAQ) consists of a desktop computer with special data acquisition cards designed to fit in the slots on the motherboard. Cards are available for general purpose applications such as digital and analog input and output (I/O), and for specialized applications such as high speed counters, motion controllers, bar code readers, etc. The cards retrieve and transmit data to and from remote sensors and devices such as valves or motors. Sensors are typically wired directly to connectors on the cards in the PC. The PC processor coordinates the data acquisition, performs any necessary calculations on the data, and acts as an operator interface terminal. The data acquisition software runs on commercially available operating systems such as Windows or UNIX.

Recent developments in PC data acquisition systems allow the PC to communicate with remote I/O as well as with I/O cards on the motherboard. PCs can also communicate with PLC systems and DCS systems by using network "gateways."

Because PCs run programs on commercial operating systems that may "crash" or lock up from time to time, PC based data acquisition systems are best suited for applications that are not mission critical. PC systems are also suitable for applications requiring large amounts of data storage or many calculations to be performed on the field data.

3.7.2 Programmable Logic Controller (PLC)

A pure PLC system consists of input and output modules connected to sensors and control devices, and communicating with a specially designed, industrial grade processor. There may be more than one processor, connected to the rest of the system by a local area network or wide area network. Originally, PLCs were a replacement for hardwired relay logic, were programmed with "ladder logic," that looked like relay logic, and performed best with bit operations on digital data.

PLCs can perform the same basic functions as PC based data acquisition systems; however, unlike PC data acquisition systems, the processors, operating system and I/O interface hardware in a pure PLC system are proprietary, and are not designed for desktop applications such as word processors, spreadsheets, and database management. PLC systems also tend to be more reliable than PCs, because PLC operating systems are stored in ROM, their operating systems are simpler, their hardware is designed for industrial environments, and their processors have watchdog timers and other features to restart the system if it locks up.

Recent developments in PLC systems have added user friendly operator interface software, programming in high level languages such as C, interfaces to PC based systems, and support for many industry standard networks such as Ethernet, Devicenet, and Modbus.

3.7.3 Distributed Control Systems (DCS)

A DCS consists of input and output modules that are connected to sensors and control devices, and that communicate to one or more specialized central processor modules. There may be more than one processor, connected to the rest of the system by a local or wide area network. DCS systems are similar in function to PLCs and PC based data acquisition systems, but process the largest amount of data of the three system types, and are best at analog process control. The processors and software in a DCS are proprietary and bound to the hardware. DCS systems operate well with both analog and digital data, and can have sophisticated and user friendly operator interfaces.

3.7.4 Supervisory Control and Data Acquisition Systems (SCADA)

SCADA systems consist of local control computers called Remote Terminal Units (RTU), located over a large geographic area and linked by telephone lines or radios to a master control computer. The RTUs are special purpose computers with analog and digital inputs and outputs and programming for local controls. The central controller polls the various RTUs, uploads field data, and downloads commands. The RTUs interpret commands from the central controller and report process data and alarm conditions back to the central controller. Both the RTUs and the master control computer are frequently PCs running special software; communication between master and field devices uses a variety of transmission media including wireless, satellite, and conventional land based telecommunication protocols.

SCADA commonly involves monitoring a relatively small amount of data over large geographic areas compared with PLC or DCS systems. SCADA systems are most often used in gas production, pipeline control, and electric utility applications, where direct control is local and the central controller only sends setpoints.

4.0 RECOMMENDATIONS FOR PACKAGING I & C SUITE

4.1 Package Certification Data

This category of data is taken during filling and sealing of containers to verify that containers meet all requirements. Instrumentation for collecting most of this data is in the scope of the Plutonium Stabilization and Packaging System (PuSPS) program. If a container fails to meet the minimum requirements for any of these tests, its contents must be transferred to a qualified container, and the faulty container must be destroyed. Package certification information will be measured with commercially available laboratory grade test equipment.

The following is a list of package certification tests and recommended test equipment for 3013 containers.

4.1.1 Leak Test for Inner (Material) Container

Inner containers will be leak tested in accordance with ANSI N14.5. Leak testing will be performed during the packaging effort and is not in the scope of this study.

4.1.2 Leak Test for Outer (Boundary) Container

Outer containers will be leak tested in accordance with ANSI N14.5. Leak testing will be performed during the packaging effort and is not in the scope of this study.

4.1.3 Exterior Surface Contamination Test for Inner (Material) Container

All inner containers will be tested for exterior surface contamination in accordance with 10 CFR 835 Appendix D. Surface contamination testing will be performed during the packaging effort and is not in the scope of this study.

4.1.4 Exterior Surface Contamination Test for Outer (Boundary) Container

All outer containers will be tested for exterior surface contamination in accordance with 10 CFR 835 Appendix D. Surface contamination testing will be performed during the packaging effort and is not in the scope of this study.

4.1.5 Weld Signature

Weld signatures will be taken for all primary and secondary containers by radioscopy. Container weld radioscopy systems will be furnished by the packaging program and is not in the scope of this study.

4.2 Materials Control and Accountability Data

This category of data is required for tracking all material from packaging, through transport, to storage. Initial MC&A data will be recorded during filling and sealing of containers. The data will be stored in an electronic record system for future reference.

All MC&A data can be collected with commercially available laboratory grade equipment. Except for container identification systems and tamper indication devices, specific equipment recommendations for gathering this data are not within the scope of this study. A list of vendors for identification systems and tamper indication devices is provided in Section 10.

4.2.1 Content Type

Information about the form (such as metal or oxide) of Plutonium in each container will be encoded in the container bar code identification.

4.2.2 Mass of Contents

Content mass in each container will be measured by a scale. Weighing equipment will be furnished by the packaging program and is not in the scope of this study.

4.2.3 Reference Gamma Signature

Gamma radiation measurements will be taken at the boundary container surface and at 30 cm. (12 inches) from the container surface. Instrumentation for this measurement will be furnished by the packaging program and is not in the scope of this study.

4.2.4 Reference Neutron Signature

Neutron radiation measurements will be taken at the boundary container surface and at 30 cm. (12 inches) from the container surface. Instrumentation for this measurement will be furnished by the packaging program and is not in the scope of this study.

4.2.5 Thermal Output, in Watts

Thermal output of radioactive material to be stored in containers will be measured with calorimeters. Equipment to measure thermal output will be furnished by the packaging program and is not in the scope of this study.

4.2.6 Container Weight

Container weight will be measured by a scale. Weighing equipment will be furnished by the packaging program and is not in the scope of this study.

4.2.7 Container Dimensions

Container dimensions will be measured during packaging. The measuring equipment will be furnished by the packaging program and is not in the scope of this study.

4.2.8 Container Identification

Containers will be individually identified with bar codes. Within a container, the outer, inner, and convenience cans will each have their own bar codes. Bar code printers, scanners, and related equipment for packaging containers will be furnished by the packaging program, and are not in the scope of this study.

4.2.9 Storage Tube Identification

Storage tubes will be individually identified with bar codes. The bar code system will be identical to the system used by the packaging program for 3013 container bar codes.

~~4.2.10 Container Tamper Indicating Devices~~

~~Tamper detection for 3013 containers will be done by comparing weld radiographs. Baseline weld radiographs will be taken during packaging. If container tampering is suspected, a new weld radiograph will be taken and compared to the container's baseline radiograph. Equipment for taking weld radiographs for container tamper indication will be furnished by the packaging program and is not in the scope of this study.~~

4.2.10~~11~~ Storage Tube Tamper Indicating Devices

In order to eliminate the requirement for IAEA material audits on the storage tubes, there will be at least two tamper indicating devices (TIDs) sealing each material diversion path, where a diversion path is defined as any opening or entrance through which material can be removed. TIDs on each diversion path must be functionally independent and must not have a common failure or tamper mode.

For the current tube design, there are four~~five~~ diversion paths associated with the storage tube; these paths are openings to the inside of the storage tube. Each storage tube has the following four~~five~~ entrances that could be used to remove material:

- the main lid, which is flanged and bolted shut
- a 4 inch threadolet port, closed with a screw plug
- an air supply connection for a helium detector
- a 2 inch threadolet port, closed with a screw plug
- ~~an air return connection for a helium detector~~

For the main lid, one of the TIDs will be an ultrasonic sealing bolt, described in Section 3.4.3 above; the TID bolt will replace one of the normal bolts holding the flanged lid. The TID bolt incorporates an ultrasonically verifiable "fingerprint" and an internal "integrity" device which breaks when the bolt is unscrewed. In order to open the tube, the TID bolt must be unscrewed, breaking the integrity device. The bolt is installed and removed with special tools and inspected manually with an ultrasonic scanner. This type of TID is currently in use at nuclear storage facilities under IAEA surveillance in Europe.

The other TID on the main lid will be a tape seal, such as the 3M CONFIRM© tape seal. The tape will completely cover the junction between the flanged lid and the mating flange underneath. The tape will incorporate a bar code which can be manually read using commercially available, hand held bar code scanners.

For the threadolet ports, one of the TIDs will be a tape seal similar to the one described above for the main lid. The tape will completely cover the junction between the screw plug and the port rim. The tape will incorporate a bar code which can be scanned to determine if the original seal has been replaced.

The other TID on the threadolet ports will be a cable barrier seal, such as the E.J. Brooks Multi-Lok©; this type of seal consists of a high strength braided steel cable secured with a special clamp that collapses upon a tampering attempt. Each port will be closed by a screw cap with a ring or loop. A corresponding ring or loop will be located on the surface of the main lid near the port. The cable seal will be threaded through the two loops and secured so that unscrewing the cap will break the cable. The clamp will incorporate a bar code which can be scanned to determine if the original seal has been replaced.

The seals on the air supply ~~and return~~ ports for the helium detector will be tape seals and cable barrier seals similar to the ones described for the threadolet ports.

4.3 Container Soak In Data

After containers are sealed, they will be stored in the packaging facility for a short "soak in" period and observed for signs of leakage, overtemperature, or overpressurization. These signs are most likely to become evident in the first few months after packaging. Soak in data must be collected 30 days after the containers are sealed in the packaging facility. If the containers are kept at the packaging facility longer than 30 days prior to transport to the Interim Storage Vault, the containers should be inspected once per month.

No facilities are planned for automatic inspection or monitoring of containers for the soak in period, because of space requirements, and because this period is relatively brief. All containers will be inspected visually or with portable instruments. Therefore, inexpensive sensors that can be operated manually or visually examined are the recommended choice for monitoring instrumentation during the soak in period.

4.3.1 Container Temperature

The surface temperature of the container will be manually measured with radiation pyrometers. Container temperature will be manually inspected for the soak in period.

Pyrometers should be in the 8-14 micron wavelength range, which will monitor object temperatures from approximately 0 to 540 °C. The pyrometer should be selected to match the emissivity of the container surface.

4.3.2 Internal Pressure of Container

The internal pressure of containers will be determined using radioscopy as described in Section 3.2.1. Radioscopy inspections will be performed on a regular schedule during the soak in period.

The radioscopy system used during the soak in period will be similar to the one used by the packaging system to measure inner container lid deformation.~~will be a relatively simple system, consisting of an isotopic fan source with shielding, a shutter, a linear array detector, and a digital imaging system. The source, shutter and detector will be designed as a collar shaped device with two halves hinged together. The bulkiest part of the system will be the shielding~~

~~The radioscopy system should be designed to capture images as fast as the tube can be pulled through the system. The handling mechanism used to pull the tube should be designed to operate at a constant rate. The handling mechanism should also have an encoder to monitor pull speed. The encoder should be wired back to the radioscopy system to correct for variations in the speed of the handling mechanism.~~

4.4 Discussion

4.4.1 Design Considerations

The following factors were considered and balanced during selection of instrumentation for the packaging phase:

- overlap of instrument requirements for packaging process and Interim Storage Vault
- need for continuous monitoring of variables during packaging and soak in
- duration of soak in period
- available space for storage of containers in packaging facility
- ALARA considerations during manual inspection of containers

4.4.2 Storage Tube Identification

The technologies studied for inventory systems, listed in Section 3.5, are bar coding and magnetic strip tagging. Of these technologies, bar coding using the same system as used in the Plutonium Stabilization and Packaging System program is the recommended choice for identification of storage tubes, for the following reasons.

First of all, using the same system will minimize spare parts inventory, simplify personnel training in how to use the system, and minimize the types of devices needed to read, transmit, and store identification. Secondly, bar coding is preferable to magnetic identification systems, because magnetic strips are less resistant to radiation and temperature extremes, and will deteriorate and possibly become unreadable during the long term storage period.

4.4.3 Storage Tube Tamper Indicating Devices

IAEA requires at least two independent TIDs on each storage tube opening in order to eliminate the requirement for annual material inspections. The TIDs must be easy to verify, easy to install, and difficult to forge. The TIDs may be passive, meaning they must be manually inspected, or active, meaning their status is continuously monitored.

Technologies studied for tamper indicating devices, listed in Section 3.4, are passive mechanical seals, bolts, plastic casting, active fiber optic cable seals, radio frequency (RF) cable seals, motion sensors, radiation sensors, and weight sensors. Of these technologies, ultrasonic sealing bolts, tape seals, and cable seals are the recommended choice for tamper indication in the Interim Storage Vault, for the following reasons:

- The bolt and tape seal TID pair for the main lid are functionally different and do not have a common failure path; in other words, the bolt will indicate an entry even if the tape seal fails, and vice versa. The same applies to the tape seal and cable seal pair for the threadolet ports.

- Ultrasonic bolt seals have been used with IAEA approval at several nuclear storage facilities in Europe. They are commercially available, relatively inexpensive, easy to install and verify, and immune to radiation. Tape and cable seals are also widely used not only at nuclear facilities but also in general industrial applications.

- Active TIDs such as RF or fiber optic cable devices, motion sensors, and weight sensors are less desirable than passive devices because they have local electronics requiring power, wiring, and space. Space in the instrument well is limited. To protect all three openings on each storage tube, at least three active TIDs with accompanying electronics and wiring would be required for each tube; the instrument well is too small to accommodate three active TIDs as well as PLC interface electronics, helium detectors, connectors, and ports.

- Use of Acoustic Resonance SpectroscopyARS to detect removal and replacement of a lid or cap is not currently practical because research is required to determine the effects of tampering on frequency response. Also, the acoustic signature will change as the tube contents shift during transport, making it difficult to distinguish between changes due to tampering and changes due to transport.

- Radiation sensors are less desirable as TIDs than passive or active seals because the storage tube would have to be pulled out of its hole to obtain a reading of the radiation field. The otherpassive and active seals described above can be checked without moving the storage tube.

4.4.4 Container Temperature

The technologies studied for temperature measurement, listed in Section 3.1, are thermocouple probes, RTD probes, thermistor probes, radiation pyrometers, thermometer decals, acoustic time domain reflectometers, and filled systems. Of these technologies, radiation pyrometers are the recommended choice for temperature monitoring during the soak in period, because of their commercial availability, ease of use, and manual operation. Also, pyrometers can be operated at a distance from the container, which will minimize personnel radiation exposure in accordance with ALARA policies. The other types of temperature sensors must be connected to some type of data acquisition system to obtain temperature readouts; these types of sensors can not be used because no facilities are currently planned for monitoring electronics for the short term storage area in the packaging facility.

4.4.5 Internal Pressure of Container

The technologies studied for pressure measurement, listed in Section 3.2, are radioscopy, acoustic resonance spectroscopy (ARS), and magnetic field sensing. Of these three technologies, radioscopy is the recommended choice for non-invasive internal pressure monitoring during the soak in period.

The 3013 container lid is a ready made pressure indicator. Tests have shown that the inner container lid deforms a predictable amount with an increase in internal pressure. For example, the lid bulges upward by approximately 0.150 inches at an internal pressure of 100 psi; this amount of deformation can be easily detected with radioscopy. A radiograph image of the lid should be made immediately after the container is sealed.

Radiograph images should be made at each subsequent inspection. Comparison of the first image with later radiographs will reveal any internal pressure changes during the soak in period.

Use of ARS to directly monitor changes in container internal pressure is not practical because ARS does not produce an image of the object being analyzed; instead, the method generates a vibration~~vibrational~~ frequency response spectrum which has an uncertain relationship to internal pressure change. Research would be required to determine the precise relationship between frequency response and pressure change. Also, moving the containers may shift the contents, which will change the acoustic "signature" and make useless any baseline data taken for comparison purposes.

Magnetic field sensing as a technique for pressure measurement is not practical for this application. Several reasons for this conclusion are discussed in Section 3.2.3.

5.0 RECOMMENDATIONS FOR TRANSFER I & C SUITE

5.1 Storage Tube Identification

Storage tubes will be identified with bar codes as discussed in Section 4.2.9. The storage tube bar code system will be identical to the system used by the Plutonium Stabilization and Packaging System program for 3013 container bar codes.

5.2 Storage Tube Tamper Indicating Device

In order to eliminate the requirement for IAEA material audits on the storage tubes, there will be at least two tamper indicating devices (TIDs) sealing each material diversion path, where a diversion path is defined as any opening or entrance through which material can be removed. The recommendations for TID quantity, location and type are in Section 4.2.10~~11~~.

5.3 Container Temperature

The surface temperature of 3013 and AL-R8 containers will be measured with 100 ohm platinum two wire RTDs. Each RTD will be encapsulated in a kapton or polyimide strip, and attached to the container surface with high temperature, radiation resistant epoxy or room temperature vulcanizing silicone adhesive (RTV). Each container will have four RTDs placed as shown on the diagram in Attachment B. Two of the RTDs will be wired to a portable datalogger system for the duration of the transport phase.

RTDs should be two wire, 100 ohm Platinum type, Class 1E nuclear qualified. Electrical connections between RTDs and monitoring electronics should be made with 90°C, Class 1E nuclear qualified shielded instrument cable. RTD probes should be the cement on type with the sensor tip embedded in a pad, washer or other attachable assembly. Probe, wiring and adhesive should use radiation resistant materials.

5.4 Internal Pressure of Container

The internal pressure of containers will be determined using radioscopy as described in Sections 3.2.1~~and 4.3.2~~.

The radioscopy system will be a relatively simple system, consisting of an isotopic fan source with shielding, a shutter, a linear array detector, and a digital imaging system. The source, shutter and detector will be designed as a collar shaped device with two halves hinged together. The bulkiest part of the system will be the shielding, which must be designed for personnel protection as well as for prevention of interference with the Criticality Alarm System.

The radioscopy system should be able to detect a 0.15 in. deflection of the inner can lid. The system should be designed to capture images as fast as the tube can be passed through the system. The handling mechanism used to drop the tube should be designed to operate at a constant rate. The handling mechanism should also have an encoder to monitor pull speed. The encoder should be wired back to the radioscopy system to correct for variations in the speed of the handling mechanism

Radioscopy inspections will be performed ~~as containers are loaded into storage tubes at packaging facility, and~~ as storage tubes are loaded in holes in the ISV. The radioscopy system in the ISV will be located on the charging deck, and will be positioned above and around the storage tube floor entry hole. Containers will be inspected, without opening the storage tube, as the tube is lowered into its hole through the radioscopy system. The radioscopy system will use an isotopic source for better portability.

5.5 Discussion

5.5.1 Design Considerations

The following factors were considered and balanced during selection of instrumentation for the transport phase:

- duration of transport period
- need for portable data acquisition equipment
- available space for instruments inside storage tube
- available space for instruments and data acquisition equipment during travel
- available power source for instruments on transport vehicles
- ALARA considerations

5.5.2 Storage Tube Identification

The technologies studied for inventory systems, listed in Section 3.5, are bar coding and magnetic strip tagging. Of these technologies, bar coding using the same system as used in the Plutonium Stabilization and Packaging System program is the recommended choice for identification of storage tubes, as discussed in Section 4.4.2.

5.5.3 Storage Tube Tamper Indicating Device

IAEA requires at least two independent TIDs on each storage tube opening in order to eliminate the requirement for annual material inspections. The TIDs must be easy to verify, easy to install, and difficult to forge. The TIDs may be passive, meaning they must be manually inspected, or active, meaning their status is continuously monitored.

Technologies studied for tamper indicating devices, listed in Section 3.4, are passive mechanical seals, bolts, plastic casting, active fiber optic cable seals, radio frequency (RF) cable seals, motion sensors, radiation sensors, and weight sensors. Of these technologies, ultrasonic sealing bolts, tape seals, and cable seals are the recommended choice for tamper indication in the Interim Storage Vault, as discussed in Section 4.4.3.

5.5.4 Container Temperature

The technologies studied for temperature measurement, listed in Section 3.1, are thermocouple probes, RTD probes, thermistor probes, radiation pyrometers, thermometer decals, acoustic time domain reflectometers, and filled systems. Of these technologies, RTD sensors in a cement on pad probe style are the recommended choice for non-invasive temperature monitoring during transport, because of their wide commercial availability, small size, ease of installation, large usable temperature range, and ease of connection to remote monitoring systems.

Although thermistors share most of the advantages of RTDs, they are unsuitable for this application because their upper temperature limit of 150°C is too low; heat transfer calculations predict that temperatures may rise above 200°C in the case of Plutonium oxides.

Thermocouple probes have most of the same features as RTDs; however, thermocouples must be wired and connected with materials compatible with the specific thermocouple type. For example, type J thermocouples are made of a chromel/alumel junction; the chromel lead must be connected to interface electronics through chromel wires and connector pins, and the alumel lead must be connected through alumel wires and pins. In contrast, RTDs and thermistors may be connected with ordinary wire and connectors.

Radiation pyrometers are unsuitable for non-invasive container temperature measurement inside the storage tube for several reasons. First, commercially available pyrometer sensors are vibration sensitive and might break during transportation. Also, pyrometers must be precisely aimed at hot spots, and are constructed of materials that can not tolerate high temperatures or radiation. In addition, even the smallest pyrometer sensors are bulky, being several inches long and at least two inches in diameter; large sensors mounted between storage tube and container would block air flow and inhibit cooling. Finally, the high ambient air temperature inside the tube would interfere with the container surface temperature reading.

Thermometer decals are unsuitable for non-invasive temperature measurement inside the storage tube because the decals must be read visually. Video cameras are vibration sensitive and delicate, and might break during transportation; video cameras must also be focused on the decal, and are too bulky to mount permanently inside the storage tube. Fiber-optic borescopes could be used to read the decals, but a borescope would violate the tertiary seal.

Use of acoustic time domain reflectometry (ATDR) inside the storage tube for temperature monitoring during transport is not practical for the following reasons. First, the container contents are variable in size and shape, and have several material boundaries due to the can-in-can construction; therefore, each container would have a different thermal response. Before ATDR could be used as a method of temperature measurement in this application, research would be required to determine the precise relationship between acoustic response and temperature. Also, transducers for this technology are bulky, and would block air flow and inhibit cooling.

Fiber optic sensors are less suitable than RTDs for non-invasive temperature measurement during transport, because fiber optic junctions are more difficult to connect and disconnect than ordinary instrument cable. Also, some types of fiber optic cable is sensitive to radiation.

Filled systems are unsuitable for non-invasive temperature measurement during transport for the following reasons. First, the capillary tubing for each sensor is much thicker than electronic cable; having multiple sensors per container would require many large feed throughs in the flanged tube lid, and would reduce free air circulation space inside the tube. Similarly, sensing bulbs are bulky and difficult to attach to surfaces, and would reduce free air circulation space and inhibit cooling. In addition, the transducer which generates the electrical signal is bulky and would use too much space in the instrument well.

5.5.5 Internal Pressure of Container

The technologies studied for pressure measurement, listed in Section 3.2, are radioscopy, acoustic resonance spectroscopy (ARS), and magnetic field sensing. Of these three technologies, radioscopy is the recommended choice for non-invasive internal pressure monitoring, as discussed in Section 4.4.5.

Radiograph images should be made as containers are loaded into the storage tubes, ~~when the storage tubes are loaded onto a vehicle for transport,~~ and when the tubes arrive at the Interim Storage Vault. Comparison of the images will reveal any internal pressure changes.

6.0 RECOMMENDATIONS FOR STORAGE I & C SUITE

6.1 Continuous Monitoring

6.1.1 Container Temperature

Container sSurface temperature, as well as rate of temperature change, of the containers will be continuously measured with 100 ohm platinum two wire RTDs. Each RTD will be encapsulated in a kapton or polyimide strip, and attached to the container surface with a high temperature, radiation resistant epoxy or RTV compound. Each container will have four RTDs placed as shown on the diagram in Attachment B. The RTDs will be wired to electrical connectors potted into the flanged lid of the storage tube. Two of the RTDs will be wired from the lid connector to PLC analog input modules mounted in the tube instrument well; the fourth RTD will be a spare for future use.

6.1.2 Air Temperature Inside Storage Tube

Air temperature inside the storage tube will be continuously measured with 100 ohm platinum two wire RTDs. Each RTD will be encapsulated in a kapton or polyimide strip, and attached to the container surface with a high temperature, radiation resistant epoxy. Each tube will have three RTDs placed as shown on the diagram in Attachments B and C. The RTDs will be wired to electrical connectors potted into the flanged lid of the storage tube.

6.1.3 Ambient Air Temperature in Vault

Ambient air temperature in the vault below the charging deck will be continuously measured with averaging temperature sensors such as thermopiles, which are thermocouples wired together in series, or averaging RTD probes. The averaging temperature sensors will be wired to remote PLC I/O electronics located outside the vault.

6.1.4 Inert Gas Detection

The atmosphere inside the storage tube will be continuously analyzed with an ion pump type helium gas detector to detect container leaks. The helium gas detector will be located in the tube instrument well outside the storage tube, and will be connected to an air sample port with a manual valve. The detector will continuously sample and analyze air from the storage tube. The air will be pumped by the detector through flexible tubing from air sample ports in the storage tube lid, then through the detector for analysis, then back to the storage tube. The detector will generate an analog output signal proportional to the helium content of the tube atmosphere; this signal will be wired to a PLC analog input module mounted in the tube instrument well.

The helium detector should be able to detect helium concentrations of 1-2 ppm or higher, for timely detection of helium leaking from a single container. The required sensitivity is based on the relative air volumes of the storage tube and containers.

6.1.5 Automatic Data Collection System

The recommended data collection system for this application is a combination of PLC and PC systems. The PLC portion of the system will perform data acquisition, trending and alarm generation, and will forward the data to a PC based operator workstation for storage and further analysis.

Container surface temperature and tube air temperature will be measured with RTDs; the RTDs will be wired to remote input electronics that will be located in each tube instrument well. Ambient air temperature in the vault will be measured with averaging temperature sensors such as thermopiles (which are constructed of multiple thermocouples wired in series) or averaging RTD probes. Averaging temperature sensors will be wired to remote input electronics that will be located outside the vault. Inert gas inside the storage tube will be analyzed by a helium detector wired to remote input electronics in the tube instrument well. All data will be continuously gathered and processed by a programmable logic controller (PLC) system.

All RTDs inside the tube will be wired to electrical connectors potted into the flange sealing the storage tube. The connectors will be wired to analog input modules located inside a small enclosure in the instrument well of each tube. The averaging temperature sensors inside the vault will be wired to analog input modules located outside the vault charging deck.

All analog input modules will be connected over a remote communication link to PLC processors located outside the vault charging deck; the processors scan all link nodes, analyze the data, and check for alarm conditions. The PLC processors will be networked to each other, as well as to operator workstations and a remote Central Alarm Station (CAS). Operator workstations will be PCs with user friendly graphics to display data for individual tubes and containers; the workstations can also be used for PLC programming and data storage. The Central Alarm Station will be a PC programmed to alarm if the PLCs detect a problem with a tube or container.

6.2 Intermittent Non-Invasive Monitoring

Information in this category is intended to be checked as part of a regular inspection, or when continuous monitoring equipment indicates a problem with a container or storage tube. The tube can then be examined using the techniques in this section, the tube can be opened and inspected with invasive monitoring equipment, or the entire tube can be removed from the vault and taken to a repackaging facility.

6.2.1 Storage Tube Identification

Storage tubes will be identified with bar codes as discussed in Section 4.2.9. The storage tube bar code system will be identical to the system used by the Plutonium Stabilization and Packaging System program for 3013 container bar codes.

6.2.2 Storage Tube Tamper Indicating Devices

IAEA requires at least two independent TIDs on each storage tube opening in order to eliminate the requirement for annual material inspections. The TIDs must be easy to verify, easy to install, and difficult to forge. The TIDs may be passive, meaning they must be manually inspected, or active, meaning their status is continuously monitored.

Technologies studied for tamper indicating devices, listed in Section 3.4, are passive mechanical seals, bolts, plastic casting, active fiber optic cable seals, radio frequency (RF) cable seals, motion sensors, radiation sensors, and weight sensors. Of these technologies, ultrasonic sealing bolts, tape seals, and cable seals are the recommended choice for tamper indication in the Interim Storage Vault, as discussed in Section 4.4.3.

6.2.3 Internal Pressure of Containers

The internal pressure of containers will be determined using radioscopy as described in Sections 3.2.1 and 4.3.2. A portable radioscopyie system will be positioned on the charging deck above and around the storage tube floor entry hole. Containers will be inspected, without opening the storage tube, by lifting the sealed storage tube out of its support through the radioscopy system. The radioscopy system will use an isotopic source for better portability. Radioscopy inspections will be performed on a regular schedule.

6.2.4 Internal Pressure of Storage Tube

For safety reasons, a tube internal pressure measurement will be taken manually before opening the tube, to verify that no dangerous overpressure situation exists inside the tube.

Storage tube internal air pressure will be measured by a pressure gauge with a bourdon tube or bellows sensor. Each storage tube lid will have air supply and return ports for a helium detector; these ports will have isolation valves. To measure storage tube air pressure, one of the isolation valves will be closed, the tubing to the helium detector will be disconnected, and a portable pressure gauge valve will be connected to the valve. The valve will then be opened to read the storage tube internal air pressure.

6.3 Intermittent Invasive Monitoring

Information in this category is intended to be checked when scheduled inspections continuous monitoring equipment indicates a problem with a container or storage tube. The tube can then be examined using the techniques in the previous section, the tube can be opened and inspected with invasive monitoring equipment, or the entire tube can be removed from the vault and taken to a repackaging facility.

6.3.1 Visual Inspection of Container

A fiber optic video system will be used to manually inspect containers and storage tube internal features. The system will have the following features as a minimum:

- flexible probe long enough to reach the bottom of the storage tube
- overall probe diameter small enough to fit through a two inch port
- smooth coating on probe, allowing easy decontamination
- probe must be able to tolerate high temperatures inside storage tube
- 100° field of view
- real time imaging
- monitor and TV camera as part of the imaging system
- capability to store images in standard formats
- high intensity light source

- retrieval tool accessory to convert scope to working channel type

The fiber optic video system will be used to check container bar codes for MC&A audits; to visually inspect the condition of the containers, support cage, and sensors; and to find broken wires, supports, tubing or other components.

6.3.2 Inert Gas Detection

If a container leak is suspected, a sensitive helium detector with a long flexible air intake hose could be used to pinpoint the location of the leak, because the concentration of helium gas in the storage tube atmosphere would be highest near the leak. The helium detector described in Section 6.1.4 could be used for this test. The inspection could be performed without opening the storage tube or removing the storage tube from the vault.

To locate a leak, the helium detector intake tube should be disconnected from the storage tube and replaced with a long flexible tube. The long tube should be fed through one of the access ports on the storage tube lid; a fiber optic video scope should be fed through the other access port to observe the position of the air intake tube. The air intake tube should be moved slowly around each container, keeping the tube tip very close to the container surface. When the helium concentration increases sharply, the air intake hose is over the leak.

Helium detectors used for this purpose should have a sensitivity of at least 10^{-5} std cc/sec.

6.4 Discussion

6.4.1 Design Considerations

The following factors were considered and balanced during selection of instrumentation for the interim storage phase:

- duration of storage period
- environmental conditions inside storage tube
- environmental conditions inside vault
- need to minimize wiring
- available space for instruments inside storage tube
- available space in instrument well
- available power sources
- need to minimize number of personnel inside vault
- need to minimize equipment calibration and repair
- ALARA considerations

6.4.2 Storage Tube Identification

The technologies studied for inventory systems, listed in Section 3.5, are bar coding and magnetic strip tagging. Of these technologies, bar coding using the same system as used in the Plutonium Stabilization and Packaging System program is the recommended choice for identification of storage tubes, for the following reasons.

First of all, using the same system will minimize spare parts inventory, simplify personnel training in how to use the system, and minimize the types of devices used to read and store identification.

Also, non-electronic identification systems such as bar coding are preferable to magnetic identification systems; magnetic strips are less resistant to radiation and temperature extremes, and will deteriorate and possibly become unreadable during the interim storage period.

6.4.3 Storage Tube Tamper Indicating Devices

IAEA requires at least two independent TIDs on each storage tube opening in order to eliminate the requirement for annual material inspections. The TIDs must be easy to verify, easy to install, and difficult to forge. The TIDs may be passive, meaning they must be manually inspected, or active, meaning their status is continuously monitored.

Technologies studied for tamper indicating devices, listed in Section 3.4, are passive mechanical seals, bolts, plastic casting, active fiber optic cable seals, radio frequency (RF) cable seals, motion sensors, radiation sensors, and weight sensors. Of these technologies, ultrasonic sealing bolts, tape seals, and cable seals are the recommended choice for tamper indication in the Interim Storage Vault, as discussed in Sections 4.4.2 and 5.5.3.

6.4.4 Container Temperature

The technologies studied for temperature measurement, listed in Section 3.1, are thermocouple probes, RTD probes, thermistor probes, radiation pyrometers, thermometer decals, acoustic time domain reflectometers, and filled systems. As discussed in Section 5.5.4, RTD sensors in a cement on pad probe style are the recommended choice for non-invasive temperature monitoring during the 15 year storage period, because of their wide commercial availability, small size, ease of installation, large usable temperature range, and ease of connection to remote monitoring systems.

6.4.5 Internal Pressure of Containers

The technologies studied for pressure measurement, listed in Section 3.2, are radioscopy, acoustic resonance spectroscopy (ARS), and magnetic field sensors. Of these three technologies, radioscopy is the recommended choice for non-invasive internal pressure determination during storage, as discussed in Section~~s 4.4.5 and~~ 5.5.5.

6.4.6 Automatic Data Collection System

The technologies studied for automatic data collection, listed in Section 3.7, are PC based data acquisition systems, programmable logic controllers (PLCs), distributed control systems (DCS), and SCADA systems. Of these technologies, a PLC system that communicates with a PC is the recommended choice for the following reasons.

First of all, the tasks of the data collection system are reading large quantities of one type of data (temperature), computing the rate of temperature change, comparing the data to setpoints, monitoring its performance, and generating alarms. The system must also time stamp and archive the temperature data and alarms for future reference. There are no output devices, feedback control loops, or complicated operations on the data set.

The temperature range of the process is relatively small, approximately 50°C-250°C. The measurement does not require great accuracy or resolution. A scan rate of one reading every minute is adequate for this application, as temperature is not expected to change rapidly.

Another system requirement is minimizing the amount of wiring between storage tubes and the I/O interface; this means that the I/O modules should be located in the storage tube instrument well. As the instrument well has a small volume, the I/O modules must be as compact and low power as possible.

A pure PC based data acquisition system is not desirable for this application because PC hardware, and operating systems tend to be unreliable, or at least less stable than the corresponding PLC and DCS components. PLC and DCS systems support distributed processing and "hot backup" processors so that if one processor locks up, the overall system will still function; office grade PCs typically do not offer a similar feature. Also, the processor operating system in PLC and DCS systems is typically simpler and less likely to fail than PC operating systems. In addition, if a PLC or DCS processor locks up, a "watchdog" timer in hardware will restart the system; again, office grade PCs typically do not offer a similar feature.

A DCS would be able to perform all required functions for this application. However, a DCS is not appropriate because most of the features of a DCS, such as analog control, high resolution analog I/O, and advanced instruction set are not needed. A DCS would be "overkill" for this application.

A SCADA system is not appropriate for this application because the sensors are all in one area, and because the quantity of data is larger than a SCADA system typically handles.

A pure PLC system is able to perform most of the required functions for this application. In addition, PLCs have proven track records for reliable components and long operating life, because PLC hardware and software is designed for performing repetitive tasks in industrial environments. However, PLC systems have limited data storage capacity. This limitation can be resolved by having the PLC transmit all data to a PC over a network link for archiving.

7.0 ADDITIONAL CONCERNS

7.1 Pressure Indication on Damaged 3013 Containers

Per DOE-STD-3013-96 Section 4.2.1, 3013 containers must be leak tight as defined by ANSI N14.5 after a free drop from a 9 meter (30 ft.) height. However, the dropped container was damaged enough that the lid of the inner container could no longer be used for pressure measurement by radioscopy.

Therefore, it is recommended that the 3013 container not be used under the following conditions:

- if the container is dropped
- if the initial radiograph taken by the packaging system ~~during packaging~~ shows inner can lid deformation
- if the initial radiograph shows inner can lid misalignment

If any of these conditions are found, the container contents should be repackaged in a new, undamaged container.

7.2 Custom Designed Instrumentation

The following devices are not currently mass produced and commercially available for the specific applications described in this study.

- Radioscopy system for container pressure indication
- Helium detector for container leak detection

However, these devices can be custom designed and manufactured using standard commercial off-the-shelf hardware, based on properly worded specifications. The specifications must describe all known conditions and requirements for the application, including the following:

- ambient conditions (radiation level, air temperature, pressure, and humidity; other concerns such as vibration, seismic design)
- required measurement resolution and accuracy
- speed of measurement
- range of signal to be measured
- required output signals
- space limitations for sensors and analysis devices
- available power source (voltage, frequency, available watts)
- maximum design life

Allowances have been made in the cost estimate in Attachment D to account for development costs for these devices. The manufacturers listed in Section 11 can be considered as bidders for these devices.

7.3 Emerging Technologies

The following devices and technologies were considered and rejected for the instrumentation suite for various reasons. For example, the technology may not be sufficiently proven, requiring further research to characterize device response in this application. The current incarnation of sensors and analysis electronics may not tolerate the storage tube environment, or may not fit in the tube or instrument well. Sensor signal processing technology may be too complicated for this application. Or, sensors may not be sensitive enough to obtain valid measurements.

- Long Range Alpha Detection (LRAD)
- Acoustic Resonance Spectroscopy (ARS)
- Fiber Optic Temperature Sensors
- Traversing gamma radiation sensor for leak detection

However, future advances may make these and other technologies feasible for use in this application. Ports will be provided on each tube lid to allow invasive inspection of containers and internal tube structure with future devices.

7.4 Storage Tube Instrument Well Design

The storage tube instrument well was specified as a recessed well so a conceptual design of the ISV building could be done. The initial criteria which forced a shallow, recessed well design were as follows.

- 18 inch maximum storage tube diameter
- tube loading with a wheeled vehicle, necessitating a flat floor with no obstructions such as instrument racks
- 13 foot maximum tube length
- installation and wiring of instruments for each tube to be done at packaging facility, not at storage vault

However, these criteria may change during detailed design of the storage tubes and the ISV building. Also, the well design may be affected by such factors as the actual instruments selected, or the actual amount of radiation shielding between well and tube interior. Therefore, the following issues should be considered during detailed design of the recessed instrument well.

- shielding between instrument well floor and storage tube interior
- personnel radiation exposure during routine surveillance and maintenance of instruments in well
- degradation of instruments in well due to radiation exposure
- accessibility of instruments and wiring for calibration or repair
- method of loading tubes in vault
- actual instruments chosen

8.0 COST BASIS

8.1 General

Reference Attachments D-1, D-2 and D-3 for cost estimates.

Attachment D-1 summarizes all costs, including capital or purchase cost, maintenance costs, and life cycle costs, for all instrumentation for the Interim Storage Vault.

Attachment D-2 computes capital costs and maintenance costs for instrumentation in each storage tube and instrument well.

Attachment D-3 computes capital costs and maintenance costs for equipment not inside tubes or instrument wells.

The following factors were considered during development of cost information for the instrumentation and controls suite for the Interim Storage Vault:

- frequency and duration of periodic inspections for radioscopy and tamper inspection
- manpower requirements for continuous supervision of alarm system
- mean time between failure (MTBF) for all equipment
- calibration and repair requirements for all equipment
- skill level of personnel required to perform inspections

9.0 RELIABILITY ASSESSMENT

9.1 General

The following issues were considered during selection of instruments for the instrumentation and controls suite for the Interim Storage Vault.

- reliability of technology
- redundancy of instruments
- simplicity of instruments
- limitation on the number of instruments in harsh (hot, radioactive) environment
- limitation on the type of instruments in harsh (hot, radioactive) environment
- commercial availability of instruments
- track record of instruments
- when more than one type of instrument would meet requirements, the simpler/more reliable one was recommended
- calibration frequency
- expected lifetime of instrument
- maintenance requirements

9.2 Sensor Reliability Considerations

The following issues were considered for each instrument type during instrument selection for the Interim Storage Vault.

Temperature Sensors

- Simplicity of device
- commercial availability
- reliability
- tolerance of nasty environments
- size
- need for active monitoring hardware
- power consumption
- redundant RTDs on container
- calibration frequency
- maintenance requirements
- expected lifetime of sensor

Data Acquisition System

- PC based system vs. PLC based system
- Wireless vs. hard wired network
- MMI on PC vs. dedicated operator interface stations
- i/o outside storage tube vs. ~~inside~~ i/o inside tubes
- location of processors inside vault vs. outside vault
- expected lifetime of system components
- maintenance requirements

Miscellaneous Topics

- Number of electrical connections made
- Materials selection

- no Teflon
- Kapton (polyimide) ~~good~~performs well in radiation environment
- silicone rubber good in radiation environment
- epoxy and RTV adhesive (silicone based) ~~good~~performs well in radiation environment
- expected lifetime of components in storage tube environment

9.3 Reliability Assessment Discussion

Components ~~Any component~~ of the instrumentation suite that could affect the reliability of the system are listed in Attachments E-1 through E-5. Only the components involved in the continuous monitoring system are considered in the system reliability assessment.

Attachment E-1 computes the mean time between failure (MTBF) for the entire instrumentation suite, including all containers, all storage tubes, all 11 vault bays, the programmable logic controller data acquisition system, the operator workstation, the CAS workstation, the IAEA workstation, and overall system wiring (data highway between PLC processors, Ethernet network between workstations, etc.).

Attachment E-2 computes the MTBF for all instruments in a storage tube and instrument well, for a single tube.

Attachment E-3 computes the MTBF for all ~~42~~ tubes in one vault bay. This basically consists of MTBF for the tubes, PLC processors, and power wiring).

Attachment E-4 gives reference MTBF data for various types of instrumentation and electrical devices, such as electrical connectors, single RTDs, etc.

Attachment E-5 computes MTBF for major components of a typical industrial grade computer.

9.4 Maintenance Schedule

A proper maintenance schedule should be applied to avoid a reactive approach to failure maintenance. Items with an MTBF greater than 15 years of building operation are considered in this schedule as requiring service upon failure and should have a like spare available on an on site or just in time delivery basis. Items listed as intermittent service should be scheduled for maintenance just prior to their use. Items installed inside the storage tube have redundant sensors available as an alternate to maintenance.

Instrumentation suite components have been divided into the following 5 categories of maintenance. These items should be targeted for major repair or replacement within the time periods identified.

1. Every 6 months (MTBF less than 4380 hours)
    - Helium Detectors (calibrating is recommended every six months, and replacing the internal sensor is recommended every 5 years)

2. Every year (MTBF between 4381 and 8760 hours)
   (no devices in this category)

3. Every 5 years (MTBF between 8761 and 43,800 hours)
    - CAS, SAS and AL-R8 Operator Workstations

4. Every 10 years (MTBF between .43,800 and 87,600 hours)
   (no devices in this category)

5. Upon malfunction
   - Averaging vault temperature sensor
   - PLC I/O modules
   - PLC processors
   - IAEA workstation

10.0 REFERENCES

10.1 RFETS Documents

10.1.1 "Statement of Work for the Advance Conceptual Design Report of the Interim Storage Vault," Rocky Flats Environmental Technology Site, October 1996

10.1.2 "Addendum to Statement of Work for the Advance Conceptual Design Report of the Interim Storage Vault," Rocky Flats Environmental Technology Site, November 8, 1996

10.1.3 "Interim Storage Vault Summary Report," Rocky Flats Environmental Technology Site, March 15, 1996

10.2 DOE Documents

10.2.1 DOE ORDER C 470.1, "Contractor Requirements Document, Safeguards and Security Program," U.S. Department of Energy, 9-28-95

10.2.2 DOE ORDER O 470.1, "Safeguards and Security Program Requirements," U.S. Department of Energy, 9-28-95

10.2.3 DOE ORDER C 471.1, "Contractor Requirements Document, Unclassified Controlled Nuclear Information," U.S. Department of Energy, 9-25-95

10.2.4 DOE ORDER O 471.1, "Unclassified Controlled Nuclear Information," U.S. Department of Energy, 9-25-95

10.2.5 DOE ORDER C 471.2, "Contractor Requirements Document, Classified Matter Protection and Control," U.S. Department of Energy, 9-25-95

10.2.6 DOE MANUAL M 471.2-1, "Manual for Classified Matter Protection and Control," U.S. Department of Energy, 9-26-95

10.2.7 DOE ORDER O 472.1A, "Personnel Security Activities," U.S. Department of Energy Office of Nonproliferation and National Security, 9-5-96

10.2.8 DOE ORDER 5632.1C, "Protection and Control of Safeguards and Security Interests," U.S. Department of Energy, 7-15-94

10.2.9 DOE MANUAL 5632.1C, "Manual for Protection and Control of Safeguards and Security Interests," U.S. Department of Energy, 7-15-94

10.2.10 DOE ORDER 5633.3B, "Control and Accountability of Nuclear Materials," U.S. Department of Energy Office of Safeguards and Security, 9-7-94

10.2.11 Guide for Implementation of DOE 5633.3B, "Control and Accountability of Nuclear Materials," U.S. Department of Energy Office of Safeguards and Security, April 1995

10.2.12 "Guide to the Evaluation of Selected Materials Control and Accountability (MC&A) Detection Elements," U.S. Department of Energy Office of Safeguards and Security, May 1994

10.2.13 DOE ORDER 5634.1B, "Facility Approvals, Security Surveys and Nuclear Material Surveys," U.S. Department of Energy Office of Safeguards and Security, 9-15-92

10.2.14 DOE ORDER 5660.1B, "Management of Nuclear Materials," U.S. Department of Energy Office of Defense Programs, 5-26-94

10.2.15 DOE ORDER 5820.2A, "Radioactive Waste Management," U.S. Department of Energy Office of Defense Waste and Transportation Management, 9-26-88

10.2.16 DOE ORDER 6430.1A, "General Design Criteria," U.S. Department of Energy Office of Project and Facilities Management, 4-6-89

10.2.17 DOE-HDBK-1012/1-92, "DOE Fundamentals Handbook, Thermodynamics, Heat Transfer, AND Fluid Flow, Volume 1 of 3," U.S. Department of Energy, June 1992

10.2.18 DOE-HDBK-1013/1-92, "DOE Fundamentals Handbook, Instrumentation AND Controls, Volume 1 of 2," U.S. Department of Energy, June 1992

10.2.19 DOE-HDBK-1013/2-92, "DOE Fundamentals Handbook, Instrumentation and Controls, Volume 2 of 2," U.S. Department of Energy, June 1992

10.2.20 DOE-HDBK-1019/1-93, "DOE FUNDAMENTALS HANDBOOK, NUCLEAR PHYSICS AND Reactor Theory, Volume 1 of 2," U.S. Department of Energy, January 1993

10.2.21 DOE -STD-3013-96, "Criteria for Preparing and Packaging Plutonium Metals and Oxides FOR Long Term Storage," U.S. Department of Energy, September 1996

10.3 Federal Regulations

10.3.1 10 CFR 71, Code of Federal Regulations, "Packaging and Transportation of Radioactive Material"

10.3.2 10 CFR 835, Code of Federal Regulations, "Occupational Radiation Protection"

10.4 Standards

10.4.1 ANSI/ANS-8.3-1986, "Criticality Accident Alarm System," American National Standards Institute

10.4.2 ANSI N14.5-1987, "Radioactive Materials Leakage Tests on Packages for Shipment," American National Standards Institute

10.4.3 IAEA Safety Series No. 6, Regulations For The Safe Transport Of Radioactive Materials, International Atomic Energy Agency, 1985

10.4.4 IEEE Std 493-1990, "IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems, Institute of Electrical and Electronics Engineers

10.5 Technical References

10.5.1 Cathy D. Key, "Use of the E.J. Brooks "Multi-Lok" for Material Safeguards at the Y-12 Plant," INMM 36th Annual Proceedings, July 1995, Vol. XXIV, p. 653.

10.5.2 G.J. Healey, J.A. Larrimore, "Dual Containment and Surveillance—Difficult-to-Access Designation: Evolution and Technical Aspects," Proceedings of Symposium on International Nuclear Safeguards 1994: Vision for the Future, Vienna Austria, March 1994, p. 209.

10.5.3 A.D. Hatt, A.F. Reynolds, A. Jeffrey, P. DeTourbet, B. d'Agraives, J. Toornvliet, B. Wilt, "Operational Experience of Ultrasonic Sealing Bolt for Safeguards Containment of Multi-Element Bottles in British Nuclear Fuel's Thorp Spent Fuel Storage Ponds," INMM 36th Annual Proceedings, July 1995, Vol. XXIV, p. 657.

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10.5.6 C.T. Olinger, T. Burr, D.R. Vnuk, "Acoustic Resonance Spectroscopy Intrinsic Seals," INMM 35th Annual Proceedings, October 1994, Vol. XXIII, p. 776

10.5.7 P. Horton, I. Waddoups, "Active Fiber Optic Technologies Used as Tamper Indicating Devices," Sandia Report SAND95-2279 ¥ UC-515, November 1995

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10.5.9 M.R. Daily, D.J. Moreno, K.M. Tolk, J.L. Wilcoxen, R.E. Oetken, J.E. Collins, R. Miller, R.W. Olsen, L. Sheets, "Development of a Special Nuclear Materials Monitoring Sensor Pack for Project Straight-Line," Sandia National Laboratories--Albuquerque, Sandia National Laboratories--Livermore, Allied-Signal Kansas City Division, INMM 35th Annual Proceedings, October 1994, Vol. XXIII, p. 597

10.5.10 J.D. Johnson, C. Whitley, M. Rawool-Sullivan, "Real-Time Alpha Monitoring of a Radioactive Liquid Waste Stream at Los Alamos National Laboratory," 17th Annual US DOE Low-Level Radioactive Waste Management Conference, Phoenix AZ, December 12-14, 1995

10.5.11 J.D. Johnson, K. Allander, J. Bounds, S. Garner, J.P. Johnson, D. MacArthur, "Applications of the Long-Range Alpha Detector (LRAD) Technology to Low-Level

Radioactive Waste Management," 15th Annual US DOE Low-Level Radioactive Waste Management Conference Phoenix AZ, December 1-3, 1993

10.5.12 David R. Lide, CRC Handbook of Chemistry and Physics (77th Edition), New York: CRC Press, 1996

10.5.13 Bela G. Liptak, Kriszta Venczel, Instrument Engineer's Handbook, Radnor: Chilton Book Company, 1982

10.5.14 Donald G. Fink, H. Wayne Beaty, Standard Handbook for Electrical Engineers (13th Edition), New York: McGraw-Hill, 1993

11.0 MANUFACTURER LIST

The following is a representative list of suggested manufacturers for various technologies discussed in this study. This list is not meant to be comprehensive; consult the following sources for additional manufacturer listings:

- "ISA Directory of Instrumentation," Instrument Society of America, Research Triangle Park, North Carolina
- Non-Destructive Testing Information Analysis Center, Texas Research Institute, Austin, Texas

11.1 PACKAGING PHASE

A. INSTRUMENTATION FOR PACKAGE CERTIFICATION

Helium Detectors:

Varian Vacuum Products 121 Hartwell Avenue Lexington, MA 02173 ph. (617) 860-5437	Leybold Inficon, Inc. Two Technology Place East Syracuse, NY 13057 ph. (315) 434-1100	Mark Products Inc. 658 N. Pastoria Avenue Sunnyvale, CA 94086 ph. (408) 732-4600
Pfeiffer Vacuum Technologies 24 Trafalgar Square Nashua, NH 03063-1988 ph. (603) 578-6500	Edwards High Vacuum International 301 Ballardvale Street Wilmington, MA 01887 ph. (800) 848-9800	

Radiation Monitors:

Rad Elec Inc. 6714-C Industry Lane Frederick, MD 21704 ph. (800) 526-5482	Canberra Industries, Inc. 800 Research Parkway Meriden, CT 06450 ph. (203) 238-2351	Science Applications Int. (SAIC) 4161~~4224~~ Campus Pt Ct San Diego, CA 92121 ph. (800) 447-4373

Radioscopy for Weld Signatures:

Science Applications Int. (SAIC) 4161~~4224~~ Campus Pt Ct San Diego, CA 92121 ph. (800) 447-4373	V.J. Technologies 89 Carlough Road Bohemia, NY 11716 ph. (516) 589-8800	Bio-Imaging Research 425 Barclay Blvd. Lincolnshire, IL 60069 ph. (708) 634-6425

B. INSTRUMENTATION FOR MC&A

Bar Code Systems:

Symbol Technologies, Inc. One Symbol Plaza Holtsville, NY 11742-1300 ph. (516) 738-2400	Telxon, Inc. 3330 W. Market St. P.O. Box 5582 Akron, OH 44334 ph. (330) 867-3700	Intermec Corporation 6001 36th Avenue West P.O. Box 4280 Everett, WA 98203 ph. (206) 348-2600

Tamper Indicating Ultrasonic Sealing Bolts:

B.C. d'Agraives
Joint Research Centre-Institute for Systems Engineering and Informatics
Seals and Identification Techniques Laboratory
1-21020 Ispra (Vo) Italy
ph. +39-332-789 107

Tamper Indicating Tape Seals:

3M Safety and
Security Systems Division
3M Center PO Box 33225
St. Paul, MN 55144
ph. (800) 328-0067

Tamper Indicating Cable Seals:

E.J. Brooks
164 North 13th Street
Newark, NJ 07107
ph. (201) 483-0335

C. INSTRUMENTATION FOR SOAK IN PERIOD

Radiation Pyrometers:

Wahl Instruments, Inc.	Omega Engineering	Quantum Logic
5750 Hannum Ave	One Omega Drive	PO Box 191
Culver City, CA 90231	Stamford, CT 06907	Westport, CT 06881
ph. (310) 641-6931	ph. (800) 826-6342	ph. (203) 226-4135

11.2 TRANSFER PHASE

Bar Codes:

Symbol Technologies, Inc.	Telxon, Inc.	Intermec Corporation
One Symbol Plaza	3330 W. Market St.	6001 36th Avenue West
Holtsville, NY 11742-1300	P.O. Box 5582	P.O. Box 4280
ph. (516) 738-2400	Akron, OH 44334	Everett, WA 98203
	ph. (330) 867-3700	ph. (206) 348-2600

RTD Temperature Probes:

MINCO, Inc.	Omega Engineering	Thermo Electric
7300 Commerce Lane	One Omega Drive	109 N. Fifth Street
Minneapolis, MN 55432-3177	Stamford, CT 06907	Saddle Brook, NJ 07662
ph. (612) 571-3121	ph. (800) 826-6342	ph. (201) 843-7144

High Temperature Epoxies and RTV:

General Electric Silicone	Magnolia Plastics, Inc.	Emerson & Cuming
260 Hudson River Road	5547 Peachtree Industrial Blvd.	77 Dragon Court
Waterford, NY 12188	Chamblee, GA 30341	Woburn, MA 01888
ph. (800) 255-8886	ph. (770) 451-2777	ph. (617) 938-8630

Dataloggers:

Fluke Corporation	Esterline Angus	Keithley Instruments
PO Box 9090	1201 Main Street	28775 Aurora Road
Everett, WA 98206	Indianapolis, IN 46224	Cleveland, OH 44139
ph. (800) 443-5853	ph. (317) 244-7611	ph. (800) 552-1115

11.3 INTERIM STORAGE PHASE

A. CONTINUOUS NON-INVASIVE INSTRUMENTATION

RTD Temperature Probes:

MINCO, Inc. 7300 Commerce Lane Minneapolis, MN 55432-3177 ph. (612) 571-3121	Omega Engineering One Omega Drive Stamford, CT 06907 ph. (800) 826-6342	Thermo Electric 109 N. Fifth Street Saddle Brook, NJ 07662 ph. (201) 843-7144

High Temperature Epoxies and RTV:

General Electric Silicone 260 Hudson River Road Waterford, NY 12188 ph. (800) 255-8886	Magnolia Plastics, Inc. 5547 Peachtree Industrial Blvd. Chamblee, GA 30341 ph. (770) 451-2777	Emerson & Cuming 77 Dragon Court Woburn, MA 01888 ph. (617) 938-8630

Helium Detectors:

Varian Vacuum Products 121 Hartwell Avenue Lexington, MA 02173 ph. (617) 860-5437	Leybold Inficon, Inc. Two Technology Place East Syracuse, NY 13057 ph. (315) 434-1100	Mark Products Inc. 658 N. Pastoria Avenue Sunnyvale, CA 94086 ph. (408) 732-4600
Pfeiffer Vacuum Technologies 24 Trafalgar Square Nashua, NH 03063-1988 ph. (603) 578-6500	Edwards High Vacuum International 301 Ballardvale Street Wilmington, MA 01887 ph. (800) 848-9800	

PLC Data Acquisition Systems:

Rockwell /Allen Bradley West 6th Avenue Building B, Suite 1 Golden, CO 80401-5000 ph. (303) 279-6444	GE Fanuc PO Box 8106 Charlottesville, VA 22906 ph. (800) 648-2001	AEG Schneider (formerly Modicon) 1 High Street North Andover, MA 01845 ph. (508) 794-0800

B. INTERMITTENT NON-INVASIVE INSTRUMENTATION

Radioscopy:

Science Applications Int. (SAIC) 4161~~4224~~ Campus Pt Ct San Diego, CA 92121 ph. (800) 447-4373	V.J. Technologies 89 Carlough Road Bohemia, NY 11716 ph. (516) 589-8800	Bio-Imaging Research 425 Barclay Blvd. Lincolnshire, IL 60069 ph. (708) 634-6425

Gamma Radiation Detectors:

Rad Elec Inc. 6714-C Industry Lane Frederick, MD 21704 ph. (800) 526-5482	Canberra Industries, Inc. 800 Research Parkway Meriden, CT 06450 ph. (203) 238-2351	Science Applications Int. (SAIC) 4161~~4224~~ Campus Pt Ct San Diego, CA 92121 ph. (800) 447-4373

Bar Code Systems

Symbol Technologies, Inc. One Symbol Plaza Holtsville, NY 11742-1300 ph. (516) 738-2400	Telxon, Inc 3330 W. Market St. P.O. Box 5582 Akron, OH 44334 ph. (330) 867-3700	Intermec Corporation 6001 36th Avenue West P.O. Box 4280 Everett, WA 98203 ph. (206) 348-2600

C. INTERMITTENT INVASIVE INSTRUMENTATION

Video-imagescopes, Borescopes and Fiberscopes:

Olympus America Inc. Two Corporate Center Drive Melville, New York 11747 ph. (516) 844-5044	Instrument Technology, Inc. (ITI) Box 381 Westfield, MA 01086 ph. (413) 562-3606	Visual Inspection Technologies 199 Highway 206 South Flanders, NJ 07836

Gamma Radiation Detectors:

Rad Elec Inc. 6714-C Industry Lane Frederick, MD 21704 ph. (800) 526-5482	Canberra Industries, Inc. 800 Research Parkway Meriden, CT 06450 ph. (203) 238-2351	Science Applications Int. (SAIC) 4161 ~~4224~~ Campus Pt Ct San Diego, CA 92121 ph. (800) 447-4373

Helium Detectors:

Varian Vacuum Products 121 Hartwell Avenue Lexington, MA 02173 ph. (617) 860-5437	Leybold Inficon, Inc. Two Technology Place East Syracuse, NY 13057 ph. (315) 434-1100	Mark Products Inc. 658 N. Pastoria Avenue Sunnyvale, CA 94086 ph. (408) 732-4600
Pfeiffer Vacuum Technologies 24 Trafalgar Square Nashua, NH 03063-1988 ph. (603) 578-6500	Edwards High Vacuum International 301 Ballardvale Street Wilmington, MA 01887 ph. (800) 848-9800	

<u>ATTACHMENT A</u>

COMPLIANCE MATRICES

ATTACHMENT A-1

SWEC J.O. NO. 06489.72

COMPLIANCE MATRIX for PACKAGING

REQUIREMENTS	DOCUMENT	DEVICE TYPE	REMARKS
contents physical change	DOE 3013 A4.3.a	radiography	Note: the radioscopy system used to detect inner container lid deformation cannot be used A more powerful radioscopy system is required to detect contents physical change.
contents physical change	DOE 3013 A4.3.a	x-ray diffraction (intrusive lab test)	This test to be performed manually if problems suspected with contents
gamma emissions at 12 in	DOE 3013 4.4.2.b.4	gamma detector	
gamma emissions at surface	DOE 3013 4.4.2.b.4	gamma detector	
inner container dimensions change	DOE 3013 A4.3.a	radioscopy	Inner container lid deformation
inner container surface free of contamination per 10 CFR 835	DOE 3013 4.2.2.c	alpha detector	
inspection	ISV Report Summary page 15	radioscopy	To identify miscellaneous problems, such as contents phase change, material shifting, container distortion due to pressure increase, etc. A radioscopy system similar to the one used by the packaging system should be used
internal pressure less than 100 psig	DOE 3013 4.2.2.b	radioscopy	Note: a radioscopy system similar to the one used by the packaging system should be used
internal pressure less than 100 psig	DOE 3013 A4.3.b	radioscopy	Note: a radioscopy system similar to the one used by the packaging system should be used
internal pressure less than 100 psig	STATEMENT OF WORK 4.5.4.2	radioscopy	Note: a radioscopy system similar to the one used by the packaging system should be used
internal pressure less than 100 psig	STATEMENT OF WORK 4.5.4.3	radioscopy	Note: a radioscopy system similar to the one used by the packaging system should be used
inventory	DOE 5633.3B III.3	bar code	
leak detection	ANSI N14.5 -	helium detector	
misc. packaging requirements	DOE 3013 4.2	not in scope of this study	
neutron emissions at 12 in	DOE 3013 4.4.2.b.4	neutron detector	

REQUIREMENTS	DOCUMENT	DEVICE TYPE	REMARKS
neutron emissions at surface	DOE 3013 4.4.2.b.4	neutron detector	
outer container surface free of contamination per 10 CFR 835	DOE 3013 4.2.3.b	alpha detector	
oxides thermally stabilized	DOE 3013 4.1.3.C	LOI furnace	
tamper detection for storage tubes	DOE 5633.3B III.5.a	tamper inspection device (TID)	
temperature of metal less than 100C (212F)	DOE 3013 4.1.2.b	RTD	
thermal output less than 30W	DOE 3013 4.1.1	calorimeter	
weight of metal 4.4 kg max per container	DOE 3013 4.1.2.a	weigh scale	
weight of oxide 5.0 kg max per container	DOE 3013 4.1.3.a	weigh scale	
weld integrity	ISV Report Summary 3.4.1 page 29	helium detector	Leak testing will be done to confirm weld integrity

ATTACHMENT A-2

SWEC J.O. NO. 06489.72

COMPLIANCE MATRIX for TRANSFER

REQUIREMENTS	DOCUMENT	DEVICE TYPE	REMARKS
contents physical (shape) change	DOE 3013 A4.3.a	radioscopy	Phase change is accompanied by density change; perform this test as tube is placed in storage vault
inner container dimensions change	DOE 3013 A4.3.a	radioscopy	Inner container lid deformation
internal pressure less than 100 psig	DOE 3013 4.2.2.b	radioscopy	
internal pressure less than 100 psig	DOE 3013 A4.3.b	radioscopy	
internal pressure less than 100 psig	STATEMENT OF WORK 4.5.4.2	radioscopy	
internal pressure less than 100 psig	STATEMENT OF WORK 4.5.4.3	radioscopy	
inventory	DOE 5633.3B III.3	bar code	
inventory	ISV Report Summary page 7	bar code	"transfer check will include verification of ...bar coded identification numbers"
tamper detection	ISV Report Summary page 7	tamper inspection device (TID)	"transfer check will include verification of storage tube tamper indicating device integrity"
temperature of metal less than 100C (212F)	DOE 3013 4.1.2.b	RTD	rate of temperature change will also be monitored

ATTACHMENT A-3

SWEC J.O. NO. 06489.72

COMPLIANCE MATRIX for STORAGE

REQUIREMENTS	DOCUMENT	DEVICE TYPE	REMARKS
container weight change	DOE 3013 A4.3.c	weigh scale (invasive test)	This check to be performed manually if tampering or sabotage is suspected (based on surveillance systems or tamper indicating devices)
contents physical (shape) change	DOE 3013 A4.3.a	radioscopy	Phase change is accompanied by density change
criticality safety for materials	ISV Report Summary Functional Requirements Matrix	by design	
inner container dimensions change	DOE 3013 A4.3.a	radioscopy	Inner container lid deformation
inspection	DOE 3013 4.2.1.d	fiber optic video system	
internal pressure less than 100 psig	DOE 3013 4.2.2.b	radioscopy	
internal pressure less than 100 psig	DOE 3013 A4.3.b	radioscopy	
internal pressure less than 100 psig	STATEMENT OF WORK 4.5.4.2	radioscopy	
internal pressure less than 100 psig	STATEMENT OF WORK 4.5.4.3	radioscopy	
inventory	DOE 3013 4.2.1.e	bar code	
inventory	DOE 5633.3B III.3	bar code	
inventory	STATEMENT OF WORK 4.5.4.1	bar code	
inventory	STATEMENT OF WORK 4.5.4.8	bar code	
leak detection	ISV Report Summary Functional Requirements Matrix	helium detector	
leak detection between inner & outer container	ISV Report Summary page 22	helium detector	Can't detect this if outer container is still sealed
leak detection between inner & outer container	STATEMENT OF WORK 4.5.4	helium detector	Can't detect this if outer container is still sealed

1.0 SCOPE

1.1 BASIS

This design input document is developed to define the applicable codes and standards for the Interim Storage Vault (ISV) and guide the development of a Conceptual Design Report (CDR) for a secure plutonium storage at the Rocky Flats Environmental Technology Site (RFETS). Additionally, handling equipment in Building 371 will be developed.

1.2 GENERAL DESIGN REQUIREMENTS

The facility will be designed to current U. S. Department of Energy (DOE) requirements for a non-reactor nuclear facility, based on the general design criteria in DOE Order 6430.1A, General Design Criteria, or its successors such as 0420.1. It will be operated per the 10 CFR 800-series on nuclear safety management rules.

2.0 FACILITIES DESIGN REQUIREMENTS

2.1 CIVIL

2.1.1 Drainage

Site development including earthwork, roads, fencing, and related civil work will be in accordance with Rocky Flats Engineering Department Standards and Specifications and DOE guidelines. Where these sources offer no specific guidance, U. S. Army Corps of Engineer Technical Manuals will be utilized.

2.1.2 Fencing

Fencing will be constructed in accordance with Rocky Flats Standard SC-102.

2.1.3 Roadways

A two-lane entrance roadway is planned into the ISV area. The roadway will connect to the existing RFETS roads to provide plutonium transfer from Building 371 and eventual transfer off site. Signage will be in accordance with the Manual on Uniform Traffic Control Devices (MUTCD).

2.2 STRUCTURAL

2.2.1 Design Standards

Structures, systems, and components will be designed in accordance with the following:

- DOE Order 6430.1A General Design Criteria.
- DOE-STD-1020-94 Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities.
- ASCE STD 7-96 Minimum Design Loads for Buildings and Other Structures.

2.2.2 Design Methods

Capacity of structural elements will be calculated in accordance with the following documents:

- ACI 349 Code Requirements for Nuclear Safety Related Concrete Structures
- AISC N690 Nuclear Facilities - Steel Safety Related Structures for Design, Fabrication, and Erection, 1984.

2.2.3 Materials

Materials for construction will be specified in accordance with the following standards, as applicable:

- American Society for Testing & Materials (ASTM).
- American Welding Society (AWS).
- American Concrete Institute (ACI).

2.2.4 Construction

Quality for construction will be in accordance with NQA-1 requirements. Exterior concrete surfaces will be coated with a waterproof material. Interior concrete surfaces will be treated with a hardener and/or dustproof penetrant. Construction should facilitate future decontamination and decommissioning.

2.3 RADIOLOGICAL

2.3.1 General

The design target dose rates, both neutron (η) and gamma (γ), will be as low as reasonably achievable (ALARA) and within the DOE regulatory limits required by 10CFR835, Occupational Radiation Protection for full-time occupancy, the total design target whole body dose rates (DRw per person) will be:

$$DRw \leq 500 \text{ mrem / year } (\gamma + \eta).$$

For full time occupancy, 2000 hrs / yr:

$$DRw \leq \frac{500 \text{ mrem}}{2{,}000 \text{ hrs}} = 0.25 \text{ mrem / hr} \quad (\gamma + \eta)$$

The limiting extremity dose rate and integrated dose rate (DRe) will be ALARA and:

$$DRe \leq 15 \text{ mrem / yr } (\gamma + \eta)$$

and:

$$DRe \leq \frac{15\,(10E3)\text{ mrem}}{2{,}000\text{ hrs}} = 7.5 \text{ mrem / hr } (\gamma + \eta \text{ average})$$

2.4 SEISMIC ANALYSIS

2.4.1 General

This ISV building will be designed to Performance Category (PC) 4 in accordance with DOE-STD-1020-94. The seismic design or evaluation, therefore, must be based on a dynamic analysis approach. Input earthquake motion can be represented as a response spectrum or an acceleration time history.

2.4.2 References

The following documents will be used for seismic analysis:

- Natural Phenomena Hazards Design and Evaluation Criteria for DOE Facilities, DOE-STD-1020-94.
- Statement of Work for the Advanced Conceptual Design Report of the Interim Storage Vault, Rocky Flats Environmental Technology Site, Golden, Colorado, October 1996.
- Analysis for Soil-Structure Interaction Effects for Nuclear Power Plants, Report by the Ad Hoc Group on Soil-Structure Interaction, Nuclear Structures and Material Committee of the Structural Division of ASCE.
- ANSYS User's Manual, Rev. 5.3, ANSYS Inc.
- ENR-DIR 93-003, Software Quality Assurance Implementing Instructions, Rev.0, 6/9/93.

3.0 MECHANICAL DESIGN REQUIREMENTS

3.1 HEATING, VENTILATING, AND AIR-CONDITIONING

The design will comply with applicable items of DOE Order 6430.1A, Section1550. Temperature control for non-storage/handling areas will be provided in accordance with RFETS Standard SMU-302 criteria of 72°F and 76°F indoor temperatures in winter and summer, respectively.

The dock and staging/overpack area will have heating units to maintain a minimum temperature of 50°F (warehouses) per DOE Order 6430.1A, Table 1550-1.2.2.

All occupied areas will be provided with outdoor air ventilation in accordance with ASHRAE Standard 62.

Truck accessway and inner truck accessway will have separate ventilation systems complying with Uniform Building Code, Sec. 705 requirements of 1.5.

All ventilation systems except the outer truck accessway will be equipped with high-efficiency particulate air (HEPA) filters. The requirements of DOE Order 6430.1A, Section 1550-2.5.5, ASME N509, and ERDA 76-21 should not apply to the HEPA filter housings for this facility. (Commercial grade side-access housings with a continuous knife-edge seal and crank-operated, spring-loaded filter-sealing mechanism should be acceptable.) This will be verified by criteria deviation approval per DOE Order 6430.1A, Sec. 0101-2 in Title I design.

3.2 FIRE PROTECTION

A preliminary fire hazards analysis will be performed during the Conceptual Design. A fire hazards analysis per DOE Order 5480.7A, Fire Protection, and RFETS plant procedures will be performed during Title I or II design.

Automatic sprinklers will be designed and installed in accordance with the most current version of NFPA 13, Standard for the Installation of Sprinkler Systems. Hose systems will be designed and installed in accordance with the most current version of NFPA 14, Standard for the Installation of Standpipe and Hose Systems.

Fire extinguishers will be installed in accordance with NFPA 10, Portable Fire Extinguishers.

The ISV facility will meet the requirements of NFPA 101, Life Safety Code, or will have a formally approved exemption from DOE.

3.3 STORAGE COMPONENT DESIGN REQUIREMENTS

3.3.1 General

The ISV will provide confinement for the plutonium inventory that satisfies the requirements of DOE Order 6430.1A, Section 1305-5, Confinement Systems, Plutonium Storage Facilities. The ISV will maintain a three-confinement strategy for dispersibles (oxides) throughout the storage process. The Conceptual Safety Report hazard and accident analysis will determine whether tertiary confinement is needed for pit storage.

Metals and oxides will be stored in 3013 containers and limited to the sizes and shapes per DOE-STD-3013-96, Criteria for Preparing and Packaging Plutonium Metals and Oxides for Long-Term Storage. The 3013 containers provide the primary and secondary confinements. Tertiary confinement will be provided by the storage tube.

3.3.2 Seismic

The ISV will protect the plutonium inventory from natural phenomena hazards.

The storage tube and internal support cage will be designed as PC-4 components, per DOE-STD-1020-94, Natural Phenomena Hazards Design Performance Categorization Guidelines for Structures, Systems, and Components, unless the accident analysis shows that a lower categorization is adequate.

Non safety-related systems and components will be categorized per DOE-STD-1021-93, Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components, with application and consideration of the possible adverse effects of system or component interactions.

4.0 ELECTRICAL DESIGN REQUIREMENTS

4.1 GENERAL REQUIREMENTS

The electrical design of this project will comply with DOE Order 6430.1A - Division 16, the National Electrical Code (NEC) - NFPA 70, National Electrical Safety Code - ANSI C2, and applicable RFETS Electrical Standards.

Equipment required to perform a safety function during or following a design basis earthquake (DBE) will comply with IEEE-323 and IEEE-344.

All electrical equipment and materials will be tested and listed by Underwriters Laboratories (UL) or approved by Factory Mutual Engineering and Research (FM). In lieu of UL or FM certification, testing and certification by a similar nationally accredited testing laboratory is permitted as required by DOE Order 6430.1A, Section 1605-1.

Labeling of equipment and conduit will comply with DOE Order 6430.1A, Section 1300-12.4.11.

4.2 BASIC ELECTRICAL MATERIALS AND METHODS

Installation of raceway systems will comply with DOE Order 6430.1A, Section 1605-2.1

Installation of cable tray systems will comply with DOE Order 6430.1A, Section 1605-2.1.8.

Cable conductors will comply with DOE Order 6430.1A, Section 1605-2.2.

Conductor identification will comply with DOE Order 6430.1A, Section 1605-2.2.3.

Receptacles will comply with DOE Order 6430.1A section 1605-2.3 and the requirements as stated in NFPA 70.

Signal cables will not be run in close proximity to power cables or other cables that could induce voltages into the signal cables. Guidance is provided in NFPA 70, Article 725-52.

The following codes and standards are applicable to the design and installation of raceways:

- NFPA-70 NEC.
- IEEE-48 Procedures and requirements for High Voltage Current Cable Terminations.
- IEEE-442 Guide for the design and Installation of Cable Systems in Power Generation Stations.

Design and installation of lighting and communications systems will satisfy the requirements of NFPA-70 and the following ANSI standards as applicable:

- ANSI A11.1 Standard Practice for Industrial Lighting.
- ANSI A85.1 Standard Practice for Protective Lighting.
- ANSI A132.1 Standard Practice for Office Lighting.
- ANSI D12.1 Standard Practice for Roadway Lighting.

Protective lighting will also comply with DOE Order 6430.1A, Section 0283-7.

Telecommunications systems will satisfy the requirements of DOE Order 5300.1C. Secure communication systems will also satisfy the requirements of DOE Orders 5300.2D and 5300.4D.

4.3 EXTERIOR ELECTRICAL SERVICE

Design of the electrical service to an area/facility will comply with DOE Order 6430.1A, Section 1630-1.

Exterior electrical equipment used to supply, transform, monitor, and protect will comply with DOE Order 6430.1A, Section 1630-2.

The design will consider the factors listed in DOE Order 6430.1A, Section 1630-4 for selection of a power supply for a building.

Lightning protection for areas/facilities will comply with DOE Order 6430.1A, Section 1630-5.

4.4 INTERIOR ELECTRICAL SERVICE

Interior electrical systems will comply with DOE Order 6430.1A, Section 1640.

Motors will comply with requirements of DOE Order 6430.1A, Section 1640-2.4 and control equipment will comply with Section 1640-2.5. AC motor protection will comply with NFPA 70, Article 430, and IEEE C37.96 (Guide for AC Motor Protection).

The design and installation of battery systems will comply with IEEE 484, Recommended Practice for Installation Design and Installation of Large Lead Storage Batteries for Generating Stations and Substations, and IEEE 485, Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations.

Exterior lighting will comply with the requirements of DOE Order 6430.1A, Section 1650. Power supplies for exterior lighting will comply with the requirements of DOE Order 6430.1A, Section 1630-3. Lighting for safety or security needs will be furnished with reliable power.

Interior lighting will comply with DOE Order 6430.1A, Section 1655. Emergency lighting systems will comply with requirements of NFPA 101, NFPA 70, and IEEE 446.

4.5 GROUNDING

Grounding systems will comply with NFPA 70, ANSI C2, and IEEE 142. Separate grounding connections will be used. Raceway systems will not be used for grounding path per DOE Order 6430.1A Section 1639-1.

Design and installation of grounding for sensitive electronic process and monitoring equipment will consider NFPA 75 and IEEE 1050 and 1100 requirements.

Permanent fence grounding will comply with ANSI C2 as required by DOE Order 6430.1A, Section 1639-3.

Grounding for lighting and communications equipment will comply with requirements listed in the following national standards, as applicable.

- ANSI A11.1 Standard Practice for Industrial Lighting.
- ANSI A85.1 Standard Practice for Protective Lighting.
- ANSI A132.1 Standard Practice for Office Lighting.
- ANSI D12.1 Standard Practice for Roadway Lighting.

Surge protection will comply with the requirements of NFPA 70 and ANSI C2.

Lightning protection will comply with NFPA 78 as required by DOE Order 6430.1A, Section 1630-5. Electric power and communication services to the facility and to underground power cables, where connected to overhead power distribution facilities, will have lightning and surge protection meeting the requirements of ANSI / IEEE C62.2 and C62.11. Grounding of air terminals (lightning rods) will comply with ANSI C2.

4.6 SPECIAL SYSTEMS

Electrical equipment for the ISV will be designated as "Non-Safety Class" and "Non-Safety Significant".

Standby and emergency systems will serve loads set forth in NFPA 110, Standard for Emergency and Standby Power Systems, and IEEE 446, Recommended Practices for Emergency and Standby Systems for Industrial and Commercial Applications.

Emergency power will be provided for protective alarm and communications systems as dictated by the system requirements. Switchover to emergency power will be automatic on failure of the normal power source. The definition of "emergency systems," "legally required standby systems" and "optional standby systems" will be in accordance with NFPA 70 and DOE Order 6430.1A, Section 1660-1.

Emergency power equipment areas will be ventilated to exhaust hazardous gases and to maintain satisfactory ambient temperatures for equipment operation or personnel access in accordance with DOE Order 6430.1A, Section 1660-1.

Emergency power will service fire alarm, security alarm and supervisory sensing devices designated essential by the cognizant DOE authority (DOE Order 6430.1A, Section 1660-1).

Uninterruptable power will be provided for equipment that cannot sustain functions through the momentary power loss that occurs when an alternate power source comes on line and picks up load. See Uninterruptable Power Systems (DOE Order 6430.1A, Section 1660-3).

Uninterruptable Power Supplies (UPS) will be provided for those loads requiring guaranteed continuous power. Application of the UPS will comply with IEEE 446, as modified by the cognizant DOE authority. UPS installations will be Non-Safety Class (seismic) or standby type dependent on the classification of loads served (DOE Order 6430.1A, Section 1660-3)

Specification of automatic transfer switches for emergency and standby systems is defined in DOE Order 6430.1A and NFPA 70.

5.0 INSTRUMENTATION AND CONTROLS DESIGN REQUIREMENTS

5.1 MONITORING, ALARM, AND DISPLAY SYSTEMS

Warning and alarm systems will be designed, installed and tested to assure that they can be heard in the ambient condition of the area they are intended to cover in accordance with DOE Order 6430.1A, Section 1300-6.5.4.

Equipment environmental considerations will meet DOE Order 6430.1A, Section 1300-3.4 requirements.

Human factors design of equipment and equipment layout will meet requirements of DOE Order 6430.1A, Section 1300-12 and will use the guidance of IEEE1023.

Graphics on all displays will be consistent with ANSI/ISA S5.1 symbology conventions.

5.2 CRITICALITY ACCIDENT ALARM SYSTEM

The criticality accident alarm system will meet the requirements of ANSI/ANS-8.3, Criticality Alarm System, and DOE Order 5480.5.

5.3 FIRE DETECTION AND ALARMS

Smoke detectors will be installed in accordance with NFPA 72 National Fire Alarm Code. Placement and number of detectors is dependent on the building arrangement.

6.0 SAFEGUARDS AND SECURITY REQUIREMENTS

The requirements for Security Systems and Material Control and Accountability Systems will be in accordance with applicable DOE Orders, Standards, and Manuals, as listed below:

7.0 REFERENCES

DOE Order C 470.1, Contractor Requirements Document, Safeguards And Security Program, U.S. Department of Energy, September 28, 1995.

DOE Order O 470.1, Safeguards And Security Program Requirements, U.S. Department of Energy, September 28, 1995.

DOE Order C 471.1, Contractor Requirements Document, Unclassified Controlled Nuclear Information, U.S. Department of Energy, September 25, 1995.

DOE Order O 471.1, Unclassified Controlled Nuclear Information, U.S. Department of Energy, September 25, 1995.

DOE Order C 471.2 , Contractor Requirements Document, Classified Matter Protection And Control, U.S. Department of Energy, September 25, 1995.

DOE Manual M 471.2-1, Manual For Classified Matter Protection And Control, U.S. Department of Energy, September 26, 1995.

DOE Order O 472.1A, Personnel Security Activities, U.S. Department of Energy Office of Nonproliferation and National Security, September 5, 1996.

DOE Order 5632.1C, Protection And Control Of Safeguards And Security Interests, U.S. Department of Energy, July 15, 1994.

DOE Manual 5632.1C, Manual For Protection And Control Of Safeguards And Security Interests, U.S. Department of Energy, July 15, 1994.

DOE Order 5633.3B, Control And Accountability Of Nuclear Materials, U.S. Department of Energy Office of Safeguards and Security, September 7, 1994.

DOE Order 5634.1B, Facility Approvals, Security Surveys And Nuclear Material Surveys, U.S. Department of Energy Office of Safeguards and Security, September 15, 1992.

DOE Order 5660.1B, Management Of Nuclear Materials, U.S. Department of Energy Office of Defense Programs, May 26, 1994.

APPENDIX 1.12.5
Issues Requiring Further Evaluation During Title Design

of the
Conceptual Design Report

for the
Interim Storage Vault

for the
Rocky Flats Environmental Technology Site
Golden, Colorado

Task Order 72

for the
S. Department of Energy
Rocky Flats Operations Office
Golden, Colorado

Prepared by
Rocky Flats Engineers and Constructors, LLC
Denver, Colorado

May 1997

Authorization No. E32CD100

TABLE OF CONTENTS

APPENDIX 1.12.5 ISSUES REQUIRING FURTHER EVALUATION DURING TITLE DESIGN

1.0 INTRODUCTION

This Appendix summarizes issues which were identified in preparing the CDR as requiring further investigation and development in the title design phase. These items are considered to be in addition to normal title design activities and beyond the scope of the CDR.

2.0 SECURITY

1. Pedestrian Portal - Evaluation location, requirements and security aspects of a hardened entrance portal.
2. Roadway Location - Alternate alignments to provide improved security will be weighed with access considerations.
3. Life Safety vs. Security Issues Relating to Personnel Egress (NFPA 101) - Further evaluation is required regarding vulnerability of emergency egress points, alarmed doors, etc.
4. Vault Security Barriers - Evaluate disruption of air flow and heat transfer considerations should security barriers be used and deployed.
5. Shower Rooms and Other Inferred Facilities - Dress-out requirements for maintenance, operations and security personnel require further evaluation.
6. Pad-mounted Transformers and Emergency Generator - Further modeling is required to analyze the security concerns for these components of the electrical supply system.
7. Electrical Pole Line - The 13.8kV supply within the ISV site boundary is proposed as underground construction. The portion of the line from the substation which is currently planned as overhead will be evaluated and modeled as underground also.
8. Ventilation Intake and Exhaust Ducts - The protection requirements for all ventilation system ducts will be analyzed.
9. Power Failure Lockdown - Additional modeling is required for this event.
10. Vault Outlet Duct - Further investigation is required with respect to the geometry of the outlet duct so that it is totally independent from the storage vault (i.e., no common walls), and it has a horizontal offset along its height.

3.0 CIVIL/STRUCTURAL

Develop site-specific seismic design criteria. Unless the criteria is significantly less than that used for the CDR phase, drilled piers should be eliminated as a foundation option.

4.0 ARCHITECTURAL

1. A special study must be performed on the requirements for life safety, and DOE certified equivalencies or exemptions made when needed.
2. Further investigation is needed for protection requirements at inlet duct to eliminate/minimize air flow blockage due to trash, soil, etc.
3. Further investigation is required for the addition of a sump in the explosive pits with a pump which transfers collected fluids to a respective holding tank.
4. An alternate method of containing the soil overburden will be investigated (instead of using retaining walls).
5. New building layout and modeling is required if several storage bays are eliminated.
6. Orientation of the ISV building will be investigated in order to take advantage of north/northwest prevailing winds and still meet all security safety clearances around the structure.

5.0 GEOTECHNICAL

Refer to Appendix 1.12.2, Geotechnical Investigation Plan, which discusses geological, geotechnical and seismological issues which will be addressed in site-specific investigations during title design work.

6.0 MECHANICAL

1. Plutonium Metal Temperature Limits: DOE-STD-3013-96 places a maximum limit of 100°C on plutonium metal temperatures. This limit is currently being reviewed. The conceptual heat transfer analyses performed on the proposed container, tube, and vault physical designs has not satisfied this temperature limit during design ambient conditions.
2. Storage Tube and Can Surface Coatings and Emissivities: Coatings and surface finish requirements that result in acceptable corrosion and scratch resistance and heat transfer properties and are radiation tolerant require further study.
3. Storage Tube Flange Seal: The design basis requirements (pressure or confinement boundary/leakage rate) need to be quantified. The material and seal configuration needs to be detailed and tested based on these requirements.
4. Charging Floor Penetration Seal: The design basis requirements for the tube to floor penetration seal need to be quantified and details based on these requirements need to be developed.
5. Support Cage Clamp, Fin, and Door Design: The details of the individual container clamps, fins, and doors on the storage tube support cage need to be further developed based on the results of heat transfer and drop testing.

6. Rotational Fall Accident: Analysis and design for a storage tube rotational fall accident needs to be further developed and documented.
7. Radiation Shielding Thickness: The requirements for occupancy of the charging level need to be established so that appropriate shield design thicknesses are used in the bottom of the instrument well and above the tube. The conceptual drawings show 4 inches of steel shielding between the upper container and personnel on the charging floor. The shielding required for full-time occupancy on this floor is estimated to be 7 inches of steel.
8. Tube Length versus Vault Height: There is a 5-inch dimensional discrepancy between tube length and vault height due to the height of the tube base support. Dimensions need to be resolved in later phases of design.
9. Fire Protection - Requirements for a second fire water supply require further evaluation.

7.0 ELECTRICAL

1. UPS Systems - Further definition of the times for the security system to remain operational after loss of normal and alternate power supplies is required.
2. Security systems electrical load requirements and characteristics are required.
3. Storage Tube Penetration Seal - The proposed material and penetration detail must be analyzed and/or test further.
4. Electric Heat Tracing - The requirements for heat tracing, including fire water and domestic water require further evaluation.

8.0 INSTRUMENTS AND CONTROLS

1. Instrument Well Shielding Requirements - Shielding requirements between instrument well floor and storage tubes interior require further evaluation.
2. Instrument Well Long-Term Degradation - Long-term degradation of storage tube and well instruments due to radiation exposure requires further evaluation.
3. Personnel Radiation Exposure - The radiation exposure levels during routine surveillance and maintenance of instruments in well must be analyzed.
4. Calibration - The accessibility of instruments and wiring for calibration or repair in the storage tube instrument well requires review.
5. Custom Designed Instrumentation - The commercial availability and performance specifications of helium detectors and radioscopy system for container pressure indication requires further evaluation.

APPENDIX 1.12.6
Environmental Data Evaluation

of the
Conceptual Design Report

for the
Interim Storage Vault

for the
Rocky Flats Environmental Technology Site
Golden, Colorado

Task Order 72

for the

U. S. Department of Energy
Rocky Flats Operations Office
Golden, Colorado

Prepared by
Rocky Flats Engineers and Constructors, LLC
Denver, Colorado

May 1997

Authorization No. E32CD100

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1.0 OBJECTIVE OF ENVIRONMENTAL DATA EVALUATION

The objective of the environmental data evaluation was to ensure that contamination does not exist at the proposed Interim Storage Vault (ISV) site that would unduly hamper construction of the facility. The objective was met by determining whether chemical constituents are present in the subsurface soils and the groundwater beneath the proposed ISV site at concentrations that exceed regulatory approved cleanup levels for Rocky Flats Environmental Technology Site (RFETS). If there were exceedances, it was necessary to evaluate if the observations were representative of contamination or simply reflected naturally occurring concentrations. The environmental data evaluation involved review of existing analytical data from a total of five boreholes and 12 monitoring wells in the vicinity of the proposed ISV site. The data available from these boreholes and monitoring wells were deemed sufficient to evaluate the proposed ISV site without mobilizing to collect additional soil and groundwater samples.

2.0 SITE SETTING

In order to evaluate the environmental data, the hydrogeology must be conceptually characterized. This discussion is not intended to be an exhaustive review of the hydrogeology, because this subject is covered in other sections of this report. This discussion is designed to set forth the geology and hydrogeology as it relates to evaluating the environmental data.

The lithology beneath the proposed ISV site consists of Rocky Flats Alluvium (Qrf) to an average depth of 30 to 40 feet. The Qrf overlies the local bedrock, which consists of the Cretaceous Arapahoe Formation and the Cretaceous Laramie Formation. At this site, the entire Arapahoe Formation and the upper portion of the Laramie Formation are weathered (see Section 1.5.1.3). For background characterization purposes, the weathered claystones, siltstones, and sandstones of the Arapahoe Formation are considered one unit and have been identified as the WCS (EG&G, 1992). Underlying the WCS, the bedrock is unweathered. For background characterization purposes, the unweathered bedrock is referred to as Kar (EG&G, 1992).

The bedrock surface forms a buried ridge that was created as an erosional remnant between Walnut Creek to the north and Woman Creek to the south. The bedrock surface slopes to the north and south toward these creeks, respectively. The soil data reviewed for this evaluation are all from the Qrf and the WCS. Table 1.12.6-1 below indicates from which formation the soil samples from each borehole were obtained. The locations of these boreholes are shown in Section 1.5.1.3.

Table 1.12.6-1 BOREHOLE DATA

BORE HOLES	166	42592	P415989	P416189	P416289	P416489	P416589
Qrf Sampled	Not Recorded	Yes	Yes	Yes	Yes	Yes	Yes
WCS Sampled	Not Recorded	Yes	Yes	Yes	Yes	Yes	Yes

The environmental data for the soils were evaluated with regard to background concentrations of present in only the Qrf and the WCS. No soil samples were available for the deeper unweathered bedrock (Kar) and, thus, this stratigraphic section could not be evaluated. The shallower Qrf and WCS are considered sufficient to assess the potential contaminants in the soils because these are the shallowest materials that might be encountered during the ISV construction and operation.

Groundwater is contained in two hydrostratigraphic units: an upper hydrostratigraphic unit and a lower hydrostratigraphic unit. The groundwater in the upper hydrostatic unit is contained in the Qrf and WCS as a water table groundwater regime. The regional groundwater flow direction in the upper hydrostratigraphic unit beneath the site is towards the east. Locally, this groundwater flow direction is dependent upon the bedrock surface. A groundwater divide in the upper hydrostratigraphic unit beneath the proposed ISV site corresponds to the bedrock ridge, which results in groundwater in the northern portion of the site to flow north-east toward the Walnut Creek drainage and groundwater in the southern portion of the site to flow south-east toward the Woman Creek drainage. Along the ridge, the groundwater flow is easterly (Appendix 1.12.1). The gradient averages a 10-foot vertical drop for every 500 to 800 feet of horizontal distance, with the steeper gradients in the area of Woman Creek. This evaluation focused on potential upgradient areas and onsite areas in the upper hydrostratigraphic unit and evaluated data from the wells installed in the Qrf and WCS. The screened interval and location of the wells relative to the proposed ISV site are shown on Table 1.12.6-2. One well, P416989, monitors the deeper, lower hydrostratigraphic unit contained in the unweathered bedrock (Kar). The data collected from this onsite well was compared to data from other Kar wells at RFETS (EG&G, 1992).

Table 1.12.6-2 MONITORING WELL DATA

MONITORING WELL/BOREHOLE	SCREENED INTERVAL	GROUNDWATER FLOW POSITION
166	Open Hole/Abandoned	Upgradient
42592	Open Hole/Abandoned	Downgradient
P415889	Qrf (poss. WCS)	Upgradient
P415989	Qrf	Side Gradient
P416089	Qrf/WCS	Upgradient
P416189	Qrf/WCS	Side Gradient
P416289	Qrf/WCS	Downgradient
P416389	Qrf/WCS	Upgradient
P416489	Qrf/WCS	Downgradient
P416589	Qrf/WCS	Downgradient
P416689	Qrf/WCS	Downgradient
P416989	Kar	Side Gradient

Based on the groundwater present beneath the proposed ISV site, background data appropriate for evaluating the Qrf and WCS of the upper hydrostratigraphic unit and the Kar of the lower hydrostratigraphic unit have been used to assess the environmental data available for the wells listed above.

3.0 LITERATURE REVIEW

R. F. Weston and Associates (Weston) reviewed existing documents to determine whether the proposed ISV site is located within an identified waste unit or an area previously identified as containing contamination. The proposed ISV site is not listed as associated with any identified Potential Area of Concern (PACs) or Individual Hazardous Substance Site (IHSSs) (DOE, 1992).

The nearest upgradient PAC is located at the northeast corner of Building 130 (PAC 100-608) and is identified as a pole-mounted electrical transformer leak of cooling oil containing PCBs. The approximate amount of PCBs released at this location was reported to be 0.0006 pounds.

Also in the upgradient location is the West Spray Field that was previously classified as an IHSS. Based on an investigation in the West Spray Field, the only contaminants associated with this area were nitrates. This area has been removed from the list of IHSSs and is not scheduled for clean up or monitoring.

Finally, the RFETS groundwater plume map of selected volatile organic analytes (VOAs) and nitrates does not identify any plumes existing at, or upgradient of, the proposed ISV site.

4.0 ANALYTICAL DATA

The data used to evaluate the soil and groundwater quality data at the proposed ISV site were provided by Rocky Mountain Remediation Services (RMRS) on digital tape. Analytical data are for soils and groundwater from five boreholes and 12 monitoring wells in the vicinity of the proposed ISV site. The data consisted of individual records or analyses dating from November 1993 to August 1996.

No new samples were obtained for this evaluation. No attempt was made to validate the data provided in the digital form, i.e., it was assumed to be correct as provided.

5.0 DATA REDUCTION

At RFETS, a myriad of VOAs, metals, and radiological parameters have been analyzed for in the various media. Not all are detected, and, of those detected, only a subset actually represent contaminants. To evaluate the proposed ISV site, Weston used procedures and data collected from other sources to determine whether contaminants are present at the proposed ISV site. Other sources include the Background Geochemical Characterization Report, Rocky Flats Plant, Golden, Colorado (EG&G, 1992), the Final Phase III RFI/RI, Rocky Flats Plant, 881 Hillside Area, (Operable Unit No. 1) (DOE, 1994), the Historical Release Report for the Rocky Flats Plant (DOE, 1992), and the Rocky Flats Cleanup Agreement (RFCA), Rocky Flats Environmental Technology Site Action Levels and Standards Framework for Surface Water, Groundwater, and Soils, Attachment 5 July 19, 1996, and Modifications to...August 30, 1996 (DOE, 1996). These reports set forth an exhaustive review of potential and actual site contaminants for the RFETS and have been used here to evaluate the data collected from the proposed ISV site. The data were reduced in an effort to identify any analytes present in the soils and the groundwater at the proposed ISV site that might represent site contaminants.

The data reduction process is summarized on Figure 1.12.6-1 and consisted of loading the data provided by RMRS into a Weston database. From this database, a listing was compiled of all analytes identified in the RFCA (DOE, 1996). Analytes not listed by RFETS were not included for further review.

The listed analytes were then divided into the following two categories:

- Detected values (i.e., the analytical result carries a laboratory qualifier other than a "U", i.e., Non-Detect).

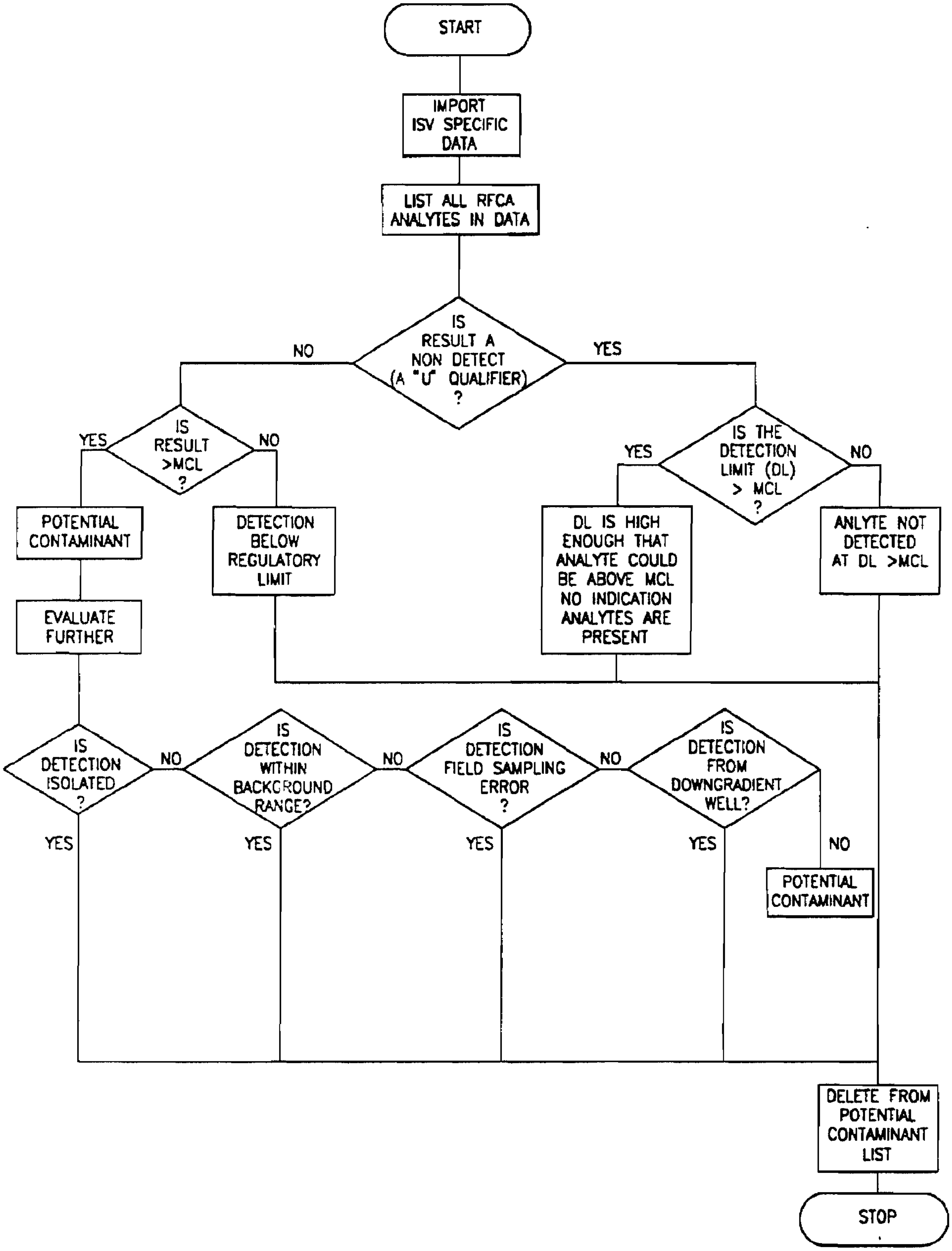
- Non-detected values (i.e., the analytical result carries a "U" qualifier).

To identify potential site contaminants, these two categories (detected and non-detected values) were further divided into the following:

A) Detected value is equal to or exceeds the Maximum Contaminant Levels (MCL) (see below).
B) Detected value is below the MCL.
C) Detection limit of the non-detected value is equal to or exceeds the MCL.
D) Detection limit is below the MCL.

RMRS has negotiated Tier I and Tier II MCLs for soils and groundwater at RFETS. The Tier I MCLs are designed to identify source areas at RFETS, and exceedance of the Tier I MCLs requires evaluation, remedial action, or management action. The Tier II MCLs are action levels that are protective of surface water. Weston selected the most restrictive MCLs when evaluating the environmental data for the proposed ISV site. For groundwater data Weston used the MCLs set forth by the RFCA on *Table 2-Ground Water Action Levels Tier II* (DOE, 1996). The Tier II MCLs have been used for groundwater because collection of groundwater and discharge to surface water may be required during construction and operation (footing drain) of the ISV. For soils data, MCLs were used for the organic compounds as defined in *Table 4-Tier I Subsurface Soil Action Levels for Organics* (DOE, 1996), and MCLs were used for inorganics and radionuclides as defined in Tier II (b) Industrial Use for Inorganics and Radionuclides (DOE, 1996). The most restrictive MCLs were used for soils, because construction of the ISV will require handling of the soils, and the more restrictive MCLs will ensure protection of onsite workers.

Based on the data reduction procedures identified above, each analyte was evaluated as possibly representing a site contaminant. Potential site contaminants are defined as those analytes detected above the selected MCL. The analytes fitting this criteria are indicated in



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INTERIM STORAGE VAULT ASSESSMENT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

ENVIRONMENTAL DATA EVALUATION FLOW CHART

FIGURE 1.12.6-1

11705001.PJ-030497

Column A of Table 1.12.6-3. The number indicated in Column A of Table 1.12.6-3 is the actual number of occurrences where the detected value (the value is not qualified as a "U)' is above the MCL. These analytes have been passed on for further evaluation (see below) because they may represent site contaminants.

The next category tabulated was the condition where the detected value (the value is not qualified as a "U") did not exceed the MCL. These parameters were not considered to be potential site contaminants and were not considered further. The analytes fitting this criteria are indicated in Column B of Table 1.12.6-3. The number indicated in Column B of Table 1.12.6-3 is the actual number of occurrences where the actual detected value (the value is not qualified as a "U") is below the MCL. The final two categories represent conditions where the value has been qualified as a "U" (not detected at the reported detection limit). These have been divided into results where the detection limit is equal to or exceeds the MCL (Column C on Table 1.12.6-3) and those where the detection limit is below the MCL (Column D on Table 1.12.6-3). If the detection limit exceeded the MCL (Column C on Table 1.12.6-3), the analyte could be present at a concentration above the MCL (indicating a potential site contaminant). This condition occurs regularly for the VOAs and semi-VOAs because the site-specific MCLs for these compounds are near method detection limits. They have not been considered further because there is no indication that these constituents are contaminants at this site. This conclusion is based on the absence of known sources onsite or upgradient of the proposed ISV site. The non-detected values with a reported detection limit below the MCL (Column D on Table 1.12.6-3) were not considered further because they are not present above regulatory limits.

6.0 EVALUATION RESULTS

6.1 SOILS

The only analyte detected in the soil data above the selected MCL was arsenic in boreholes P415989, P416289, and P416589. The MCL for arsenic is 3.27 milligrams per kilogram (mg/kg). The concentrations of arsenic detected in the soil samples from the boreholes are all less than eight mg/kg, except at a zero to three-foot sampled interval from well P416589 (8.9 mg/kg). The established background concentration of arsenic in the Qrf and the WCS is 12.14 mg/kg (EG&G, 1992). Because the majority of detected concentrations are below the background concentration established for the soil type, arsenic is not considered a site contaminant.

Weston's review of the available soil data for the proposed ISV site indicate that there are no potential site contaminants and no reason to eliminate the site from consideration based on the existing soil data.

6.2 GROUNDWATER

The analytes detected at concentrations in excess of the Tier II MCLs (Column A on Table 1.12.6-3) are considered further because they might be possible site contaminants. All of the analytes fitting these criteria and tabulated in Column A of Table 1.12.6-3 have been

TABLE 1.12.6-3
Groundwater Result Matrix

CRITERIA:

- A — Number of Values Greater than or Equal to MCL
- B — Number of Values Below MCL
- C — Number of Non-Detects Above MCL
- D — Number of Non-Detects Below MCL
- E — Total Number of Samples

WELL			166					5671					P415889					P415989					P416089					P416189					P416289					P416389					P416489					P416589					P416689					P416989				
Criterion			A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Analyte	RFAC MCLs	UNIT																																																													
1,1,1-TRICHLOROETHANE	0.2	mg/L	0	0	0	3	3	0	0	0	1	1	0	0	0	8	8	0	0	0	9	9	0	0	0	8	8	0	0	0	24	24	0	1	0	17	18	0	0	0	9	9	0	0	0	9	9	0	0	0	13	13	0	5	0	7	12	0	0	0	11	11
1,1,2,2-TETRACHLOROETHANE	8.95E-05	mg/L	0	0	3	0	3	0	0	1	0	1	0	0	8	0	8	0	0	9	0	9	0	0	8	0	8	0	0	24	0	24	0	0	18	0	18	0	0	9	0	9	0	0	9	0	9	0	0	13	0	13	0	0	12	0	12	0	0	11	0	11
1,1,2-TRICHLOROETHANE	0.005	mg/L	0	0	3	0	3	0	0	0	1	1	0	0	0	8	8	0	0	0	9	9	0	0	0	8	8	0	0	0	24	24	0	0	1	17	18	0	0	0	9	9	0	0	0	9	9	0	0	0	13	13	0	0	0	12	12	0	0	0	11	11
1,1-DICHLOROETHANE	1.01	mg/L	0	0	0	3	3	0	0	0	1	1	0	0	0	8	8	0	0	0	9	9	0	0	0	8	8	0	0	0	24	24	0	1	0	17	18	0	0	0	9	9	0	0	0	9	9	0	0	0	13	13	0	0	0	12	12	0	0	0	11	11
1,1-DICHLOROETHENE	0.007	mg/L	0	0	0	3	3	0	0	0	1	1	0	0	0	8	8	0	0	0	9	9	0	0	0	8	8	0	0	0	24	24	1	0	0	17	18	0	0	0	9	9	0	0	0	9	9	0	0	0	13	13	0	12	0	0	12	0	0	0	11	11
1,2,4-TRICHLOROBENZENE	0.07	mg/L	0	0	0	0	0	0	0	0	1	1	0	0	0	11	11	0	0	0	12	12	0	0	0	11	11	0	0	0	31	31	0	0	0	19	19	0	0	0	12	12	0	0	0	10	10	0	0	0	16	16	0	1	0	12	13	0	0	0	14	14
1,2-DICHLOROBENZENE	0.6	mg/L	0	0	0	0	0	0	0	0	1	1	0	0	0	11	11	0	0	0	12	12	0	0	0	11	11	0	0	0	31	31	0	0	0	19	19	0	0	0	12	12	0	0	0	10	10	0	0	0	16	16	0	0	0	13	13	0	0	0	14	14
1,2-DICHLOROETHANE	0.005	mg/L	0	0	3	0	3	0	0	0	1	1	0	0	0	8	8	0	0	0	9	9	0	0	0	8	8	0	0	0	24	24	0	1	1	16	18	0	0	0	9	9	0	0	0	9	9	0	0	0	13	13	0	0	0	12	12	0	1	0	10	11
1,2-DICHLOROETHENE	0.07	mg/L	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,2-DICHLOROPROPANE	0.005	mg/L	0	0	3	0	3	0	0	0	1	1	0	0	0	8	8	0	0	0	9	9	0	0	0	8	8	0	0	0	24	24	0	0	1	17	18	0	0	0	9	9	0	0	0	9	9	0	0	0	13	13	0	0	0	12	12	0	0	0	11	11
1,3-DICHLOROBENZENE	0.6	mg/L	0	0	0	0	0	0	0	0	1	1	0	0	0	11	11	0	0	0	12	12	0	0	0	11	11	0	0	0	31	31	0	0	0	19	19	0	0	0	12	12	0	0	0	10	10	0	0	0	16	16	0	0	0	13	13	0	0	0	14	14
1,4-DICHLOROBENZENE	0.075	mg/L	0	0	0	0	0	0	0	0	1	1	0	0	0	11	11	0	0	0	12	12	0	0	0	11	11	0	0	0	31	31	0	0	0	19	19	0	0	0	12	12	0	0	0	10	10	0	0	0	16	16	0	1	0	12	13	0	0	0	14	14
2,4,5-TRICHLOROPHENOL	0.05	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	0	0	3	0	3	0	0	2	1	3	0	0	7	0	7	0	0	1	0	1	0	0	2	1	3	0	0	1	0	1	0	0	2	1	3	0	0	1	0	1	0	0	1	2	3
2,4,6-TRICHLOROPHENOL	0.00773	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	3	0	3	0	0	3	0	3	0	0	7	0	7	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3
2,4-DICHLOROPHENOL	0.11	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	0	0	0	7	7	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3
2,4-DIMETHYLPHENOL	0.73	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	0	0	0	7	7	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3
2,4-DINITROPHENOL	0.073	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	0	0	0	7	7	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3
2,4-DINITROTOLUENE	0.073	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	0	0	0	7	7	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3
2,6-DINITROTOLUENE	0.000125	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	0	0	0	7	7	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3
2-BUTANONE	2.47	mg/L	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-CHLORONAPHTHALENE	2.92	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	0	0	0	7	7	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3
2-CHLOROPHENOL	0.183	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	0	0	0	7	7	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3
2-METHYLPHENOL	1.83	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	0	0	0	7	7	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3
3,3'-DICHLOROBENZIDINE	0.000189	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	3	0	3	0	0	3	0	3	0	0	7	0	7	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3
4,4'-DDD	0.000354	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	0	0	0	7	7	0	0	0	2	2	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	0	0	0	0	0	3	3
4,4'-DDE	0.00025	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	0	0	0	7	7	0	0	0	2	2	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	0	0	0	0	0	3	3
4,4'-DDT	0.00025	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	0	0	0	7	7	0	0	0	2	2	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	0	0	0	0	0	3	3
4-CHLOROANILINE	0.146	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	0	0	0	7	7	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3
4-METHYL-2-PENTANONE	0.203	mg/L	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ACENAPHTHENE	2.19	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	0	0	0	7	7	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3
ACETONE	3.65	mg/L	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ALDRIN	0.000005	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	3	0	3	0	0	3	0	3	0	0	7	0	7	0	0	2	0	2	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3	0	0	0	0	0	0	0	3	0	3
alpha-BHC	1.35E-05	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	3	0	3	0	0	3	0	3	0	0	7	0	7	0	0	2	0	2	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3	0	0	0	0	0	0	0	3	0	3
alpha-CHLORDANE	0.002	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	0	0	0	7	7	0	0	0	2	2	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	0	0	0	0	0	3	3
ALUMINUM	106	mg/L	0	6	0	2	8	0	1	0	0	1	0	9	0	8	17	0	10	0	7	17	0	8	0	9	17	0	21	0	31	52	0	6	0	8	14	2	7	0	8	17	0	8	0	7	15	0	8	0	8	16	0	2	0	4	6	0	9	0	7	16
AMERICIUM-241	0.145	pCi/L	0	3	0	0	3	1	1	0	0	2	0	8	0	8	16	0	8	0	7	15	0	7	0	7	14	0	14	0	31	45	0	4	0	2	6	0	8	0	9	17	0	4	0	2	6	0	12	0	7	19	0	0	0	0	0	0	14	0	6	20
ANTHRACENE	11	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	0	0	0	7	7	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3
ANTIMONY	0.006	mg/L	1	0	7	0	8	0	0	1	0	1	2	1	13	1	17	0	0	17	0	17	0	0	16	1	17	1	0	51	0	52	0	1	12	1	14	0	0	17	0	17	1	2	12	0	15	1	0	15	0	16	1	1	3	1	6	0	0	12	4	16
AROCLOR-1016	0.0005	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	3	0	3	0	0	3	0	3	0	0	7	0	7	0	0	2	0	2	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3	0	0	0	0	0	0	0	3	0	3
AROCLOR-1221	0.0005	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	3	0	3	0	0	3	0	3	0	0	7	0	7	0	0	2	0	2	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3	0	0	0	0	0	0	0	3	0	3
AROCLOR-1232	0.0005	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	3	0	3	0	0	3	0	3	0	0	7	0	7	0	0	2	0	2	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3	0	0	0	0	0	0	0	3	0	3
AROCLOR-1242	0.0005	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	3	0	3	0	0	3	0	3	0	0	7	0	7	0	0	2	0	2	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3	0	0	0	0	0	0	0	3	0	3
AROCLOR-1248	0.0005	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	3	0	3	0	0	3	0	3	0	0	7	0	7	0	0	2	0	2	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3	0	0	0	0	0	0	0	3	0	3
AROCLOR-1254	0.0005	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	3	0	3	0	0	3	0	3	0	0	7	0	7	0	0	2	0	2	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3	0	0	0	0	0	0	0	3	0	3

TABLE 1.12.6-3
Groundwater Result Matrix

CRITERIA:

- A — Number of Values Greater than or Equal to MCL
- B — Number of Values Below MCL
- C — Number of Non-Detects Above MCL
- D — Number of Non-Detects Below MCL
- E — Total Number of Samples

WELL			166					5671					P415889					P415989					P416089				
Criterion			A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Analyte	RFAC MCLs	UNIT																									
AROCLOR-1260	0.0005	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	3	0	3	0	0	3	0	3
ARSENIC	0.05	mg/L	0	0	0	8	8	0	0	0	1	1	0	4	0	13	17	0	6	0	11	17	0	1	0	16	17
BARIUM	2	mg/L	0	6	0	2	8	0	1	0	0	1	0	17	0	0	17	0	17	0	0	17	0	17	0	0	17
BENZENE	0.005	mg/L	0	0	3	0	3	0	0	0	1	1	0	0	0	8	8	0	0	0	9	9	0	0	0	8	8
BENZO(a)ANTHRACENE	0.000116	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	3	0	3	0	0	3	0	3
BENZO(a)PYRENE	0.0002	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	3	0	3	0	0	3	0	3
BENZO(b)FLUORANTHENE	0.000116	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	3	0	3	0	0	3	0	3
BENZO(k)FLUORANTHENE	0.000116	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	3	0	3	0	0	3	0	3
BENZOIC ACID	146	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	3	3	0	0	0	2	2
BENZYL ALCOHOL	11	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	3	3	0	0	0	2	2
beta-BHC	4 72E-05	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	3	0	3	0	0	3	0	3
BIS(2-CHLOROETHYL)ETHER	1 63E-05	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	3	0	3	0	0	3	0	3
BIS(2-CHLOROISOPROPYL)ETHER	0.000422	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	3	0	3	0	0	3	0	3
BIS(2-ETHYLHEXYL)PHTHALATE	0.006	mg/L	0	0	0	0	0	0	0	0	0	0	1	0	2	0	3	0	0	3	0	3	0	1	2	0	3
BROMODICHLOROMETHANE	0 1	mg/L	0	0	0	3	3	0	0	0	1	1	0	0	0	8	8	0	0	0	9	9	0	0	0	8	8
BROMOFORM	0 1	mg/L	0	0	0	3	3	0	0	0	1	1	0	0	0	8	8	0	0	0	9	9	0	0	0	8	8
BROMOMETHANE	0.0109	mg/L	0	0	0	3	3	0	0	0	1	1	0	0	0	8	8	0	0	0	9	9	0	0	0	8	8
BUTYL BENZYL PHTHALATE	7 3	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3
CADMIUM	0.005	mg/L	0	0	0	8	8	0	0	0	1	1	0	1	0	16	17	0	0	1	16	17	0	0	1	16	17
CARBON DISULFIDE	0.0276	mg/L	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CARBON TETRACHLORIDE	0.005	mg/L	0	0	3	0	3	0	0	0	1	1	0	0	0	8	8	0	0	0	9	9	0	0	0	8	8
CESIUM-137	1.51	pCi/L	0	3	0	0	3	0	0	0	0	0	0	1	0	0	1	0	1	0	0	1	0	1	0	0	1
CHLOROBENZENE	0.1	mg/L	0	0	0	3	3	0	0	0	1	1	0	0	0	8	8	0	0	0	9	9	0	0	0	8	8
CHLOROETHANE	27.8	mg/L	0	0	0	3	3	0	0	0	1	1	0	0	0	8	8	0	0	0	9	9	0	0	0	8	8
CHLOROFORM	0.1	mg/L	0	0	0	3	3	0	0	0	1	1	0	0	0	8	8	0	0	0	9	9	0	0	0	8	8
CHLOROMETHANE	0.00232	mg/L	0	0	3	0	3	0	0	0	1	1	0	0	0	8	8	0	0	0	9	9	0	0	0	8	8
CHROMIUM	0.1	mg/L	0	0	0	8	8	0	0	0	1	1	0	7	0	10	17	0	6	0	11	17	1	3	0	13	17
CHRYSENE	0.0116	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3
cis-1,3-DICHLOROPROPENE	0.000127	mg/L	0	0	3	0	3	0	0	1	0	1	0	0	7	1	8	0	0	9	0	9	0	0	8	0	8
COBALT	2 19	mg/L	0	2	0	6	8	0	0	0	1	1	0	4	0	13	17	0	10	0	7	17	0	2	0	15	17
COPPER	1.3	mg/L	0	2	0	6	8	0	1	0	0	1	0	7	0	10	17	0	7	0	10	17	0	6	0	11	17
CYANIDE	0.2	mg/L	0	0	0	4	4	0	0	0	1	1	0	0	0	9	9	0	1	0	8	9	0	1	0	9	10
DI-n-BUTYL PHTHALATE	3.65	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3
DIBENZO(a,h)ANTHRACENE	1.16E-05	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	3	0	3	0	0	3	0	3
DIBROMOCHLOROMETHANE	0.00101	mg/L	0	0	3	0	3	0	0	0	1	1	0	0	0	8	8	0	0	0	9	9	0	0	0	8	8
DIELDRIN	5.31E-06	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	3	0	3	0	0	3	0	3
DIETHYL PHTHALATE	29.2	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	1	0	2	3
DIMETHYL PHTHALATE	365	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3
ENDOSULFAN I	0.219	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3
ENDOSULFAN II	0.219	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3
ENDOSULFAN SULFATE	0.219	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3
ENDRIN	0.002	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3
ETHYLBENZENE	0.7	mg/L	0	0	0	3	3	0	0	0	1	1	0	0	0	8	8	0	0	0	9	9	0	0	0	8	8
FLUORANTHENE	1.46	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3

WELL	P416189					P416289					P416389					P416489					P416589					P416689					P416989				
Criterion	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
AROCLOR-1260	0	0	7	0	7	0	0	2	0	2	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3	0	0	0	0	0	0	0	3	0	3
ARSENIC	0	8	0	43	51	0	2	0	12	14	0	5	0	12	17	0	3	0	12	15	0	5	0	11	16	0	2	0	4	6	0	2	0	14	16
BARIUM	0	47	0	5	52	0	17	0	0	17	0	17	0	0	17	0	15	0	0	15	0	18	0	0	18	0	6	0	0	6	0	19	0	0	19
BENZENE	0	0	0	24	24	0	0	1	17	18	0	0	0	9	9	0	0	0	9	9	0	0	0	13	13	0	0	0	12	12	0	0	0	11	11
BENZO(a)ANTHRACENE	0	0	7	0	7	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3
BENZO(a)PYRENE	0	0	7	0	7	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3
BENZO(b)FLUORANTHENE	0	0	7	0	7	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3
BENZO(k)FLUORANTHENE	0	0	7	0	7	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3
BENZOIC ACID	0	0	0	7	7	0	0	0	1	1	0	0	0	2	2	0	0	0	1	1	0	0	0	2	2	0	0	0	1	1	0	0	0	1	1
BENZYL ALCOHOL	0	0	0	7	7	0	0	0	1	1	0	0	0	2	2	0	0	0	1	1	0	0	0	2	2	0	0	0	1	1	0	0	0	1	1
beta-BHC	0	0	7	0	7	0	0	2	0	2	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3	0	0	0	0	0	0	0	3	0	3
BIS(2-CHLOROETHYL)ETHER	0	0	7	0	7	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3
BIS(2-CHLOROISOPROPYL)ETHER	0	0	7	0	7	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3
BIS(2-ETHYLHEXYL)PHTHALATE	1	0	6	0	7	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	1	1	1	0	3	0	0	1	0	1	0	0	3	0	3
BROMODICHLOROMETHANE	0	0	0	24	24	0	0	0	18	18	0	0	0	9	9	0	0	0	9	9	0	0	0	13	13	0	0	0	12	12	0	0	0	11	11
BROMOFORM	0	0	0	24	24	0	0	0	18	18	0	0	0	9	9	0	0	0	9	9	0	0	0	13	13	0	0	0	12	12	0	0	0	11	11
BROMOMETHANE	0	0	0	24	24	0	0	0	18	18	0	0	0	9	9	0	0	0	9	9	0	0	0	13	13	0	0	0	12	12	0	0	0	11	11
BUTYL BENZYL PHTHALATE	0	0	0	7	7	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3
CADMIUM	0	1	2	49	52	0	0	2	12	14	0	0	1	16	17	1	0	1	13	15	0	0	1	15	16	0	2	0	4	6	0	0	1	15	16
CARBON DISULFIDE	0	0	0	0	0	0	0	0	0	0	0	0	0	9	9	0	0	0	9	9	0	0	0	13	13	0	0	0	0	0	0	1	0	10	11
CARBON TETRACHLORIDE	0	0	0	24	24	0	0	1	17	18	0	2	0	15	17	0	2	0	13	15	0	1	0	15	16	0	2	0	10	12	0	2	0	14	16
CESIUM-137	0	1	0	0	1	0	2	0	12	14	0	1	0	0	1	0	1	0	0	1	0	1	0	0	1	0	2	0	4	6	0	1	0	0	1
CHLOROBENZENE	0	0	0	24	24	0	0	0	18	18	0	0	0	9	9	0	0	0	9	9	0	0	0	13	13	0	0	0	12	12	0	0	0	11	11
CHLOROETHANE	0	0	0	24	24	0	0	0	18	18	0	0	0	9	9	0	0	0	9	9	0	0	0	13	13	0	0	0	12	12	0	0	0	11	11
CHLOROFORM	0	0	0	24	24	0	18	0	0	18	0	0	0	9	9	0	0	0	9	9	0	2	0	11	13	0	9	0	3	12	0	1	0	10	11
CHLOROMETHANE	0	0	0	24	24	0	0	3	15	18	0	0	0	9	9	0	0	0	9	9	0	0	0	13	13	0	0	0	12	12	0	0	0	11	11
CHROMIUM	0	14	0	38	52	0	1	0	16	17	1	5	0	11	17	0	1	0	14	15	0	3	0	15	18	0	2	0	4	6	0	1	0	18	19
CHRYSENE	0	0	0	7	7	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3
cis-1,3-DICHLOROPROPENE	0	0	24	0	24	0	0	18	0	18	0	0	9	0	9	0	0	9	0	9	0	0	13	0	13	0	0	12	0	12	0	0	11	0	11
COBALT	0	9	0	43	52	0	0	0	14	14	0	3	0	14	17	0	2	0	13	15	0	2	0	14	16	0	0	0	6	6	0	0	0	16	16
COPPER	0	21	0	31	52	0	4	0	10	14	0	7	0	10	17	0	4	0	11	15	0	4	0	12	16	0	4	0	2	6	0	2	0	14	16
CYANIDE	0	2	0	23	25	0	2	0	0	2	0	2	0	7	9	0	1	0	1	2	0	0	0	9	9	0	0	0	0	0	0	2	0	6	8
DI-n-BUTYL PHTHALATE	0	0	0	7	7	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3
DIBENZO(a,h)ANTHRACENE	0	0	7	0	7	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3
DIBROMOCHLOROMETHANE	0	0	0	24	24	0	0	3	15	18	0	0	0	9	9	0	0	0	9	9	0	0	0	13	13	0	0	0	12	12	0	0	0	11	11
DIELDRIN	0	0	7	0	7	0	0	2	0	2	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3	0	0	0	0	0	0	0	3	0	3
DIETHYL PHTHALATE	0	0	0	7	7	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3
DIMETHYL PHTHALATE	0	0	0	7	7	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3
ENDOSULFAN I	0	0	0	7	7	0	0	0	2	2	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	0	0	0	0	0	3	3
ENDOSULFAN II	0	0	0	7	7	0	0	0	2	2	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	0	0	0	0	0	3	3
ENDOSULFAN SULFATE	0	0	0	7	7	0	0	0	2	2	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	0	0	0	0	0	3	3
ENDRIN	0	0	0	7	7	0	0	0	2	2	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	0	0	0	0	0	3	3
ETHYLBENZENE	0	0	0	24	24	0	0	0	18	18	0	0	0	9	9	0	0	0	9	9	0	0	0	13	13	0	0	0	12	12	0	0	0	11	11
FLUORANTHENE	0	0	0	7	7	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3

TABLE 1.12.6-3
Groundwater Result Matrix

CRITERIA:

A	Number of Values Greater than or Equal to MCL
B	Number of Values Below MCL
C	Number of Non-Detects Above MCL
D	Number of Non-Detects Below MCL
E	Total Number of Samples

WELL			166					5671					P415889					P415989					P416089					P416189					P416289					P416389					P416489					P416589					P416689					P416989				
Criterion			A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Analyte	RFAC MCLs	UNIT																																																											
FLUORENE	1.46	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	0	0	0	7	7	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3
FLUORIDE	4	mg/L	0	3	0	1	4	0	0	0	0	0	0	7	0	2	9	0	8	0	0	8	0	8	0	1	9	0	20	0	4	24	0	4	0	0	4	0	11	0	0	11	0	5	0	0	5	0	9	0	0	9	0	2	0	0	2	0	8	0	0	8
gamma-BHC (LINDANE)	0.0002	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	0	0	0	7	7	0	0	0	2	2	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	0	0	0	0	0	3	3
gamma-CHLORDANE	0.002	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	0	0	0	7	7	0	0	0	2	2	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	0	0	0	0	0	3	3
HEPTACHLOR	0.0004	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	0	0	0	7	7	0	0	0	2	2	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	0	0	0	0	0	3	3
HEPTACHLOR EPOXIDE	0.0002	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	0	0	0	7	7	0	0	0	2	2	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	0	0	0	0	0	3	3
HEXACHLOROBENZENE	0.001	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	3	0	3	0	0	3	0	3	0	0	7	0	7	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3
HEXACHLOROBUTADIENE	0.00109	mg/L	0	0	0	0	0	0	0	0	1	1	0	0	3	8	11	0	0	3	9	12	0	0	3	8	11	0	0	7	24	31	0	0	4	15	19	0	0	3	9	12	0	0	1	9	10	0	0	3	13	16	0	1	1	11	13	0	0	3	11	14
HEXACHLOROCYCLOPENTADIEN	0.05	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	0	0	0	7	7	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3
HEXACHLOROETHANE	0.00607	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	3	0	3	0	0	3	0	3	0	0	7	0	7	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3
INDENO(1,2,3-cd)PYRENE	0.000116	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	3	0	3	0	0	3	0	3	0	0	7	0	7	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3
ISOPHORONE	0.0895	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	0	0	0	7	7	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3
LITHIUM	0 73	mg/L	0	7	0	1	8	0	0	0	1	1	0	9	0	8	17	0	10	0	7	17	0	11	0	6	17	0	26	0	26	52	0	9	0	8	17	0	9	0	8	17	0	5	0	10	15	0	8	0	10	18	0	2	0	4	6	0	15	0	4	19
MANGANESE	0 183	mg/L	6	2	0	0	8	0	1	0	0	1	7	6	0	4	17	17	0	0	0	17	1	9	0	7	17	4	30	0	18	52	0	9	0	5	14	5	7	0	5	17	3	5	0	7	15	3	6	0	7	16	0	4	0	2	6	0	9	0	7	16
MERCURY	0.002	mg/L	0	0	0	8	8	0	0	0	1	1	0	2	1	14	17	0	11	0	6	17	0	1	0	15	16	0	1	0	50	51	0	0	0	14	14	0	5	0	12	17	0	1	0	14	15	0	2	0	14	16	0	0	0	6	6	0	0	0	16	16
METHOXYCHLOR	0.04	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	0	0	0	7	7	0	0	0	2	2	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	0	0	0	0	0	3	3
METHYLENE CHLORIDE	0.005	mg/L	0	0	3	0	3	0	0	0	1	1	0	0	0	8	8	0	1	0	8	9	0	2	0	6	8	0	2	0	22	24	0	1	1	16	18	0	0	0	9	9	0	0	0	9	9	0	0	0	13	13	0	0	0	12	12	0	1	0	10	11
MOLYBDENUM	0 183	mg/L	0	0	0	8	8	0	0	0	1	1	0	0	0	17	17	0	0	0	17	17	0	0	0	17	17	0	1	0	51	52	0	11	0	3	14	0	1	0	16	17	0	0	0	15	15	0	0	0	16	16	0	4	0	2	6	0	0	0	16	16
N-NITROSO-DI-n-PROPYLAMINE	1.21E-05	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	3	0	3	0	0	3	0	3	0	0	7	0	7	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3
N-NITROSODIPHENYLAMINE	0.0173	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	0	0	0	7	7	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3
NAPHTHALENE	1.46	mg/L	0	0	0	0	0	0	0	0	1	1	0	0	0	11	11	0	0	0	12	12	0	0	0	11	11	0	1	0	30	31	0	1	0	18	19	0	1	0	11	12	0	0	0	10	10	0	2	0	14	16	0	1	0	12	13	0	0	0	14	14
NICKEL	0 1	mg/L	0	4	0	4	8	0	0	0	1	1	0	10	0	7	17	0	7	0	10	17	0	5	0	12	17	0	9	0	43	52	0	0	0	17	17	0	5	0	12	17	0	1	0	14	15	0	4	0	14	18	6	0	0	0	6	0	0	0	19	19
NITRATE/NITRITE	11	mg/L	0	3	0	1	4	0	2	0	0	2	0	8	0	1	9	0	8	0	0	8	0	8	0	1	9	0	20	0	4	24	0	11	0	0	11	0	11	0	0	11	0	7	0	0	7	0	12	0	0	12	0	9	0	0	9	0	3	0	8	11
NITROBENZENE	0.0042	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	3	0	3	0	0	3	0	3	0	0	7	0	7	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3
PENTACHLOROPHENOL	0.001	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	3	0	3	0	0	3	0	3	0	0	7	0	7	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3	0	0	1	0	1	0	0	3	0	3
PHENOL	21.9	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	0	0	0	7	7	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3
PLUTONIUM-239/240	0.151	pCi/L	0	3	0	0	3	2	0	0	0	2	0	9	0	8	17	0	8	0	7	15	0	6	0	8	14	0	12	0	35	47	0	4	0	2	6	0	8	0	9	17	0	4	0	2	6	0	7	0	12	19	0	0	0	0	0	0	12	0	9	21
ROPANE, 1,2-DIBROMO-3-CHLOR	0.0002	mg/L	0	0	0	0	0	0	0	1	0	1	0	0	8	0	8	0	0	9	0	9	0	0	8	0	8	0	0	24	0	24	0	0	18	0	18	0	0	9	0	9	0	0	9	0	9	0	0	13	0	13	0	0	12	0	12	0	0	11	0	11
PYRENE	1.1	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	0	0	0	7	7	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3	0	0	0	1	1	0	0	0	3	3
RADIUM-226	20	pCi/L	0	0	0	0	0	0	0	0	0	0	0	8	0	0	8	0	7	0	0	7	0	2	0	1	3	0	14	0	0	14	0	8	0	0	8	0	8	0	0	8	0	8	0	0	8	0	10	0	0	10	0	2	0	0	2	0	3	0	0	3
RADIUM-228	20	pCi/L	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3	0	3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3	0	0	0	0	0	0	3	0	0	3
SELENIUM	0.05	mg/L	0	0	0	8	8	0	0	0	1	1	0	1	0	16	17	0	5	0	12	17	0	1	0	16	17	0	5	0	46	51	0	4	0	13	17	0	3	0	14	17	1	0	0	14	15	0	4	0	14	18	0	1	0	5	6	0	3	0	16	19
SILVER	0.183	mg/L	0	0	0	8	8	0	0	0	1	1	0	0	0	17	17	0	0	0	17	17	0	1	0	16	17	0	0	0	52	52	0	0	0	14	14	0	0	0	17	17	0	3	0	12	15	0	3	0	13	16	0	0	0	6	6	0	0	0	16	16
STRONTIUM	21.9	mg/L	0	7	0	1	8	0	1	0	0	1	0	17	0	0	17	0	17	0	0	17	0	17	0	0	17	0	45	0	7	52	0	14	0	0	14	0	17	0	0	17	0	15	0	0	15	0	16	0	0	16	0	6	0	0	6	0	16	0	0	16
STRONTIUM-89,90	4.82	pCi/L	0	4	0	0	4	0	0	0	0	0	0	8	0	9	17	0	10	0	5	15	0	9	0	7	16	0	13	0	37	50	0	0	0	0	0	0	6	0	11	17	0	5	0	1	6	0	6	0	7	13	0	0	0	0	0	0	6	0	9	15
STYRENE	0.1	mg/L	0	0	0	3	3	0	0	0	1	1	0	0	0	8	8	0	0	0	9	9	0	0	0	8	8	0	0	0	24	24	0	0	0	18	18	0	0	0	9	9	0	0	0	9	9	0	0	0	13	13	0	0	0	12	12	0	0	0	11	11
SULFATE	500	mg/L	0	3	0	1	4	0	0	0	0	0	0	9	0	0	9	0	8	0	0	8	0	9	0	0	9	0	19	0	5	24	0	9	0	0	9	0	11	0	0	11	0	5	0	0	5	0	13	0	0	13	0	3	0	0	3	0	11	0	0	11
TETRACHLOROETHENE	0.005	mg/L	0	0	3	0	3	0	0	0	1	1	0	0	0	8	8	0	0	0	9	9	0	0	0	8	8	0	0	0	24	24	1	0	1	16	18	0	0	0	9	9	0	0	0	9	9	0	11	0	2	13	0	12	0	0	12	0	1	0	10	11
THALLIUM	0.002	mg/L	0	3	0	5	8	0	0	1	0	1	1	0	16	0	17	4	0	11	2	17	0	0	11	6	17	7	0	20	24	51	2	0	10	2	14	3	0	11	3	17	1	0	14	0	15	3	0	11	2	16	0	0	5	1	6	3	0	10	3	16
TIN	21.9	mg/L	0	0	0	8	8	0	0	0	1	1	0	5	0	12	17	0	2	0	15	17	0	1	0	16	17	0	2	0	50	52	0	1	0	13	14	0	4	0	13	17	0	2	0	13	15	0	2	0	14	16	0	1	0	5	6	0	1	0	15	16
TOLUENE	1	mg/L	0	0	0	3	3	0	0	0	1	1	0	0	0	8	8	0	0	0	9	9	0	0	0	8	8	0	1	0	23	24	0	0	0	18	18	0	0	0	9	9	0	0	0	9	9	0	0	0	13	13	0	0	0	12	12	0	0	0	11	11
TOTAL XYLENES	10	mg/L	0	0	0	3	3	0	0	0	0	0	0	0	0	2	2	0	0	0	4	4	0	0	0	4	4	0	0	0	7	7	0	0	0	13	13	0	0	0	4	4	0	0	0	3	3	0	0	0	9	9	0	0	0	8	8	0	0	0	6	6
TOXAPHENE	0.003	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	2	1	3	0	0	0	3	3	0	0	1	2	3	0	0	0	7	7	0	0	0	2	2	0	0	1	2	3	0	0	0	1	1	0	0	1	2	3	0	0	0	0	0	0	0	2	1	3
trans-1,3-DICHLOROPROPENE	0.000127	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	18	0	0	9	0	9	0	0	9	0	9	0	0	13	0	13	0	0	12	0	12	0	0	11	0	11

TABLE 1.12.6-3
Groundwater Result Matrix

CRITERIA:

- A — Number of Values Greater than or Equal to MCL
- B — Number of Values Below MCL
- C — Number of Non-Detects Above MCL
- D — Number of Non-Detects Below MCL
- E — Total Number of Samples

WELL			166					5671					P415889					P415989					P416089				
Criterion			A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Analyte	RFAC MCLs	UNIT																									
TRICHLOROETHENE	0.005	mg/L	0	0	3	0	3	0	0	0	1	1	0	1	0	7	8	0	0	0	9	9	0	0	0	8	8
TRITIUM	666	pCi/L	0	4	0	0	4	0	0	0	0	0	0	7	0	3	10	0	6	0	2	8	0	6	0	3	9
URANIUM-233,-234	2.98	pCi/L	0	3	0	0	3	0	0	0	0	0	0	17	0	0	17	0	17	0	0	17	0	11	0	5	16
URANIUM-235	1.01	pCi/L	0	3	0	0	3	0	0	0	0	0	0	10	0	7	17	0	10	0	7	17	0	7	0	9	16
URANIUM-238	0.768	pCi/L	0	3	0	0	3	0	0	0	0	0	6	11	0	0	17	6	10	0	1	17	2	10	0	4	16
VANADIUM	0.256	mg/L	0	6	0	2	8	0	0	0	1	1	0	9	0	8	17	0	7	0	10	17	0	4	0	13	17
VINYL ACETATE	36.5	mg/L	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VINYL CHLORIDE	0.002	mg/L	0	0	3	0	3	0	0	0	1	1	0	0	0	8	8	0	0	0	9	9	0	0	0	8	8
ZINC	11	mg/L	0	6	0	2	8	0	0	0	1	1	0	10	0	7	17	0	11	0	6	17	0	9	0	8	17

WELL	P416189					P416289					P416389					P416489					P416589					P416689					P416989				
Criterion	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
TRICHLOROETHENE	0	1	0	23	24	0	1	1	16	18	0	0	0	9	9	0	1	0	8	9	0	0	0	13	13	1	11	0	0	12	0	0	0	11	11
TRITIUM	0	9	0	14	23	0	9	0	3	12	0	6	0	3	9	0	4	0	4	8	0	8	0	4	12	0	9	0	4	13	0	8	0	5	13
URANIUM-233,-234	0	35	0	10	45	13	0	0	0	13	0	17	0	0	17	0	15	0	0	15	0	20	0	0	20	2	2	0	0	4	2	16	0	3	21
URANIUM-235	0	10	0	35	45	0	8	0	5	13	0	6	0	11	17	0	8	0	7	15	0	10	0	10	20	0	4	0	0	4	1	9	0	11	21
URANIUM-238	7	27	0	11	45	13	0	0	0	13	7	10	0	0	17	15	0	0	0	15	5	14	0	1	20	4	0	0	0	4	3	12	0	6	21
VANADIUM	0	23	0	29	52	0	2	0	12	14	0	9	0	8	17	0	4	0	11	15	0	6	0	10	16	0	1	0	5	6	0	0	0	16	16
VINYL ACETATE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VINYL CHLORIDE	0	0	0	24	24	0	0	4	14	18	0	0	0	9	9	0	0	0	9	9	0	0	0	13	13	0	0	0	12	12	0	0	0	11	11
ZINC	0	27	0	25	52	0	8	0	6	14	0	12	0	5	17	0	8	0	7	15	0	8	0	8	16	0	2	0	4	6	0	9	0	7	16

presented on Table 1.12.6-4. A total of 17 analytes were detected that exceed Tier II MCLs. A careful review of the analytes listed on Table 1.12.6-4 and the original data for each of these exceedances has allowed for the causes of the exceedances to be assigned to one of the following four categories:

(1) The exceedance is an isolated event and is not representative of the concentration of the analyte in the groundwater. These analytes are not considered further.

(2) The exceedances are attributed to naturally occurring concentrations of the analyte that have been detected at similar concentrations in groundwater from areas near the plant and undisturbed by plant operations. These analytes naturally occur in the groundwater at the site at concentrations above the Tier II MCL.

(3) The exceedances were in groundwater from wells located downgradient of the proposed ISV site. These analyte concentrations are not present in groundwater on the proposed site and are not considered further.

(4) The exceedance can be attributed to field sampling errors. The detection of these analytes does not indicate that the analyte is present in the groundwater at the proposed ISV site.

Table 1.12.6-4 presents a summary of the analytes detected above Tier II MCLs and the rationale for eliminating each as a site contaminant. Each is described below.

6.2.1 Isolated Exceedances

The analytes whose concentrations exceeded the Tier II MCL during isolated sampling events are as follows:

1,1-Dichloroethene	Aluminum	Cadmium
Chromium	Tetrachloroethene	Uranium-235
Americium-241	Plutonium-239/240	Selenium

The exceedances observed for each of these analytes is determined to be an outlier and not indicative of groundwater conditions, because, in all cases, the exceedance was preceded and followed by events where the analyte was not detected. Americium and plutonium were only detected once in a well that was abandoned. Because the well was abandoned, it could not be resampled. Neither americium nor plutonium were detected at any other sampling location in the data reviewed. Based on the isolated occurrence of the analyte concentration above MCLs, they are not considered to be site contaminants and have not been considered further.

6.2.2 Exceeds MCLs But Naturally Occurring

These analytes exceed the Tier II MCL. The concentrations detected are similar to background concentrations in groundwater. The background concentrations were established in the EG&G report (1992) for the RFETS. The referenced document contains background concentrations for all of the geologic formations present at RFETS. The wells at the

TABLE 1.12.6-4 DETECTED CONCENTRATIONS EXCEEDING MCLs

Chemical Name	166	5671	P415889	P415989	P416089	P416189	P416289	P416389	P416489	P416589	P416689	P416989
1,1-DICHLOROETHENE							1					
ALUMINUM								1				
AMERICIUM-241		1										
ANTIMONY	2		2			2			2	2	2	
BIS(2-ETHYLHEXYL)PTHALATE			4			4				4		
CADMIUM									1			
CHROMIUM								1				
MANGANESE	2		2		2	2		2	2	2		
NICKEL												
PLUTONIUM-239/240		1										
SELENIUM										1		
TETRACHLOROETHENE							1					
THALLIUM			2	2	2	2	2	2	2	2		2
TRICHLOROETHENE											3	
URANIUM-233, -234							2				2	2
URANIUM-235												1
URANIUM-238			2		2	2	2	2	2	2	2	2

1=ISOLATED EVENT
2=NATURALLY OCCURRING
3=DOWN GRADIENT
4=SAMPLING ERRORS

proposed ISV site are screened across the Qrf and the WCS (see Monitoring Well Description Table), resulting in the sampled groundwater representing both the saturated alluvium and weathered claystone. Therefore, the background values for either the Qrf or the WCS are considered applicable for groundwater from these wells. Background values for the Kar are substantially lower and only apply to well P416989, a Kar bedrock well. The analytes whose concentrations exceed the Tier II MCLs but whose concentrations are similar to background levels are as follows:

Antimony	Manganese
Thallium	Uranium-233,-234
Uranium-238	

These analyte concentrations were observed to be prevalent in the groundwater in all or a majority of the monitoring wells.

Although most of the detections are within established background concentrations, some isolated detections exceeded these background concentrations. The following table presents the specific detections of analytes exceeding the background concentrations:

Table 1.12.6-5 EXCEEDANCE OF BACKGROUND CONCENTRATIONS IN Qrf AND WCS WELLS

ANALYTE	BACKGROUND Qrf	BACKGROUND WCS	WELL	RESULTS EXCEEDING BACKGROUND WITH MONTH/YEAR
Dissolved Antimony	51.248 ug/l	51.248 ug/l metals	P416689	71 ug/l Feb. 1994
Total Manganese	932.505 ug/l	932.505 ug/l	P415889 P415989 P416089 P416389 P416589	970 ug/l 2,270 ug/l 228 ug/l 540 ug/l 1,600 ug/l All occurred in Nov. 1993
Total Thallium	3 ug/l	3 ug/l	P415889 P415989 P416189 P416389 P416989	U/5 ug/l 3.9/4.9 ug/l 4.8/6.2 ug/l 5.2/4.9 ug/l 5.1/U ug/l All occurred in Feb./May 1995
Total Uranium 238	1.817 pCi/l	91.978 pCi/l	P415889	3.0 pCi/l, Feb. 1994; 2.9 pCi/l, Aug. 1994; 3.3 pCi/l, Nov. 1994; 2.2 pCi/l, Mar. 1995

Although established background concentrations have been exceeded, the following discussion presents justification for eliminating these analytes as site contaminants.

The single incidence of a reported concentration of antimony above background occurs in a downgradient location (P416689),and subsequent results have all been "U" values. Antimony is not considered a contaminant and is not considered further.

The reported concentrations of manganese above background for the five listed monitoring wells occurred during a single sampling event in November 1993. The reported concentrations of manganese subsequent to this event have all been either below MCL or background, with a majority of the results reported as "U" values. Manganese is not considered a contaminant and is not considered further.

The reported concentrations of thallium above background occurred during the February and May 1995 sampling events in the five listed wells. These results were qualified by the lab as also present in the blanks ("B"). All other results prior to and subsequent of these events are either below MCLs, background, or reported as "U" values. Thallium is not considered as a contaminant and is not considered further.

Well P415889 has relatively high uranium-238 values for an alluvial well. Inspection of the borehole log and comparison with adjacent well P415989 suggest the well may extend into the bedrock. The reported values of this well are representative of WCS background levels. It is concluded that uranium-238 is not a contaminant.

Concentrations in groundwater from the Kar bedrock are discussed below.

Table 1.12.6-6 EXCEEDANCE OF BACKGROUND CONCENTRATIONS IN Kar BEDROCK WELLS

ANALYTE	BACKGROUND WCS	BACKGROUND Kar	WELL	RESULTS EXCEEDING BACKGROUND AND MONTH/YEAR
Dissolved - Uranium 233,-234	15.176 pCi/l	9.057 pCi/l	P416989	26 pCi/l in Nov. 1993 13.2 pCi/l in Oct. 1995
Dissolved - Uranium -238	10.297 pCi/l	4.765 pCi/l	P416989	29 pCi/l in Nov. 1993 10.1 pCi/l in Oct. 1995

Although established background concentrations have been exceeded, the following discussion presents justification for eliminating these analytes as site contaminants.

The reported concentrations of uranium-233, -234, and -238 above background occurred in well P416989 for the November 1993 and October 1995 sampling events. All subsequent reported values at P416989 are below background and reported as "J", "B", or "U" values. Uranium-233, -234, and -238 are not considered contaminants and are not considered further. Also, the Kar bedrock groundwater is not expected to be encountered during construction or operation of the ISV.

6.2.3 Downgradient Exceedance

Nickel was detected above MCLs in the groundwater at one location (P416689). Although these values still exceed the MCL, the location is downgradient to the site, with no upgradient locations reporting nickel in concentrations above the MCL. Nickel is not considered a contaminant and is not considered further.

Trichloroethene was detected above detection limits throughout the reported data and on one occasion above the MCL at well P416689. As with the occurrence of nickel in the groundwater at this location, it is in a downgradient position to the site and is not identified above detection limits in upgradient wells. Trichloroethene is not considered a contaminant at the site and is not considered further.

6.2.4 Field Sampling Errors

Bis (2-Ethylhexyl)phthalate is a common contaminant introduced by field sampling equipment. Data sets are available from November 1993 through May 1994. The analyte was detected above MCLs in three wells. Of the three wells, two have concentrations that are at "J" values below detection limits. The result from well P415889 occurred in November 1993 and results since have been not detected. Bis(2-Ethylhexyl)phthalate is not considered a contaminant and is not considered further.

7.0 CONCLUSIONS

The concentrations of VOAs, metals, and radionuclides identified in the soils and groundwater of the proposed ISV site do not suggest a source area or an area with contaminants that exceed Tier II criteria and present a health risk. Based on this data review, no site contaminants are present that would eliminate this site as à candidate for construction of the ISV.

8.0 REFERENCES

EG&G, 1992. Background Geochemical Characterization Report, Rocky Flats Plant, Golden, Colorado.

DOE (U. S. Department of Energy), 1992. Historical Release Report for the Rocky Flats Plant, Environmental Restoration Program, Rocky Flats Plant, Golden, Colorado.

DOE (U. S. Department of Energy), 1994. Final Phase III RFI/RI Report, Rocky Flats Plant, 881 Hillside Area (Operable Unit No. 1), Rocky Flats Plant, Golden, Colorado.

DOE (U. S. Department of Energy), 1996. Rocky Flats Cleanup Agreement, Rocky Flats Plant, Golden, Colorado.

APPENDIX 1.12.7
Material Take-Offs and Estimating Assumptions

of the
Conceptual Design Report

for the
Interim Storage Vault

for the
Rocky Flats Environmental Technology Site
Golden, Colorado

Task Order 72

for the

U. S. Department of Energy
Rocky Flats Operations Office
Golden, Colorado

Prepared by
Rocky Flats Engineers and Constructors, LLC
Denver, Colorado

May 1997

Authorization No. E32CD100

APPENDIX 1.12.7

MATERIAL TAKE-OFFS

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

CONCEPTUAL DESIGN REPORT
FOR:

INTERIM STORAGE VAULT

Authorization No. E32 CD 100

TABLE OF CONTENTS

CLIENT: Rocky Flats Environmental Technology Site						EST. NO.	JO NO. 0648	SHT. NO. 1of	
DESCRIPTION OF WORK: Interim Storage Vault						QTY. BY:	CK. BY:	PRICES BY :	
Drawing No. C102						DATE:	APPROVED:		
ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	1	8 ft. high chain link fence w/ outriggers	3094 LF						
	2	20 ft. wide, 2 leaf gate	1 EA						
		Roadway							
	3	4" asphalt	4840 SY						
	4	CDOH Class 6 Base Course	1885 CY						
	5	Compact subgrade	51000 SF						
	6	4 ft. wide mangate	1 EA						

CLIENT: Rocky Flats Environmental Technology Site						EST. NO.	JO NO. 0648	SHT. NO. 1of	
DESCRIPTION OF WORK: Interim Storage Vault						QTY. BY:	CK. BY:	PRICES BY :	
Drawing No. C103						DATE:	APPROVED:		
ACCOUNT NO	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	1	Fdn Drain - 6" PVC 30 ft. deep trench	940 LF						
	2	Raw Water - 10" D.I.P. 5 ft. trench	573 LF						
	3	Raw Water - 12" D.I.P. 5 ft. trench	627 LF						
	4	San Sewer - 6" PVC 8 ft. trench	197 LF						
	5	San Sewer - 8" PVC 8 ft. trench	1177 LF						
	6	San Sewer - 8 ft. deep manhole	3 EA						
	7	Water - 6" PVC 5 ft. trench	107 LF						
	8	Water - 10" D.I.P. 5 ft. trench	666 LF						
	9	Gas - 1-1/2" Polyethylene 4 ft. trench	733 LF						

CLIENT: Rocky Flats Environmental Technology Site	EST. NO.	JO NO. 0648	SHT. NO. 1of
DESCRIPTION OF WORK: Interim Storage Vault	QTY. BY:	CK. BY:	PRICES BY :
Drawing No. C104	DATE:	APPROVED:	

ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
		Excavation							
	1	Foundation	67400 CY						
	2	Ditch	940 CY						
		Embankment							
	3	Common fill - foundation	19320 CY						
	4	Common fill- overburden	27000 CY						
	5	Common fill - berm	25800 CY						
	6	River rock - foundation	6180 CY						
	7	River rock - overburden	46900 CY						
	8	Clay fill - overburden	27000 CY						
	9	Final Grading	16.5 AC						
	10	Geotextile	30300 SY						
	11	Holding Tank drain - 4" PVC 4 ft. trench	200 LF						
	12	Precast Conc. Catch Basin 4'x4'x6' deep with grat	1 EA						
	13	Culvert - 30" RCP 6 ft. trench	230 LF						
	14	Culvert - 18" CMP 4 ft. trench	30 LF						

CLIENT: Rocky Flats Environmental Technology Site						EST. NO.	JO NO. 0648	SHT. NO. 1of	
DESCRIPTION OF WORK: Interim Storage Vault						QTY. BY:	CK. BY:	PRICES BY :	
Drawing No. C105						DATE:	APPROVED:		
ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	1	Foundation drain - 4" PVC perforated pipe	2805 LF						
	2	Foundation drain - 6" PVC solid pipe	126 LF						

CLIENT: Rocky Flats Environmental Technology Site						EST. NO.	JO NO. 0648	SHT. NO. 1of	
DESCRIPTION OF WORK: Interim Storage Vault						QTY. BY:	CK. BY:	PRICES BY :	
Drawing No. C106						DATE:	APPROVED:		
ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
		Demolition							
		Buildings - include foundations & utility stubups							
	1	Bldg. 100	1 EA						
	2	Bldg. 119	1 EA						
	3	Bldg. 126	1 EA						
	4	Bldg. 128	1 EA						
		Trailers - include utility stubups							
	5	T119A	1 EA						
	6	T119B	1 EA						
	7	T121A	1 EA						
	8	T124A	1 EA						
		Miscellaneous - remove & properly dispose of offsite							
	9	Fence - 8 ft. chain link	2018 LF						
	10	Paving - parking lot/road - 4" asphalt	37300 SY						
		Utilities							
	11	2" stl natural gas 4 ft. bury	753 LF						
	12	8" san sewer 8 ft. bury	400 LF						
	13	10" C.I.P. water - 5 ft. bury	299 LF						
	14	12" D.I.P. water - 5 ft. bury	343 LF						
	15	12" C.I.P. water - 5 ft. bury	285 LF						

CLIENT: Rocky Flats Environmental Technology Site							EST. NO.	JO NO. 0648	SHT. NO. 1of	
DESCRIPTION OF WORK: Interim Storage Vault							QTY. BY:	CK. BY:	PRICES BY :	
Drawing No. C302							DATE:	APPROVED:		
ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS	
	1	form 3 ft. concrete slab on grade	16557 SF							
	2	slab on grade - concrete	11127 CY							
	3	slab on grade - reinforcement	2059 T							
	4	finish slab	68101 SF							
	5	walls - form	132005 SF							
	6	walls - concrete	5293 CY							
	7	walls - reinforcement	1029 T							
	8	columns - form	8064 SF							
	9	columns - concrete	280 CY							
	10	columns - reinforcement	92 T							

CLIENT: Rocky Flats Environmental Technology Site							EST. NO.	JO NO. 0648	SHT. NO. 1of	
DESCRIPTION OF WORK: Interim Storage Vault							QTY. BY:	CK. BY:	PRICES BY :	
Drawing No. C303							DATE:	APPROVED:		
ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS	
	1	form 3 ft. concrete slab on grade	6294 SF							
	2	slab - concrete	9772 CY							
	3	slab - reinforcement	2126 T							
	4	finish slab	44318 SF							
	5	walls - form	135275 SF							
	6	walls - concrete	6611 CY							
	7	walls - reinforcement	1652 T							
	8	columns - form	8880 SF							
	9	columns - concrete	304 CY							
	10	columns - reinforcement	98 T							
	11	form 2.5 ft. structural slab	55348 SF							

CLIENT: Rocky Flats Environmental Technology Site	EST. NO.	JO NO. 0648	SHT. NO. 1of
DESCRIPTION OF WORK: Interim Storage Vault	QTY. BY:	CK. BY:	PRICES BY :
Drawing No. 51493-C304	DATE:	APPROVED:	

ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	1	structural slab - form	49238 SF						
	2	structural slab - concrete	5601 CY						
	3	structural slab - reinforcement	1608 T						
	4	walls - form	75600 SF						
	5	walls - concrete	3880 CY						
	6	walls - reinforcement	1180 T						

CLIENT: Rocky Flats Environmental Technology Site	EST. NO.	JO NO. 0648	SHT. NO. 1of
DESCRIPTION OF WORK: Interim Storage Vault	QTY. BY:	CK. BY:	PRICES BY :
Drawing No. 51493-C306	DATE: 4/24/9	APPROVED:	

ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	1	Steel shapes and plates, A36	328 T						
	2	TS 6x6x1/2, A500 Grade A	5824 T						
	3	3/4" dia x 6" headed anchor stud, A108	588 EA						
	4	1/2" dia x 4" headed anchor stud, A108	38024 EA						

CLIENT. Rocky Flats Environmental Technology Site	EST. NO.	JO NO. 0648	SHT. NO. 1of
DESCRIPTION OF WORK. Interim Storage Vault	QTY. BY:	CK. BY:	PRICES BY :
Drawing No. 51493-C307	DATE:	APPROVED:	

ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
		Rolling Concrete Security Doors - 9 each							
	1	Steel shapes and plates, A36	22 T						
	2	1/2" dia. threaded rod with nuts	1716 LF						
	3	1/2" dia x 4" headed anchor studs, A108	550 EA						
	4	reinforcement, A615 Grade 60	14 T						
	5	concrete	59 CY						
	6	8NT Hillman Roller	24 EA						
	7	15NT Hillman Roller	8 EA						
	8	20NT Hillman Roller	4 EA						

CLIENT: Rocky Flats Environmental Technology Site	EST. NO.	JO NO. 0648	SHT. NO. 1of
DESCRIPTION OF WORK: Interim Storage Vault	QTY. BY:	CK. BY:	PRICES BY :
Drawing No. 51493-C201	DATE:	APPROVED:	

ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
		Finishes							
	1	ceramic tile	2033 SF						
	2	2 ft. x 2 ft. acoustical suspended ceiling	5042 SF						
		Fixtures/Equipment							
	3	water closets	3 EA						
	4	sink	2 EA						
	5	shower unit	2 EA						
	6	mirror	2 EA						
	7	set of (6) lockers	2 EA						
	8	wood bench	2 EA						
	9	urinal	1 EA						
	10	metal stud wall w/ 5/8" gypsum each side	515 LF						
	11	4 ft. x 6 ft. bullet proof glass window	1 EA						

CLIENT: Rocky Flats Environmental Technology Site

DESCRIPTION OF WORK: Interim Storage Vault

Drawing No. 51493-C202

EST. NO.	JO NO. 0648	SHT. NO. 1of
QTY. BY:	CK. BY:	PRICES BY :
DATE:	APPROVED:	

ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	1	Galv. steel heavy duty grating	19269 SF						
	2	TS 5x3x1/4, A500 Grade A	4 T						
	3	TS 3x3x1/4, A500 Grade A	0.7 T						
	4	10 Ga. x 3" galv. corrugated metal arch	7520 SF						

CLIENT: Rocky Flats Environmental Technology Site						EST. NO.	JO NO. 0648	SHT. NO. 1of	
DESCRIPTION OF WORK: Interim Storage Vault						QTY. BY:	CK. BY:	PRICES BY :	
Drawing No. 51493-C203						DATE:	APPROVED:		
ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
		Hollow metal doors and frames							
	1	2-4'x9' double door, wired glass lite, fire label B	1 EA						
	2	22' wide x 13' high rolling overhead door	1 EA						
	3	3'x7' door, wired glass lite	3 EA						
	4	2-3'x7' double door, wired glass lite	1 EA						
	5	3'x7' door, wired glass lite, fire label B	2 EA						
	6	3'x7' door, fire label C	5 EA						
	7	3'x7' door, wired glass lite, fire label C	4 EA						
		Vault doors							
	8	8' wide x 9' high steel, fire rated, explosion rated	2 EA						
	9	4' wide stair w/ 12" stl grate tread and handrails	22 LF						

CLIENT: Rocky Flats Environmental Technology Site						EST. NO.	JO NO. 0648	SHT. NO. 1of	
DESCRIPTION OF WORK: Interim Storage Vault						QTY. BY:	CK. BY:	PRICES BY :	
Drawing No. 51493-C607						DATE:	APPROVED:		
ACCOUNT NO.	ITEM NO.	3013 Can Storage Tube Floor Penetration and Misc. Items DESCRIPTION	* QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	1	HT-1 Holding Tank: 30,000 gal Capy (16' dia x 20' deep); fiberglass, concrete, or steel with corrosion protection; underground vented with access manway on top and mounting pad with removable cover for duplex pumps	1						
	2	P-3 A and B Pumps: Duplex, submerged-type, 150 gpm per pump at 30' HD with 3 HP/1730 rpm, 230 V motor; ITT/FLYGT C-3102 or equivalent	2						
	3	P-2 A and B Pumps /Lift Station: Unit w/ duplex pumps, submerged-type, 300 gpm per pump at 20' HD 4" discharge piping with check valve, complete with level controls. Access cover, motor starter and wiring. ITT/FLYGT Lift Station # CP-3102 or equivalent.	1						
	4	MH-1 Manhole: Pre-fabricated unit, concrete, 4ft. dia x 8 ft deep (verify according to location/depth)	1						
	5	DP-1 drain pipe, 6" cast iron, service wt., Hub and spigot-type, ASTM A74	1350 ft						
	6	WP-1 Pipe, water supply: 6" Sch 40 black iron							
	7	WD-1 Waterflow detector/alarm: 6" electrically-operated w/remote station signal.	1						
	8	BFP-1 Backflow preventor: 6" reduced-pressure type, FEBCO Brand or approved equivalent	1						
	9	CV-1 Check valve: 6" swing-type, class 150 flanged, R.F.	2						
	10	FDC-1 Fire Department Connection: 6" Y-type with caps	1						

CLIENT: Rocky Flats Environmental Technology Site						EST. NO.	JO NO. 0648	SHT. NO. 1of	
DESCRIPTION OF WORK: Interim Storage Vault						QTY. BY:	CK. BY:	PRICES BY :	
Drawing No. 51493-C606						DATE:	APPROVED:		

ACCOUNT NO.	ITEM NO.	3013 Can Storage Tube DESCRIPTION	* QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	1	CYL-1 Cylinder, Hydraulic: 6" Bore, 3 1/2" dia. rod, 150" stroke w/rod eye and base clevis, cushion stops on both ends, Ortman series 2M Style 'P' (NFPA Mounting Style-ME6) or equivalent	1	$4,088					
	2	CL-2 Cylinder Hydrolic: 5" Bore 2 1/2" dia. rod, 102" Stroke w/ rod eye and base clevis, cushion stops on both ends, Ortman Series 2M Style 'P' (NFPA Mounting Style-ME6) or equivalent	2	$2,021					
	3	CYL-3 Cylinder Hydraulic: 2 1/2", Bore 1 3/8" dia. rod, 42" stroke w/ rod eye and base clevis, cushion stops on both ends, Ortman series 2M style 'P' (NFPA Mounting Style-ME6) or equivalent	6	$511					
	4	HS-1 Hydraulic Supply Unit:Complete w/ reservoir 40 gal; pump-gear type,9.2 gal/min at 250 psi:valve, directional control,4-way/3position, center return, solenoid-actuated;relief valve,set at 275 psi w/ oil filter and all assoc piping. Ref Dwg 51493-C411	1	$1,137					
	5	HS-2 Hydraulic Supply Unit: Same as HS-1 except reservoir size 20 gallon	1	$1,064					
	6	HS-3 Hydraulic Supply Unit: Same as HS-1 except reservoir size 10 gallon	1	$1,033					
	7	ENCL-1 Material: 70 ft, 3 x 3 x 1/4 structural angle, M.S., 130 sq. ft., 16 GA Sheet Steel	1 Lot						

CLIENT. Rocky Flats Environmental Technology Site						EST. NO.	JO NO. 0648	SHT. NO. 1of	
DESCRIPTION OF WORK: Interim Storage Vault						QTY. BY:	CK. BY:	PRICES BY :	
Drawing No. 51493-606 (continued, 2)						DATE:	APPROVED:		
ACCOUNT NO.	ITEM NO.	3013 Can Storage Tube Base Support DESCRIPTION	* QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	8	ENCL-2 Material: 50 ft, 2 x 2 x 3/16 structural angle, M.S., 75 sq. ft., 16 GA Sheet Steel	2 Lots						
	9	ENCL-3 Material: 30 ft, 1 1/2 x 1 1/2 x 1/8 structural angle, M. S., 30 sq. ft. 16 GA Sheet Steel	6 Lots						
	10	DOOR SET, security vault-type, double leaf, hinged with combination lock for 8' wide X 9' high opening (2 Types)	2						
		Type 1: Confirming to Federal Specification AA D-600B / Class 5 per quote from Mosler Inc., Hamilton, Ohio		$17,534 (including freight)					
		Type 2: Confirming to Military Specification for Nuclear material storage - blast, missile and attack resistant, air tight, per quote from Protective Door Industries, Inc. (budgetary quote only)		$200,000 (installed)					

DESCRIPTION OF WORK: Interim Storage Vault						EST. NO.	JO NO. 0648	SHT. NO. 1of	
Drawing No. 51493-C604						QTY. BY:	CK. BY:	PRICES BY :	
						DATE:	APPROVED:		
ACCOUNT NO.	ITEM NO.	DESCRIPTION	* QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	1	AHU-1 Air Handling Unit: Trane Co. Size 17C with inlet vane damper, 8180 cfm @ 5.0" T.S.P. @ 6000'; 15 hp; 165.7 MBH chilled water coil; 4 Row, 134 FPF; Mixing Box. Filter Secton to be FARR Co. Sidelock Housing Model	1						
		SA-D-40-80-242412 (2H X 4W Filter Bank) with transition sections to mate with size 17 AHU.							
		0							
	2	SF-1 Supply Fan: New York Blower Co. General Purpose Fan, Size 123 AF wheel, belt drive; 1300 cfm @ 3.5" T.S.P. @ 6000; 1 1/2 hp.	1						
	3	EF-1 Exhaust Fan: Same as SF-1 except 1500 cfm @ 3.0" T.S.P.	1						
	4	SF-2 A and B Supply Fan: New York Blower Co. Compact GI Fan size 126, Direct Drive, 200 cfm @ 2.0" T.S.P. @ 6000'; 1/3 hp.	2						
	5	CH-1 Air cooled chiller: Trane Co. Model CGA 180 B4 with low ambient (0°F) option. Nominal 15 tons (Shown on 51439-C705)	1						
	6	P-1 A and B Pump: Bell & Gossett Series 90 In-line mounted pump, size 1 1/2 A, Model 90-37T; 1 hp; 45 gpm @ 40' head.	2						
	7	CV-1 A thru H Convector: CHROMALOX wall mounted convection header Model HCH-301; 3.0 kW	8						

DESCRIPTION OF WORK: Interim Storage Vault						EST. NO.	JO NO. 0648	SHT. NO. 1of	
Drawing No. 51493-C604 (continued, 2)						QTY. BY:	CK. BY:	PRICES BY :	
						DATE:	APPROVED:		
ACCOUNT NO.	ITEM NO.	DESCRIPTION	* QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	8	HC-1 thru HC-8 (Electric) Heating Coil; BRASCH Manufacturing Co; Slip in duct heater, Ni-Chrome wire coils; built-in control panel with SCR Controller, UL & NEC compliance, door MTD. disconnect switch							
		Tag No. / kW / V/Ph/Hz / Duct Size							
		HC-1 / 16 / 480/3/60 / 20 x 14	1						
		HC-2 / 6 / 208/1/60 / 12 x 12	1						
		HC-3 / 8 / " / 16 x 12	1						
		HC-4 / 10 / " / 20 x 12	1						
		HC-5 / 5 / " / 8 x 8	1						
		HC-6 / 5 / " / 8 x 8	1						
		HC-7 / 4 / " / 8 x 8	1						
		HC-8 / 10 / " / 14 x 14	1						
	9	FP-1 A and B Filter Plenum; FARR Co. Sidelock Housing Model SA-D-20-40-242412 (1 H x 2 W Filter bank)	2						
	10	FP-2 And B Filter Plenum; FARR Co. Sidelock Housing Model SA-D-20-20-242412 (1H x 1 W Filter Bank)	2						
	11	RH-1 Radiant Heater: CHROMALOX Overhead Radiant Space Heater Model No. RBC-33680, 3.6kW	1						

DESCRIPTION OF WORK: Interim Storage Vault						EST. NO.	JO NO. 0648	SHT. NO. 1of	
Drawing No. 51493-C604 (continued, 3)						QTY. BY:	CK. BY:	PRICES BY :	
						DATE:	APPROVED:		
ACCOUNT NO.	ITEM NO.	DESCRIPTION	* QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	12	HAM-1 Portable HEPA Air Mover: consists of fan and tow stage testable HEPA filter housing mounted on steel base frame/dolly, fan New York Blower Co. Compact GI fan size 126 belt drive, 1000 cfm @ 5" T.S.P. @ 6000; 2 hp.	1						
		Flanders Filters, Inc. Model E-5 bagout housing with in-place DOP Test inlet, combination and outlet sections (1H x 1W Filter Bank - Two Stages)							
	13	CCH-1 Portable Contamination Control Hood: Assume 11 GA 304 Stainless steel hood approx. 3'x3'x4' deep with 10" dia collar, connect to HAM-1 with heavy duty Flex duct mounted on stainless steel frame with casters.	1						
	14	CCC-1 Portable contamination control cell: Assume to be "PERMACON" structure 16'L x 8'W x 8'H feasibility mounting on base with casters and skirt to seal to floor to be investigated in T-1 design.	1						

CLIENT: Rocky Flats Environmental Technology Site						EST. NO.	JO NO. 0648	SHT. NO. 1of	
DESCRIPTION OF WORK: Interim Storage Vault						QTY. BY:	CK. BY:	PRICES BY :	
Drawing No. 51493-C605						DATE:	APPROVED:		
ACCOUNT NO.	ITEM NO.	3013 Can Storage Tube Instrument Well DESCRIPTION	* QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	1	AHU-2 Air Handling Unit: Trane Co. Size 35C with inlet vane damper for both supply and return/exhaust fans (each fan 14 400 cfm @ 4" T.S.P. @ 6000'; 15 hp), mixing box and economizer sections. Filter sections for each fan to be FARR Co. Sidelock Housing Model SA-D-60-100-242412 (3H x 5W Filter Bank) with transition sections to mate with size 35 AHU	1						
	2	AHU-3 Air Handling Unit: Trane Co. Size 12 C with inlet vane damper for both supply and return/exhaust fans (each fan 5750 cfm @ 4" T.S.P. @ 6000'; 10 hp) mixing box and economizer sections. Filter sections for each fan to be FARR Co. Sidelock housing Model SA-D-40-60-242412	1						
	3	UH-1 A thru D Unit Heaters: CHROMALOX horizontal unit heater Model LUH-05-81 with Built-in thermostat kit LUH-TK2, 5kW.	4						
	4	EF-2 Exhaust Fan: New York Blower Co., general purpose fan size 183 AF wheel, belt drive, 6500 cfm @ 1.5" T.S.P. @ 6000'; 3 hp	1						
	5	SF-3 Supply Fan: New York Blower Co., general purpose fan size 183 AF wheel, belt drive, 4300 cfm @4" T.S.P. @ 6000', 5 hp	1						
	6	EF-3 Exhaust Fan: Same as SF-3	1						

CLIENT: Rocky Flats Environmental Technology Site						EST. NO.	JO NO. 0648	SHT. NO. 1of	
DESCRIPTION OF WORK: Interim Storage Vault						QTY. BY:	CK. BY:	PRICES BY :	
Drawing No. 51493-C605 (continued, 2)						DATE:	APPROVED:		
ACCOUNT NO.	ITEM NO.	3013 Can Storage Tube Instrument Well DESCRIPTION	* QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	7	FP-3 A and B Filter Plenum: FARR Co. Sidelock Housing Model SA 40-40-242412 (2H x 2W Filter Bank)	2						
	8	LV-1 60"W x 96"H stationary blade louver and motorized damper mounted in a 36" deep galvanized steel sleve 4" deep extruded aluminum blade louver, Ruskin MFG Co. Model ELF 375 Galvanized steel damper, Ruskin MFG Co. Model CD 35.	1						

CLIENT: Rocky Flats Environmental Technology Site						EST. NO.	JO NO. 0648	SHT. NO. 1of	
DESCRIPTION OF WORK: Interim Storage Vault						QTY. BY:	CK. BY:	PRICES BY :	
Drawing No. 51493-C604 and C605						DATE:	APPROVED:		
ACCOUNT NO.	ITEM NO.	3013 Can Storage Tube Instrument Well DESCRIPTION	* QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
		Note: Sheet metal estimates are based on 18GA Galvanized Steel with 30% added to take off weights for waste in fabrication and allowance to cover dampers, registers and diffusers.							
		Support Area Systems:							
		AHU-1, SF-1, and EF-1 Sheetmetal	9200 lbs						
		SF-1 Intake Stack: 14" Sch 10S SST Pipe	50 ft						
		EF-1 Exhaust Stack: 14" Sch 10S SST Pipe	50 ft						
		SF-2 A and B Intake Stacks: Sch 10S SST Pipe	100 ft						
		Charging Area System:							
		AHU-2 Sheetmetal	22200 lbs						
		Shipping and Receiving Area Systems:							
		AHU-3 Sheetmetal	7600 lbs						
		SF-3 and EF-3 Sheetmetal	1500 lbs						
		EF-2 Stack: 20" Sch 10S SST Pipe	50 ft						
		Chilled Brine Piping: 2" Black Steel Pipe with Insulation							
		Chiller Hook-up: 20' pipe, 8 elbows, 2 ball valves, aluminum jacketed insulation	1 Lot						
		Buried Lines: 75' pipe, 4 elbows, waterproof insulation	1 Lot						
		Mechanical Room Piping: 60' Pipe, 4 balancing valves, 2 check valves, 3 ball valves, 1 3-way control valve, 2 strainers, 20 elbows, 6 tees, insulation	1 Lot						

CLIENT: Rocky Flats Environmental Technology Site						EST. NO.	JO NO. 0648	SHT. NO. 1of	
DESCRIPTION OF WORK: Interim Storage Vault						QTY. BY:	CK. BY:	PRICES BY :	
Drawing No. 51493-C402						DATE:	APPROVED:		
ACCOUNT NO.	ITEM NO.	3013 Can Storage Tube Floor Penetration and Misc. Items DESCRIPTION	* QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	1	27" Dia x 1" Plate, ASTM A36	575 sq in						
	2	28" OD x 1.5" x 3/8" Ring from Plate, ASTM A36	132 sq in						
	3	27-1/4" OD x 15" x 1/2" Ring from Plate, ASTM A36	1300 sq in						
	4	26-1/2" OD x 19-1/2" ID x 3/8" Plate, ASTM A36	550 sq in						
	5	20" Sched 10 Pipe, ASTM A53	1'-3"						
	6	3/8" x 4-1/8"H4L TRW - Nelson Stud Part No. 101-053-043	8						
	7	Hoist Ring - American Drill Bushing Co. Part No. 23327	2						
	8	Crouse-Hinds Chico A Compound	1/2 lb						
		Crouse-Hinds Chico X Fiber	1-1/2 oz						
		* Quantities are per 3013 Can Storage Tube							

CLIENT: Rocky Flats Environmental Technology Site							EST. NO.	JO NO. 0648	SHT. NO. 1of	
DESCRIPTION OF WORK: Interim Storage Vault							QTY. BY:	CK. BY:	PRICES BY :	
Drawing No. 51493-C404							DATE:	APPROVED:		

ACCOUNT NO.	ITEM NO.	3013 Can Storage Tube DESCRIPTION	* QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	1	18" 150# Slip-on Flange, ASTM A105	1						
	2	18" XS Pipe, ASTM A53 Gr. B	13'-7"						
	3	18" Dia. x 1" Plate, ASTM A36	255 sq. in.						
		* Quantities are per 3013 Can Storage Tube							

CLIENT: Rocky Flats Environmental Technology Site									EST. NO.	JO NO. 0648	SHT. NO. 1of
DESCRIPTION OF WORK: Interim Storage Vault									QTY. BY:	CK. BY:	PRICES BY :
Drawing No. 51493-C405									DATE:	APPROVED:	
ACCOUNT NO.	ITEM NO.	3013 Can Storage Tube Base Support DESCRIPTION	* QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS		
	1	27" x 27" x 5/8 " Plate, ASTM A240 TP304	729 sq in								
	2	5/8" x 6" Hilti Kwik Bolt II, AISI 304, Item No. 000453969	4								
	3	6" Sched 120 Pipe, ASTM A106 Gr. B	2'-9"								
	4	WT 4 x 7.5, ASTM A36	4'-0"								
	5	4" x 6" x 3/8" Plate, ASTM A36	96 sq in								
	6	18" x 18" x 3/4" Plate, ASTM A36	324 sq in								
	7	S 5 x 10, ASTM A36	1'-2"								
		* Quantities are per 3013 Can Storage Tube									

CLIENT: Rocky Flats Environmental Technology Site						EST. NO.	JO NO. 0648	SHT. NO. 1of	
DESCRIPTION OF WORK: Interim Storage Vault						QTY. BY:	CK. BY:	PRICES BY :	
Drawing No. 51493-C406, 51493-C407						DATE:	APPROVED:		
ACCOUNT NO.	ITEM NO.	3013 Can Storage Tube Instrument Well DESCRIPTION	* QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	1	18" Class 125# Slip-on Flange, ASTM A105 Special Bore to 16.16" Dia.	1						
	2	16 " Std. Pipe, ASTM A53 Gr. B	1'-10"						
	3	16-3/4" Dia x 2" Plate, ASTM A36, Per Detail 3	225 sq in						
	4	1/4" SS Tubing Valve (included on C752 BOM)	1						
	5	1/4" x .035" SS Tubing (included on C752 BOM)	2 ft						
	6	Tube Full Coupling, 316 SS, Detail 5	1						
	7	1-1/8" x 5" Bolt w/ Heavy Hex Nut, ASTM A307 Gr B	13						
		1-1/8" x 6" Bolt w/ Heavy Hex Nut, ASTM A307 Gr B	2						
	8	4" Threaded Plug, ASTM A36, from Bar Stock per Detail 6	1						
	9	2" Threaded Plug, ASTM A36, from Bar Stock per Detail 7	1						
		* Quantities are per 3013 Can Storage Tube							

CLIENT: Rocky Flats Environmental Technology Site						EST. NO.	JO NO. 0648	SHT. NO. 1of	
DESCRIPTION OF WORK: Interim Storage Vault						QTY. BY:	CK. BY:	PRICES BY :	
Drawing No. 51493-C408, 51493-C409, 51493-C410						DATE:	APPROVED:		

ACCOUNT NO.	ITEM NO.	3013 Can Storage Tube Support Cage DESCRIPTION	* QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	1	L 3 x 3 x 3/8, ASTM A36, Per Detail 1	35'						
	2	8" x 6" x 3/8" Plate, ASTM A36	48 sq in						
	3	16-1/4" Dia x 1" Plate, ASTM A36, Per Detail 2	210 sq in						
	4	4 x 2 x 1/4 Structural Tubing, ASTM A500 Gr B	16'						
	5	3/4" Dia Std. Pipe, ASTM A106 Gr. B	7'						
	6	6" Dia. x 3/8" Plate, ASTM A240 Tp 316	480 sq in						
	7	53" x 3" x 5/16" Plate, ASTM A36, Per Section E-E Bend to 16-3/4" OD	318 sq in						
	8	4" x 4" Blank Full Surface Hinge, CS McMaster-Carr Part No. 16175A35	8						
	9	3/4" x 3/4" x 1/8" Sheet, ASTM A36	4.5 sq in						
	10	16 gage Sheet, ASTM A240 Tp 316 Cut and Fabricated as shown.	3200 sq in						
		* Quantities are per 3013 Can Storage Tube							

CLIENT. Rocky Flats Environmental Technology Site						EST. NO.	JO NO. 0648	SHT. NO. 1 of	
DESCRIPTION OF WORK: Interim Storage Vault						QTY. BY:	CK. BY:	PRICES BY :	
Drawing No.51493-C001, C003 and C005						DATE:	APPROVED:		

ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
		ISV PACKAGING FACILITY, BLDG 371							
	1	Storage Tube - Support Cage Staging Crane	1						
		5 ton capacity A-Frame monorail							
		2 ton capacity manual chain hoist w/ safety hook							
		5 ton capacity two-leg wire rope bridle sling w/ pear link							
	2	Storage Tube Transport Cart	2						
		Bishamon LX-200N Low Profile electrohydraulic lift table							
		(4) 053770 Wesco 1200# capacity phenolic wheels							
		(4) wheel locks							
		15' x 3' x 1/2" steel plate							
		36' 1x1x1/4 steel angle							
		40' 4x4x3/8 structural steel tube							
		(2) 3/4 x 6 ball detent locking pin							
		1/2" steel plate welded fabrication support block							
		1/2" steel plate welded fabrication pivot frame							
	3	Storage Tube Transport Cart Mover	1						
		4000# capacity motorized hand pallet truck							
	4	Storage Tube Support Cage Handling Fixture	1						
		1/2" steel plate welded fabrication Face Plate							
		(3) 1-3/4" x 8", conical hex head captured bolts							

CLIENT: Rocky Flats Environmental Technology Site						EST. NO.	JO NO. 0648	SHT. NO. 1 of	
DESCRIPTION OF WORK: Interim Storage Vault						QTY. BY:	CK. BY:	PRICES BY :	
Drawing No.51493-C001, C003 and C005 (continued, 2)						DATE:	APPROVED:		

ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	4 cont.	(3) 1" x 8" hardened sst alignment pins							
		(2) Thomson Superslide 2RB screw drive system, 16 ft							
		Thomson Motion Control package TMC-1000							
		AccuLOCK Bellows Coupling							
		Thomson Progammable Limit Switch w/ Resolver							
		6x6x3/8 structural steel tube support table 16'x3'x36"							
	5	Ball Joint Manipulator	2						
		Central Research Labs Ball Manipulator							
	6	Overhead Electromechanical Manipulator	1						
		20' 150# capacity monorail track, ceiling supports							
		150# capacity electric trolley w/ cushion stop/start							
		CRL System 50 Telemanipulator							

CLIENT: Rocky Flats Environmental Technology Site						EST. NO.	JO NO. 0648	SHT. NO. 2 of	
DESCRIPTION OF WORK: Interim Storage Vault						QTY. BY:	CK. BY:	PRICES BY :	
Drawing No. 51493-C001, C003, C004, and C005						DATE:	APPROVED:		

ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	7	Fixed Electromechanical Manipulator	1						
		CRL System 50 Telemanipulator							
		3-pronged grasping end-effector w/ 3013 can support							
		support pedestal with 360 rotating turret, 1/3 HP							
	8	Barrier Shield Wall	1						
		45'x8'x3" bolted steel structure (or equivalent mass)							
		(3) leaded glass viewing windows							
	9	Monitoring System	1						
		(3) CCTV color cameras (not radiation hardened)							
		Power zoom, tilt and pan camera controls							
		(3) color monitors, 13"							
	10	Monitoring/Controls							
		MCC and Control Panels for manipulators, etc.							
		Radiation detection monitors/alarms							
		TRANSPORT							
	11	Shipping Tie-down System	2						
		(8) 1/2 x 16 turnbuckles							
		(4) 10' 3/4 wire rope w/ spliced eye loops							
		(8) 1/2 shackles							

CLIENT: Rocky Flats Environmental Technology Site						EST. NO.	JO NO. 0648	SHT. NO. 2 of	
DESCRIPTION OF WORK: Interim Storage Vault						QTY. BY:	CK. BY:	PRICES BY :	
Drawing No. 51493-C001, C003, C004, and C005 (continued, 2)						DATE:	APPROVED:		

ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
		ISV FACILITY							
	12	Storage Tube Transport Cart	2						
		same as for packaging facility							
	13	Storage Tube Transport Cart Mover	1						
		same as for packaging facility							
	14	Overhead Storage Tube Emplacement Crane	4						
		Whiting 35 ft span 5 ton capacity top running bridge							
		Yale 5 ton top running electric trolley hoist							
		Micro-speed CX controls for cushioned stop/start							
		Load swing control							
	15	Glove Box and Storage Tube Retreat Module	1						

CLIENT: Rocky Flats Environmental Technology Site								EST. NO.	JO NO. 06489.72			
DESCRIPTION OF WORK: Interim Storage Vault								QTY. BY:	CK. BY:	PRICES BY :		
DRAWING No. 51493-C705								DATE:	APPROVED:			

ACCOUNT NO.	ITEM NO.	DESCRIPTION	SPEC. REFERENCE	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	E	ELECTRICAL EQUIPMENT ROOM and OUTSIDE PAD								
	E1	500Kva Transformer, 13.8Kv - 480V, 3 - phase, delta - wye connected, oil filled.	16460	1						
	E2	500Kva Transformer, 13.8Kv - 480V, 3 - phase, delta - wye connected, oil filled.	16460	1						
		Primary Protection - Manually Operated Disconnect with fusable links, for Item E1 & E2.	16460	2						
	E3	Switchgear (Primary) - Metal Enclosed drawout type, Westinghouse type DSII or equal. 6-800Amp. Frame Breakers (4-Feeder sections,1-Main section and 1-tie breaker), 3-Elect. operated and 3-Manual breakers. NEMA 12 enclosure.	16150	1						
		Each drawout unit shall be equipped with Trip Unit and Bus shall be copper with full capacity neutral.								
	E4	Switchgear (Alternate) -Metal Enclosed drawout type, Westinghouse type DSII or equal. 6-800Amp. Frame Breakers (4-Feeder sections,1-Main section, 2-Elect. operated and 3-Manual breakers. NEMA 12 enclosure.	16150	1						
		Each drawout unit shall be equipped with Trip Unit and Bus shall be copper with full capacity neutral.								

CLIENT: Rocky Flats Environmental Technology Site	EST. NO.	JO NO. 06489.72	
DESCRIPTION OF WORK: Interim Storage Vault	QTY. BY:	CK. BY:	PRICES BY :
DRAWING No. 51493-C705 (continued, 2)	DATE:	APPROVED:	

ACCOUNT NO.	ITEM NO.	DESCRIPTION	SPEC. REFERENCE	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	E5	Automatic Transfer Switch - Vertical construction, solid state, molded case, 600A frame, 3-pole, 480V, 60Hz, 3-phase, 4-wire, NEMA 12 enclosure.	None	1						
	E6	Diesel Generator - 500Kw, 480V, 3-phase, with controls indicators and alarms mounted in a single panel on the unit. The controls shall be supplied by a 24vdc battery.	None	1						
	E7	Emergency Power Motor Control Center - Dead front construction, 600A horizontal bus, 300A vertical bus w/ 9 feeder breakers - molded case 100A max., NEMA 12 encl., Control power Xfmr., metering and bus under voltage relay	16150	1						
	E8	Normal Power Motor Control Center - Dead front construction, 600A horizontal bus, 300A vertical bus w/ 10 feeder breakers - molded case 100A max. & 7 Nema size 1 combination starters, NEMA 12 encl., Control power Xfmr., metering.	16150	1						
	E9	Uninteruptable Power Supply (UPS) for Monitoring and Alarm. Prices are Budgetary from Solidstates Controls Inc.. See attached Price Summary	None	1	$77,500+					

CLIENT: Rocky Flats Environmental Technology Site							EST. NO.	JO NO. 06489.72			
DESCRIPTION OF WORK: Interim Storage Vault							QTY. BY:	CK. BY:	PRICES BY :		
DRAWING No. 51493-C705 (continued, 3)							DATE:	APPROVED:			
ACCOUNT NO.	ITEM NO.	DESCRIPTION	SPEC. REFERENCE	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS	
	E10	Uninteruptable Power Supply (UPS) for Security System. Prices are Budgetary from Solidstates Controls Inc.. See attached Price Summary	None	1	$77,500+						
	E11	Battery *Cabinet* for Item E9	None	See E9	NA						
	E12	Battery *Cabinet* for Item E10	None	See E9	NA						
	E13	*Same as H4*	*None*	*1*							
	E14,E15,E16	Distribution Panelboard 208Y/120V, 3-phase, 4-wire, 24Ckt., 100A main circuit breaker, NEMA 12 enclosure. (Refer to Spec. 16160)	16160	3							
	E17	Distribution Panelboard - Yard Lighting, 480Y/277V, 3-phase, 4-wire, 24Ckt., 100A main circuit breaker, NEMA *12* enclosure.(Refer to Spec. 16160)	16160	1							
	E18	*Bypass* Transformer - Dry Type, 480-208Y/120V, *30Kva*		2							
	E19	Transformer (Yard Ltg.) - Dry Type, 480Y/277V, 45Kva, wall mounted.(Refer to Spec. 16460)	16460	1							
	E20	Generator Status Panel (by Generator Supplier)	None	1							

CLIENT: Rocky Flats Environmental Technology Site	EST. NO.	JO NO. 06489.72	
DESCRIPTION OF WORK: Interim Storage Vault	QTY. BY:	CK. BY:	PRICES BY :
DRAWING No. 51493-C705 (continued, 4)	DATE:	APPROVED:	

ACCOUNT NO.	ITEM NO.	DESCRIPTION	SPEC. REFERENCE	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	H	HALLWAY								
	H1	Emergency Distribution Panelboard - 208Y/120V, 3-phase, 4-wire, 42Ckt., 225A main breaker, NEMA 1 enclosure.	16160	3						
	H2	Power and Lighting Panelboard - 208Y/120V, 3-phase, 4-wire, 42Ckt., 225A main breaker, NEMA 1 enclosure.	16160	3						
	H3	PLC Cabinets -	None	See I&C Bill of Material						
	H4	Transformer - Dry Type, 480-208Y/120V, 45Kva, wall mounted.(Refer to Spec. 16460)	16460	6						
	H5	Disconnect - Safety Switch	Later	6						
	H6	Flex I/O Power Supply Enclosure - 72"Hx36"Wx24"Deep NEMA 12 free standing single door enclosure w/ backpanel and 2 sidepanels. Install 6 1500VA power supplies in one enclosure and 5 in the second. 4 - 75point term. bks., 2/side and 2 - 6 pt pwr bks..	None	4						
	NA	Fused Safety Switches for various HVAC equipment	Later	10						

CLIENT: Rocky Flats Environmental Technology Site							EST. NO.	JO NO. 06489.72			
DESCRIPTION OF WORK: Interim Storage Vault							QTY. BY:	CK. BY:	PRICES BY :		
DRAWING No. 51493-C705 (continued, 5)							DATE:	APPROVED:			
ACCOUNT NO.	ITEM NO.	DESCRIPTION	SPEC. REFERENCE	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS	
	C	CONTROL ROOM									
		CONTROL ROOM									
	C1	Criticality Alarm Panel - for 10 detector inputs with with internal battery power supply, LED status indicators, audible and visual alarms and coincidence logic circuits.	None	1							
	C2	Fire Alarm Panel - for 60 alarm points with 120 LED status indicators, 5 alarm and status lights with audible alarm horn.	None	1							
	C3	Utility Control and Monitoring Panel	None	1							
	C4	Leak Detection System, Operator Workstation	None	See Storage Tube Insts.							
	C5	Life Safety Disaster Warning Control Panel with 2 Microphones, audio tone generator and preamplifiers.	None	1							
	C6	Printer (Leak Detection System)	None	2							
	C7	Security Door Status Panel (Security System)	None	1							
	C8	PLC Communication Hardware Link Cabinet	None	1							
	C9	CCTV Panel	None	1							

CLIENT: Rocky Flats Environmental Technology Site							EST. NO.	JO NO. 06489.72			
DESCRIPTION OF WORK: Interim Storage Vault							QTY. BY:	CK. BY:	PRICES BY :		
DRAWING No. 51493-C705 (continued, 6)							DATE:	APPROVED:			
ACCOUNT NO.	ITEM NO.	DESCRIPTION	SPEC. REFERENCE	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS	
	I	IAEA CONTROL ROOM									
	I1	CCTV Monitor Panel	None	1							
	I2	3013 Leak Detection System Operator Workstation	None	See Storage Tube Insts.							
	I3	Printer	None	1							
	G	GUARD STATION / CENTRAL ALARM STATION									
	G1	Security Supervisory Panels (Security System)	None	1							
	G2	LS/DW Microphone	None	1							
	G3	LS/DW Speaker	None	25							
	G4	CCTV Monitor	None	10							
	G5	Guard and CAS Workstation	None	1							

CLIENT: Rocky Flats Environmental Technology Site	EST. NO.	JO NO. 06489.72	
DESCRIPTION OF WORK: Interim Storage Vault	QTY. BY:	CK. BY:	PRICES BY :
DRAWING No. 51493-C705 (continued, 7)	DATE:	APPROVED:	

ACCOUNT NO.	ITEM NO.	DESCRIPTION	SPEC. REFERENCE	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	M	MECHANICAL ROOM								
	M1	Disconnect Safety Switch	later	1						
	EM	ELECTRICAL MATERIALS								
	EM1	Basic Materials and Methods -	16050							
	EM2	Conductors - See Drawing 51493-C709, C751 and C801 for cable bills of material	16050	See Dwgs						
	EM3	Conduit and Fittings - 3/4" RGS	16050	10,000LF						
		1" RGS	16050	5,000LF						
		3" RGS	16050	2,000LF						
		1" PVC	16050	600LF						
		3/4" Liquid tight Flexible Conduit	16050	2,000LF						
	EM4	Wireway "Walker Duct" with all necessary Hardware and fittings per spec., 175LF for one double bay or 112tubes	16113	1050LF(North Side)						
	EM5	Wiring Devices -	16140							
	EM6	Receptacles - SEE LIGHTING ESTIMATE	16140	NA						
	EM7	480 Volt Receptacles	16140	2						
	EM8	Switches - SEE LIGHTING ESTIMATE	16140	NA						

CLIENT: Rocky Flats Environmental Technology Site	EST. NO.	JO NO. 06489.72	
DESCRIPTION OF WORK: Interim Storage Vault	QTY. BY:	CK. BY:	PRICES BY :
DRAWING No. 51493-C705 (continued, 8)	DATE:	APPROVED:	

ACCOUNT NO.	ITEM NO.	DESCRIPTION	SPEC. REFERENCE	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	EM9	Cable Tray -	None							
		Ladder type 24"wide, SOLID BOTTOM, load depth 4".		1400LF						
		Tray Cover, louvered		700LF						
		Flat Tee Fittings		10						
		Tray Cover, Flat Tee		4						
		90deg. horiz. bend, 12"radus, 24"wide		8						
		Straight & angled section barrier strips		700LF						
		Required accessories for covers tray sections cable protection and supports.		1Lot						
	EM10	Power Equipment -	16150							
	EM11	Motors - To be purchased with Driven Equipment, See Mechanical Estimate		NA						
	EM12	Motor Control		See Item E7&E8						
	EM13	Motor Control Centers		See Item E7&E8						

CLIENT: Rocky Flats Environmental Technology Site	EST. NO.	JO NO. 06489.72	
DESCRIPTION OF WORK: Interim Storage Vault	QTY. BY:	CK. BY:	PRICES BY :
DRAWING No. 51493-C705 (continued, 9)	DATE:	APPROVED:	

ACCOUNT NO.	ITEM NO.	DESCRIPTION	SPEC. REFERENCE	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	O	OVERHEAD ELECTRICAL SERVICE SYSTEM	16401							
		(Referance Dwg. 51493-0707)								
	O1	Wood Pole Structures (Including all Insulators and Hardware)								
		Single Circuit Tangent, Type B		12	$1,100					
		Double Circuit Deadend (Riser), Type C		1	$7,200					
		Double Circuit Deadend (Corner), Type D		7	$6,000					
		Double Circuit Tangent, Type E		11	$1,400					
		Single Circuit Deadend (Corner), Type F		3	$2,400					
		Single Circuit Deadend (Riser), Type G		1	$4,000					
	O2	Conductors:								
		# 3/0 ACSR phase conductor		21,000FT.						
		# 1/0 ACSR static line		4,550FT.						
	O3	Anchors and Anchor Rods		1Lot						
	O4	Guy Wire		1Lot						
	O5	Insulators and Hardware - included with structures		NA						

CLIENT: Rocky Flats Environmental Technology Site	EST. NO.	JO NO. 06489.72	
DESCRIPTION OF WORK: Interim Storage Vault	QTY. BY:	CK. BY:	PRICES BY :
DRAWING No. 51493-C705 (continued, 10)	DATE:	APPROVED:	

ACCOUNT NO.	ITEM NO.	DESCRIPTION	SPEC. REFERENCE	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	U	UNDERGROUND ELECTRICAL SERVICE	16492							
	U1	Service Conduit - 3"	16492	1840LF						
	U2	Concrete Ductline:								
	U2a	Duct Bank, 15-3" conduits 35"wide x 23"deep	16492	140LF						
	U2b	Duct Bank, 3-3" conduit 23"wide x 11"deep (Typical for 3 Ducts)	16492	50LF						
	U2c	Duct Bank, 1-3" conduit 11" wide x 11"deep (Typical for 2 Ducts)	16492	100LF						
	U2d	Duct Bank, 2-3" conduits 18" wide x 18"deep	16492	320LF						
	U3	Trenching and Backfill - 580LF, 5' deep	16492							
		GROUNDING	16450							
	G1	Electrodes: 10ft long, 3/4" copper clad steel rods	16450	10						
	G2	Equipment Ground Conductor insulated green #12 minimum	16450	10,000LF						
	G3	System Grounding Conductor: bare copper 4/0	16450	8,000LF						
	G4	Ground Connections - Exothermic Welds	16450	20						
	G5	Ground Connections - Bolted	16450	1LOT						

CLIENT. Rocky Flats Environmental Technology Site						EST. NO.	JO NO. 06489.72		
DESCRIPTION OF WORK: Interim Storage Vault						QTY. BY:	CK. BY:	PRICES BY :	
Drawing No. (NONE)						DATE:	APPROVED:		

ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
		LIGHTING							
	L1	LAMP TYPE A: 40 WATT FLUORESCENT LAMP, GE TYPE F-40 T-12 (F40CW), RAPID START PREHEAT, 48 INCH LENGTH	478						
	L2	FIXTURE TYPE C: 2 LAMP INDUSTRIAL FLUORESCENT FIXTURE 2-F40CW	31						
	L3	FIXTURE TYPE C/B: EMERGENCY / BATTERY BACKED 2 LAMP INDUSTRIAL FLUORESCENT FIXTURE 2-F40CW	10						
	L4	FIXTURE TYPE F: 2 LAMP FLUORESCENT TROFFER (RECESSED) 2-F40CW WITH PRISMATIC LENSE	76						
	L5	FIXTURE TYPE F/B: EMERGENCY / BATTERY BACKED 2 LAMP FLUORESCENT TROFFER (RECESSED) 2-F40CW WITH PRISMATIC LENSE	25						
	L6	FIXTURE TYPE H: 4 LAMP FLUORESCENT TROFFER (RECESSED) 4-F40CW WITH PRISMATIC LENSE	45						
	L7	FIXTURE TYPE H/B: EMERGENCY / BATTERY BACKED 4 LAMP FLUORESCENT TROFFER (RECESSED) 4-F40CW WITH PRISMATIC LENSE	15						

CLIENT: Rocky Flats Environmental Technology Site										
DESCRIPTION OF WORK: Interim Storage Vault					EST. NO.	JO NO. 06489.72				
Drawing No. (NONE) (continued, 2)					QTY. BY:	CK. BY:	PRICES BY :			
					DATE:	APPROVED:				
ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS	
	L8	FIXTURE TYPE K: HIGH BAY FIXTURE WITH 175 WATT MERCURY VAPOR CLEAR LAMP, 7000 LUMEN, HOLOPHANE ENDURALUME COMPACT ENCLOSURE CAT. No. ENDR-175MV27-A418, 277 VOLT, OR EQUAL.	98							
	L9	FIXTURE TYPE Y1: WALL MOUNTED OUTDOOR FIXTURE WITH 100 WATT HIGH PRESSURE SODIUM CLEAR LAMP, 8550 LUMEN, HOLOPHANE WALLPACK 2, CAT. No. WL2K-100HP27-GR, 277 VOLT, OR EQUAL.	27							
	L10	FIXTURE TYPE Y2: OUTDOOR FIXTURE WITH 250 WATT HIGH PRESSURE SODIUM CLEAR LAMPS (TWO), 27500 LUMEN EACH, 35 FT POLE, HOLOPHANE EXPRESSWAY/SECURITY LIGHT, CAT. No. SGRT35J-2-1235-480, 480 VOLT, OR EQUAL.	36							
	L11	FIXTURE TYPE Q. LED EXIT LIGHT FIXTURE, SINGLE FACED, EXITRONIX MODEL No. 602, WITH BATTERY, OR EQUAL.	24							
	L12	FIXTURE TYPE Q/S: LED EXIT LIGHT FIXTURE WITH PAR36 SPOTLIGHTS (TWO), SINGLE FACED, EXITRONIX MODEL No. 602-2F, WITH BATTERY, OR EQUAL.	8							

CLIENT: Rocky Flats Environmental Technology Site						EST. NO.	JO NO. 06489.72			
DESCRIPTION OF WORK: Interim Storage Vault						QTY. BY:	CK. BY:	PRICES BY :		
Drawing No. (NONE) (continued, 3)						DATE:	APPROVED:			
ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS	
	L13	FIXTURE TYPE R. LED EXIT LIGHT FIXTURE, DOUBLE FACED, EXITRONIX MODEL No. 603, WITH BATTERY, OR EQUAL.	5							
	L14	FIXTURE TYPE S1: EMERGENCY SPOTLIGHT FIXTURE, EXITRONIX MODEL No. LL40, BATTERY BACKED WITH TWO SPOTLIGHTS, OR EQUAL.	24							
	L15	TYPE R1 RECEPTACLE: 15 AMP, 125 VOLT, 2 POLE, DUPLEX, HUBBELL CAT. No. 5262, OR EQUAL.	231							
	L16	TYPE S2 SWITCH: 20 AMP, 120 VOLT, DOUBLE POLE, HUBBELL CAT. No. 1222, OR EQUAL.	52							
	L17	EMT 3/4 INCH CONDUIT FOR LIGHTING, TOTAL LINEAR FEET	5862							
	L18	EMT 1-INCH CONDUIT FOR LIGHTING, TOTAL LINEAR FEET	1954							
	L19	RGS 1-INCH CONDUIT FOR LIGHTING, TOTAL LINEAR FEET	5712							
	L20	RGS 1-1/2- INCH CONDUIT FOR LIGHTING, TOTAL LINEAR FEET	18164							

CLIENT: Rocky Flats Environmental Technology Site						EST. NO.	JO NO. 06489.72			
DESCRIPTION OF WORK: Interim Storage Vault						QTY. BY:	CK. BY:	PRICES BY :		
Drawing No. (NONE) (continued, 4)						DATE:	APPROVED:			
ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS	
	L21	EMT CONDUIT FITTINGS FOR LIGHTING	1 LOT							
	L22	RGS CONDUIT FITTINGS FOR LIGHTING	1 LOT							
	L23	TOTAL #10 AWG CABLE THHN/THWN-COMPOSITE (LINEAR FEET) FOR LIGHTING	30481							
	L24	TOTAL #8 AWG CABLE THHN/THWN-COMPOSITE (LINEAR FEET) FOR LIGHTING	22278							
	L25	TOTAL #6 AWG CABLE THHN/THWN-COMPOSITE (LINEAR FEET) FOR LIGHTING	94453							

CLIENT: Rocky Flats Environmental Technology Site						EST. NO.	JO. NO. 06489.72			
DESCRIPTION OF WORK: Interim Storage Vault						QTY. BY:	CK. BY:	PRICES BY :		
Drawing No.D 51493-C801						DATE:	APPROVED:			
ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS	
	PS	**PERSONNEL SAFETY INSTRUMENTS**								
		Neutron Criticality Detector	10							
	PS1	Area Smoke Detector	48							
	PS2	Area Smoke Detection System Speakers	10							
	PS3	Air Handling Unit Smoke Detector	3							
	PS4	Portable Continuous Air Monitor, RADEC model 452, with vacuum pump, cart and alarm beacon	6							
	PS5	Sprinkler System Flow Switch	1							
	PS6	Fire Alarm Pull Station	5							
	PS7	Criticality Strobe Beacons	4							
	PS8	LS/DW Area Speakers	25							

CLIENT: Rocky Flats Environmental Technology Site							EST. NO.	JO. NO. 06489.72		
DESCRIPTION OF WORK: Interim Storage Vault							QTY. BY:	CK. BY:	PRICES BY :	
Drawing No.D 51493-C752							DATE:		APPROVED:	
ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS	
		STORAGE TUBE INSTRUMENTATION								
	MH	**MISCELLANEOUS HARDWARE:**								
	MH1	Electrical connectors (3 per storage tube)	1,368							
	MH2	Adhesive for RTDs (10 oz qty per stor. tube), GE Silicone RTV-655A	456							
	MH3	SS tubing for He detector (1 ft. length per storage tube)	456							
	MH4	Isol. valve for He detector (1 per stor. tube), Varian Vacuum 951-5014	456							
	MH5	Miscellaneous hardware (1 set per storage tube)	456							
	W	**WIRING:**								
	W1	Cable for RTDs (units are lin. ft of cable), Belden 1503A	31,920							
	W2	Cable for helium detector (units are lin. ft of cable), Belden 1503A	912							
	R	**REMOTE I/O LINK TO PLC:**								
	R1	I/O adapter (1 per storage tube), Allen-Bradley 1794-ASB	456							
	R2	RTD input module (4 per storage tube), Allen-Bradley 1794-IR8	1,824							
	R3	RTD module base (4 per storage tube), Allen-Bradley 1794-TB3	1,824							
	R4	Analog input module (1 per storage tube), Allen-Bradley 1794-IE8	456							

CLIENT: Rocky Flats Environmental Technology Site						EST. NO.	JO. NO. 06489.72			
DESCRIPTION OF WORK: Interim Storage Vault						QTY. BY:	CK. BY:	PRICES BY :		
Drawing No.D 51493-C752 (continued, 2)						DATE:	APPROVED:			
ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS	
	R5	Analog module base (1 per storage tube), Allen-Bradley 1794-TB3	456							
	R6	DIN rail (1 per storage tube), Allen-Bradley 199-DR1	456							
	R7	Enclosure and miscellaneous hardware (1 per storage tube)	456							
	TS	**TUBE SENSORS:**								
	TS1	RTD for contnr temp. (32 per storage tube), Minco S32PB11Y240A	14,592							
	TS2	RTD for tube air temp. (3 per storage tube), Minco S32PB11Y240A	1,368							
	TS3	Helium detector (1 per stor. tube), Varian Vacuum Helitest (modified)	456							
	TI	**TUBE IDENTIFICATION AND TAMPER PROTECTION:**								
	TI1	Ultrasonic bolt tamper seal (1 per storage tube), JRC-Ispra	456							
	TI2	Tamper tape seal (10 per storage tube), 3M Confirm	4,560							
	TI3	Cable seal (10 per storage tube), EJ Brooks Multilok	4,560							
	TI4	Bar code (1 per storage tube)	456							

CLIENT: Rocky Flats Environmental Technology Site						EST. NO.	JO. NO. 06489.72			
DESCRIPTION OF WORK: Interim Storage Vault						QTY. BY:	CK. BY:	PRICES BY :		
Drawing No.D 51493-C752 (continued, 3)						DATE:		APPROVED:		
ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS	
		INSTRUMENTATION OUTSIDE STORAGE TUBE								
	V	**VAULT TEMPERATURE SENSORS:**								
	V1	Averaging RTD for vault temperature (5 per bay), Minco S447PBY24	55							
	V2	Mounting hardware for RTD (5 per bay)	55							
	V3	I/O adapter (5 per bay), Allen-Bradley 1794-ASB	55							
	V4	RTD input module (5 per bay), Allen-Bradley 1794 IR8	55							
	V5	RTD module base (5 per bay), Allen-Bradley 1794 TB3	55							
	V6	DIN rail (5 per bay), Allen-Bradley 199-DR1	55							
	V7	Enclosure and miscellaneous hardware (5 per bay)	55							
	PLC	**PLC SYSTEM:**								
	PLC1	Processor (1 per bay), Allen-Bradley 1785-L80B	11							
	PLC2	EEPROM for processor (1 per bay), Allen-Bradley 1785-ME64	11							
	PLC3	I/O chassis (1 per bay) Allen-Bradley 1771-A1B	11							
	PLC4	Power supply, Allen-Bradley 1771-P4S	11							
	PLC5	Enclosure and miscellaneous hardware (4 per vault)	4							
	PLC6	PLC programming software, Allen-Bradley WinLogic	1							

CLIENT: Rocky Flats Environmental Technology Site						EST. NO.	JO. NO. 06489.72		
DESCRIPTION OF WORK: Interim Storage Vault						QTY. BY:	CK. BY:	PRICES BY :	
Drawing No.D 51493-C752 (continued, 4)						DATE:	APPROVED:		

ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	M	**MISCELLANEOUS INSTRUMENTS:**							
	M1	Bar code scanner, Symbol Technology	2						
	M2	Fiber optic video system, Olympus	2						
	M3	Radioscopy system, custom designed, SAIC	2						
	M4	Datalogger, Fluke	2						
	M5	Pressure gauge, Ashcroft S1279	2						
	OW	**OPERATOR WORKSTATION FOR 3013 CONTAINERS:**							
	OW1	Computer (industrial grade)	1						
	OW2	UPS	1						
	OW3	PLC/operator interface software, Wonderware FactoryLink	1						
	OW4	Operating System Software, Microsoft Windows NT	1						
	OW5	PLC Gateway to PC, Allen-Bradley 1784-KT	1						
	OW6	Ethernet hub to bldg 371	1						
	OW7	Ethernet card in workstation	1						
	OW8	Ethernet cable (1 30 ft length)	1						
	OW9	Tamper indicating devices on Ethernet cable (2 per cable)	2						

CLIENT: Rocky Flats Environmental Technology Site						EST. NO.	JO. NO. 06489.72			
DESCRIPTION OF WORK: Interim Storage Vault						QTY. BY:	CK. BY:	PRICES BY :		
Drawing No.D 51493-C752 (continued, 5)						DATE:	APPROVED:			
ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS	
	SAS	**SAS WORKSTATION:**								
	SAS1	Computer (industrial grade)	1							
	SAS2	UPS	1							
	SAS3	PLC/operator interface software, Wonderware FactoryLink	1							
	SAS4	Operating System Software, Microsoft Windows NT	1							
	SAS5	PLC Gateway to PC, Allen-Bradley 1784-KT	1							
	IAEA	**IAEA WORKSTATION:**								
	IAEA1	Computer (industrial grade)	1							
	IAEA2	UPS	1							
	IAEA3	PLC/operator interface software, Wonderware FactoryLink	1							
	IAEA4	Operating System Software, Microsoft Windows NT	1							
	IAEA5	PLC Gateway to PC, Allen-Bradley 1784-KT	1							

CLIENT: Rocky Flats Environmental Technology Site						EST. NO.	JO. NO. 06489.72			
DESCRIPTION OF WORK: Interim Storage Vault						QTY. BY:	CK. BY:	PRICES BY :		
Drawing No.D 51493-C752 (continued, 6)						DATE:	APPROVED:			
ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS	
		Notes:								
		1. Quantities are totals for all 456 tubes in 11 bays.								
		2. Refer to Instrument and Controls Tradeoff Study Attachment D for detailed bill of materials including equipment costs, maintenance costs, and manpower estimates								
		3. Quantities for AL-R8 instruments not included								

ELECTRICAL EQUIPMENT SPECIFICATIONS

SECTION

SECTION 16050–BASIC MATERIALS AND METHODS

PRODUCT REQUIREMENTS: All electrical equipment shall be suitable for operation at an altitude of 6,000 ft.

CIRCUIT BREAKERS: Circuit breakers for 120/240V and 480V shall be suitable for use in the panelboard or motor control center (MCC) in which they are installed. Circuit breaker shall be new and UL listed.

CONDUCTORS

A. General–All conductors shall be sized according to the American wire gage (AWG) standard. All conductors shall be copper. All conductors shall be stranded. Minimum size shall be No. 14. Wire sizes No. 14-1 shall be sized at a conductor temperature rating of 60°C. Wire sizes No. 2 and larger shall be sized at a conductor temperature rating of 75°C.

B. Other–All conductors for other than general use shall be as specified on the drawings.

CONDUIT AND FITTINGS: Rigid steel conduit shall be zinc-coated and shall be 3/4 in. minimum size.

END OF SECTION

SECTION 16113--UNDERFLOOR DUCT

UNDERFLOOR DUCT: Underfloor duct shall be "Walker Duct," complete with all necessary junction boxes, couplings, supports, adapters and conduit feeders to form a complete system. The underfloor duct systems shall be made up of two separate ducts: One for power, one for and one for low-voltage signal systems.

A. The duct shall be 14-gage rectangular steel tubing, sherardized and enameled. Underfloor duct shall be furnished in standard 10 ft. lengths. Each 10 ft. length shall have five equally spaced, threadless, present insets expanded into the rectangular duct. Insert height shall be as specified on the drawings.

B. Boxes for underfloor duct shall be as required to supply a complete, workable system. Boxes shall be manufactured of gray cast iron, sherardized and enameled and designed to permit access to underfloor ducts through 9-in. hand holes. All boxes shall be equipped with standard tops suitable for concrete finish. Linoleum holders, terrazzo cover or any special covers shall be furnished compatible with the proposed floor finish.

C. All ducts terminated in the junction boxes shall be made watertight and secured with hardened set screws. Ducts which do not terminate in junction boxes shall be closed with end caps and made watertight.

D. All junction boxes shall be set by instrument to finished floor grade. Adjusting of junction boxes shall be accomplished by four box leveling screws. Cover adjusting screws shall not be used for this purpose. All junction boxes shall be securely anchored by grouting or other means before concrete pour. Duct shall be set by instrument with insert no more than 1/8 in below finished floor grade. Marker screws shall be installed on adjacent inserts to junction boxes, on each side of dividing walls and at the end of all duct runs.

E Ducts shall be rigidly supported at intervals of 5 ft. with standard duct supports Service fittings shall be of type, quantity and location as specified on the drawings. A complete set of tools for installation of service fittings, including after-set inserts, shall be turned over to the Contractor at the completion of the installation.

END OF SECTION

SECTION 16140--WIRING DEVICES

RECEPTACLES: 120 V and 250 V receptacles shall be Specification Grade as follows or as shown on drawings:

2 Pole, 3 Wire Grounding
15 Amperes, 125 Volt Straight Blade
NEMA 5-15R 15A 125V
Hubbell No. 5261 Single Receptacle
Hubbell No. 5262 Duplex Receptacle
Hubbell No. GF5262 GFCI Duplex Receptacle

2 Pole, 3 Wire Grounding
20 Amperes, 125 Volts, Straight Blade
NEMA 5-20R 20A 125V
Hubbell No. 5361 Single Receptacle
Hubbell No. 5362 Duplex Receptacle
Hubbell No. GF5362 GFCI Duplex Receptacle

2 Pole, 3 Wire Grounding
15 Amperes, 250 Volts, Straight Blade
NEMA 6-15R 15A 250V
Hubbell No. 5661 Single Receptacle
Hubbell No. 5662 Duplex Receptacle

2 Pole, 3 Wire Grounding
20 Amperes, 250 Volts, Straight Blade
NEMA 6-20R 20A 250V
Hubbell No. 5461 Single Receptacle
Hubbell No. 5462 Duplex Receptacle

2 Pole, 3 Wire Grounding
15 Amperes, 125 Volts, Twist-Lock
NEMA L5-15R 15A 125V
Hubbell No. 4710 Single Receptacle
Hubbell No 4700 Duplex Receptacle

2 Pole, 3 Wire Grounding
15 Amperes, 250 Volts, Twist-Lock
NEMA L6-15R 15A 250V
Hubbell No. 4560 Single Receptacle
Hubbell No. 4550 Duplex Receptacle

2 Pole, 3 Wire Grounding
20 Amperes, 125 Volts, Twist-Lock
NEMA L5-20R 20A 125V
Hubbell No. 2310A Single Receptacle

2 Pole, 3 Wire Grounding
30 Amperes, 125 Volts, Twist-Lock
NEMA L5-30R 30A, 125V
Hubbell No. 2610A Single Receptacle

2 Pole, 3 Wire Grounding
20 Amperes, 250 Volts, Twist-Lock
NEMA L6-20R 20A 250V
Hubbell No. 2320A Single Receptacle

2 Pole, 3 Wire Grounding
30 Amperes, 250 Volts, Twist-Lock
NEMA L6-30R 30A 250V
Hubbell No. 2620A Single Receptacle

2 Pole, 3 Wire Grounding
30 Amperes, 125 Volts, Straight Blade
NEMA 5-30R 30A 125V
Hubbell No. 9308 Single Receptacle

2 Pole, 3 Wire Grounding
30 A, 250 Volts, Straight Blade
NEMA 6-30R 30A 250V
Hubbell No. 9330

2 Pole, 3 Wire Grounding
50 Amperes, 125 Volts, Straight Blade
NEMA 5-50R 50A 125V
Hubbell No. 9360

2 Pole, 3 Wire Grounding
50 Amperes, 250 Volts, Straight Blade
NEMA 6-50R 50A 250V
Hubbell No. 9367

3 Pole, 4 Wire Grounding
20 Amperes, 125/250 Volts AC-DC Twist-Lock
NEMA L14-20R 20A 125/250V
Hubbell No 2410A Single Receptacle

3 Pole, 4 Wire Grounding
30 Amperes, 125/250 Volts AC-DC Twist-Lock
NEMA L14-30R 30A 125/250V
Hubbell No. 2710A Single Receptacle

3 Pole, 4 Wire Grounding
50 Amperes, 125/250 Volts AC Twist-Lock
Hubbell No. CS6369 Single Receptacle

480 Volt 3 phase receptacles

A. Crouse-Hinds Catalog Number AR342, 30 Amp, 600 Volts AC, 3-Wire, 4-Pole, Style 2 Arktite heavy duty circuit breaking receptacle assembly with spring door for weather proof applications. These receptacles take a Crouse-Hinds plug, Catalog Number APJ3485.

Note: These receptacles shall be mounted on the Type AR back boxes manufactured by Crouse-Hinds.

B. Crouse-Hinds Catalog Number AR642, 60 A, 600 Volts AC, 3-wire, 4-pole, style 2 Arktite heavy duty circuit breaking receptacle assembly with spring door for weatherproof applications. These receptacles take a Crouse-Hinds plug, Catalog Number APJ6485.

Note: These receptacles shall be mounted on the type AR back boxes manufactured by Crouse-Hinds.

SURFACE DUCT

A. Surface-mounted plug-in raceways shall be National Series 1700 or Wiremold 3000. Surface raceways shall be installed true and level, and all joints shall be made with couplings to ensure continuity.

B. Wire shall be installed in raceways with wire clips, and the number of conductors shall not exceed the National Electrical Code requirements.

SWITCHES

A. For 120 volt single-pole lighting circuits use an Industrial Specification Grade 20A, 120-277 VAC Single-pole switch Bryant Catalog Number 4901 or Hubbell Catalog Number 1221 and for fluorescent lighting loads of 1,200 Watts to 1,800 Watts use the Bryant Catalog Number 3001, 30A, 120-277 VAC rated single-pole switch.

B. For 120 volt lighting circuits needing three-way switches use the Industrial Specification Grade 20A, 120-277 VAC three-way switches Bryant Catalog Number 4903 or the Hubbell Catalog Number 1223 and for fluorescent lighting loads of 1,200 Watts to 1,800 Watts use the Bryant Catalog Number 3003, 30A, 120-277 VAC rated three-way switches.

END OF SECTION

SECTION 16150--ELECTRICAL POWER EQUIPMENT

MOTORS

A. Rating

Horsepower	Voltage	Phase
1/2 to 150 (inclusive)	230/460	3
Larger than 150	2,300	3
Less than 1/2*	115/230	1

*All 3600-rpm motors and any requiring high-starting torque or where the continuity of operation is vital, shall be 460 V, 3 phase.

Motors smaller than 1/2 hp furnished on machine tools or other equipment having a 460-V main drive motor, shall be as normally furnished by the manufacturer and shall include any accessories required to operate from the main power supply.

B. Enclosures--All motors shall be open type, unless otherwise specified.

Motors shall be only one of the following, unless otherwise specified:

1 Drip-proof.

2. Totally enclosed fan cooled (TEFC) or totally enclosed nonventilated (TENC). Where frame size and price are the same, the nonventilated is preferred.

3 Explosion-proof of group and class specified.

4 Combination of any one of the above enclosures with a totally molded, vacuum-impregnated, encapsulated winding.

C Frames

1. All motor frames and end-bells shall be National Electrical Manufacturers Association (NEMA) standard

2. Polyphase motors 1 hp and larger with frames larger than Frame 256 shall have cast iron or fabricated steel end-bells and frames.

D. Bearings--All motors shall have anti-friction ball bearings unless otherwise specified, except fractional horsepower motors which may have sleeve bearings.

E. Connection Boxes--All polyphase motors 1 hp and larger shall have conduit connection boxes of cast iron or cast aluminum (with threaded opening) or steel plate. On fractional horsepower motors, where the connections are made in the end-bell space rather than in an attached connection box, a screwed conduit connection shall be provided in the end-bell. Where sheet metal terminal boxes are provided, they shall include knockouts for conduit terminations.

MOTOR CONTROL

A. SINGLE-PHASE MANUAL STARTERS--Single-phase manual starters shall conform to Allen-Bradley Bulletin 600.

B. Single-Phase and Three-Phase Manual Starting Switches--Manual starting switches shall conform to Allen-Bradley Bulletin 609.

C. Magnetic Motor Starters--Starters shall conform to the following:

1. Full-Voltage Starters: Allen-Bradley Bulletin 709.

2. Combination Fused or "No-Fuse" Disconnect and Starter: Allen-Bradley Bulletin 712.

3. Combination Circuit Breaker and Starter: Allen-Bradley Bulletin 713.

4. Full-Voltage Reversing Starter: Allen-Bradley Bulletin 705.

5. Combination Disconnect and Reversing Starter: Allen-Bradley Bulletin 706.

6. Combination Circuit Breaker and Reversing Starter: Allen-Bradley Bulletin 707.

D. Single-Phase Manual Starters--Single-phase manual starters shall consist of a toggle switch, single or double pole, with a thermal overload heater element capable of interrupting the circuit in case of overload. These manual motors starters shall be flush or surface mounting, as required. The starter shall be furnished with a NEMA Type 1 enclosure unless otherwise specified

E Single-Phase and Three-Phase Manual Starting Switches-- Manual starting switches may be used where remote control is not required and where "no-voltage" or "under-voltage" protection is not required.

Manual motor starting switches shall furnish overload protection by thermal-type overload relays

F Magnetic Motor Starters

1 Magnetic motor starters shall be installed in all cases where remote control is required and "no-voltage"or "undervoltage" protection is required. Two or three overload relays, for installation of interchangeable overload relay heaters, shall be furnished with each starter. Operating coil voltage, enclosure, number and position of auxiliary contacts, NEMA size and all starter modifications shall be as shown on the drawings.

2. All combination starters with fused disconnect switches shall be installed with fuse clips and Bussman Fusetron fuses sized in accordance with the latest Protection Handbook of the Bussman Manufacturing Division, McGraw-Edison Company.

MOTOR CONTROL CENTERS

Motor control centers shall be as manufactured by Cutler Hammer, Allen-Bradley or Westinghouse Electric Company and shall comply with Part I, Section 1.3, above.

A. Enclosure--Motor control centers shall consist of one or more sections 90 in. high, 20 in. wide and 20 in. deep. Each section shall include top, bottom and side wireways; horizontal and vertical bus bars; movable unit support bars; pan-type, gasketed, pin-hinged doors with pressure-type fasteners; and provisions for locking. Each section shall conform to NEMA standard enclosures for NEMA Types 1, 3, 5 and 12 as specified. Each section shall have standardized construction, dimensions and all provisions for replacement or addition of vertical sections to either side without adjustments, alterations or structural changes. Each section shall be provided with removable sections for maintenance and inspection of all interior component parts. All sections shall be cleaned, primed and painted with standard color.

B. Bus Bars--Horizontal bus bars shall be rated for 600-A capacity with a 50°C rise, silver-plated and braced for 25,000-Arms fault current. Vertical bus bars shall extend full length of the working area. Each bar shall be silver plated and be braced to withstand 25,000=A rms fault current.

C. Control Units

1. Motor control centers shall be a combination of standardized combination starter units of NEMA Sizes 1 through 5. The smallest acceptable modular size shall be 12 in. high. Each unit shall be semi-enclosed and electrically isolated. Each unit shall be equipped with handles for removal from the section. Cam-type or screw-type latches shall positive latch units in operating, test, disconnected and removed positions.

2 Silver-plated stab-on power connectors shall be furnished, on the back of each unit, to connect the line side of the unit to the vertical bus bars. Load side connections shall be equipped with pressure connectors. Pushbuttons and indicating lights shall be assembled to the control unit. Each control unit shall have all load and control connections wired to a terminal board at the side of the unit. All wiring shall conform to NEMA Class C.

D. General

1 All spare compartments shall be furnished complete with a bus, unit supports and a matching blank door. All compartments, which contain control units, shall have doors with built-in reset button operators and disconnect or circuit breaker operators, in the door. Doors shall have cover interlock latches to prevent the opening of the unit door when the disconnect is on. A screwdriver interlock bypass shall be incorporated to permit opening of the door for inspection without interrupting the power. All disconnect or circuit breaker operators shall be capable of being locked in the open position. All motor controls with remote operators shall have 120-V control systems.

2. Complete shop drawings, schematic and elementary wiring diagrams shall be approved by the Contractor before purchase of the equipment.

END OF SECTION

SECTION 16160--PANELBOARDS

A. Enclosures--Cabinet boxes shall be constructed of zinc-coated sheet steel and shall conform to the requirements of the Underwriters' Laboratories, Inc. (UL), Standard for Cabinets and Boxes. Boxes shall be zinc-coated after fabrication. Trims and doors shall have a suitable primer coat and a finish coat of a color specifically designated by the Contractor. Cabinets for panelboards shall be provided with not less than 5-in. wide wiring gutters at the sides, 6 in. wide at the top and bottom, and 5 3/4 in. deep. Flush or surface-mounted cabinets shall be door-in-door construction. Both doors shall have hinges on the same side. The smaller door which covers all overcurrent protective device handles with a combination lock latch. All locks shall be keyed alike. The larger trim door will expose the wire gutter in the panelboard and shall be secured in the closed position with a minimum of three bolts. A directory holder shall be provided on the inside of the smaller door. A neatly typed directory, properly identifying each circuit, shall be mounted in the directory holder.

B. Interiors--Panelboard interiors shall be made up with reinforced backpan with a means for adjusting in and out. Easy-access covers shall be provided over lug compartment and neutral bar. All bus bars shall be securely supported from backpan with bus bar insulators and shall not depend on branch circuit breakers for support. All bus bards shall be drilled and tapped full length to facilitate changes. The use of plug-on circuit breaker panelboards shall be permitted in office and administration buildings. All other areas shall require the use of bolt-on circuit breaker panelboards.

A minimum of 25 percent spare circuit spaces shall be designed into each panelboard.

All panelboards shall be equipped with a copper ground bus bar kit.

C. Circuit Breakers

1. All branch circuit panelboards shall be equipped with a main circuit breaker. The main shall be an integral part of the panelboard.

2. Circuit breakers that are being used to switch lights and other loads on and off at the panelboard shall be switch duty-rated (SWD) circuit breakers.

3. The uses of new thin or slim line circuit breakers is not acceptable.

4. All panelboard circuit breakers shall have a minimum interrupting capacity and short circuit rating of 10,000 amperes RMS unless otherwise specified.

5. The total loan on any overcurrent protective device located in a single phase panelboard shall not exceed 80 percent of its rating. A 20 amp circuit breaker is the minimum size breaker to be used in panelboards.

D. Grounding--Panelboard enclosures shall be bonded to the equipment grounding system using conductors sized per the National Electrical Code (NEC).

E. Panelboard Manufactures--Complete factory-assembled circuit breaker panelboards for 120/208 volts, 3-phase, 4-wire shall be similar to square "D" type NQOD or Westinghouse Pow-R-Line C or equal. Panelboards shall be equipped with 20 amp branch circuit breakers unless otherwise specified.

END OF SECTION

SECTION 16401--OVERHEAD ELECTRICAL SERVICE SYSTEM

WOOD POLES

A. All wood poles for this utility line construction shall meet the American National Standard Specifications and Dimensions for Wood Poles ANSI 05.1-1987. The wood poles shall be treated with the pentachlorophenol preservative per ASTM Standard D1272 Specification for Pentachlorophenol and ASTM Designation: D4064-89, The Standard Practice for Preservative Treatment of Utility Poles by Thermal Process and/or the American Wood Preservers Association (AWPA) Standard M6 brands used on forest products.

B. Wood poles to which this specification is applicable shall be Douglas Fir (both types) and Southern Pine poles and shall have their butts pressure treated with pentachlorophenol, or an acceptable substitute, from the bottom of the pole to a point 1 ft. above the ground line for the purpose of retarding decay, rot, etc. Poles having the following defects shall not be acceptable:

1) Cross breaks (cracks)
2) Bird holes
3) Plugged holes (except borer holes)
4) Hollow butts tops (except as noted hereafter)
5) Marine borer damage
6) Splits through cracks in the top (except as noted hereafter)
7) Nails, spikes and metal

C. Poles having the following limited defects shall be acceptable:

1) Cracks and splits in butts Through cracks splits in the butt surface, provided their height from the butt along the surface does not exceed 2 ft.

2) A separation along the grain (shake) extending through an arc of not more than 90°. Those extending through an arc of more than 90° will be acceptable when they are in a circle, the center of which corresponds to the center of the butt surface and the diameter of which is not greater than one-half the average butt diameter

3) Insect damage consisting of holes 1/16 in. or less in diameter or surface scoring channeling

4) Knots of 1/2 in. or less in diameter. However, the diameter of any single knot or the sum of the diameters in any 1 ft. section shall not exceed the following limits:

Pole Length	Sum of the Diameters of Knots
45 ft. or less	4 in.
50 ft. or more	5 in.

5) Poles having dead knots provided such knots are not associated with heart rot.

6) Poles having dead streaks that are sound and not wider than one-fourth the circumference of the pole at the point of measurement.

7) Poles whose outer 1 in. is free from compression wood.

8) Poles whose butts have a hollowing caused by splinter pulling provided the area of the hollowing is less than 10% of the butt area.

D. Poles shall be straight. Bends or defects in a given pole shall not exceed those specified in the ANSI 05.1-1987 Specifications and Dimensions for Wood Poles.

E. Poles less than 50 ft. in length shall not be more than 6 in. shorter or more than 6 in. longer than the nominal length. Poles more than 50 ft. in length shall not be more than 6 in. shorter or more than 12 in. longer than the nominal length.

F. Each pole shall be completely free of outer bark and neatly sawed. Completely overgrown knots rising more than 1 in. above the pole surface, branch stubs and partially overgrown knots shall be trimmed close. Trimming may be done by a shaving machine by hand.

G. Each pole shall be sided in accordance with ANSI 05.1-1987 Specifications and Dimensions for Wood Poles, per Table 8.

DIMENSIONS OF DOUGLAS FIR (BOTH TYPES) AND SOUTHERN PINE POLES

Length of Pole (ft.)	Ground Line Distance From Butt (ft.)	ANSI 05.1-1987 Min. Top Class (in.)	Cir. (in.)	ANSI 05.1-1987 Mn. Circ. 6 ft. from Butt
30	5.5	3	23	32.0
35	6	3	23	34.0
40	6	3	23	36.0
45	6.5	3	23	37.5
50	7	3	23	39.0
30	5.5	2	25	34.0
35	6	2	25	36.5
40	6	2	25	38.0
45	6.5	2	25	40.5
50	7	2	25	42.0

H Each pole shall be branded with the Suppliers code or trademark, plant location and year of treatment, species and preservation code, size class number and length of pole.

The bottom of the brand or mark shall be placed squarely on the fence of the pole and at 10 ft. +- 2 in. from the butt of poles 50 ft. or less in length and at 14 ft. +- 2 in. from the butt of poles 55 ft. or more in length

ANCHORS AND ANCHOR RODS: Anchors for guying purposes shall be of the cone type, steel construction, 16 in. in diameter and suitable for a 3/4 in. 1 in. guy rod either 7 or 8 ft. long. The anchors shall be designed for use in hard pan, adobe clay, rocky soils and suitable for installation in inclined holes. Anchors shall be asphalt-painted for protection. Anchors shall be designed to permit salvaging of anchor rods should guys be abandoned. The ultimate soil-anchor holding strength in Class 3 soil shall be 19,000 lb. Anchors shall be LM Catalog Item No. B-20018-1 or approved equal. Anchor rods shall be 1 in. in diameter, 8 ft. long and suitable for use with the above-described anchor. Anchor rods shall be galvanized and constructed in a manner that will make the use of a thimble unnecessary.

GUY WIRE: Guy wire shall be extra high strength, double-galvanized, consisting of seven No. 8 gage steel wires twisted into a single conductor and have a diameter of 1/2 in. The minimum strength rating of the wire shall be 26,000 lb. Anchor guys shall be equipped with half-round guy wire protectors. These shall be hot galvanized and clamped to the guy wire with two (U) bolts and shall be 8 ft. long. Hubbard Catalog Item No. 7558, or approved equal, shall be used. Guy wires shall be clamped with a heavy-type guy clamp having three bolts. Clamps shall be fabricated from 3/8 in. hot galvanized steel and equipped with straight parallel grooves. Clamps shall be Hubbard Catalog Item No. 7484 or approved equal. Guy hooks shall be attached to each pole that is anchor guyed. Each head guy, tail guy or anchor guy shall be fitted with a guy insulator, Ohio Brass Company Catalog Item No. 31352 or approved equal.

LIGHTNING ARRESTERS: These shall be installed per drawings. Drive ground rod at the base of each such building and ground the lightning arresters in accordance with the drawings and the National Electrical Code (NEC).

INSULATORS AND HARDWARE: Insulators and pole line hardware shall be suitable for vertical construction as manufactured by line Materials Company, A. B. Chance Company or Joslyn Manufacturing Company.

END OF SECTION

SECTION 16450--GROUNDING

GROUNDING ELECTRODES

A. Grounding electrodes shall consist of 3/4 in. or larger galvanized steel pipe or 5/8 in. or larger galvanized or copper-clad steel rods.

B. The preferred electrode shall be the copper-clad steel rod, 10 ft. long.

C. The standard length electrode shall be 10 ft. Where electrodes are longer than the standard, their length shall be clearly marked near the top.

D. The size of the electrode used will depend on its length and the driving quality of the soil. It shall, if possible, be long enough to reach permanently moist earth below the frostline.

CONDUCTORS

A. Equipment Grounding Conductor--The equipment grounding conductor shall be an insulated (green) copper conductor.

B. Grounding Electrode Conductor--The grounding electrode conductor shall be copper.

STANDARD GROUNDING SYSTEM OR MAIN LOOP

A. A standard grounding system or main loop shall consist of a grounded loop of bare stranded copper wire, buried at a depth of at least 3 ft. below grade and completely encircling the building or structure.

B The distance between grounds on this loop shall not exceed 50 ft. At least two grounds shall be used, and where only two are required, each shall consist of three ground electrodes driven at the corners of an 8 ft. equilateral triangle and banded together They shall be located on opposite sides of the building, perfectly at opposite corners.

C. The loop shall be further bonded to the steel of steel frame buildings, all isolated grounds, and where practicable, to metal underground water and sewer piping systems, steel piling, well casings, etc.

D. The main ground loop and its connections to driven electrodes and other ground terminals, shall not be smaller than size No. 1/0.

PIPE AND ROD ELECTRODES

A. Electrodes shall be driven at a distance of not less than 3 ft. from the building foundation walls or structure footings.

B. Where convenient, and with the approval of the Contractor, they may be driven in the bottom of excavations.

C. Where ground electrodes are part of a loop or standard grounding system, their tops shall be driven below grade.

D. Pipe electrodes shall be fitted with ground points and caps.

E. Isolated ground electrodes shall be left with their tops projecting 6 in. above the grade so that the removable connectors are accessible for inspection and testing of ground resistance.

GROUND CONNECTIONS

A. All ground connections shall be bolted or brazed.

B. In order to ensure a low-resistance joint, care shall be taken in cleaning and preparing the contact surfaces.

C. The ground terminal at piping or tanks shall consist of 1/4 x 2 x 2 in. copper bar, brazed to the pipe or tank, to which is bolted a clamp-type terminal plug.

D. Connections of ground leads to isolated electrodes shall be made with bolted clamp-type connectors to facilitate removal for testing.

E. Disconnectors shall be installed in group leads to a standard grounding system or main loop.

F. No ground connections shall be made to gas piping.

EQUIPMENT GROUND SYSTEM

A. All metallic raceways, electrical equipment and related enclosures shall be continuously grounded.

B. A separate equipment-grounding conductor (green wire) shall be installed in all raceways for feeders, branch circuits, etc., regardless of size, location or length.

C. Parallel pipe lines shall be bonded and grounded at 30 to 40 ft. intervals and at every point where they cross within a few inches of each other or as indicated on the drawings.

END OF SECTION

SECTION 16460--TRANSFORMERS

GENERAL DISTRIBUTION TRANSFORMERS (13.8 kilovolts--480 volts)

General distribution transformers shall be Westinghouse, Sorgel or equivalent.

A. Distribution transformers shall be air-cooled or liquid filled type and shall be three-phase of the voltage specified. All connections shall be delta-wye.

B. The coil construction shall be either barrel-type or disk-type windings braced to prevent movement of conductor under heavy loads or short-circuit stress conditions. All windings shall be continuous, without splices and shall be brazed to the terminals. Coils shall be vacuum-impregnated with high-grade insulating varnish to make a completely unified structure of the winding. No spliced shall be made in the high-voltage windings. Windings shall be designed with generous spacing to allow for cooling circulations. Magnetic cores shall be built from a high-grade, nonaging, silicon steel manufactured for that purpose. The core steel shall have high magnetic permeabilities and low hysteresis and eddy current losses. Cores shall be held together with rigid steel channels or hinges, properly braced to ensure ruggedness.

C. All transformers shall meet the requirements of the National Electrical Manufacturers Association, Institute of Electrical and Electronics engineers and American National Standards Institute and shall have Underwriters' Laboratories, Inc., approval.

D. Primary Protection Transformers shall be provided with manually operated disconnectors, isolation switches and fusible links, for primary protection.

E Switching--All switching shall be designed for three-pole switches to handle any load. Special cases of multiple-source switching shall be called out in the design. Switches shall be designed for vertical pole construction.

F Grounding--The grounding of all structures, installations and equipment shall be in accordance with the latest National Electrical Code Standard Practices, national Electrical Safety Code and Federal, state and local recommendations.

CONTROL TRANSFORMERS

Control transformers shall be 50 V-A or larger.

Control transformers shall be Jefferson Electric Company or equivalent.

LIGHTING TRANSFORMERS:

Lighting transformers shall be dry type, Class "H" insulation; with ratio of 480 V, 3 phase, delta primary; 120/208 V, three-phase, four-wire wye secondary; Westinghouse Type "DT-3", with four 2 1/2% FCBN taps.

Lighting transformers shall be Westinghouse Type "DS-3", with two 5% by four 2 1/2 % FCBN taps.

A. Transformers shall be located remote from buildings containing hazardous areas as shown on drawings.

B. Transformers shall be connected to the primary feeder with three single-conductor pot heads.

END OF SECTION

SECTION 16492–UNDERGROUND ELECTRICAL SERVICE

SERVICE CONDUITS: Conduits for underground service shall conform to the National Electrical Code (NEC).

A. Conduits for underground electric service shall be installed as shown on the drawings.

B. Conduits shall be buried a minimum of 3 ft. below finished grade.

DUCTS: Underground ducts shall be heavy-walled polyvinyl chloride, fiber duct (Orangeburg) or transite.

A. Duct runs shall be encased in concrete with no less than 3 in. of concrete between ducts and no less than 4 in. around the outside periphery.

B. When multiple duct runs are installed, they shall be banded together with steel banding wire no less than 5 ft. on center.

C. All duct runs shall be tied down in an acceptable manner. The Subcontractor shall inspect all duct installations before concrete is poured.

D. A pull wire shall be installed in each duct run. This wire shall be pulled into each duct as it is installed. Under no circumstances shall any amount of duct be installed without pull wire. The pull wire shall be No 9 steel wire securely fastened at each end or completion of installation.

MANHOLES

A All manholes shall have a sump pit and sump pump.
B. All manholes shalL have pull irons to afford an efficient method of pulling cable.
C. All manholes shall have a frame and cover specifically designed for that purpose.
D All conduits entering manholes shall be terminated in end steel bells.
E. All manholes shall be completed with a manhole cover, flush with finished grade.
F All manholes shall have a steel ladder (approved industrial type), securely welding or bolted to cover frame and painted with rust-resistant primer and finish coat.
G All manholes shall be complete with insert cable racks placed to allow the neat raining of all cables around the manhole from entrance to exit.
Cable racks shall be of sufficient in number to support all cables with 20% additional supports to accommodate future needs.
H. All excavations for manholes shall be large enough to set forms and afford room for waterproofing after forms are removed.
Manholes excavations shall be kept free of water, debris and foreign materials. Manhole excavations of a depth of prevent cave-in hazards during construction shall be protected with shoring or sheet piling.

TRENCHING AND BACKFILL

A. Trenching shall be of size and location as shown on the drawings. All trenching shall be kept free of water, debris and foreign materials. Care shall be taken that trenches are properly sloped, where depth and job condition indicate a possible safety hazard to personnel and approved by the Contractor.

The use of shoring and trench bracing may be required by the Contractor at no additional cost to the Government.

B. All backfill shall be done in 6 in. layers with each layer compacted 98% according to the Modified Proctor Method.

C. The backfill in the immediate area of cable or conduit shall be done with clean sand to a depth of 6 in. above cable or conduit. Succeeding layers of backfill may be with fill material compacted after each layer.

END OF SECTION

UPS PRICE SUMMARY

Date: 03-31-1997

The designed system consists of the following components:

ITEM	QTY	DESCRIPTION	EACH	TOTAL
1	[1]	One SCI series 3SS 30 KVA, Three phase 60 hertz industrial grade UPS system, complete with zero-break static transfer switch make-before-break manually operated maintenance bypass switch, and specified features and alarms.	Price $ 33,751	$ 33,751
2	[1]	One SCI series RCS rectifier/charger rated 130 volts, 300 amps including specified features and alarms.	Price $ 13,103	$ 13,103
3	[1]	15 Minute 20 Yr Valve Reg. Battery-Cab. Model Chloride 60-2C200-H0	Price $ 14,754	$ 14,754
4	[1]	Bypass Transformer Series Dry rated 30 KVA	Price $ 1,183	$ 1,183

System budgetary price Fob Factory : $ 62,790
Recommended spare parts : $ 11,682
Estimated Freight to NEW YORK Region : $ 80
Start-Up Services : $ 2,911

OPTIONAL EXPORT PRICE ADDERS

Ocean Freight Estimate to NEW YORK : $ 14

TOTAL SYSTEM PRICE ESTIMATE : S 77,477

Prices shown are budgetary. Firm prices can be obtained by contacting your factory representative or SCI direct at 1-800 635-7300 or (614) 846-7500.

APPENDIX 1.12.8
Drawings

of the
Conceptual Design Report

for the
Interim Storage Vault

for the
Rocky Flats Environmental Technology Site
Golden, Colorado

Task Order 72

for the

U. S. Department of Energy
Rocky Flats Operations Office
Golden, Colorado

Prepared by
Rocky Flats Engineers and Constructors, LLC
Denver, Colorado

May 1997

Authorization No. E32CD100

DRAWINGS

COMPLETE SECTION CAN BE FOUND IN LIBRARY

0 0 1

ROCKY FLATS ENGINEERS AND CONSTRUCTORS, LLC

7677 EAST BERRY AVENUE, ENGLEWOOD, COLORADO 80111-2137

TELEPHONE: 303-741-7077 FAX: 303-741-7562

July 11, 1997

Mr. Brac Melton, Project Manager
Kaiser-Hill Company, LLC
Rocky Flats Environmental Technology Site
P. O. Box 464, Building T130F
Golden, Colorado 80402-0464

J.O. No. 06489.72

Letter Ref: rfc503.doc

ADDENDUM TO CONCEPTUAL DESIGN REPORT
INTERIM STORAGE VAULT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE (RFETS)

Attached is the completed addendum to the Conceptual Design Report referenced in our correspondence to you dated 6/30/97 (Ltr. Ref: RFC487). This package includes a revised bill of materials, revised drawings, and a revised schedule.

If you have any questions or comments regarding this package, please advise.

Sincerely,

Rick Sanchez
Task 72 Manager

RLS/rlb

Attachments

CLIENT: Rocky Flats Environmental Technology Site | EST. NO. | JO NO.06489.72
DESCRIPTION OF WORK: Interim Storage Vault | QTY. BY: | CK. BY: | PRICES BY:
DATE: | APPROVED:
Drawing No. 51493-C705 (7 of 10)

ACCOUNT NO.	ITEM NO.	DESCRIPTION	SPEC. REFERENCE	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	M	**MECHANICAL ROOM**								
	M1	Disconnect Safety Switch	Later	1						
	EM	**ELECTRICAL MATERIALS**								
	EM1	Basic Materials and Methods -	16050							
	EM2	Conductors - See Drawing 51493-C709, C751 and C801 for cable bills of material								
	EM3	Conduit and Fittings - 3/4" RGS	**16050**	**5000LF**						
		1" RGS	**16050**	**2500LF**						
		3" RGS	**16050**	**1000LF**						
		1" PVC	**16050**	**300LF**						
		3/4" Liquid Tight Flexible Conduit	**16050**	**1000LF**						
	EM4	Wireway "Walker Duct" with all necessary hardware and fittings per spec., 175LF for one double bay or 112 tubes	16113	**750LF**						
	EM5	Wiring Devices -	16140							
	EM6	Receptacles - SEE LIGHTING ESTIMATE	16140	N/A						
	EM7	480 Volt Receptacles	16140	1						
	EM8	Switches - SEE LIGHTING ESTIMATE	16140	N/A						

CLIENT: Rocky Flats Environmental Technology Site	EST. NO.		JO NO.06489.72
DESCRIPTION OF WORK: Interim Storage Vault	QTY. BY:	CK. BY:	PRICES BY:
	DATE:		APPROVED:
Drawing No. 51493-C752 (2 of 6)			

ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	R5	Analog module base (1 per storage tube), Allen-Bradley 1794-TB3	325						
	R6	DIN rail (1 per storage tube), Allen-Bradley 199-DR1	325						
	R7	Enclosure and miscellaneous hardware (1 per storage tube)	325						
	TS	**TUBE SENSORS:**							
	TS1	RTD for container temp. (32 per storage tube), Minco S32PB11Y240A	10,400						
	TS2	RTD for tube air temperature (3 per storage tube), Minco S32PB11Y240A	975						
	TS3	Helium detector (1 per storage tube), Varian Vacuum Helitest (modified)	325						
	TI	**TUBE IDENTIFICATION AND TAMPER PROTECTION:**							
	TI1	Ultrasonic bolt tamper seal (1 per storage tube), JRC-Ispra	325						
	TI2	Tamper tape seal (10 per storage tube), 3M confirm	3,250						
	TI3	Cable seal (10 per storage tube), EJ Brooks Multilok	3,250						
	TI4	Bar code (1 per storage tube)	325						

CLIENT: Rocky Flats Environmental Technology Site				EST. NO.					JO NO.06489.72	
DESCRIPTION OF WORK: Interim Storage Vault				QTY. BY:		CK. BY:		PRICES BY:		
				DATE:				APPROVED:		
Drawing No. 51493-C752 (4 of 6)										
ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS	
	M	**MISCELLANEOUS INSTRUMENTS:**								
	M1	Bar code scanner, Symbol Technology	**2**							
	M2	Fiber optic video system, Olympus	**2**							
	M3	Radioscopy system, custom-designed, SAIC	**2**							
	M4	Datalogger, Fluke	**2**							
	M5	Pressure gauge, Ashcroft S1279	**2**							
	OW	**OPERATOR WORKSTATION FOR 3013 CONTAINERS:**								
	OW1	Computer (industrial grade)	**1**							
	OW2	UPS	**1**							
	OW3	PLC/Operator interface software, Wonderware FactoryLink	**1**							
	OW4	Operating System Software, Microsoft Windows NT	**1**							
	OW5	PLC Gateway to PC, Allen-Bradley 1784-KT	**1**							
	OW6	Ethernet hub to bldg 371	**1**							
	OW7	Ethernet card in workstation	**1**							
	OW8	Ethernet cable (1 30 ft. length)	**1**							
	OW9	Tamper indicating devices on Ethernet cable (2 per cable)	**2**							

CLIENT: Rocky Flats Environmental Technology Site | EST. NO. | JO NO.06489.72
DESCRIPTION OF WORK: Interim Storage Vault | QTY. BY: | CK. BY: | PRICES BY:
DATE: | APPROVED:
Drawing No. 51493-C752 (5 of 6)

ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	SAS	**SAS WORKSTATION:**							
	SAS1	Computer (industrial grade)	1						
	SAS2	PLC/operator interface software, Wonderware FactoryLink	1						
	SAS3	Operating System Software, Microsoft Windows NT	1						
	SAS4	NT							
	SAS5	PLC Gateway to PC, Allen-Bradley 1784-KT							
	IAEA	**IAEA WORKSTATION:**							
	IAEA1	Computer (industrial grade)	1						
	IAEA2	UPS	1						
	IAEA3	PLC/operator interface software, Wonderware FactoryLink	1						
	IAEA4	Operating System Software, Microsoft Windows NT	1						
	IAEA5	PLC Gateway to PC, Allen-Bradley 1784-KT	1						

CLIENT: Rocky Flats Environmental Technology Site	EST. NO.		JO NO.06489.72
DESCRIPTION OF WORK: Interim Storage Vault	QTY. BY:	CK. BY:	PRICES BY:
	DATE:		APPROVED:
Drawing No. 51493-C752 (6 of 6)			

ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
		NOTES:							
		1. Quantities are total for all **325** tubes in **6** bays.							
		2. Refer to Instrument and Control Tradeoff Study							
		Attachment D for detailed bill of materials including							
		equipment costs, maintenance costs, and manpower							
		estimates.							

CLIENT: Rocky Flats Environmental Technology Site	EST. NO.		JO NO.06489.72
DESCRIPTION OF WORK: Interim Storage Vault	QTY. BY:	CK. BY:	PRICES BY.
	DATE:		APPROVED:
Drawing No. NONE (1 of 4)			

ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
		LIGHTING							
	L1	Lamp Type A: 40 Watt Fluorescent lamp, GE type F-40 T-12 (F40CW), rapid start preheat, 48-inch length	300						
	L2	Fixture type C: 2 lamp industrial fluorescent fixture 2-F40Cw	31						
	L3	Fixture type C/B: Emergency/battery backed 2-lamp industrial fluorescent fixture 2-F40CW.	10						
	L4	Fixture type F: 2 lamp fluorescent troffer (recessed) 2-F40CW with prismatic lense	50						
	L5	Fixture type F/B: Emergency/battery backed 2 lamp fluorescent troffer (recessed) 2-F40CW with prismatic lense	25						
	L6	Fixture type H: 4 lamp fluorescent troffer (recessed) 4-F40CW with prismatic lense	30						
	L7	Fixture type H/B: Emergency/battery backed 4 lamp fluorescent troffer (recessed) 4-F40CW with prismatic lense.	15						

CLIENT: Rocky Flats Environmental Technology Site	EST. NO.		JO NO.06489.72
DESCRIPTION OF WORK: Interim Storage Vault	QTY. BY:	CK. BY:	PRICES BY:
	DATE:		APPROVED:
Drawing No. NONE (2 of 4)			

ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	L8	Fixture type K: High bay fixture with 175 Watt mercury vapor clear lamp, 7,000 lumen, holophane Enduralume Compact enclosure Cat. No. ENDR-175MV27-A418, 277 Volt, or equal.	40						
	L9	Fixture type Y1: wall-mounted outdoor fixture with 100 Watt high pressure sodium clear lamp, 8550 lumen, holophane wallpack 2, Cat. No. WL2K-100HP27-GR, 277 Volt, or equal	27						
	L10	Fixture type Y2: outdoor fixture with 250 Watt high pressure sodium clear lamps (TWO), 27500 lumen each, 35 ft. pole, holophane expressway/security light, Cat. No. SGRT35J-2-1235-480, 480 Volt, or equal	36						
	L11	Fixture type Q. Led exit light fixture, single-faced, Exitronix Model No. 602, with battery, or equal.	24						
	L12	Fixture type Q/S: Led exit light fixture with PAR36 spotlights (two) single-faced, Exitronix Model No. 602-2F, with battery, or equal.	8						

CLIENT: Rocky Flats Environmental Technology Site	EST. NO.		JO NO.06489.72
DESCRIPTION OF WORK: Interim Storage Vault	QTY. BY:	CK. BY:	PRICES BY:
	DATE:		APPROVED:
Drawing No. NONE (3 of 4)			

ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	L13	Fixture type R. Led exit light fixture, double-faced, Exitronix Model No. 603, with battery, or equal.	5						
	L14	Fixture type S1: Emergency spotlight fixture, Exitronix Model No. LL40, battery backed with two spotlights, or equal.	24						
	L15	Type R1 receptacle: 15AMP, 125 Volt, 2 pole, duplex, Hubbell Cat. No. 5262, or equal.	140						
	L16	Type S2 switch: 20 Amp, 120 Volt, double pole, Hubbell Cat . No. 1222, or equal.	52						
	L17	EMT 3/4 inch conduit for lighting, total linear feet	3,500						
	L18	EMT 1 inch conduit for lighting, total linear feet	1,200						
	L19	RGS 1 inch conduit for lighting, total linear feet	3,500						
	L20	RGS 1-1/2 inch conduit for lighting, total linear feet	11,000						

CLIENT: Rocky Flats Environmental Technology Site					EST. NO.			JO NO.06489.72	
DESCRIPTION OF WORK: Interim Storage Vault					QTY. BY:	CK. BY:		PRICES BY:	
					DATE:		APPROVED:		
Drawing No. NONE (4 of 4)									
ACCOUNT NO.	ITEM NO.	DESCRIPTION	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	L21	EMT conduit fittings for lighting	1LOT						
	L22	RGS conduit fittings for lighting	1LOT						
	L23	Total #10 AWG cable THHN/THWN-composite (linear feet) for lighting	18,000						
	L24	Total #8 AWG cable THHN/THWN-composite (linear feet) for lighting	13,000						
	L25	Total #6 AWG cable THHN/THWN-composite (linear feet) for lighting	56,000						

CLIENT: Rocky Flats Environmental Technology Site | EST. NO. | JO NO.06489.72

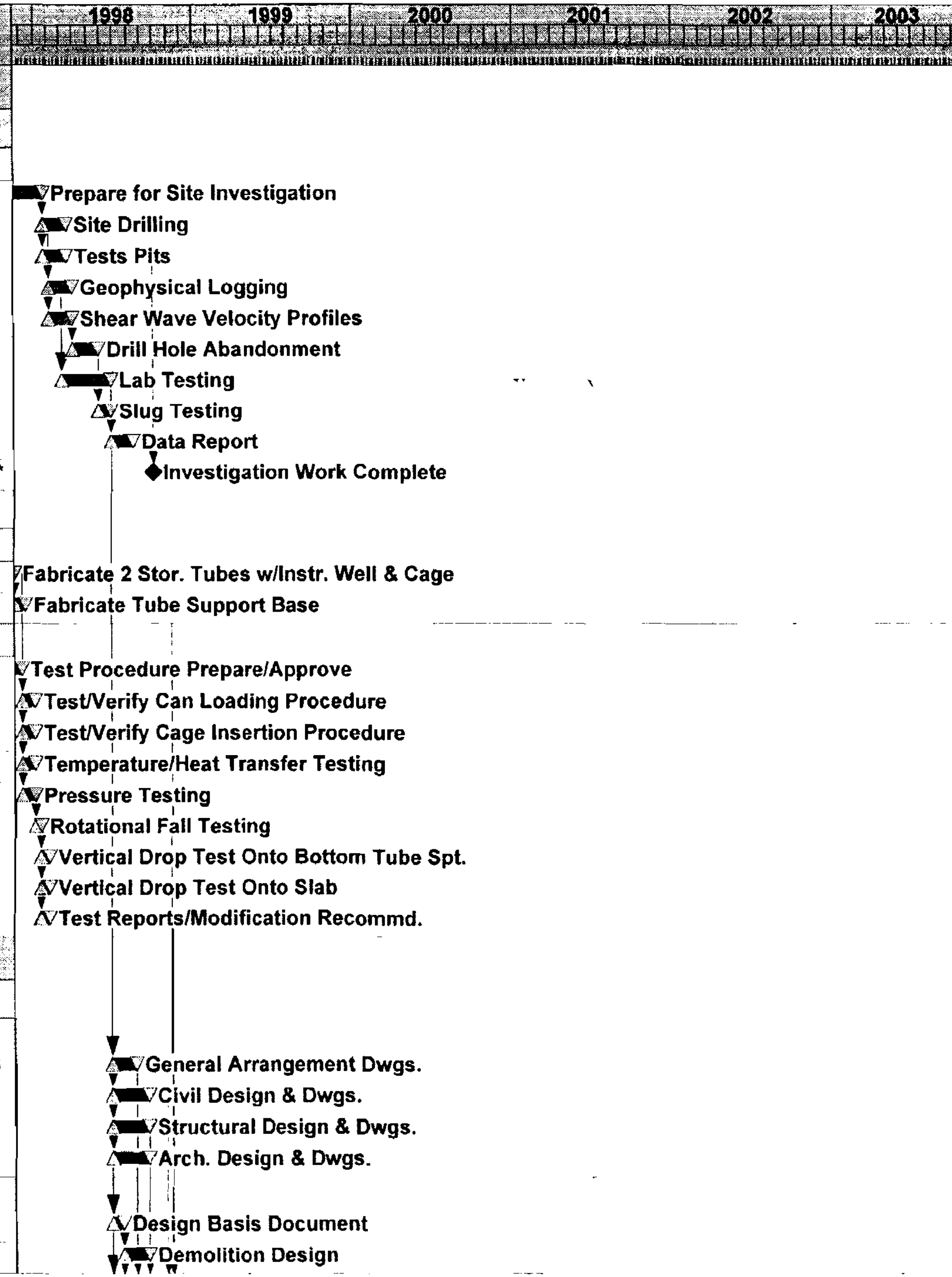
DESCRIPTION OF WORK: Interim Storage Vault | QTY. BY: | CK. BY: | PRICES BY:

DATE: | APPROVED:

Drawing No. 51493-C801

ACCOUNT NO.	ITEM NO.	DESCRIPTION	SPEC. REFERENCE	QUANTITIES	UNIT COST MAT'L	UNIT COST MH/RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
	PS	**PERSONNEL SAFETY INSTRUMENTS**								
		Neutron Criticality Detector	6							
	PS1	Area Smoke Detector	24							
	PS2	Area Smoke Detection System Speakers	6							
	PS3	Air Handling Unit Smoke Detector	3							
	PS4	Portable Continuous Air Monitor, RADEC model 452, with vacuum pump, cart and alarm beacon	4							
	PS5	Sprinkler System Flow Switch	1							
	PS6	Fire Alarm Pull Station	5							
	PS7	Criticality Strobe Beacons	4							
	PS8	LS/DW Area Speakers	15							

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
PRELIMINARY						
GEO TECH						
SITE INVESTIGATION						
000000	Prepare for Site Investigation	80	80	0	01OCT97*	20JAN98
000001	Site Drilling	40	40	0	21JAN98	17MAR98
000005	Tests Pits	40	40	0	21JAN98	17MAR98
000002	Geophysical Logging	40	40	0	04FEB98	31MAR98
000003	Shear Wave Velocity Profiles	40	40	0	04FEB98	31MAR98
000006	Drill Hole Abandonment	40	40	0	01APR98	26MAY98
000007	Lab Testing	80	80	0	04MAR98	23JUN98
000004	Slug Testing	20	20	0	27MAY98	23JUN98
000008	Data Report	38	38	0	24JUN98	14AUG98
000010	Investigation Work Complete	0	0	0		30SEP98*
STORAGE TUBE						
STORAGE TUBE MOCK-UP						
400000	Fabricate 2 Stor. Tubes w/Instr. Well &	30	30	0	01OCT97	11NOV97
400009	Fabricate Tube Support Base	20	20	0	12NOV97	09DEC97
TESTING						
400003	Test Procedure Prepare/Approve	46	46	0	01OCT97	03DEC97
400001	Test/Verify Can Loading Procedure	20	20	0	03DEC97	30DEC97
400102	Test/Verify Cage Insertion Procedure	20	20	0	03DEC97	30DEC97
400104	Temperature/Heat Transfer Testing	20	20	0	03DEC97	30DEC97
400106	Pressure Testing	20	20	0	03DEC97	30DEC97
400108	Rotational Fall Testing	10	10	0	31DEC97	13JAN98
400110	Vertical Drop Test Onto Bottom Tube	14	14	0	14JAN98	02FEB98
400112	Vertical Drop Test Onto Slab	14	14	0	14JAN98	02FEB98
400114	Test Reports/Modification Recommd.	14	14	0	14JAN98	02FEB98
TITLE 1						
CIVIL/ARCH/STRUCTURAL						
DRAWINGS						
600000	General Arrangement Dwgs.	40	40	0	24JUN98	18AUG98
300009	Civil Design & Dwgs.	60	60	0	24JUN98	15SEP98
300013	Structural Design & Dwgs.	60	60	0	24JUN98	15SEP98
300015	Arch. Design & Dwgs.	60	60	0	24JUN98	15SEP98
MISC. OTHER						
300000	Design Basis Document	20	20	0	24JUN98	21JUL98
300011	Demolition Design	40	40	0	22JUL98	15SEP98



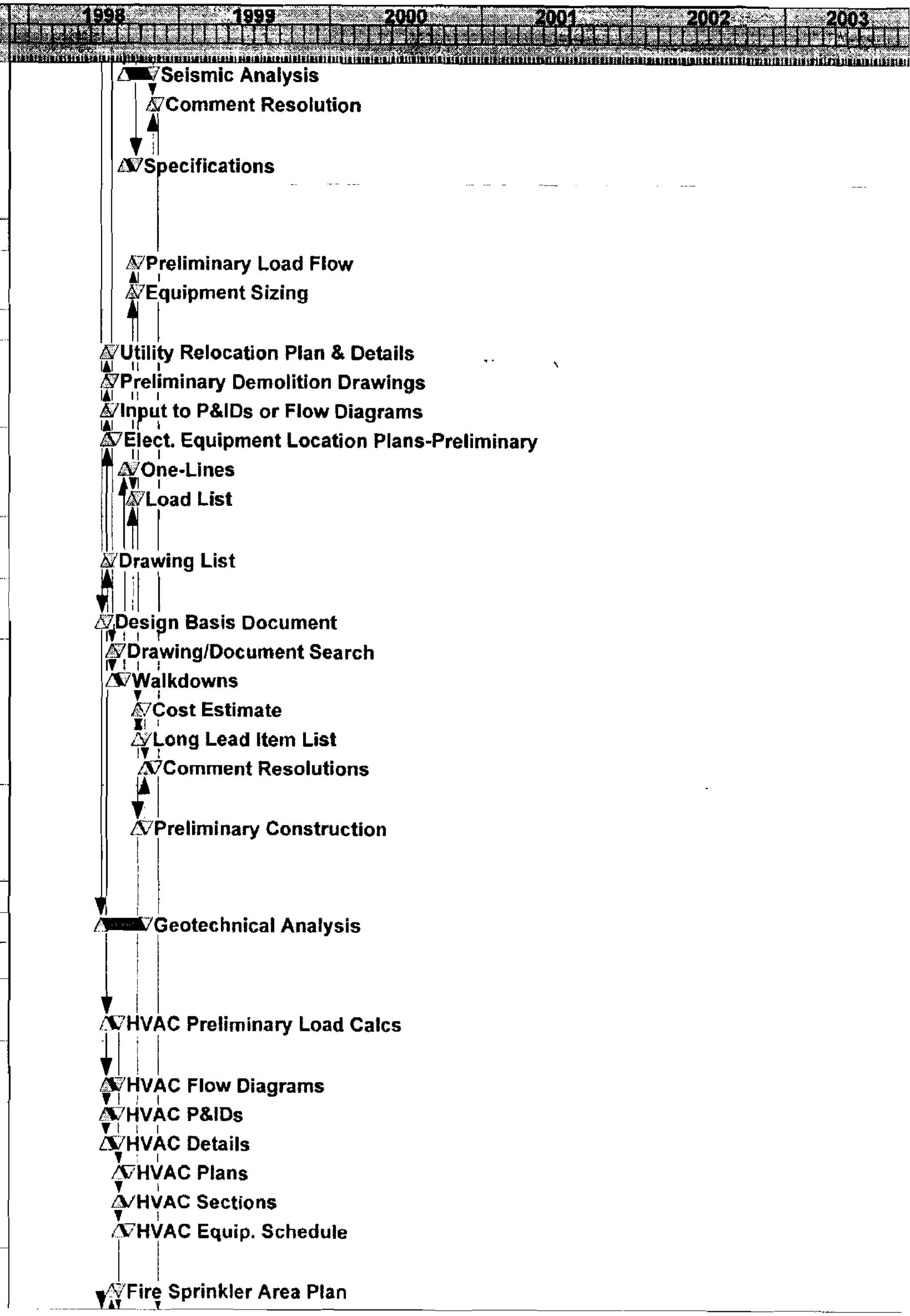
Project Start 01OCT97
Project Finish 05FEB02
Data Date 01OCT97
Run Date 11JUL97

Early Bar
Progress Bar
Critical Activity

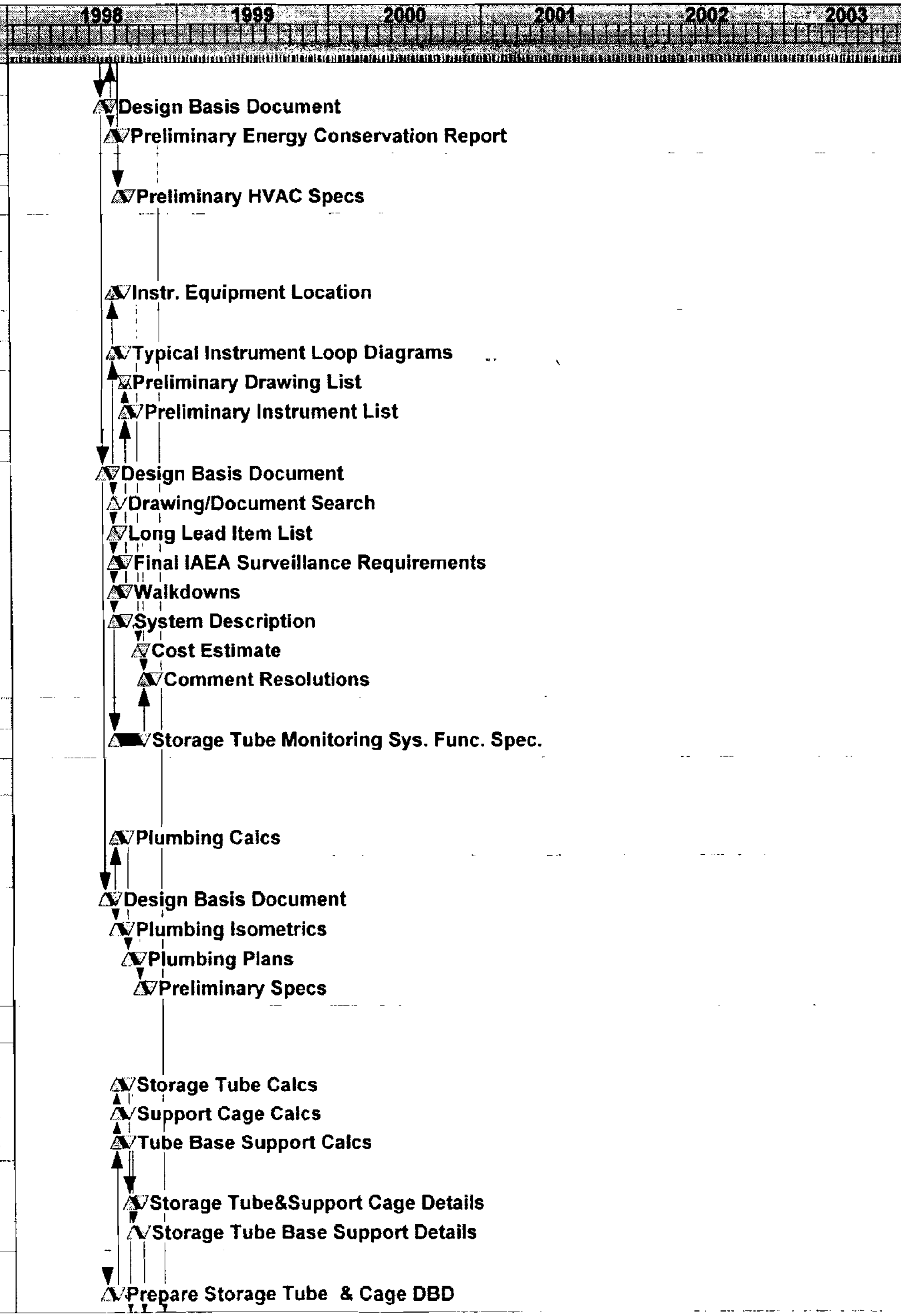
ISV1

RFEC
Interim Storage Vault
Title I, II, & III Schedule

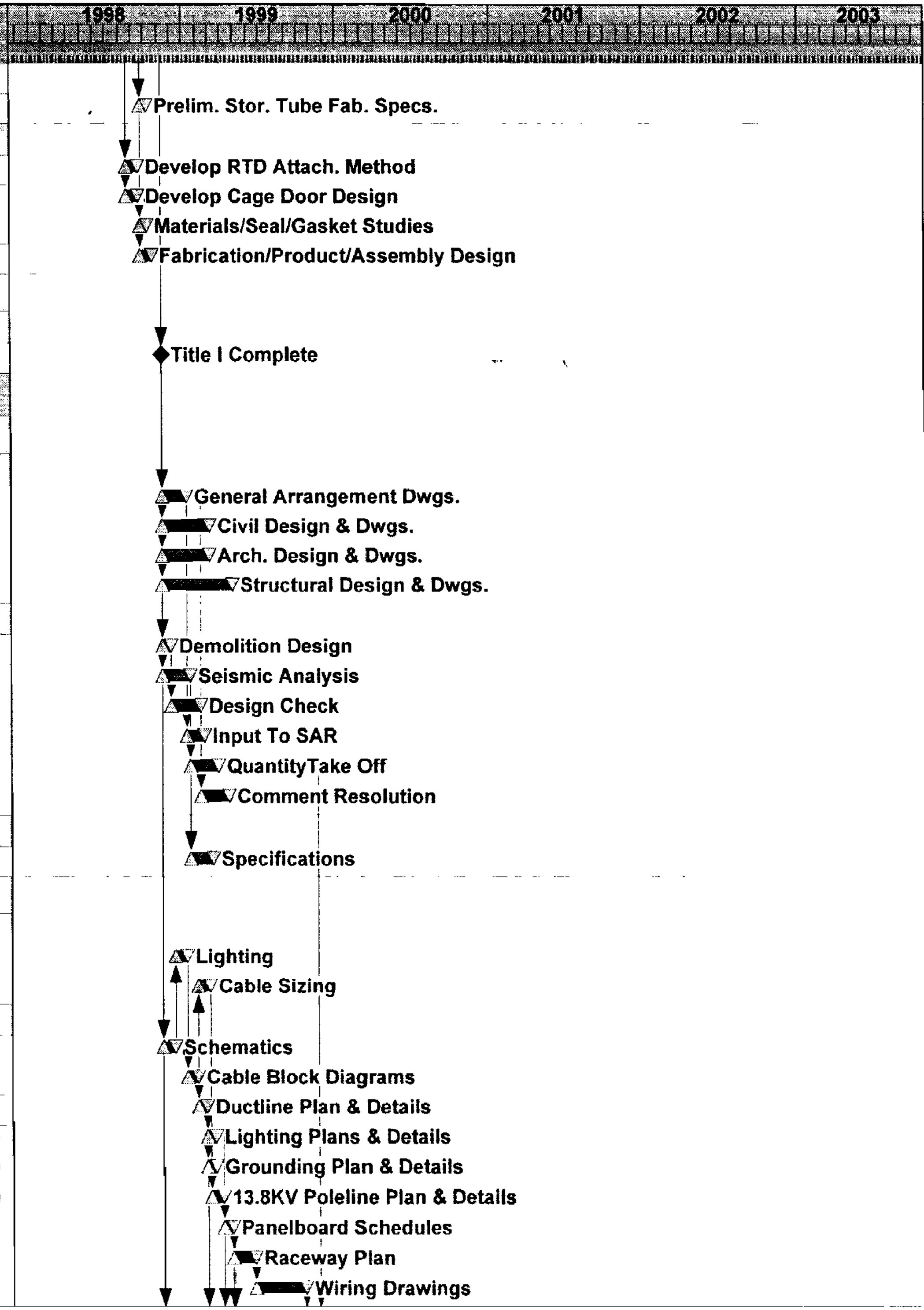
Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
300007	Seismic Analysis	50	50	0	19AUG98	27OCT98
300005	Comment Resolution	10	10	0	28OCT98	10NOV98
SPECIFICATIONS						
300001	Specifications	20	20	0	19AUG98	15SEP98
ELECTRICAL						
CALCULATIONS						
111115	Preliminary Load Flow	10	10	0	09SEP98	22SEP98
111131	Equipment Sizing	10	10	0	09SEP98	22SEP98
DRAWINGS						
111136	Utility Relocation Plan & Details	10	10	0	08JUL98	21JUL98
111138	Preliminary Demolition Drawings	10	10	0	08JUL98	21JUL98
111148	Input to P&IDs or Flow Diagrams	10	10	0	08JUL98	21JUL98
111137	Elect. Equipment Location	15	15	0	08JUL98	28JUL98
111134	One-Lines	15	15	0	19AUG98	08SEP98
111200	Load List	10	10	0	09SEP98	22SEP98
MISC. LISTS						
111156	Drawing List	5	5	0	08JUL98	14JUL98
MISC. OTHER						
111113	Design Basis Document	10	10	0	24JUN98	07JUL98
111111	Drawing/Document Search	10	10	0	22JUL98	04AUG98
111112	Walkdowns	20	20	0	22JUL98	18AUG98
111170	Cost Estimate	10	10	0	23SEP98	06OCT98
111171	Long Lead Item List	10	10	0	23SEP98	06OCT98
111172	Comment Resolutions	20	20	0	07OCT98	03NOV98
SPECIFICATIONS						
111123	Preliminary Construction	15	15	0	23SEP98	13OCT98
GEO TECH						
SITE INVESTIGATION						
000009	Geotechnical Analysis	80	80	0	24JUN98	13OCT98
HVAC						
CALCULATIONS						
600001	HVAC Preliminary Load Calcs	20	20	0	08JUL98	04AUG98
DRAWINGS						
600002	HVAC Flow Diagrams	20	20	0	08JUL98	04AUG98
600003	HVAC P&IDs	20	20	0	08JUL98	04AUG98
600006	HVAC Details	20	20	0	08JUL98	04AUG98
600004	HVAC Plans	20	20	0	05AUG98	01SEP98
600005	HVAC Sections	20	20	0	05AUG98	01SEP98
600007	HVAC Equip. Schedule	20	20	0	05AUG98	01SEP98
FIRE PROTECTION						
600011	Fire Sprinkler Area Plan	10	10	0	22JUL98	04AUG98



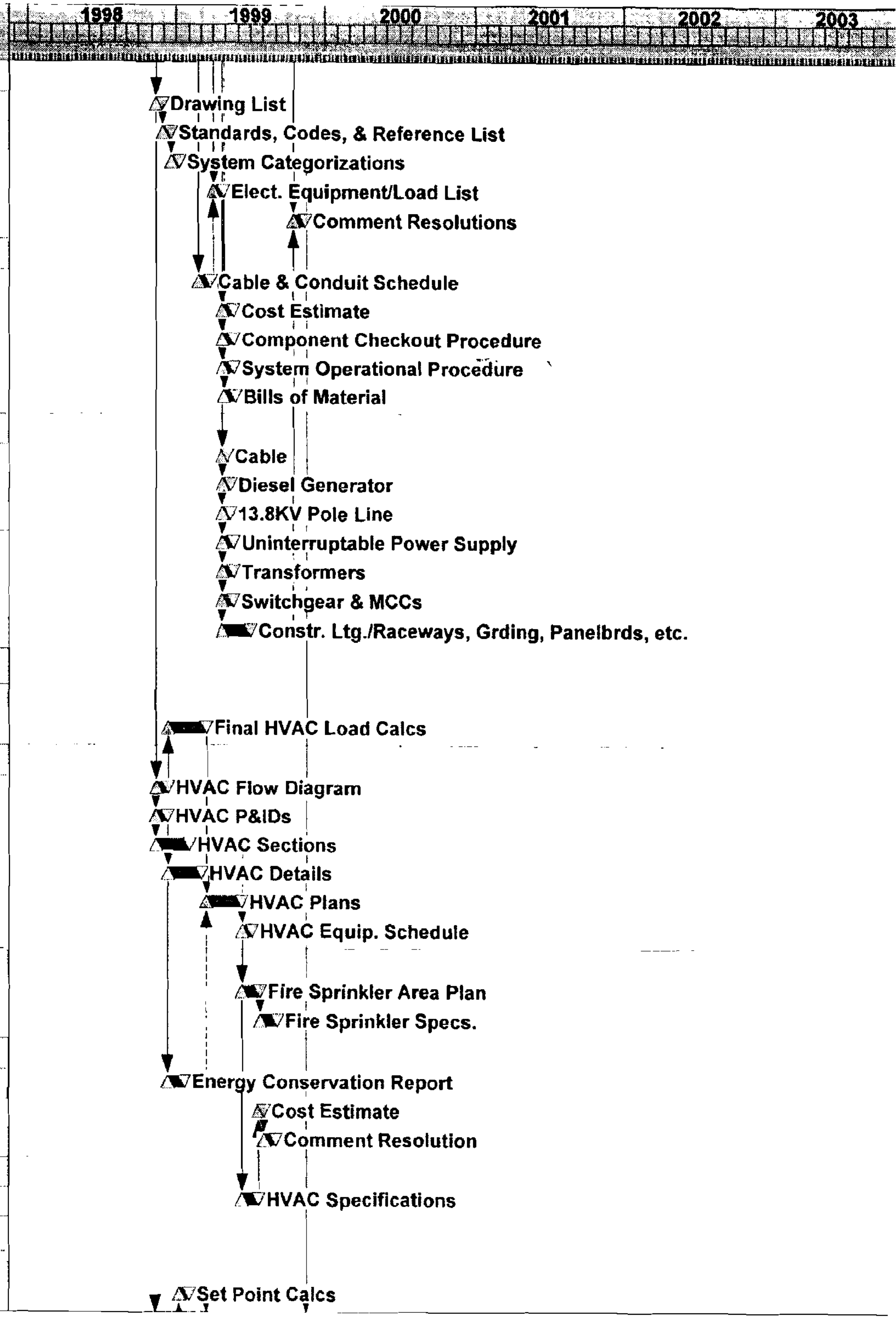
Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
MISC. OTHER						
600010	Design Basis Document	20	20	0	24JUN98	21JUL98
600009	Preliminary Energy Conservation Report	20	20	0	22JUL98	18AUG98
SPECIFICATIONS						
600008	Preliminary HVAC Specs	20	20	0	05AUG98	01SEP98
INSTRUMENTATION & CONTROLS						
DRAWINGS						
222290	Instr. Equipment Location	20	20	0	22JUL98	18AUG98
MISC. LISTS						
222277	Typical Instrument Loop Diagrams	20	20	0	22JUL98	18AUG98
222255	Preliminary Drawing List	2	2	0	19AUG98	20AUG98
222275	Preliminary Instrument List	20	20	0	19AUG98	15SEP98
MISC. OTHER						
222334	Design Basis Document	20	20	0	24JUN98	21JUL98
222221	Drawing/Document Search	10	10	0	22JUL98	04AUG98
222272	Long Lead Item List	10	10	0	22JUL98	04AUG98
222223	Final IAEA Surveillance Requirements	20	20	0	22JUL98	18AUG98
222333	Walkdowns	20	20	0	22JUL98	18AUG98
222335	System Description	20	20	0	22JUL98	18AUG98
222271	Cost Estimate	10	10	0	16SEP98	29SEP98
222273	Comment Resolutions	20	20	0	30SEP98	27OCT98
SPECIFICATIONS						
222279	Storage Tube Monitoring Sys. Func.	50	50	0	22JUL98	29SEP98
PLUMBING						
CALCULATIONS						
600013	Plumbing Calcs	20	20	0	22JUL98	18AUG98
DRAWINGS						
600210	Design Basis Document	20	20	0	24JUN98	21JUL98
600225	Plumbing Isometrics	20	20	0	22JUL98	18AUG98
600220	Plumbing Plans	20	20	0	19AUG98	15SEP98
600235	Preliminary Specs	20	20	0	16SEP98	13OCT98
STORAGE TUBE						
CALCULATIONS						
400300	Storage Tube Calcs	20	20	0	22JUL98	18AUG98
400305	Support Cage Calcs	20	20	0	22JUL98	18AUG98
400307	Tube Base Support Calcs	20	20	0	22JUL98	18AUG98
DRAWINGS						
400011	Storage Tube&Support Cage Details	20	20	0	19AUG98	15SEP98
400013	Storage Tube Base Support Details	20	20	0	26AUG98	22SEP98
DESIGN						
400010	Prepare Storage Tube & Cage DBD	20	20	0	24JUN98	21JUL98



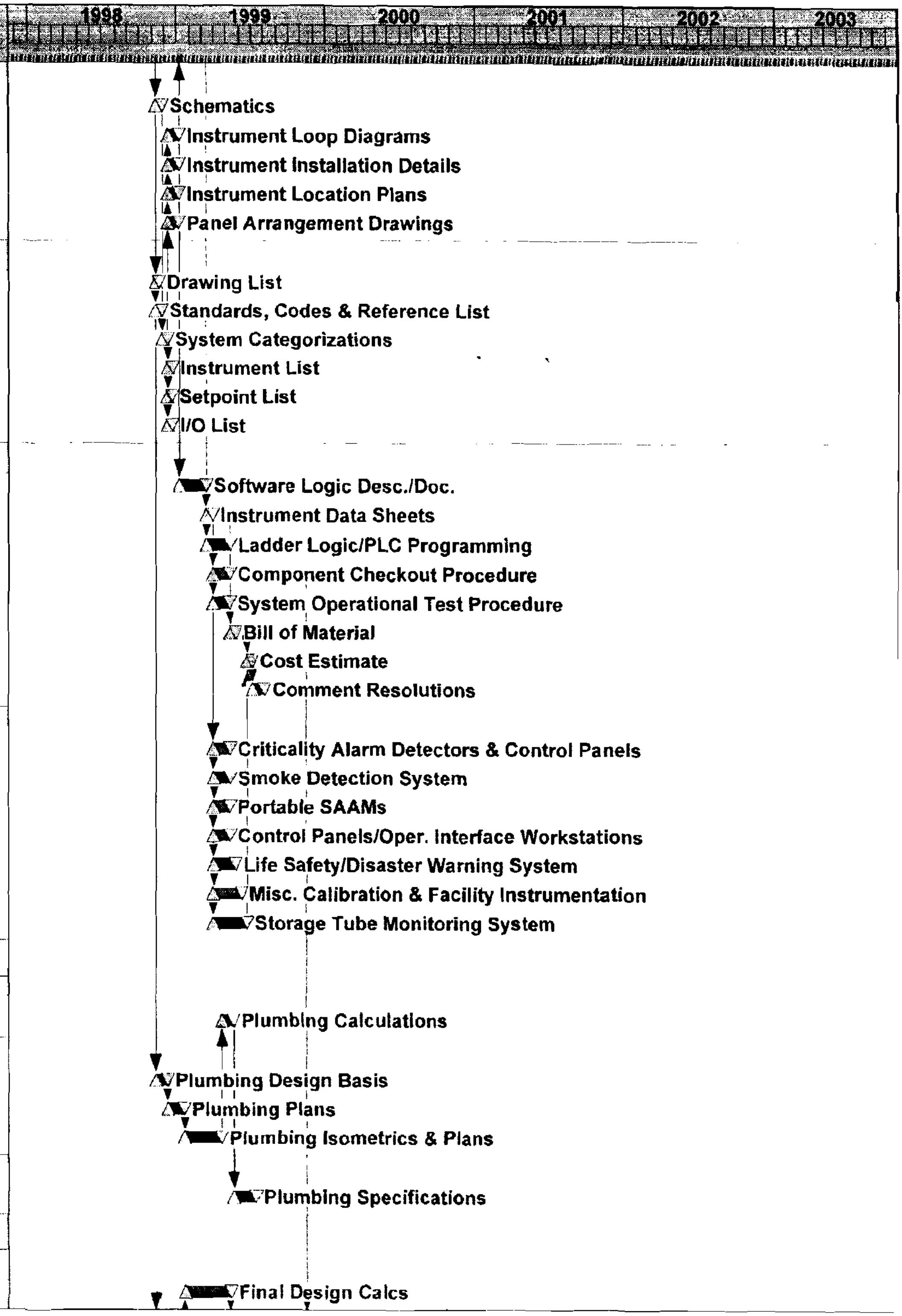
Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
SPECIFICATIONS						
400019	Prelim. Stor. Tube Fab. Specs.	10	10	0	23SEP98	06OCT98
STUDIES						
400304	Develop RTD Attach. Method	20	20	0	19AUG98	15SEP98
400306	Develop Cage Door Design	20	20	0	19AUG98	15SEP98
400303	Materials/Seal/Gasket Studies	10	10	0	23SEP98	06OCT98
400308	Fabrication/Product/Assembly Design	20	20	0	23SEP98	20OCT98
900000	Title I Complete	0	0	0		10NOV98
TITLE 2						
CIVIL/ARCH/STRUCTURAL						
DRAWINGS						
600050	General Arrangement Dwgs.	40	40	0	11NOV98	05JAN99
300010	Civil Design & Dwgs.	80	80	0	11NOV98	02MAR99
300016	Arch. Design & Dwgs.	80	80	0	11NOV98	02MAR99
300014	Structural Design & Dwgs.	120	120	0	11NOV98	27APR99
MISC. OTHER						
300012	Demolition Design	16	16	0	11NOV98	02DEC98
300008	Seismic Analysis	48	48	0	11NOV98	15JAN99
300017	Design Check	48	48	0	03DEC98	08FEB99
300002	Input To SAR	32	32	0	06JAN99	18FEB99
300004	QuantityTake Off	48	48	0	18JAN99	24MAR99
300006	Comment Resolution	48	48	0	09FEB99	15APR99
SPECIFICATIONS						
300003	Specifications	40	40	0	18JAN99	12MAR99
ELECTRICAL						
CALCULATIONS						
111132	Lighting	20	20	0	09DEC98	05JAN99
111133	Cable Sizing	20	20	0	03FEB99	02MAR99
DRAWINGS						
111124	Schematics	20	20	0	11NOV98	08DEC98
111135	Cable Block Diagrams	20	20	0	06JAN99	02FEB99
111140	Ductline Plan & Details	15	15	0	03FEB99	23FEB99
111145	Lighting Plans & Details	15	15	0	24FEB99	16MAR99
111146	Grounding Plan & Details	15	15	0	24FEB99	16MAR99
111141	13.8KV Poleline Plan & Details	20	20	0	03MAR99	30MAR99
111147	Panelboard Schedules	15	15	0	31MAR99	20APR99
111180	Raceway Plan	40	40	0	21APR99	15JUN99
111195	Wiring Drawings	85	85	0	16JUN99	12OCT99



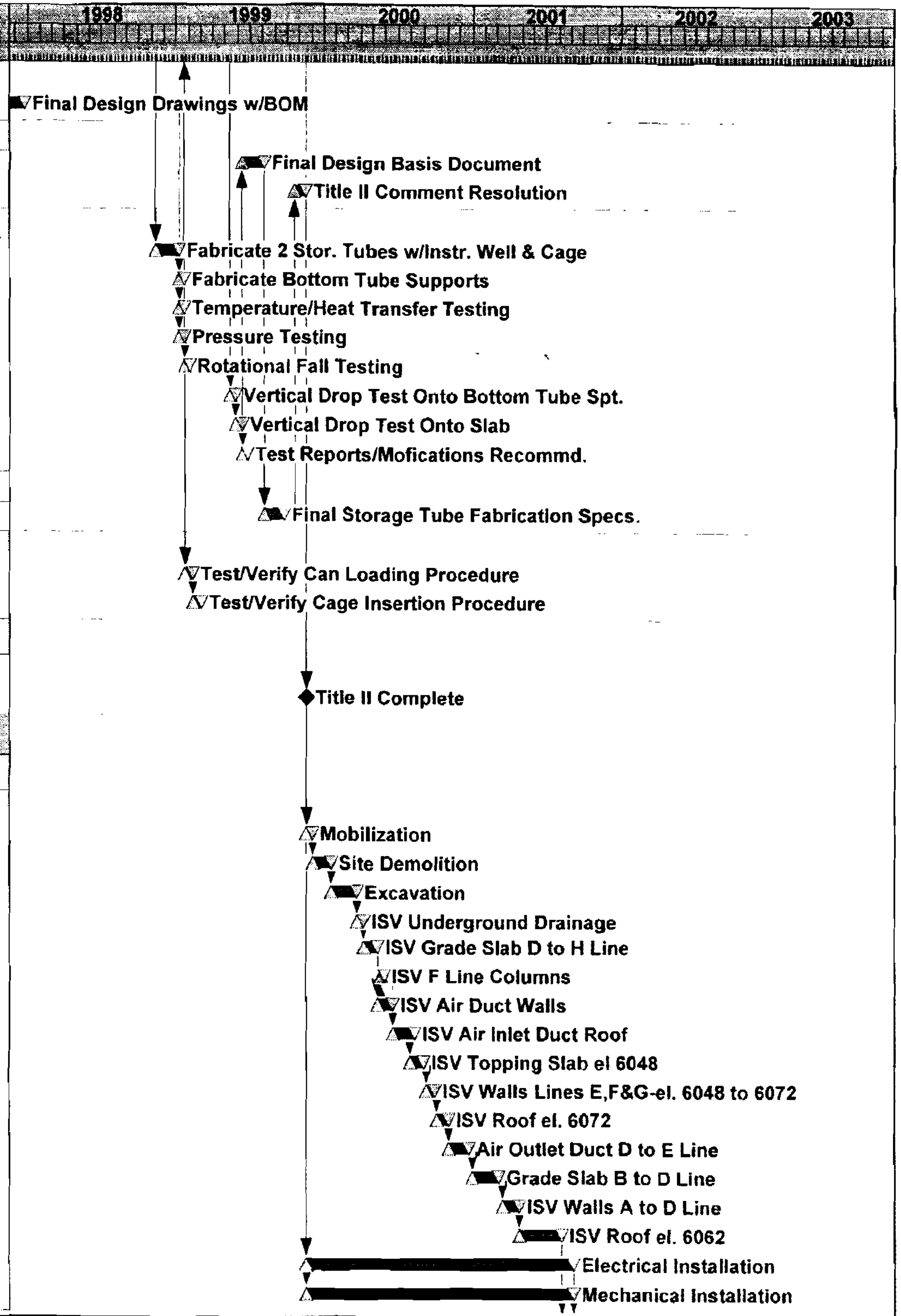
Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
MISC. LISTS						
111153	Drawing List	10	10	0	11NOV98	24NOV98
111154	Standards, Codes, & Reference List	15	15	0	25NOV98	15DEC98
111155	System Categorizations	15	15	0	16DEC98	05JAN99
111152	Elect. Equipment/Load List	20	20	0	31MAR99	27APR99
111160	Comment Resolutions	20	20	0	13OCT99	09NOV99
MISC. OTHER						
111157	Cable & Conduit Schedule	20	20	0	24FEB99	23MAR99
111158	Cost Estimate	20	20	0	21APR99	18MAY99
111163	Component Checkout Procedure	20	20	0	21APR99	18MAY99
111164	System Operational Procedure	20	20	0	21APR99	18MAY99
111149	Bills of Material	20	20	0	28APR99	25MAY99
SPECIFICATIONS						
111122	Cable	10	10	0	21APR99	04MAY99
111118	Diesel Generator	15	15	0	21APR99	11MAY99
111121	13.8KV Pole Line	15	15	0	21APR99	11MAY99
111116	Uninterruptable Power Supply	20	20	0	21APR99	18MAY99
111117	Transformers	20	20	0	21APR99	18MAY99
111119	Switchgear & MCCs	20	20	0	21APR99	18MAY99
111120	Constr. Ltg./Raceways, Grding,	50	50	0	21APR99	29JUN99
HVAC						
CALCULATIONS						
600017	Final HVAC Load Calcs	70	70	0	09DEC98	16MAR99
DRAWINGS						
600018	HVAC Flow Diagram	20	20	0	11NOV98	08DEC98
600019	HVAC P&IDs	20	20	0	11NOV98	08DEC98
600021	HVAC Sections	60	60	0	11NOV98	02FEB99
600022	HVAC Details	60	60	0	09DEC98	02MAR99
600020	HVAC Plans	60	60	0	17MAR99	08JUN99
600023	HVAC Equip. Schedule	20	20	0	09JUN99	06JUL99
FIRE PROTECTION						
600027	Fire Sprinkler Area Plan	35	35	0	09JUN99	27JUL99
600028	Fire Sprinkler Specs.	30	30	0	28JUL99	07SEP99
MISC. OTHER						
600025	Energy Conservation Report	30	30	0	09DEC98	19JAN99
600035	Cost Estimate	10	10	0	21JUL99	03AUG99
600045	Comment Resolution	20	20	0	04AUG99	31AUG99
SPECIFICATIONS						
600024	HVAC Specifications	30	30	0	09JUN99	20JUL99
INSTRUMENTATION & CONTROLS						
CALCULATIONS						
222236	Set Point Calcs	20	20	0	06JAN99	02FEB99



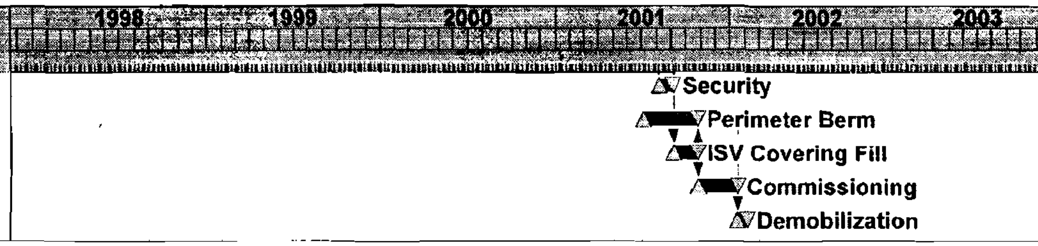
Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
DRAWINGS						
222231	Schematics	10	10	0	11NOV98	24NOV98
222239	Instrument Loop Diagrams	20	20	0	09DEC98	05JAN99
222240	Instrument Installation Details	20	20	0	09DEC98	05JAN99
222241	Instrument Location Plans	20	20	0	09DEC98	05JAN99
222242	Panel Arrangement Drawings	20	20	0	09DEC98	05JAN99
MISC. LISTS						
222250	Drawing List	5	5	0	11NOV98	17NOV98
222251	Standards, Codes & Reference List	10	10	0	11NOV98	24NOV98
222252	System Categorizations	10	10	0	25NOV98	08DEC98
222247	Instrument List	10	10	0	09DEC98	22DEC98
222248	Setpoint List	10	10	0	09DEC98	22DEC98
222249	I/O List	10	10	0	09DEC98	22DEC98
MISC. OTHER						
222259	Software Logic Desc./Doc.	50	50	0	06JAN99	16MAR99
222260	Instrument Data Sheets	10	10	0	17MAR99	30MAR99
222295	Ladder Logic/PLC Programming	40	40	0	17MAR99	11MAY99
222261	Component Checkout Procedure	30	30	0	31MAR99	11MAY99
222262	System Operational Test Procedure	30	30	0	31MAR99	11MAY99
222245	Bill of Material	10	10	0	12MAY99	25MAY99
222256	Cost Estimate	10	10	0	23JUN99	06JUL99
222257	Comment Resolutions	20	20	0	07JUL99	03AUG99
SPECIFICATIONS						
222225	Criticality Alarm Detectors & Control	30	30	0	31MAR99	11MAY99
222226	Smoke Detection System	30	30	0	31MAR99	11MAY99
222227	Portable SAAMs	30	30	0	31MAR99	11MAY99
222230	Control Panels/Oper. Interface	30	30	0	31MAR99	11MAY99
222228	Life Safety/Disaster Warning System	40	40	0	31MAR99	25MAY99
222238	Misc. Calibration & Facility	50	50	0	31MAR99	08JUN99
222229	Storage Tube Monitoring System	60	60	0	31MAR99	22JUN99
PLUMBING						
CALCULATIONS						
600029	Plumbing Calculations	20	20	0	21APR99	18MAY99
DRAWINGS						
600033	Plumbing Design Basis	20	20	0	11NOV98	08DEC98
600030	Plumbing Plans	30	30	0	09DEC98	19JAN99
600031	Plumbing Isometrics & Plans	65	65	0	20JAN99	20APR99
SPECIFICATIONS						
600032	Plumbing Specifications	40	40	0	19MAY99	13JUL99
STORAGE TUBE						
CALCULATIONS						
400022	Final Design Calcs	80	80	0	20JAN99	11MAY99



Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
DRAWINGS						
400023	Final Design Drawings w/BOM	60	60	0	01OCT97	23DEC97
MISC. OTHER						
400021	Final Design Basis Document	40	40	0	09JUN99	03AUG99
400025	Title II Comment Resolution	20	20	0	20OCT99	16NOV99
PROTOTYPE						
400030	Fabricate 2 Stor. Tubes w/Instr Well &	40	40	0	11NOV98	05JAN99
400032	Fabricate Bottom Tube Supports	10	10	0	06JAN99	19JAN99
400038	Temperature/Heat Transfer Testing	10	10	0	06JAN99	19JAN99
400040	Pressure Testing	10	10	0	06JAN99	19JAN99
400042	Rotational Fall Testing	10	10	0	20JAN99	02FEB99
400044	Vertical Drop Test Onto Bottom Tube	10	10	0	12MAY99	25MAY99
400046	Vertical Drop Test Onto Slab	10	10	0	26MAY99	08JUN99
400048	Test Reports/Mofications Recommd.	10	10	0	09JUN99	22JUN99
SPECIFICATIONS						
400024	Final Storage Tube Fabrication Specs.	35	35	0	04AUG99	21SEP99
TESTING						
400034	Test/Verify Can Loading Procedure	15	15	0	20JAN99	09FEB99
400036	Test/Verify Cage Insertion Procedure	15	15	0	10FEB99	02MAR99
900001	Title II Complete	0	0	0		16NOV99
TITLE 3						
CONSTRUCTION						
500000	Mobilization	10	10	0	17NOV99	30NOV99
500001	Site Demolition	35	35	0	01DEC99	18JAN00
500002	Excavation	45	45	0	19JAN00	21MAR00
500004	ISV Underground Drainage	10	10	0	22MAR00	04APR00
500006	ISV Grade Slab D to H Line	25	25	0	05APR00	09MAY00
500010	ISV F Line Columns	5	5	0	17MAY00	23MAY00
500008	ISV Air Duct Walls	25	25	0	10MAY00	13JUN00
500012	ISV Air Inlet Duct Roof	40	40	0	14JUN00	08AUG00
500014	ISV Topping Slab el 6048	25	25	0	26JUL00	29AUG00
500016	ISV Walls Lines E,F&G-el. 6048 to 6072	15	15	0	06SEP00	26SEP00
500018	ISV Roof el. 6072	20	20	0	04OCT00	31OCT00
500020	Air Outlet Duct D to E Line	35	35	0	01NOV00	19DEC00
500022	Grade Slab B to D Line	50	50	0	27DEC00	06MAR01
500024	ISV Walls A to D Line	30	30	0	14MAR01	24APR01
500026	ISV Roof el. 6062	75	75	0	25APR01	07AUG01
500028	Electrical Installation	470*	470*	0	17NOV99	04SEP01
500032	Mechanical Installation	470*	470*	0	17NOV99	04SEP01



Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
500042	Security	20	20	0	08AUG01	04SEP01
500038	Perimeter Berm	80	80	0	04JUL01	23OCT01
500034	ISV Covering Fill	35	35	0	05SEP01	23OCT01
500044	Commissioning	60	60	0	24OCT01	15JAN02
500046	Demobilization	15	15	0	16JAN02	05FEB02



DRAWINGS

COMPLETE SECTION CAN BE FOUND IN LIBRARY

87/8901

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Cost Engineering

PROJECT: INTERIM STORAGE VAULT

JOB NUMBER: E32PM100-01

CONCEPTUAL DESIGN REPORT ESTIMATE
REVISION #: 00

DATE ISSUED: June 24, 1997

TOTAL COST:	$	63,013,178
CONTINGENCY %:		20%
CONTINGENCY TOTAL:	$	12,602,634
(ADJUSTED TO MEET DOE 5100.4)	$	84,188
TOTAL ESTIMATED COST (TEC):	$	75,700,000
TOTAL OTHER COSTS:	$	0
CONTINGENCY %:		%
CONTINGENCY TOTAL:	$	0
(ADJUSTED TO MEET DOE 5100.4)	$	0
TOTAL PROJECT COST (TPC):	$	0

REMARKS: The total capital cost reflects the estimate for the base structure plus the cost for six (6) bays to store the DOE 3013 containers, using the estimate developed for one (1) common storage bay. The estimate was developed in this manner due to previous classification concerns, which are no longer relevant.

ESTIMATOR K. R. BRUSEGAARD	K. R. Brusegaard	Date: 6/24/97
PROJECT MANAGER: B. B. MELTON	B. B. Melton	Date: 6/25/97
PROJECT ENGINEER: M. H. AUBLE	M. H. Auble	Date: 6/25/97

Rocky Flats Environmental Technology Site
P.O. Box 464
Golden, Colorado 80402-0464

Kaiser-Hill

Cost Engineering

ESTIMATE SUMMARY

Interim Storage Vault (Capital)

A. Design and Management Costs			$ 10,955,992
Engineering, Design, & Inspection		$ 7,786,632	
Title-I	$ 3,256,182		
Title-II	$ 3,624,360		
Title-III	$ 906,090		
Inspection	$ 0		
Construction Management		$ 1,299,097	
Project Management		$ 1,870,263	
B. Construction Costs			$ 50,033,281
Improvements to Land		$ 876,544	
Buildings		$ 29,239,435	
New	$29,239,435		
Modifications	$ 0		
Other Structures		$ 141,158	
Special Facilities		$ 19,120,103	
Equipment	$19,018,466		
Installation	$ 101,637		
Utilities		$ 656,041	
C. Standard Equipment			$ 0
D. Major Computer Items			$ 0
E. Removal Cost Less Salvage			$ 2,023,905
Subtotal			$ 63,013,178
F. Contingency @ 20% of all other Costs			$ 12,602,634
G. Adjusted to meet DOE 5100.4			$ 84,188
H. Total Estimated Costs (TEC)			**$ 75,700,000**
I. OPC Costs			$ 0
J. Contingency @ % of all other Costs			$ 0
K. Adjusted to meet DOE 5100.4			$ 0
Subtotal			$ 0
L. Total Project Costs (TPC)			**$ 0**

ESTIMATE BASIS

GENERAL PROJECT INFORMATION

DOE Project Title: Interim Storage Vault
DOE Project Number :
ADS Number :
B&R Code :
Plant WBS :

PROJECT SCOPE

The scope of this project is the design and construction of a new Interim Storage Vault (ISV) to safety store Department of Energy (DOE) 3013 containers. The project also includes the design and installation of a storage tube handling facility within Building 371.

The Total Estimated Cost (TEC) for this project is $75,700,000. Copies of the detailed cost estimate for the basic vault building and the "per bay" estimate for the common vault bays along with various estimate summaries can be found at the end of this report. A comparison of costs between the cost estimate developed in March 1996 for an Interim Storage Vault and this cost estimate is also located at the end of this report.

DOCUMENTS & DRAWINGS

The cost estimate was based on the Conceptual Design Report, Revision 0 which was issued by Rocky Flats Engineers and Constructors (RFEC), dated May 8, 1997 and supplied by the K-H Project Engineer.

LABOR RATES

Labor rates for work performed by a Fixed Price (FP) Contractor and AECCM Contractor are based on the General Manager's Determination Project Labor Agreement for the site. The Integrating Management Contractor (IMC) rates are those issued by Finance and Administration (effective October 1, 1996, and revised February, 1997). IMC rates include fringe benefits, company overhead, company general and administrative (G&A), and site G&A.

GENERAL REQUIREMENTS/OVERHEADS

Contractor Markups - Fixed Price: A 10% markup was applied to all work which was assumed will be performed by a subcontractor to the prime contractor. A 25.3% markup was applied to all prime contractor costs including subcontract costs to account for overhead, profit and bond.

ESCALATION

Escalation percentages were calculated using the January 1997 update of the economic escalation price change indices for Department of Energy Headquarters' construction projects as published by the "Office of Infrastructure Acquisition" FM-50.

ROUNDING

U. S. Department of Energy - DOE Order 5100.4 Page I-32 Subparagraph (M), requires rounding of all General Plant Projects (GPP's) and Line Item (LI) cost estimates, reference: DOE 5100.4, Figure I-11, Dated 10-31-84.

PRODUCTIVITY FACTORS

No adders were applied to the standard labor hours obtained from national estimating databases, to account for losses in productivity associated with work on the storage vault. It was assumed that this project could be segregated from the rest of the site and worked using standard OSHA regulations. A productivity factor of 78% has been incorporated into all labor for work associated with the installation of the storage tube handling system within Building 371.

GENERAL ASSUMPTIONS

A) Labor rates are based on a 40-hour work week with an adequate supply of skilled and unskilled labor available. No overtime has been accounted for.

B) The site considered is on DOE land, hence; no land acquisition and condemnation costs are required or included.

C) The estimate assumes that the construction of the vault will be performed under a contract with a general contractor and their subcontractors selected as a result of competitive bidding.

D) The estimate is based on normal oriented construction with no costs allowed in the estimate to cover major rework due to construction errors, recycle, or additional work that may be from the results of unforeseen events or conditions. Normal weather conditions allowances are included in the scope of work.

E) It is assumed that the storage tubes including the cap are the only safety class rated items associated with this project, since the tube serves as the tertiary boundary for confinement of the plutonium stored in the vault. The storage vault structure, although it is not rated as a safety class component, must meet PC-4 criteria. For that reason labor and material costs have been adjusted to account for higher quality assurance requirements.

F) The estimate contains no labors costs associated with the installation of the storage tubes and cages since only a select number of storage tubes will be temporarily installed in the vault in order to test all monitoring systems to determine if they are functional. The installation of all tubes will occur during the operation phase of the project.

G) The CDR includes electrical and mechanical systems to serve both the vault holding 3013 containers as well as a vault holding the AL-R8 containers. Since the AL-R8 containers will no longer require storage in the vault, the requirement for electrical and mechanical systems supporting that portion of the vault are not needed. Only those items clearly identified in the CDR as serving that portion of the vault were omitted from the cost estimate. Those systems which would be re-sized were priced as they are currently designed.

H) Title I, II and III Engineering were based on a percentage of construction. In determining the cost of construction only the cost for one common storage vault bay was used since the design for the other bays is identical.

I) Based on the Conceptual Design Report Section 1.5.1.3 Geotechnical Design Criteria which states that groundwater would pose a problem during excavations, costs for de-watering the site while sub-grade work is in progress were included.

J) It was assumed that all work associated with the storage tube handling facility within Building 371, including demolition of existing gloveboxes and the installation of new handling equipment would be performed by an AECCM Contractor using “Q” cleared crafts under a fixed unit rate contract and were priced accordingly.

K) It was assumed that the current siting location for the proposed ISV is not an Individual Hazardous Substance Site (IHSS) and no contaminated soil would be encountered during construction.
L) It was assumed that soil excavated for the building foundation could be used as backfill and any excess material could be used in the common fill layer of the overburden.
M) It was assumed that a concrete batch plant would be set-up on-site to maintain consistent concrete quality and timely delivery of concrete.
N) Quantities in the cost estimate are based on material take-offs in Appendix 1.12.7 of the CDR. Additional material take-offs, not included in the CDR provided the means to deduct quantities associated with both vaults in order for the estimator to develop a "per bay" cost estimate.
O) All costs associated with cast-in-place concrete construction were developed using Richardson's Cost Estimating standards. These standards lend themselves more towards "heavy" construction than R. S. Means.
P) All equipment is assumed to be procured by the Contractor, no Government Furnished Equipment is included in the estimate.
Q) Costs for geotechnical investigation and for the fabrication of two storage tubes with cage assemblies, to be used for testing purposes, were included in the Capital cost estimate at the direction of the Project Manager.
R) It was assumed that the construction contractor would only disassemble the trailers currently located within the construction area and move them to a designated location at RFETS for Kaiser-Hill to disposition.
S) The estimate assumes minimal interference by RFETS operations during construction.
T) The "per bay" cost estimate includes construction of the structural components of the vault for a typical bay located between column lines 3 and 13. Construction of structural components for a non-typical bay located between column lines 2 and 3 were included in the base building estimate. Quantities for the five (5) typical bays were modified to allow for the bottom line cost to be multiplied by six (6) to arrive at the total cost for the storage bays without double counting the structural components in the non-typical end bay.

CONTINGENCY ANALYSIS

The U. S. Department of Energy (DOE) Order 5700.2D "Cost Estimating, Analysis and Standardization", and the DOE Office of Infrastructure Acquisition (FM-50) "Cost Estimating Guide, Volume 6, Cost Guide", provides guidelines for estimate contingencies. The guideline for a conceptual design estimate should have an overall range of 15% to 25%, and up to 40% for experimental or special conditions.

Title I, II, III Engineering, Design and Inspection

An average contingency of 19% was added to the engineering and design costs based on this project consisting of a routine civil design at a conceptual design stage.

Project and Construction Management

An average contingency of 20% was applied to Project and Construction Management based on standard building construction.

Improvements to Land

An average contingency of 18% was applied to costs associated with Improvements to Land based on unobstructed area and fixed price construction.

New Buildings

A contingency of 19% was applied to New Building costs since standard building construction and fixed price contracts are anticipated.

Other Structures

An average of 19% was applied to these costs based routine construction and an unobstructed construction site.

Special Facility Equipment

An average contingency of 22% was applied to equipment based on defined complex instrumentation and control package as well as the storage tube and cage assembly requirements.

Special Facility Installation

A 21% contingency was applied to the installation based on site conditions and the complexity of systems being installed.

Utilities

An average 20% contingency was applied to utility costs based on work with underground utilities.

Removals

An average contingency of 20% was applied to removal costs based on a combination of routine site removals by the Fixed Price Contractor, along with removal of contaminated equipment items by the AECCM Contractor.

AVERAGE PROJECT CONTINGENCY 20%

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Cost Engineering

ESCALATION RATES

REFERENCE DATE: 6/1/97

	START	FINISH	MIDPOINT	RATE
TITLE I/II ENGINEERING	10/1/98	5/1/2000	7/17/99	5.20%
TITLE III ENGINEERING	3/20/2000	1/2/2003	8/11/2001	10.79%
PROJECT MANAGEMENT	10/1/98	1/2/2003	11/16/2000	9.02%
CONSTRUCTION	3/20/2000	1/2/2003	8/11/2001	10.79%

Interim Storage Vault

DOE Code of Accounts Summary

Base Bldg. & "Per Bay" Estimates

INTERIM STORAGE VAULT (ISV)-CDR
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
BASE ISV BLDG COST ESTIMATE

Client	B.B. MELTON
	T-130F
Estimator	K.R. BRUSEGAARD
Report format	Sorted by 'DOE'
	'DOE' summary
	Allocate addons
	Print DOE notes

BASE ISV BLDG COST EST. 9:24 AM

Description	Quantity	Unit Price	Amount
TITLE-I			3,256,182
TITLE-II			3,624,360
TITLE-III			906,090
CONSTRUCTION MGMT.			1,299,097
PROJECT MANAGEMENT			1,870,263
BUILDINGS (NEW)			21,018,679
IMPROVEMENTS TO LAND			876,544
OTHER STRUCTURES			141,158
REMOVAL LESS SALVAGE			2,023,905
SPEC. FACIL. EQUIP.			1,888,304
SPEC. FACIL. INSTALL			14,643
UTILITIES			656,041

Estimate Totals

Labor	22,843,887		319,103.595	hrs	
Material	10,435,445				
Subcontract	832,169				
Equipment	3,431,774		116,860.933	hrs	
Other	31,992				
	37,575,267	37,575,267			
Contingency	7,515,054		20.000	%	T
Adjustment to meet DOE 5100.4	9,679				L
	Total	***45,100,000***			

Description	Quantity	Unit Price	Amount
BUILDINGS (NEW)			**1,370,126**
SPEC. FACIL. EQUIP.			**2,855,027**
SPEC. FACIL. INSTALL			**14,499**

Estimate Totals

Labor	955,582		19,035.492 hrs	
Material	1,273,909			
Equipment	2,010,161		6,436.119 hrs	
	4,239,652	4,239,652		
Contingency	847,930		20.000 %	T
Adjustment to meet DOE 5100.4	12,417			L
	Total	***5,099,999***		

Interim Storage Vault

Group Phase Summary

Base Bldg. & "Per Bay" Estimates

INTERIM STORAGE VAULT (ISV)-CDR
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
BASE ISV BLDG COST ESTIMATE

Client	B.B. MELTON
	T-130F
Estimator	K.R. BRUSEGAARD
Report format	Sorted by 'Group phase'
	'Group phase' summary
	Print group phase notes

Description		Quantity	Unit Price	Amount
001000	DESIGN AND MANAGEMENT			8,075,156
010000	OVERHEAD			1,102,621
014000	QUALITY CONTROL			57,923
015000	CNST FCLT AND TMPR CNTR			913,164
020000	SBSRF INVSTG&SITE DEMOL			1,230,102
021000	SITE PREPARATION			213,266
022000	EARTHWORK			1,091,052
025000	PAVING AND SURFACING			246,346
026000	PIPED UTILITIES			88,098
027000	SEWERAGE & DRAINAGE			25,483
028000	SITE IMPROVEMENTS			60,111
029000	LANDSCAPING			31,201
031000	CONCRETE FORMWORK			2,536,404
032000	CONCRETE REINFORCEMEN			2,794,401
033000	CAST-IN-PLACE CONCRETE			2,309,483
050000	METAL MTRLS,FNSHS&FAST			357,958
055000	METAL FABRICATIONS			3,399
080000	DOORS & WINDOWS			28,977
083000	SPECIAL DOORS			331,823
092000	LATH,PLST AND GYPSM BOA			29,844
093000	TILE			9,048
095000	ACST TRTMN AND WOOD FL			9,602
098000	SPECIAL COATINGS			11,134
099000	PAINTING & WALL COVERING			4,472
100000	SPECIALTIES			667,635
101000	CHLKBRD,CMPRTMN&CUBIC			1,384
105000	LCKR,PRTC CVRS&PSTL SPC			1,501
110000	EQUIPMENT			2,954
111000	MRCN,COMM AND DTNT EQP			5,774
132000	TNKS,TANK CVRS,FLTR EQP			92,477
145000	MATERIAL HANDLING SYSTE			428,973
146000	HOISTS AND CRANES			114,869
151000	PIPE AND FITTINGS			55,108
152000	PLUMBING FIXTURES			9,313
153000	PLUMBING APPLIANCES			6,700
154000	FIRE EXTNGSHNG SYSTEMS			38,667
155000	HEATING			131,138

BASE ISV BLDG COST EST.

Description		Quantity	Unit Price	Amount
157000	AIR CNDTNG/VNTLTNG			271,234
160000	RACEWAYS			450,382
161000	CONDUCTORS AND GROUND			332,392
162000	BOXES AND WIRING DEVICES			399
163000	MTRS,STRT,BRDS AND SWTC			344,667
164000	TRNSFRMRS AND BUS DUCT			71,508
165000	POWER SYSTMS AND CAPAC			90,346
166000	LIGHTING			137,995
167000	ELECTRIC UTILITIES			17,784
168000	SPECIAL SYSTEMS			277,067
169000	POWER TRNSMS AND DISTR			138,577

Estimate Totals

Labor	15,746,137		319,103.595 hrs	
Material	6,721,161			
Subcontract	530,323			
Equipment	2,232,293		116,860.933 hrs	
Other	20,000			
	25,249,914	25,249,914		
Negative Spreadsheet Balance	-25,249,914		-100.000 %	T
	-25,249,914			
Fixed Price Base Construction	11,760,422		100.000 %	C
Fixed Price Misc. Labor & Matl	365,475		5.000 %	C
Fixed Price Subcontracted Cost	4,290,722		100.000 %	C
Fixed Price Subcontract Markup	429,072		10.000 %	C
Fixed Price OH&P	4,261,960		25.300 %	O
	21,107,651	21,107,651		
AECCM Non Manual Serv On-site	193,211		100.000 %	C
AECCM Non Manual Serv Off-site	52,960		100.000 %	C
AECCM Materials	300,235		100.000 %	C
AECCM Craft Labor	481,292		100.000 %	C
AECCM Support Craft Labor	27,421		100.000 %	C
AECCM Construction Management	91,494		100.000 %	C
AECCM F.U.R. Fee	71,942		8.500 %	C
	1,218,555	22,326,206		
Escalation on Construction	2,408,998		10.790 %	T
	2,408,998	24,735,204		
A/E Design Base Costs	4,493,496		100.000 %	C
A/E Subcontracted Costs	957,500		100.000 %	C
	5,450,996	30,186,200		
Escalation on TI/II Eng.	233,662		5.200 %	C
	233,662	30,419,862		
Site G&A	4,319,620		14.200 %	T
	4,319,620	34,739,482		
KH Company Labor	2,601,160		100.000 %	C
	2,601,160	37,340,642		
Escalation on Proj. Mgmt.	234,625		9.020 %	C
	234,625	37,575,267		
Contingency	7,515,054		20.000 %	T
Adjustment to meet DOE 5100.4	9,67[illegible]			L
	Tot	***45,100,000***		

Description		Quantity	Unit Price	Amount
022000	EARTHWORK			31,004
031000	CONCRETE FORMWORK			129,846
032000	CONCRETE REINFORCEMEN			186,181
033000	CAST-IN-PLACE CONCRETE			125,411
050000	METAL MTRLS,FNSHS&FAST			850,163
098000	SPECIAL COATINGS			2,616
100000	SPECIALTIES			1,112,350
146000	HOISTS AND CRANES			2,707
161000	CONDUCTORS AND GROUND			5,693

Estimate Totals

Labor	548,898		19,035.492	hrs	
Material	738,673				
Equipment	1,158,400		6,436.119	hrs	
	2,445,971	2,445,971			
Negative Spreadsheet Balance	-2,445,971		-100.000	%	T
	-2,445,971				
Fixed Price Base Construction	806,314		100.000	%	C
Fixed Price Misc. Labor & Matl	64,379		5.000	%	C
Fixed Price Subcontracted Cost	1,639,656		100.000	%	C
Fixed Price Subcontract Markup	163,966		10.000	%	C
Fixed Price OH&P	676,602		25.300	%	O
	3,350,917	3,350,917			
Escalation on Construction	361,564		10.790	%	T
	361,564	3,712,481			
Site G&A	527,172		14.200	%	T
	527,172	4,239,653			
Contingency	847,930		20.000	%	T
Adjustment to meet DOE 5100.4	12,417				L
	Total	***5,100,000***			

Interim Storage Vault

Detailed Base Bldg. Cost Estimate

INTERIM STORAGE VAULT (ISV)-CDR
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
BASE ISV BLDG COST ESTIMATE

Client	B.B MELTON
	T-130F
Estimator	K.R. BRUSEGAARD
Report format	Sorted by 'PROJECT/Phase'
	'Detail' summary
	Print item notes
	Print PROJECT notes

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount

00 Other

001100 Engineering (K-H/Subs)

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
04	**Engineering Support(Title-I)** *Title I site design review. Includes Rad Eng, Crit Eng, H&S, K-H Eng Discipline Leads, Safeguards & Security, B371 Risk Reduction, Fire Prot Eng, etc.*		1.00	ls	Lab		40.00000	ch/ls	40.00	ch	698.16	27,926
04	**Engineering Support(Title-II)** *Title II site design review. Includes Rad Eng. Crit Eng, H&S. K-H Eng. Discipline Leads, Safeguards & Security, B371 Risk Reduction, Fire Prot Eng, etc.*		1.00	ls	Lab		80.00000	ch/ls	80.00	ch	698.16	55,853
	Engineering (K-H/Subs) **1,560.00 Labor hours**											83,779

001150 Engineering (A/E)

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
01	**Title I Engineering** *Based on 5% of unescalated construction costs for base building and one storage bay of $25,677,123.*		1.00	ls	Lab				1.00	ls	1,283,856.00	1,283,856
02	**Title II Engineering** *Based on 10% of unescalated construction costs for base building and one storage bay of $25,677,123.*		1.00	ls	Lab				1.00	ls	2,567,712.00	2,567,712
03	**Title III Eng/Inspection** *Title III Engineering calculated @ 2.5% of construction costs for base building and one storage bay of $25,677,123.*		1.00	ls	Lab				1.00	ls	641,928.00	641,928
----	**Prep for Site Geotech Investig**		1.00	ls	Lab				1.00	ls	25,000.00	25,000
----	**Geotech Specifications**		1.00	ls	Lab				1.00	ls	25,000.00	25,000
----	**Geotech Subcontractor Quals**		1.00	ls	Lab				1.00	ls	10,000.00	10,000
----	**Geotech Site Drilling**		1.00	ls	Lab				1.00	ls	500,000.00	500,000
----	**Geotech Geophysical Logging**		1.00	ls	Lab				1.00	ls	20,000.00	20,000
----	**Geotech Shear Wave Vel. Test**		1.00	ls	Lab				1.00	ls	50,000.00	50,000
----	**Geotech Grnd Wtr Mon./Slug Tst**		1.00	ls	Lab				1.00	ls	25,000.00	25,000
----	**Test Pit Excavation**		1.00	ls	Lab				1.00	ls	7,500.00	7,500
----	**Drill Hole Abandonment**		1.00	ls	Lab				1.00	ls	15,000.00	15,000
----	**Laboratory Testing**		1.00	ls	Lab				1.00	ls	50,000.00	50,000
----	**Interpretation & Analysis**		1.00	ls	Lab				1.00	ls	100,000.00	100,000
----	**Reconciliation**		1.00	ls	Lab				1.00	ls	80,000.00	80,000
----	**Design Criteria**		1.00	ls	Lab				1.00	ls	50,000.00	50,000
----	**Fab 2 compl strg tubes wo embd** *Fabricate tubes, instrument well, cage and support base for various testing during preliminary design phase.*		2.00	ea	Sub				2.00	ea	11,500.00	23,000
	Engineering (A/E)											5,473,996

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
001300	Proj Mgmt (K-H/Subs)											
----	**K-H Project Manager**		208.00	wks	Lab		40.00000	mh/wks	8,320.00	mh	56.25	468,000
----	**Prepare Project Close Out** *Project Close out by Project Management*		1.00	ls	Lab		160.00000	mh/ls	160.00	mh	56.25	9,000
----	**Accounting Close Out**		1.00	ls	Lab		40.00000	mh/ls	40.00	mh	56.25	2,250
----	**Consolidate Files**		1.00	ls	Lab		80.00000	mh/ls	80.00	mh	56.25	4,500
----	**Cost Estimating support** *Assume 2 estimators 8 weeks for Title I estimate, 3 estimators 12 weeks for Title II/Fair Cost estimate, and assume 10/month during construction for CFC's.*		1.00	ls	Lab		2,430.00000	mh/ls	2,430.00	mh	52.61	127,842
----	**Project Scheduling support** *Assume 20 hours/week of project duration for schedule development and updates.*		208.00	wks	Lab		20.00000	mh/wks	4,160.00	mh	52.61	218,858
----	**Budget Analyst Support** *Assume 20 mhrs/week during project duration.*		208.00	wks	Lab		20.00000	mh/wks	4,160.00	mh	44.97	187,075
----	**K-H Project Engineer** *Assume full time project engineer during design, 1/2 timeduring construction.*		208.00	wks	Lab		40.00000	mh/wks	8,320.00	mh	56.25	468,000
	Proj Mgmt (K-H/Subs) 27,670.00 Labor hours											1,485,525
001400	Const. Mgmt (K-H/Subs)											
----	**Construction Mgmt** *Based on DOE Guidelines of 5% - 15% range. Utilized 10% of construction costs as basis.*		1.00	ls	Lab				1.00	ls	859,880.00	859,880
----	**Construction Coordination** *Based on DOE Guidelines of 5% to 1% of construction costs, utilized 75% as basis*		1.00	ls	Lab				1.00	ls	85,988.00	85,988
----	**Health & Safety** *Based on DOE Guidelines of .5% to 1%, utilized .75% as basis.*		1.00	ls	Lab				1.00	ls	85,988.00	85,988
	Const. Mgmt (K-H/Subs)											1,031,856
	00 Other 29,230.00 Labor hours											*8,075,156*

01 General Reqrmnts

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
010001	General Requirements											
----	**Mobilize/Demobilize to site**		1.00	ls	Lab				1.00	ls	25,000.00	25,000
					Eqp				1.00	ls		
----	**Misc laydown yards, sheds, etc**		1.00	ls	Mat	0			1.00	ls	25,000.00	25,000

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
010001	General Requirements											
----	GET/Site Specific Training		100.00	crft	Lab		4.00000	mh/crft	400.00	mh	25.041	10,016
	General Requirements											60,016
	400.000 Labor hours											
010034	Field office expense											
0100	Fld off exp,off eqp rtal,averg		35.00	mo	Mat	0			35.00	mo	147.00	5,145
0100	Field off. supplies		35.00	mo	Mat	0			35.00	mo	147.00	5,145
0100	Fld office first aid supplies		35.00	mo	Mat	0			35.00	mo	147.00	5,145
0100	Project signs		35.00	mo	Mat	0			35.00	mo	147.00	5,145
0100	Project photgraphs		35.00	mo	Mat	0			35.00	mo	147.00	5,145
	Field office expense											25,725
010036	Field personnel											
0010	Constr. Contractor Proj. Mgr. *Based on duration of construction phase.*		152.00	week	Lab				152.00	week	1,250.00	190,000
0200	Constr. Contractor Super. *Based on duration of construction phase*		152.00	week	Lab				152.00	week	1,180.00	179,360
0260	Constr. Contractor Field Eng. *Based on duration of construction phase.*		152.00	week	Lab				152.00	week	775.00	117,800
0260	Constr. Contractor Field Clerk *Based on duration of construction phase.*		152.00	week	Lab				152.00	week	685.00	104,120
0260	Constr. Cont. Proj Cntrls/Sch *Based on duration of construction phase.*		152.00	week	Lab				152.00	week	775.00	117,800
0260	Constr. Cont. Qual. Contrl Mgr *Based on duration of construction phase*		152.00	week	Lab				152.00	week	1,250.00	190,000
0260	Constr. Cont. Qual. Contrl Eng *Based on duration of construction phase.*		152.00	week	Lab				152.00	week	775.00	117,800
	Field personnel											1,016,880
	42,560.00 Labor hours											
014108	Testing											
----	CC Testing, S.O. Testing *Assumes a crew of crafts people for 6 weeks. Crew consists of Electrician, Millwright, Sheetmetal Worker, Carpenter and Pipefitter*		1.00	ls	Lab		240.00000	ch/ls	240.00	ch	137.18	32,923
----	Testing Services during Const. *Testing includes asphalt testing, concrete testing, soil testing, etc.*		1.00	ls	Lab				1.00	ls	25,000.00	25,000
	Testing											57,923
	1,200.00 Labor hours											

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
015104	Temporary utilities											
----	**Portable toilets**		35.00	mo	Mat	0	3.00000	ea/mo	105.00	ea	75.00	7,875
----	**Communications**		35.00	mo	Mat	0			35.00	mo	250.00	8,750
	Temporary utilities											16,625
015304	Fencing											
0250	**Chainlink fence rental/install**		600.00	lf	Lab		0.14545	mh/lf	87.27	mh	17.29	1,509
					Mat	0			600.00	lf	3.50	2,100
	Fencing around laydown area. Assume construction area will be fenced using outer boundary fence											
	Fencing											3,609
	87.27 **Labor hours**											
016400	Equipment Rental											
----	**Crane-Operator/Equip/Oper.Cost**		24.00	mon	Lab		173.33000	ch/mon	4,159.92	ch	50.71	210,950
					Mat	0			24.00	mon	5,014.53	120,349
					Eqp				24.00	mon	6,850.00	164,400
	Pricing includes operator/oiler labor, operating costs including fuel, oil. lubrication, expendables and percentof maintenance, and equipment cost.											
----	**Scaffolding-**		24.00	mon	Mat	0	256.00000	frms/mon	6,144.00	frms	11.37	69,857
	Scaffold based on 25' high around entire vault, inside & outside. Assumes 2 erect/teardown-Below Grd/Above Grd. Est. 256 frames reqd. w/2 levels of planks.											
----	**Scaffolding erect/dismantle**		32,040.00	sf	Lab		0.01429	mh/sf	457.85	mh	25.52	11,684
	Erection/dismantling of scaffolding-assume 2 times required, once for below grade and once for above grade walls.											
----	**Fuel/Maintenance of Const. Eq**		35.00	mon	Lab		21.00000	mh/mon	735.00	mh	23.08	16,964
					Mat	0			35.00	mon	300.00	10,500
----	**Project Mgr's Vehicle**		35.00	mo	Eqp				35.00	mo	1,004.00	35,140
----	**Superintendent's Vehicle**		35.00	mo	Eqp				35.00	mo	1,004.00	35,140
----	**Job-site Pickup**		35.00	mo	Eqp				35.00	mo	1,004.00	35,140
----	**Small tools-Repair/Replace**		35.00	mo	Lab		10.00000	mh/mo	350.00	mh	27.16	9,506
					Mat	0			35.00	mo	500.00	17,500
	Repair/replace small hand tools during project.											
	Equipment Rental											737,130
	9,862.692 **Labor hours**											
	01 General Reqrmnts											***1,917,908***
	54,109.962 **Labor hours**											

02 Sitework

020500 Demolition - General

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
----	Remove I/O teletype, Rm 3206		1.00	ea	Lab		8.00000	ch/ea	8.00	ch	65.460	524
					Mat	0			1.00	ea	100.00	100
	Material costs for crating material.											
----	Remove Oxygen Analyzer, Rm3206		1.00	ea	Lab		16.00000	ch/ea	16.00	ch	94.13	1,506
					Mat	0			1.00	ea	250.00	250
	Material cost to cover crating of analyzer.											
----	Remv Piping GB46		1.00	ea	Lab		125.29002	mh/ea	125.29	mh	28.67	3,592
					Mat	0			1.00	ea	125.00	125
	Based on estimate prepared by RMRS for GB46 using detailed glovebox removal from B707 as basis. Cost based on proportion using size of glovebox.											
----	Remv Mech Devices GB46		1.00	ea	Lab		139.21114	mh/ea	139.21	mh	28.67	3,991
					Mat	0			1.00	ea	40.00	40
----	Remv Electrical Syst. GB46		1.00	ea	Lab		116.00928	mh/ea	116.01	mh	27.16	3,151
					Mat	0			1.00	ea	125.00	125
----	Remv Alarms GB46		1.00	ea	Lab		139.21114	mh/ea	139.21	mh	27.16	3,781
					Mat	0			1.00	ea	25.00	25
----	Remv Ductwork GB46		1.00	ea	Lab		120.64965	mh/ea	120.65	mh	29.36	3,542
					Mat	0			1.00	ea	580.00	580
----	Apply Decon Paint GB46		1.00	ea	Lab		174.01392	mh/ea	174.01	mh	23.60	4,107
					Mat	0			1.00	ea	1,000.00	1,000
----	Remv GB46		1.00	ea	Lab		1,229.69838	mh/ea	1,229.70	mh	29.36	36,104
					Mat	0			1.00	ea	400.00	400
----	Size Reduce GB46		1.00	ea	Lab		1,109.04872	mh/ea	1,109.05	mh	29.36	32,562
					Mat	0			1.00	ea	475.00	475
----	Paint Floor to match		1.00	ea	Lab		116.00928	mh/ea	116.01	mh	23.60	2,738
					Mat	0			1.00	ea	100.00	100
----	GB46 General Requirements		1.00	ea	Lab		684.45476	mh/ea	684.45	mh	23.533	16,107
					Mat	0			1.00	ea	1,000.00	1,000
----	Remv Piping GB45A		1.00	ea	Lab		41.76334	mh/ea	41.76	mh	28.67	1,197
					Mat	0			1.00	ea	50.00	50
	Based on estimate prepared by RMRS using detailed glovebox removal from B707 as basis.											
----	Remv Mech Devices GB45A		1.00	ea	Lab		46.40371	mh/ea	46.40	mh	28.67	1,330
					Mat	0			1.00	ea	15.00	15
----	Remv Electrical Syst. GB45A		1.00	ea	Lab		41.76334	mh/ea	41.76	mh	27.16	1,134
					Mat	0			1.00	ea	50.00	50
----	Remv Alarms GB45A		1.00	ea	Lab		46.40371	mh/ea	46.40	mh	27.16	1,260
					Mat	0			1.00	ea	10.00	10
----	Remv Ductwork GB45A		1.00	ea	Lab		41.76334	mh/ea	41.76	mh	29.36	1,226
					Ma[illegible]	0			1.00	ea	580[illegible]	580
----	Ap[illegible]econ Paint GB45A		1.00	ea	La[illegible]		58.00464	mh/ea	58.00	mh	23[illegible]	1,369

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
020500	Demolition - General											
----	Apply Decon Paint GB45A		1.00	ea	Mat	0			1.00	ea	350.00	350
----	Remv GB45A		1.00	ea	Lab		417.63341	mh/ea	417.63	mh	29.36	12,262
					Mat	0			1.00	ea	350.00	350
----	Size Reduce GB45A		1.00	ea	Lab		371.22970	mh/ea	371.23	mh	29.36	10,899
					Mat	0			1.00	ea	160.00	160
----	Paint Floor to match		1.00	ea	Lab		41.76334	mh/ea	41.76	mh	23.60	986
					Mat	0			1.00	ea	35.00	35
----	GB45A General Requirements		1.00	ea	Lab		232.01856	mh/ea	232.02	mh	23.533	5,460
					Mat	0			1.00	ea	350.00	350
----	Remv Piping GB45B		1.00	ea	Lab		153.13225	mh/ea	153.13	mh	28.67	4,390
					Mat	0			1.00	ea	150.00	150
	Based on estimate prepared by RMRS using detailed glovebox removal from B707 as basis											
----	Remv Mech Devices GB45B		1.00	ea	Lab		169.37355	mh/ea	169.37	mh	28.67	4,856
					Mat	0			1.00	ea	50.00	50
----	Remv Electrical Syst. GB45B		1.00	ea	Lab		141.53132	mh/ea	141.53	mh	27.16	3,844
					Mat	0			1.00	ea	150.00	150
----	Remv Alarms GB45B		1.00	ea	Lab		169.37355	mh/ea	169.37	mh	27.16	4,600
					Mat	0			1.00	ea	30.00	30
----	Remv Ductwork GB45B		1.00	ea	Lab		146.17169	mh/ea	146.17	mh	29.36	4,292
					Mat	0			1.00	ea	580.00	580
----	Apply Decon Paint GB45B		1.00	ea	Lab		213.45708	mh/ea	213.46	mh	23.60	5,038
					Mat	0			1.00	ea	1,220.00	1,220
----	Remv GB45B		1.00	ea	Lab		1,501.16009	mh/ea	1,501.16	mh	29.36	44,074
					Mat	0			1.00	ea	1,220.00	1,220
----	Size Reduce GB45B		1.00	ea	Lab		1,352.66821	mh/ea	1,352.67	mh	29.36	39,714
					Mat	0			1.00	ea	580.00	580
----	Paint Floor to match		1.00	ea	Lab		141.53132	mh/ea	141.53	mh	23.60	3,340
					Mat	0			1.00	ea	120.00	120
----	GB45B General Requirements		1.00	ea	Lab		835.26682	mh/ea	835.27	mh	23.533	19,656
					Mat	0			1.00	ea	1,220.00	1,220
----	Remv Piping AL-6 A&B		1.00	ea	Lab		125.29002	mh/ea	125.29	mh	28.67	3,592
					Mat	0			1.00	ea	125.00	125
	Based on estimate prepared by RMRS using detailed glovebox removal from B707 as basis.											
----	Remv Mech Devices AL-6 A&B		1.00	ea	Lab		139.21114	mh/ea	139.21	mh	28.67	3,991
					Mat	0			1.00	ea	40.00	40
----	Remv Electrical Syst. AL-6 A&B		1.00	ea	Lab		116.00928	mh/ea	116.01	mh	27.16	3,151
					Mat	0			1.00	ea	125.00	125
----	Remv Alarms AL-6 A&B		1.00	ea	Lab		139.21114	mh/ea	139.21	mh	27.16	3,781
					Mat	0			1.00	ea	25.00	25
----	Remv Ductwork AL-6 A&B		1.00	ea	Lab		120.64965	mh/ea	120.65	mh	29.36	3,542
					Mat	0			1.00	ea	580.00	580
----	Apply Decon Paint AL-6 A&B		1.00	ea	Lab		174.01392	mh/ea	174.01	mh	23.60	4,107
					Mat	0			1.00	ea	1,000.00	1,000
----	Remv AL-6 A&B		1.00	ea	Lab		1,229.69838	mh/ea	1,229.70	mh	29.36	36,104
					Mat	0			1.00	ea	1,000.00	1,000
----	Size Reduce AL-6 A&B		1.00	ea	Lab		1,109.04872	mh/ea	1,109.05	mh	29.36	32,562
					Mat	0			1.00	ea	475.00	475

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
020500	Demolition - General											
----	Paint Floor to match		1.00	ea	Lab		116.00928	mh/ea	116.01	mh	23.60	2,738
					Mat	0			1.00	ea	100.00	100
----	AL-6 A&B General Requirements		1.00	ea	Lab		684.45476	mh/ea	684.45	mh	23.533	16,107
					Mat	0			1.00	ea	1,000.00	1,000
----	Non-manual Off-site AECCM Labr		1.00	ea	Lab				1.00	ea	52,960.00	52,960
					Mat	0			1.00	ea		
	Based on previous bids submitted by RFEC @ 13.5% of construction labor dollars Calculated on all B371 Demolition/Construction work											
----	Non-manual On-site AECCM Labor		1.00	ea	Lab				1.00	ea	193,211.00	193,211
					Mat	0			1.00	ea		
	Based on previous bids from RFEC @ 49.25% of construction/demo labor dollars Calculated on all B371 construction/demo costs.											
----	Clean-up & labor supprot		1.00	ea	Lab				1.00	ea	41,976.00	41,976
					Mat	0			1.00	ea		
	Based on 10% of construction labor dollars.											
----	Craft labor training		1.00	ea	Lab		991.00000	mh/ea	991.00	mh	27.67	27,421
					Mat	0			1.00	ea		
	Based on 7% of construction labor hours.											
----	Craft labor adder		15,148.00	hr	Lab				15,148.00	hr	6.04	91,494
					Mat	0			15,148.00	hr		
	Demolition - General 30,296.606 Labor hours											815,330
020554	Site demolition											
1750	Site demolition, NO hauling, p		79,860.00	sy	Lab		0.05000	mh/sy	3,993.00	mh	24.826	99,130
					Eqp		0.05000	mh/sy	3,993.00	mh	38.800	154,928
	Demolition of pavement											
2400	Site demo, conc 7" to 24" thic		1,200.00	lf	Lab		0.07385	mh/lf	88.62	mh	20.350	1,803
					Eqp		0.02462	mh/lf	29.54	mh	25.99	768
----	Remove T-124A trailer complex		16.00	unit	Lab		16.00000	ch/unit	256.00	ch	282.42	72,300
					Mat	0			16.00	unit		
	Involves removal of skirting & entry stairs/wind breaks, disconnect from utilities, disconnect trailer sections, remove from leveling blocks. pick up debris											
----	Remove chainlink fencing		2,018.00	lf	Lab		0.05400	mh/lf	108.97	mh	20.350	2,218
					Mat	0			2,018.00	lf		
					Eqp		0.05400	mh/lf	108.97	mh	25.99	2,832
	Includes 3 strands of barbed wire on outriggers.											
----	Remove Trailer T-121A		2.00	unit	Lab		16.00000	ch/unit	32.00	ch	289.89	9,276
					Mat	0			2.00	unit		
					Eqp		16.00000	ch/unit	32.00	ch		
----	Demo Helicopter Landing Site		1,422.30	sy	Lab		0.09500	mh/sy	135.12	mh	24.826	3,354
					Mat	0			1,422.30	sy		
					Eqp		0.09500	mh/sy	135.12	mh	38.800	5,243
	12,800 square feet of asphalt only Demolition of electrical landing lights covered under separate item.											
----	De[illegible]uilding 126		450.00	sf	La[illegible]				450.00	sf	50[illegible]	22,500
					Ma[illegible]	0			450.00	sf		

Item	Description	Location	Takeoff Qty		W%	Conversion	Order Qty	Unit Price	Amount
020554	**Site demolition**								
----	Demo Building 126		450.00 sf	Eqp			450.00 sf		
----	Demo helicopter landing lights		1.00 ls	Lab		40.00000 mh/ls	40.00 mh	27.16	1,086
				Eqp			1.00 ls		
	Site demolition 7,533.711 Labor hours 4,298.635 Equipment hours								375,439
020620	**Rubbish handling**								
3080	Rubbish Handling, Load trucks		1,000.00 cy	Lab		0.30000 mh/cy	300.00 mh	20.350	6,105
				Eqp		0.10000 mh/cy	100.00 mh	25.99	2,599
	Load site debris (curb/gutter, trees, asphalt, u/g piping/conduit, etc.) into trucks to haul to landfill or recycle facility.								
5100	Rubbish Hndlg- Haul to dump		1,000.00 cy	Lab		0.30000 mh/cy	300.00 mh	27.89	8,367
				Eqp		0.30000 mh/cy	300.00 mh	53.67	16,101
	Haul site debris to site landfill or offsite recycle facility.								
	Rubbish handling 600.00 Labor hours 400.00 Equipment hours								33,172
020708	**Electrical demolition**								
----	Remove 13.8kV Overhd Pwr Line	Utility Removal	600.00 lf	Lab		0.15000 mh/lf	90.00 mh	28.154	2,534
				Mat	0		600.00 lf		
				Eqp		0.15000 mh/lf	90.00 mh	40.307	3,628
	Electrical demolition 90.000 Labor hours 90.000 Equipment hours								6,161
021144	**Stripping**								
0020	Strip topsoil & stockpile		1,613.00 cy	Lab		0.00522 mh/cy	8.42 mh	23.443	197
				Eqp		0.00348 mh/cy	5.61 mh	106.61	598
----	General site grading/leveling		79,860.00 sy	Lab		0.00400 mh/sy	319.44 mh	21.975	7,020
				Eqp		0.00400 mh/sy	319.44 mh	86.89	27,756
	Stripping 327.860 Labor hours 325.053 Equipment hours								35,572

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
021154	**Selective clearing**											
1040	Grub stumps & remove,w/backhoe		125.00	ea	Lab		0.53333	mh/ea	66.67	mh	22.235	1,482
					Eqp		0.26667	mh/ea	33.33	mh	34.86	1,162
2050	Selective clring,rmv trees W/c		125.00	ea	Lab		2.66667	mh/ea	333.33	mh	22.227	7,409
					Eqp		1.77778	mh/ea	222.22	mh	35.178	7,817
	Selective clearing											17,871
	400.00 Labor hours											
	255.556 Equipment hours											
021444	**Wellpoints**											
1600	Wellpt,compl inst,&rmv of sys 2"wellpt 5'oc,1000'l,10"dia,first mo		1,480.00	hdr	Lab		2.75387	mh/hdr	4,075.73	mh	22.35	91,093
					Mat	0			1,480.00	hdr	29.025	42,957
	Assumes de-watering system will be in place and operating during the approximate 12 month period the below grade construction is in progress.											
1700	Wellpt,compl inst,&rmv of sys 2"wellpt 5'oc,1000'l,10"dia,ea addl mo		1,480.00	hdr	Lab				1,480.00	hdr		
					Mat	0			1,480.00	hdr	17.415	25,774
	Pricing is based on each additional month after first month 1,480 lf of header x 11 months = 16280 lf hdr.											
	Wellpoints											159,824
	4,075.728 Labor hours											
022208	**Backfill, structural**											
4020	Backfill, structural, 200 H.P.		8,567.00	cy	Lab		0.00545	mh/cy	46.69	mh	23.443	1,095
					Eqp		0.00364	mh/cy	31.18	mh	53.645	1,673
	Backfill using front end loader, includes compactions in 12" layers with sheepsfoot roller.											
	Backfill, structural											2,767
	46.690 Labor hours											
	31.184 Equipment hours											
022212	**Borrow**											
----	Washed river rock, 1-1/2" diam		20,093.00	cy	Lab		0.04700	mh/cy	944.37	mh	25.995	24,549
					Mat	0			20,093.00	cy	14.30	287,330
					Eqp		0.04700	mh/cy	944.37	mh	54.55	51,515
	Washed river rock overburden & foundation - for common area of vault.											
----	G[illegible]mbrane betwn rock & clay		171,720.00	sf	La[illegible]		0.01000	mh/sf	1,717.20	mh	23.9[illegible]	41,122
					M[illegible]	0			171,720.00	sf		18,889
					Eqp		0.01000	mh/sf	1,717.20	mh		

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
022212	Borrow											
	Geomembrane placed between river rock layer and clay fill layer. These quantities account for the common areas of the vault building.											
----	**Select clay fill**		17,650.00	cy	Lab		0.04700	mh/cy	829.55	mh	25.995	21,564
					Mat	0			17,650.00	cy	7.80	137,670
					Eqp		0.04700	mh/cy	829.55	mh	54.55	45,252
----	**Common Fill**		17,650.00	cy	Lab		0.04700	mh/cy	829.55	mh	25.995	21,564
					Mat	0			17,650.00	cy	1.70	30,005
					Eqp		0.04700	mh/cy	829.55	mh	54.55	45,252
	Common fill placed ovr top of select clay fill.Quantities account for common areas of vault. Assumes 9,221 cy of excess soil from excavations will be utilized.											
	Borrow											724,712
	4,320.671 Labor hours											
	4,320.671 Equipment hours											
022238	Excvtng,bulk bank measure											
0250	**Excavating, backhoe, hyd, craw**		17,127.00	cy	Lab		0.02000	mh/cy	342.54	mh	26.015	8,911
					Eqp		0.01000	mh/cy	171.27	mh	88.81	15,210
	Increased by 15% to account for loading onto trucks											
	Excvtng,bulk bank measure											24,122
	342.54 Labor hours											
	171.27 Equipment hours											
022246	Excavation,bulk,scrapers											
1300	**E, p s,14 CY 1/4 p d, e,1500'**		25,800.00	cy	Lab		0.01700	mh/cy	438.60	mh	23.789	10,434
					Eqp		0.01200	mh/cy	309.60	mh	186.063	57,605
	Berm construction.											
1300	**E, p s,14 CY 1/4 p d, e,1500'**		940.00	cy	Lab		0.01700	mh/cy	15.98	mh	23.789	380
					Eqp		0.01200	mh/cy	11.28	mh	186.063	2,099
	Ditch excavation.											
	Excavation,bulk,scrapers											70,518
	454.580 Labor hours											
	320.88 Equipment hours											
022254	Excavating, trench											
0110	**E,/ f,NO s d,4'-6' D,3/4 CY h**	10"Raw Water	212.222	cy	Lab		0.05333	mh/cy	11.32	mh	26.015	294
					Eqp		0.02667	mh/cy	5.66	mh	56.33	319
0110	**E,/ f,NO s d,4'-6' D,3/4 CY h**	12"Raw Water	232.222	cy	Lab		0.05333	mh/cy	12.38	mh	26.015	322
					Eqp		0.02667	mh/cy	6.19	mh	56.33	349
0110	**E,/ f,NO s d,4'-6' D,3/4 CY h**	10" Dom Water	246.667	cy	Lab		0.05333	mh/cy	13.15	mh	26.015	342
					Eqp		0.02667	mh/cy	6.58	mh	56.33	371

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
022254	Excavating, trench											
0110	E,/ f,NO s d,4'-6' D,3/4 CY h	Gas Line	217.185	cy	Lab		0.05333	mh/cy	11.58	mh	26.015	301
					Eqp		0.02667	mh/cy	5.79	mh	56.33	326
0110	E,/ f,NO s d,4'-6' D,3/4 CY h	Utility Removal	1,040.518	cy	Lab		0.05333	mh/cy	55.49	mh	26.015	1,444
					Eqp		0.02667	mh/cy	27.75	mh	56.33	1,563
0110	E,/ f,NO s d,4'-6' D,3/4 CY h	Elect. Removal	518.519	cy	Lab		0.05333	mh/cy	27.65	mh	26.015	719
					Eqp		0.02667	mh/cy	13.83	mh	56.33	779
	Remove underground electrical cable/conduit, 13 8 kV, 15kV and 277v lines											
0110	E,/ f,NO s d,4'-6' D,3/4 CY h	Alarm Removal	177.778	cy	Lab		0.05333	mh/cy	9.48	mh	26.015	247
					Eqp		0.02667	mh/cy	4.74	mh	56.33	267
	Remove underground Honeywell alarm cable/conduit.											
0110	E,/ f,NO s d,4'-6' D,3/4 CY h		59.259	cy	Lab		0.05333	mh/cy	3.16	mh	26.015	82
					Eqp		0.02667	mh/cy	1.58	mh	56.33	89
0110	E,/ f,NO s d,4'-6' D,3/4 CY h		204.444	cy	Lab		0.05333	mh/cy	10.90	mh	26.015	284
					Eqp		0.02667	mh/cy	5.45	mh	56.33	307
0110	E,/ f,NO s d,4'-6' D,3/4 CY h		13.333	cy	Lab		0.05333	mh/cy	0.71	mh	26.015	19
					Eqp		0.02667	mh/cy	0.36	mh	56.33	20
0500	Excav,trench/cont ftg,NO sht o	Sewer Line	233.481	cy	Lab		0.07111	mh/cy	16.60	mh	26.015	432
					Eqp		0.03556	mh/cy	8.30	mh	56.33	468
0500	Excav,trench/cont ftg,NO sht o	6" Dom Water	31.704	cy	Lab		0.07111	mh/cy	2.25	mh	26.015	59
					Eqp		0.03556	mh/cy	1.13	mh	56.33	64
0500	Excav,trench/cont ftg,NO sht o	8" Sewer Line	1,394.963	cy	Lab		0.07111	mh/cy	99.20	mh	26.015	2,581
					Eqp		0.03556	mh/cy	49.60	mh	56.33	2,794
1320	Excav,trench/cont ftg,NO sht o	Found. Drain	10,444.444	cy	Lab		0.01882	mh/cy	196.56	mh	26.015	5,114
					Eqp		0.00941	mh/cy	98.28	mh	217.25	21,352
1900	Excavating, for tamping backfi	10"Raw Water	169.778	cy	Lab		0.08889	mh/cy	15.09	mh	17.57	265
					Eqp		0.08889	mh/cy	15.09	mh	7.53	114
1900	Excavating, for tamping backfi	12"Raw Water	185.778	cy	Lab		0.08889	mh/cy	16.51	mh	17.57	290
					Eqp		0.08889	mh/cy	16.51	mh	7.53	124
1900	Excavating, for tamping backfi	Sewer Line	204.296	cy	Lab		0.08889	mh/cy	18.16	mh	17.57	319
					Eqp		0.08889	mh/cy	18.16	mh	7.53	137
1900	Excavating, for tamping backfi	6" Dom Water	23.778	cy	Lab		0.08889	mh/cy	2.11	mh	17.57	37
					Eqp		0.08889	mh/cy	2.11	mh	7.53	16
1900	Excavating, for tamping backfi	10" Dom Water	197.333	cy	Lab		0.08889	mh/cy	17.54	mh	17.57	308
					Eqp		0.08889	mh/cy	17.54	mh	7.53	132
1900	Excavating, for tamping backfi	Gas Line	162.889	cy	Lab		0.08889	mh/cy	14.48	mh	17.57	254
					Eqp		0.08889	mh/cy	14.48	mh	7.53	109
1900	Excavating, for tamping backfi	8" Sewer Line	1,220.593	cy	Lab		0.08889	mh/cy	108.50	mh	17.57	1,906
					Eqp		0.08889	mh/cy	108.50	mh	7.53	817
1900	Excavating, for tamping backfi	Utility Removal	1,137.00	cy	Lab		0.08889	mh/cy	101.07	mh	17.57	1,776
					Eqp		0.08889	mh/cy	101.07	mh	7.53	761
1900	Excavating, for tamping backfi	Elect. Removal	566.00	cy	Lab		0.08889	mh/cy	50.31	mh	17.57	884
					Eqp		0.08889	mh/cy	50.31	mh	7.53	379
1900	Excavating, for tamping backfi	Alarm Removal	194.00	cy	Lab		0.08889	mh/cy	17.24	mh	17.57	303
					Eqp		0.08889	mh/cy	17.24	mh	7.53	130
1900	Excavating, for tamping backfi	Found. Drain	10,340.00	cy	Lab		0.08889	mh/cy	919.12	mh	17.57	16,149
					Eqp		0.08889	mh/cy	919.12	mh	7.53	6,921
1900	Ex ing, for tamping backfi		44.444	cy	L		0.08889	mh/cy	3.95	mh	17	69
					Eq		0.08889	mh/cy	3.95	mh	7.	30

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
022254	**Excavating, trench**											
1900	Excavating, for tamping backfi		137.074	cy	Lab		0.08889	mh/cy	12.18	mh	17.57	214
					Eqp		0.08889	mh/cy	12.18	mh	7.53	92
1900	Excavating, for tamping backfi		11.10	cy	Lab		0.08889	mh/cy	0.99	mh	17.57	17
					Eqp		0.08889	mh/cy	0.99	mh	7.53	7
3020	Excavating,backfill trench,f.e	10"Raw Water	169.778	cy	Lab		0.03000	mh/cy	5.09	mh	23.443	119
					Eqp		0.02000	mh/cy	3.40	mh	29.13	99
3020	Excavating,backfill trench,f.e	12"Raw Water	185.778	cy	Lab		0.03000	mh/cy	5.57	mh	23.443	131
					Eqp		0.02000	mh/cy	3.72	mh	29.13	108
3020	Excavating,backfill trench,f.e	Sewer Line	204.296	cy	Lab		0.03000	mh/cy	6.13	mh	23.443	144
					Eqp		0.02000	mh/cy	4.09	mh	29.13	119
3020	Excavating,backfill trench,f.e	6" Dom Water	23.778	cy	Lab		0.03000	mh/cy	0.71	mh	23.443	17
					Eqp		0.02000	mh/cy	0.48	mh	29.13	14
3020	Excavating,backfill trench,f.e	10" Dom Water	197.333	cy	Lab		0.03000	mh/cy	5.92	mh	23.443	139
					Eqp		0.02000	mh/cy	3.95	mh	29.13	115
3020	Excavating,backfill trench,f.e	Gas Line	162.889	cy	Lab		0.03000	mh/cy	4.89	mh	23.443	115
					Eqp		0.02000	mh/cy	3.26	mh	29.13	95
3020	Excavating,backfill trench,f.e	8" Sewer Line	1,220.593	cy	Lab		0.03000	mh/cy	36.62	mh	23.443	858
					Eqp		0.02000	mh/cy	24.41	mh	29.13	711
3020	Excavating,backfill trench,f.e	Utility Removal	1,137.00	cy	Lab		0.03000	mh/cy	34.11	mh	23.443	800
					Eqp		0.02000	mh/cy	22.74	mh	29.13	662
	Quantity accounts for swell and compaction.											
3020	Excavating,backfill trench,f.e	Elect. Removal	566.00	cy	Lab		0.03000	mh/cy	16.98	mh	23.443	398
					Eqp		0.02000	mh/cy	11.32	mh	29.13	330
	Quantity accounts for swell and compaction.											
3020	Excavating,backfill trench,f.e	Alarm Removal	194.00	cy	Lab		0.03000	mh/cy	5.82	mh	23.443	136
					Eqp		0.02000	mh/cy	3.88	mh	29.13	113
	Quantity accounts for swell and compaction.											
3020	Excavating,backfill trench,f.e	Found. Drain	10,340.00	cy	Lab		0.03000	mh/cy	310.20	mh	23.443	7,272
					Eqp		0.02000	mh/cy	206.80	mh	29.13	6,024
3020	Excavating,backfill trench,f.e		44.444	cy	Lab		0.03000	mh/cy	1.33	mh	23.443	31
					Eqp		0.02000	mh/cy	0.89	mh	29.13	26
3020	Excavating,backfill trench,f.e		137.074	cy	Lab		0.03000	mh/cy	4.11	mh	23.443	96
					Eqp		0.02000	mh/cy	2.74	mh	29.13	80
3020	Excavating,backfill trench,f.e		11.10	cy	Lab		0.03000	mh/cy	0.33	mh	23.443	8
					Eqp		0.02000	mh/cy	0.22	mh	29.13	6
	Excavating, trench											92,634
	2,205.544 Labor hours											
	1,824.398 Equipment hours											
022304	**Base**											
0100	Base, prepare and roll sub-bas		30,160.00	sy	Lab		0.00865	mh/sy	260.88	mh	24.178	6,308
					Eqp		0.00649	mh/sy	195.74	mh	67.513	13,215
	Base											19,523
	260.884 Labor hours											
	195.738 Equipment hours											

022308 Base course

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
0400	Base course, bank run gravel,		30,160.00	sy	Lab		0.00889	mh/sy	268.12	mh	24.178	6,483
					Mat	0			30,160.00	sy	4.489	135,388
					Eqp		0.00667	mh/sy	201.17	mh	67.513	13,581
												155,452

Base course
268.122 Labor hours
201.167 Equipment hours

025104 Bitumns concrete pavement

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
0160	Asphaltic conc pavement, and l		30,160.00	sy	Lab		0.01794	mh/sy	541.07	mh	21.712	11,748
					Mat	0			30,160.00	sy	5.186	156,410
					Eqp		0.00489	mh/sy	147.48	mh	67.993	10,028
0300	Asphaltic conc pavement, and l		30,160.00	sy	Lab		0.00908	mh/sy	273.85	mh	22.101	6,052
					Mat	0			30,160.00	sy	1.883	56,791
					Eqp		0.00303	mh/sy	91.38	mh	58.185	5,317
												246,346

Bitumns concrete pavement
814.923 Labor hours
238.867 Equipment hours

026012 Bedding

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
0200	Bedding, sand, dead or bank,	10"Raw Water	42.444	cy	Lab		0.16000	mh/cy	6.79	mh	20.350	138
					Mat	0			42.44	cy	4.838	205
					Eqp		0.05333	mh/cy	2.26	mh	25.99	59
0200	Bedding, sand, dead or bank,	12"Raw Water	46.444	cy	Lab		0.16000	mh/cy	7.43	mh	20.350	151
					Mat	0			46.44	cy	4.838	225
					Eqp		0.05333	mh/cy	2.48	mh	25.99	64
0200	Bedding, sand, dead or bank,	Sewer Line	21.889	cy	Lab		0.16000	mh/cy	3.50	mh	20.350	71
					Mat	0			21.89	cy	4.838	106
					Eqp		0.05333	mh/cy	1.17	mh	25.99	30
0200	Bedding, sand, dead or bank,	6" Dom Water	7.926	cy	Lab		0.16000	mh/cy	1.27	mh	20.350	26
					Mat	0			7.93	cy	4.838	38
					Eqp		0.05333	mh/cy	0.42	mh	25.99	11
0200	Bedding, sand, dead or bank,	10" Dom Water	49.333	cy	Lab		0.16000	mh/cy	7.89	mh	20.350	161
					Mat	0			49.33	cy	4.838	239
					Eqp		0.05333	mh/cy	2.63	mh	25.99	68
0200	Bedding, sand, dead or bank,	Gas Line	54.296	cy	Lab		0.16000	mh/cy	8.69	mh	20.350	177
					Mat	0			54.30	cy	4.838	263
					Eqp		0.05333	mh/cy	2.90	mh	25.99	75
0200	Bedding, sand, dead or bank,	8" Sewer Line	130.778	cy	Lab		0.16000	mh/cy	20.92	mh	20.350	426
					Ma[illegible]	0			130.78	cy	4.8[illegible]	633
					E[illegible]		0.05333	mh/cy	6.97	mh	2[illegible]	181

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
026012	Bedding											
0200	Bedding, sand, dead or bank,	Found. Drain	104.444	cy	Lab		0.16000	mh/cy	16.71	mh	20.350	340
					Mat	0			104.44	cy	4.838	505
					Eqp		0.05333	mh/cy	5.57	mh	25.99	145
0200	Bedding, sand, dead or bank,		14.815	cy	Lab		0.16000	mh/cy	2.37	mh	20.350	48
					Mat	0			14.82	cy	4.838	72
					Eqp		0.05333	mh/cy	0.79	mh	25.99	21
0200	Bedding, sand, dead or bank,		25.556	cy	Lab		0.16000	mh/cy	4.09	mh	20.350	83
					Mat	0			25.56	cy	4.838	124
					Eqp		0.05333	mh/cy	1.36	mh	25.99	35
0200	Bedding, sand, dead or bank,		2.222	cy	Lab		0.16000	mh/cy	0.36	mh	20.350	7
					Mat	0			2.22	cy	4.838	11
					Eqp		0.05333	mh/cy	0.12	mh	25.99	3
	Bedding											4,741
	80.024 Labor hours											
	26.673 Equipment hours											
026686	Pipng,water dstrb systems											
1440	Piping, ductile iron pipe, mec	10"Raw Water	573.00	lf	Lab		0.31111	mh/lf	178.27	mh	27.666	4,932
					Mat	0			573.00	lf	19.286	11,051
					Eqp		0.04444	mh/lf	25.46	mh	27.06	689
1450	Piping, ductile iron pipe, mec	12"Raw Water	627.00	lf	Lab		0.38889	mh/lf	243.83	mh	27.666	6,746
					Mat	0			627.00	lf	24.639	15,449
					Eqp		0.05556	mh/lf	34.84	mh	27.06	943
2900	Piping, polyvinyl chloride pip	6" Dom Water	107.00	lf	Lab		0.13333	mh/lf	14.27	mh	27.847	397
					Mat	0			107.00	lf	6.966	745
2900	Piping, polyvinyl chloride pip	Found. Drain	940.00	lf	Lab		0.13333	mh/lf	125.33	mh	27.847	3,490
					Mat	0			940.00	lf	6.966	6,548
8060	Piping, fittings, 90< bend, 10	10"Raw Water	4.00	ea	Lab		1.33333	mh/ea	5.33	mh	27.666	148
					Mat	0			4.00	ea	332.82	1,331
					Eqp		0.19048	mh/ea	0.76	mh	27.06	21
8080	Piping, fittings, 90< bend, 12	12"Raw Water	4.00	ea	Lab		1.55556	mh/ea	6.22	mh	27.666	172
					Mat	0			4.00	ea	438.60	1,754
					Eqp		0.22222	mh/ea	0.89	mh	27.06	24
----	Thrust Blocks @ bends	10"Raw Water	4.00	ea	Lab				4.00	ea		
					Mat	0			4.00	ea	60.00	240
----	Thrust Blocks @ bends	12"Raw Water	4.00	ea	Lab				4.00	ea		
					Mat	0			4.00	ea	60.00	240
----	Pipe fittings, 90 Elbow, 6"	6" Dom Water	2.00	ea	Lab		0.30000	mh/ea	0.60	mh	27.847	17
					Mat	0			2.00	ea	133.00	266
----	Thrust Blocks @ bends	6" Dom Water	2.00	ea	Lab				2.00	ea		
					Mat	0			2.00	ea	60.00	120
----	Pipe, D.I.P., 10" diameter	10" Dom Water	666.00	lf	Lab		0.31110	mh/lf	207.19	mh	27.666	5,732
					Mat	0			666.00	lf	19.286	12,844
					Eqp		0.31110	mh/lf	207.19	mh	27.06	5,607
----	Misc. pipe fittings, 10" dia.	10" Dom Water	4.00	ea	Lab		1.33300	mh/ea	5.33	mh	27.847	148
					Mat	0			4.00	ea	332.00	1,328

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
026686	Pipng,water dstrb systems											
----	Thrust Blocks @ bends	10" Dom Water	4.00	ea	Lab				4.00	ea		
					Mat	0			4.00	ea	60.00	240
	Pipng,water dstrb systems											81,222
	786.377 Labor hours											
	269.144 Equipment hours											
026852	Gas service&distribution											
----	Pipe, Polyethylene, 1-1/2"	Gas Line	733.00	lf	Lab		0.06400	mh/lf	46.91	mh	27.847	1,306
					Mat	0			733.00	lf	1.130	828
	Gas service&distribution											2,135
	46.912 Labor hours											
027152	Catch basins or manholes											
0900	Catch basins or manholes, conc		1.00	ea	Lab		16.00000	mh/ea	16.00	mh	20.350	326
					Mat	0			1.00	ea	599.85	600
					Eqp		5.33333	mh/ea	5.33	mh	25.99	139
1130	Catch basins or manholes, conc	8" Sewer Line	3.00	ea	Lab		12.00000	mh/ea	36.00	mh	20.350	733
					Mat	0			3.00	ea	619.200	1,858
					Eqp		4.00000	mh/ea	12.00	mh	25.99	312
1600	Catch bsns or manholes, frames		1.00	ea	Lab		3.07692	mh/ea	3.08	mh	20.350	63
					Mat	0			1.00	ea	234.78	235
					Eqp		1.02564	mh/ea	1.03	mh	25.99	27
1900	Catch bsns or manholes, frs an	8" Sewer Line	3.00	ea	Lab		2.75862	mh/ea	8.28	mh	20.350	168
					Mat	0			3.00	ea	187.05	561
					Eqp		0.91954	mh/ea	2.76	mh	25.99	72
	Catch basins or manholes											5,091
	63.353 Labor hours											
	21.118 Equipment hours											
027162	Pipng,drng&sewage,concret											
2050	Piping, reinforced culvert, cl		230.00	lf	Lab		0.63636	mh/lf	146.36	mh	22.716	3,325
					Mat	0			230.00	lf	27.09	6,231
					Eqp		0.09091	mh/lf	20.91	mh	64.14	1,341
	Pipng,drng&sewage,concret											10,897
	146.363 Labor hours											
	20.909 Equipment hours											

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
027164	**Ppng,drng&sewg,corr metal**											
2600	Piping, plain, 20' lengths, 18		30.00	lf	Lab		0.13659	mh/lf	4.10	mh	27.666	113
					Mat	0			30.00	lf	10.514	315
					Eqp		0.01951	mh/lf	0.59	mh	27.06	16
	Ppng,drng&sewg,corr metal											445
	4.098 Labor hours											
	0.585 Equipment hours											
027168	**Ppng,drng&sewg,plyv chlrd**											
2000	Piping, 10' lengths, s.d.r 35,		200.00	lf	Lab		0.06400	mh/lf	12.80	mh	27.847	356
					Mat	0			200.00	lf	1.109	222
2040	Piping, 10' lengths, s.d.r 35,	Sewer Line	197.00	lf	Lab		0.06857	mh/lf	13.51	mh	27.847	376
					Mat	0			197.00	lf	2.348	463
2080	Piping, 10' lengths, s.d.r 35,	8" Sewer Line	1,177.00	lf	Lab		0.07164	mh/lf	84.32	mh	27.847	2,348
					Mat	0			1,177.00	lf	4.089	4,813
----	Misc PVC pipe fittings, 6"	Sewer Line	1.00	ls	Lab		8.00000	mh/ls	8.00	mh	27.847	223
					Mat	0			1.00	ls	250.00	250
	Ppng,drng&sewg,plyv chlrd											9,051
	118.629 Labor hours											
028308	**Fence,chain link industrl**											
0500	Fence, barbed wire, 6 Ga wire,		3,094.00	lf	Lab		0.12800	mh/lf	396.03	mh	26.123	10,346
					Mat	0			3,094.00	lf	11.546	35,723
					Eqp		0.06400	mh/lf	198.02	mh	28.13	5,570
1400	Fence, barbed wire, gate for 6		1.00	ea	Lab		3.20000	mh/ea	3.20	mh	26.123	84
					Mat	0			1.00	ea	84.495	85
					Eqp		1.60000	mh/ea	1.60	mh	28.13	45
	Man-gate, 4'-0" wide x 8' high.											
5060	Fence, double swing gates, 6'		1.00	opng	Lab		10.00000	mh/opng	10.00	mh	26.123	261
					Mat	0			1.00	opng	318.63	319
					Eqp		5.00000	mh/opng	5.00	mh	28.13	141
	20' wide gate, 2 leaf											
----	Perimeter fence grounding syst		33.00	ea	Lab		4.08200	mh/ea	134.71	mh	31.37	4,226
					Mat	0			33.00	ea	100.38	3,313
	Incl. bare strd conductor, clamps (barb wire, post & grnd rod), and grnd rods @ 100 lf intervals + 2/gate. Based on Note 1 of RFETS Plt Std SC-102 Dwg 23852-001.											
	Fence,chain link industrl											60,111
	543.938 Labor hours											
	204.616 Equipment hours											

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
029304	**Seeding**											
----	**Fine grade & seed**		**79,860.00**	**sy**	**Lab**		**0.00500**	**mh/sy**	**399.30**	**mh**	**22.148**	**8,844**
					Mat	**0**			**79,860.00**	**sy**	**0.15**	**11,979**
					Eqp		**0.00500**	**mh/sy**	**399.30**	**mh**	**25.99**	**10,378**
	Fine grade over-burden and seed including lime, fertilizer, seed and equipment. Quantities account only for common areas of vault not impacted by strg vault size											
	Seeding											**31,201**
	399.300 Labor hours											
	399.300 Equipment hours											
	02 Sitework											***2,984,336***
	54,226.850 Labor hours											
	13,615.765 Equipment hours											

03 Concrete

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
016400	**Equipment Rental**											
----	**Concrete batch plant**		**24.00**	**mon**	**Sub**				**24.00**	**mon**	**5,450.00**	**130,800**
	Rental price/month based on 1995 Richardson's estimating standards.											
----	**Mob/Setup/Teardn/Demob Batch P**		**1.00**	**ls**	**Sub**				**1.00**	**ls**	**25,000.00**	**25,000**
	Equipment Rental											**155,800**
031142	**Forms in place, columns**											
----	**Cast-in-place columns-formwork**		**2,016.00**	**sfca**	**Lab**		**0.07000**	**mh/sfca**	**141.12**	**mh**	**26.092**	**3,682**
					Mat	**0**			**2,016.00**	**sfca**	**1.07**	**2,157**
					Eqp		**0.07000**	**mh/sfca**	**141.12**	**mh**	**1.150**	**162**
	Unit labor hours have been adjusted to account for PC-4 criteria or Safety Class Criteria per DOE 6430.1A.											
	Forms in place, columns											**6,002**
	141.12 Labor hours											
	141.12 Equipment hours											
031150	**Fip,elevated slabs**											
----	**C[illegible] place elev slab-frmwrk**		**34,905.00**	**sfca**	**L[illegible]**		**0.18000**	**mh/sfca**	**6,282.90**	**mh**	**28[illegible]**	**176,945**
					M[illegible]	**0**			**34,905.00**	**sfca**		**52,707**

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
031150	**Fip,elevated slabs**											
----	**Cast-in-place elev slab-frmwrk**		34,905.00	sfca	Eqp		0.18000	mh/sfca	6,282.90	mh	1.150	7,225
	Labor adjusted to reflect PC-4 criteria or Safety Class criteria per DOE 6430.1A											
	Fip,elevated slabs											236,877
	6,282.90 Labor hours											
	6,282.90 Equipment hours											
031166	**Fip,mat foundation**											
----	**Cast-in-place found. mat-frmwk**		13,014.00	sfca	Lab		1.11000	mh/sfca	14,445.54	mh	26.452	382,113
					Mat	0			13,014.00	sfca	2.88	37,480
					Eqp		1.11000	mh/sfca	14,445.54	mh	1.150	16,612
	Fip,mat foundation											436,206
	14,445.540 Labor hours											
	14,445.540 Equipment hours											
031182	**Forms in place, walls**											
----	**Cast-in-place walls-formwork**		113,090.00	sfca	Lab		0.49000	mh/sfca	55,414.10	mh	28.163	1,560,627
					Mat	0			113,090.00	sfca	2.06	232,965
					Eqp		0.49000	mh/sfca	55,414.10	mh	1.150	63,726
	Unit labor hours adjusted to account for PC-4 criteria or Safety Class criteria per DOE 6430.1A.											
	Forms in place, walls											1,857,319
	55,414.100 Labor hours											
	55,414.100 Equipment hours											
032107	**Reinforcing in place**											
----	**Cast-in-place columns-reinf.**		22.00	ton	Lab		18.03900	mh/ton	396.86	mh	27.10	10,755
					Mat	2			22.44	ton	438.04	9,830
					Eqp				22.00	ton		
	Place reinforcing steel in column forms Labor and material adjusted to reflect PC-4 criteria or Safety Class criteria per DOE 6430.1A.											
----	**Cast-in-place walls-reinf.**		1,208.00	ton	Lab		10.83000	mh/ton	13,082.64	mh	27.10	354,540
					Mat	0			1,208.00	ton	420.00	507,360
					Eqp				1,208.00	ton		
	Place reinforcing steel in wall forms Labor & Mat'l adjusted to account for PC-4 criteria or Safety Class criteria per DOE 6430 1A.											
----	**Cast-in-place found. mat-reinf**		296.00	ton	Lab		24.37000	mh/ton	7,213.52	mh	27.10	195,486
					Mat	0			296.00	ton	507.01	150,075
					Eqp				296.00	ton		
	Place reinforcing steel in foundation mat.											

Item	Description	Location	Takeoff Qty		W%	Conversion	Order Qty	Unit Price	Amount
032107	**Reinforcing in place**								
----	Cast-in-place elev slab-reinf		1,835.00 ton	Lab		16.00000 mh/ton	29,360.00 mh	27.10	795,656
				Mat	0		1,835.00 ton	420.00	770,700
				Eqp			1,835.00 ton		
	Place reinforcing steel in elevated slabs								
	Reinforcing in place								2,794,401
	50,053.018 Labor hours								
033130	**Concrete in place**								
----	Cast-in-place columns-concrete		66.00 cy	Lab		2.52000 mh/cy	166.32 mh	22.069	3,671
				Mat	5		69.30 cy	67.55	4,681
				Eqp		2.52000 mh/cy	166.32 mh	25.983	4,321
	Place concrete in forms Labor and material prices adjusted to reflect PC-4 criteria or Safety Class criteria per DOE 6430.1A.								
----	Cast-in-place walls-concrete		5,435.00 cy	Lab		1.94000 mh/cy	10,543.90 mh	22.069	232,693
				Mat	5		5,706.75 cy	68.56	391,255
				Eqp		1.94000 mh/cy	10,543.90 mh	25.983	273,962
	Labor and matl adjusted to account for PC-4 criteria or Safety Class criteria per DOE 6430.1A.								
----	Cast-in-place found. mat-conc.		1,847.00 cy	Lab		0.50000 mh/cy	923.50 mh	22.069	20,381
				Mat	5		1,939.35 cy	67.650	131,197
				Eqp		0.50000 mh/cy	923.50 mh	25.983	23,995
----	Cast-in-place elev slab-concr		8,151.00 cy	Lab		1.47500 mh/cy	12,022.73 mh	22.069	265,330
				Mat	5		8,558.55 cy	68.83	589,085
				Eqp		1.47500 mh/cy	12,022.73 mh	25.983	312,386
	Concrete in place								2,252,958
	23,656.445 Labor hours								
	23,656.445 Equipment hours								
	03 Concrete								*7,739,563*
	149,993.123 Labor hours								
	99,940.105 Equipment hours								

05 Metals

Item	Description	Location	Takeoff Qty		W%	Conversion	Order Qty	Unit Price	Amount
050001	**Metals**								
----	Type D tube bundle-TS 6x6x1/2"		60,894.00 lbs	Lab			60,894.00 lbs		
				Mat	0		60,894.00 lbs	0.86	52,369
	*Re..ires 24 x 9 TS each way @ 4' long = 864 lf @ 35.24 lf ... 0,447 lbs. 2 locations requiring this bundle a... y, 30,447 * 2 = 60,894 lbs.*								
----	Type E tube bundle-TS 6x6x1/2"		111,640.00 lbs	La..			111,640.00 lbs		

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
050001	**Metals**											
----	**Type E tube bundle-TS 6x6x1/2"**		111,640.00	lbs	Mat	0			111,640.00	lbs	0.86	96,010
	*Requires 33 x 24 TS each way @ 4' long = 3,168 lf @ 35.24 lbs/lf = 111,640 lbs. 1 location requiring this bundle assembly, 111,640 * 1 = 111,640 lbs*											
----	**Type D tube bundle-Plate 1/2"**		7,004.00	lbs	Lab				7,004.00	lbs		
					Mat	0			7,004.00	lbs	0.335	2,346
	4'-1" wide x 42' long = 171 5 sf/location x 2 locations = 343 sf @ 20 42 lbs/sf = 7,004 lbs											
----	**Type E tube bundle-Plate 1/2"**		4,753.00	lbs	Lab				4,753.00	lbs		
					Mat	0			4,753.00	lbs	0.335	1,592
	4'-1" wide x 57' long = 232 74 sf/location x 1 location = 232.74 sf @ 20.42 lbs/sf = 4,753 lbs.											
----	**Type D tube bundle-Anchor Stud**		272.00	ea	Lab				272.00	ea		
					Mat	0			272.00	ea	0.23	63
	5 required 2 sides & 12 required 2 sides x 4 wide = 136 @ 2 locations = 272 - 1/2" x 4-1/8" H4L Nelson Studs.											
----	**Type E tube bundle-Anchor Stud**		224.00	ea	Lab				224.00	ea		
					Mat	0			224.00	ea	0.23	52
	16 required 2 sides & 12 required 2 sides x 4 wide = 224 @ 1 location = 224 - 1/2" x 4-1/8" H4L Nelson Stud.											
----	**Assemble Type D bundle**		2,592.00	lf	Lab		0.10000	mh/lf	259.20	mh	30.945	8,021
					Mat	0			2,592.00	lf	0.36	933
					Eqp		0.10000	mh/lf	259.20	mh	9.89	2,563
	Assume 3" stitch weld every 6" at each joint (1/4" fillet weld). Weld tube stl together, weld to 1/2" plate along outside edges. 1.5' weld/lf of tube - 1,728 lf of tube.											
----	**Assemble Type E bundle**		3,168.00	lf	Lab		0.10000	mh/lf	316.80	mh	30.945	9,803
					Mat	0			3,168.00	lf	0.36	1,140
					Eqp		0.10000	mh/lf	316.80	mh	9.89	3,133
	Assume 3" stitch weld every 6" along each joint (1/4" fillet) Weld tube stl together. weld to 1/2" plate along outside edges. 1.5' of weld/lf of tube - 3,168 lf tube											
----	**Weld anchor studs to plate**		736.00	ea	Lab		0.01600	mh/ea	11.78	mh	30.945	364
			0		Eqp		0.01600	mh/ea	11.78	mh	12.214	144
----	**Set bundles into formwork**		5.00	ea	Lab		8.00000	ch/ea	40.00	ch	110.78	4,431
					Eqp				5.00	ea		
----	**Hvy Duty Grating @ Inlet/Outlt**		1,434.00	sf	Lab		0.10000	mh/sf	143.40	mh	29.28	4,199
					Mat	0			1,434.00	sf	21.00	30,114
					Eqp		0.10000	mh/sf	143.40	mh	9.89	1,418
	Pricing based on IKG/Greulich Bridge Decking 5" - 4way Standard w/5.51 lb main bar. Located @ air inlet and outlet openings.											
----	**Tubing, Str. 5"x3"x1/4", A500**		600.00	lbs	Lab		0.10000	mh/lbs	60.00	mh	29.28	1,757
					Mat	0			600.00	lbs	0.86	516
					Eqp		0.10000	mh/lbs	60.00	mh	9.89	593
	Framing for weather cover over air outlet duct											
----	**Tubing, Str. 3"x3"x1/4", A500**		100.00	lbs	Lab		0.10000	mh/lbs	10.00	mh	29.28	293
					Mat	0			100.00	lbs	0.87	87
					Eqp		0.10000	mh/lbs	10.00	mh	9.89	99
	Framing for weather cover over air outlet duct.											
----	**Corrugated metal arch, 10 ga**		1,434.00	sf	Lab		0.10000	mh/sf	143.40	mh	29.28	4,199
					Mat	0			1,434.00	sf	40.00	57,360

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
050001	Metals											
----	**Corrugated metal arch, 10 ga**		1,434.00	sf	Eqp		0.10000	mh/sf	143.40	mh	9.89	1,418
	Weather cover over air outlet duct. 3" galv Pricing based on quote from Contech Construction Products of $130/lf											
----	**Type B tube bundle-TS 6x6x1/2"**		67,660.00	lbs	Lab				67,660.00	lbs		
					Mat	0			67,660.00	lbs	0.86	58,188
	*Requires 24 x 10 TS each way @ 4' long = 960 lf @ 35 24 lbs/lf = 33,830 lbs. 2 locations requiring this bundle assembly, 33,830 * 2 = 67,660 lbs*											
----	**Type B tube bundle-Plate 1/2"**		5,669.00	lbs	Lab				5,669.00	lbs		
					Mat	0			5,669.00	lbs	0.335	1,899
	4'-1" wide x 34' long = 138.8 sf/location x 2 locations = 277 6 sf @ 20 42 lbs/sf = 5,669 lbs.											
----	**Type B tube bundle-Anchor Stud**		240.00	ea	Lab				240.00	ea		
					Mat	0			240.00	ea	0.23	55
	3 required 2 sides & 12 required 2 sides x 4 wide = 120 @ 2 locations = 240 - 1/2" x 4-1/8" H4L Nelson Stud.											
----	**Assemble Type B bundle**		2,880.00	lf	Lab		0.10000	mh/lf	288.00	mh	30.945	8,912
					Mat	0			2,880.00	lf	0.36	1,037
					Eqp		0.10000	mh/lf	288.00	mh	9.89	2,848
	Assume 3" stitch weld every 6" along each joint (1/4" fillet weld). Weld tube stl together, weld to 1/2" plate along edges. 1.5' of weld/lf of tube - 1,920 lf of tube.											
	Metals											357,958
	1,392.576 Labor hours											
	1,232.576 Equipment hours											
	05 Metals											*357,958*
	1,392.576 Labor hours											
	1,232.576 Equipment hours											

08 Doors/Windows

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
080001	Doors & Windows											
----	**Cylinder, Hydraulic, 6" Bore**		1.00	ea	Lab		16.00000	ch/ea	16.00	ch	58.17	931
					Mat	0			1.00	ea	4,088.23	4,088
	3-1/2" Dia. Rod, 150" stroke w/rod eye and base clevis, cushion stops both ends. Ortman Series 2M Style "P" (NFPA Mounting Style ME6) or equivalent											
----	**Cylinder, Hydraulic, 5" Bore**		2.00	ea	Lab		12.00000	ch/ea	24.00	ch	58.17	1,396
					Mat	0			2.00	ea	2,021.27	4,043
	2-1/2" Dia. Rod, 102" stroke w/rod eye and base clevis, cushion stops both ends. Ortman Series 2M Style "P" (NFPA Mo...ing Style ME6) or equivalent.											
----	**C... r, Hydraulic,2-1/2"Bore**		6.00	ea	L...		8.00000	ch/ea	48.00	ch	58...	2,792
					M...	0			6.00	ea	51...	3,066

Item	Description	Location	Takeoff Qty		W%	Conversion	Order Qty	Unit Price	Amount
080001	Doors & Windows								
	1-3/8" Dia Rod, 42" stroke w/rod eye and base clevis, cushion stops both ends. Ortman Senes 2M Style "P" (NFPA Mounting Style ME6) or equivalent.								
----	**Hydraulic Supply Unit HS-1**		1.00 ea	Lab		40.00000 mh/ea	40.00 mh	29.085	1,163
				Mat	0		1.00 ea	1,137.00	1,137
	Complete w/40 gal reservoir, gear type pump, 9.2gpm @ 250psi, directional control, 4-way/3posit., center return solenoid act., relief vlv, oil filter & all assoc piping								
----	**Hydraulic Supply Unit HS-2**		1.00 ea	Lab		40.00000 mh/ea	40.00 mh	29.085	1,163
				Mat	0		1.00 ea	1,064.00	1,064
	Complete w/20 gal. reservoir, gear type pump, 9 2gpm @ 250psi, directional control, 4-way/3posit., center return solenoid act., relief vlv, oil filter & all assoc. piping								
----	**Hydraulic Supply Unit HS-3**		1.00 ea	Lab		40.00000 mh/ea	40.00 mh	29.085	1,163
				Mat	0		1.00 ea	1,033.00	1,033
	Complete w/10 gal. reservoir, gear type pump, 9.2gpm @ 250psi, directional control, 4-way/3posit., center return solenoid act., relief vlv, oil filter & all assoc. piping								
----	**ENCL-1 Hydraulic Safety Encl**		1.00 ls	Lab		16.00000 mh/ls	16.00 mh	34.980	560
				Mat	0		1.00 ls	312.00	312
	*40 Gallon Capacity 70lf 3"x3"x1/4" angle, 130 sf 16 gauge sheet steel, C.S (2 5#/sf*130sf=325# sheet) +(4.9#/lf*70lf=343# angle), .05mh/lb labor.*								
----	**ENCL-2 Hydraulic Safety Encl**		2.00 ls	Lab		16.00000 mh/ls	32.00 mh	34.980	1,119
				Mat	0		2.00 ls	142.00	284
	*20 Gallon Capacity. 50lf 2"x2"x3/16" angle, 75 sf 16 gauge sheet steel, C.S (2.5#/sf*75sf=188# sheet) +(2.52#/lf*50lf=126# angle), 05mh/lb labor.*								
----	**ENCL-3 Hydraulic Safety Encl**		6.00 ls	Lab		16.00000 mh/ls	96.00 mh	34.980	3,358
				Mat	0		6.00 ls	50.67	304
	*10 Gallon Capacity. 30lf 1.5"x1.5"x1/8" angle, 30 sf 16 gauge sheet steel, C.S. (2.5#/sf*30sf=75# sheet) +(1.29#/lf*30lf=39# angle), .05mh/lb labor.*								
	Doors & Windows								28,977
	440.00 Labor hours								
083184	Vault front								
----	**Security Door, Vault Type**		1.00 ls	Sub			1.00 ls	217,534.00	217,534
	Dbl leaf, hgd w/comb. lock for 8'wx9'h opening 2 types, 1 conforming to AA-D-600B/Class 5 & 1 conforming to Mil Std for Nuclear Matl Strg per quotes from vendors.								
	Vault front								217,534
083732	Rolling service doors								
----	**Stl Shapes/Plate, A36**		22.00 ton	Lab		60.00000 mh/ton	1,320.00 mh	29.28	38,650
				Mat	0		22.00 ton	800.00	17,600

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
083732	Rolling service doors											
	Includes 1/4" steel plate, 3"x3"x1/4" steel angle, 1-1/2"x1-1/2"x1/4" steel angle, 3/4" steel plate, 1" steel plate, W12x96 steel beam. Assume .03mh/lb for fab.											
----	Threaded rods w/nuts, 1/2" dia		1,716.00	lf	Lab		0.10000	mh/lf	171.60	mh	29.28	5,024
					Mat	0			1,716.00	lf	0.90	1,544
----	Anchor studs, 1/2"x4", A108		550.00	ea	Lab		1.12500	mh/ea	618.75	mh	29.28	18,117
					Mat	0			550.00	ea	0.75	413
	.25mh/ stud size diameter + length											
----	Reinforcing Steel, #8, Grd 60		14.00	ton	Lab		8.00000	mh/ton	112.00	mh	29.28	3,279
					Mat	0			14.00	ton	510.00	7,140
----	Rollers, Hilman 8NT		24.00	ea	Lab		3.00000	mh/ea	72.00	mh	29.28	2,108
					Mat	0			24.00	ea	223.00	5,352
	Pricing based on quote from Hilman Rollers.											
----	Rollers, Hillman 15NT		8.00	ea	Lab		3.00000	mh/ea	24.00	mh	29.28	703
					Mat	0			8.00	ea	258.00	2,064
	Price based on quote from Hilman Rollers.											
----	Rollers, Hillman 20NT		4.00	ea	Lab		3.00000	mh/ea	12.00	mh	29.28	351
					Mat	0			4.00	ea	346.00	1,384
	Price based on quote from Hilman Rollers.											
----	Concrete for Rolling Doors		59.00	cy	Lab		0.64000	mh/cy	37.76	mh	22.069	833
					Mat	0			59.00	cy	55.00	3,245
					Eqp		0.64000	mh/cy	37.76	mh	25.983	981
----	Roll-up Door, 22'w x 13'h		1.00	ea	Sub				1.00	ea	5,500.00	5,500
	Includes draft stop mouldings, bottom weatherstripping, cylinder lock and electric door operator.											
	Rolling service doors											114,289
	2,368.11 Labor hours											
	37.76 Equipment hours											
092620	Partition wall											
----	Door, HM, "B"Label,Dbl 4/0x9/0		2.00	ea	Lab		10.45000	mh/ea	20.90	mh	26.11	546
					Mat	0			2.00	ea	2,106.780	4,214
	Double door, 4/0 x 9/0 w/Narrow Lite in both doors, wired glass in lite, double door welded frame, with all hrdwr incl. closers, hinges and panic bar with pull.											
----	Door, HM, No Label, Sgl		3.00	ea	Lab		4.93000	mh/ea	14.79	mh	26.11	386
					Mat	0			3.00	ea	671.90	2,016
	3/0 x 7/0 w/Narrow Lite, wired glass in lite, 1-3/4" thick, single welded door frame, with all hardware incl. closer, hinges and panic bar with pull.											
----	Door, HM, No Label, Dbl		1.00	ea	Lab		7.00000	mh/ea	7.00	mh	26.11	183
					Mat	0			1.00	ea	1,031.30	1,031
	2-3/0 x 7/0 w/Narrow Lite, wired glass in lite, 1-3/4" thick, double welded door frame, with all hardware incl. closer, hinges and lockset.											
----	Door, HM, "B" Label, Sgl		2.00	ea	Lab		5.60000	mh/ea	11.20	mh	26.11	292
					Mat	0			2.00	ea	815.00	1,630
	[illegible] w/Narrow Lite, wired glass in lite, 1-3/4" th[illegible] single welded door frame, with all hardware incl. closer, hinges and lockset.											

Item	Description	Location	Takeoff Qty		W%	Conversion	Order Qty	Unit Price	Amount
092620	**Partition wall**								
----	**Door, HM, "C" Label, Sgl**		2.00 ea	Lab		3.50000 mh/ea	7.00 mh	26.11	183
				Mat	0		2.00 ea	438.90	878
	3/0 x 7/0 flush, 1-3/4" thick, single welded door frame, with all hardware incl. closer, hinges and lockset.								
----	**Door, HM, "C" Label, Sgl**		2.00 ea	Lab		4.60000 mh/ea	9.20 mh	26.11	240
				Mat	0		2.00 ea	746.90	1,494
	3/0 x 7/0 w/Narrow Lite, wired glass in lite, 1-3/4" thick, single welded door frame, with all hardware incl. closer, hinges and panic bar with pull.								
----	**Door, HM, "C" Label, Dbl**		1.00 ea	Lab		7.00000 mh/ea	7.00 mh	26.11	183
				Mat	0		1.00 ea	806.50	807
	2-3/0 x 7/0 flush, 1-3/4" thick, single welded door frame, with all hardware incl. closer, hinges and lockset.								
----	**Door, HM, "C" Label, Sgl**		2.00 ea	Lab		3.50000 mh/ea	7.00 mh	26.11	183
				Mat	0		2.00 ea	438.90	878
	3/0 x 7/0 flush, 1-3/4" thick, single welded door frame, with all hardware incl. closer, hinges and push/pull handle.								
----	**Door, HM, "C" Label, Sgl**		2.00 ea	Lab		4.60000 mh/ea	9.20 mh	26.11	240
				Mat	0		2.00 ea	746.00	1,492
	3/0 x 7/0 w/Narrow Lite, wired glass in lite, 1-3/4" thick, single welded door frame, with all hardware incl. closer, hinges and panic bar with pull								
	Partition wall 93.29 Labor hours								16,874
110301	**Bank equipment**								
5800	**Bank equip, pass thru, bullet-**		1.00 ea	Lab		20.00000 mh/ea	20.00 mh	25.19	504
				Mat	0		1.00 ea	2,450.00	2,450
	Bank equipment 20.00 Labor hours								2,954
	08 Doors/Windows 2,921.40 Labor hours; 37.76 Equipment hours								*380,628*

09 Finishes

Item	Description	Location	Takeoff Qty		W%	Conversion	Order Qty	Unit Price	Amount
033454	**Finishing floors**								
2100	**Finishing floors, hardeners, metallic, heavy service, 1.0 psf, add**		59,337.00 sf	Lab		0.01231 mh/sf	730.44 mh	22.35	16,325
				Mat	0		59,337.00 sf	0.427	25,337
				Eqp		0.01231 mh/sf	730.44 mh	5.04	3,681

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
033454	Finishing floors											
	Concrete hardener applied to interior concrete walls & ceilings											
3850	**Finishing floors, dustproofing, silicate liquids, 2 coats**		59,337.00	sf	Lab		0.00615	mh/sf	364.92	mh	22.35	8,156
					Mat	0			59,337.00	sf	0.051	3,026
	Dustproofing on interior walls and ceilings.											
	Finishing floors											56,526
	1,095.361 Labor hours											
	730.438 Equipment hours											
055104	Stair											
0500	**Stair, st, safety nose, st str**		23.00	risr	Lab		1.14286	mh/risr	26.29	mh	28.068	738
					Mat	0			23.00	risr	89.001	2,047
					Eqp		0.28571	mh/risr	6.57	mh	9.89	65
	Stair from staging/overpack area into lower level HEPA filter area, Room 102. Increased matl by 15% and labor by 8% for 4'-0" wide stair.											
	Stair											2,850
	26.286 Labor hours											
	6.571 Equipment hours											
055203	Railing, pipe											
0520	**Railing, pipe, steel, 2 rail,**		22.00	lf	Lab		0.20000	mh/lf	4.40	mh	28.068	124
					Mat	0			22.00	lf	9.105	200
					Eqp		0.05000	mh/lf	1.10	mh	9.89	11
	Outside mount on stair											
0940	**Railing, wall rail, steel pipe**		22.00	lf	Lab		0.15023	mh/lf	3.31	mh	28.068	93
					Mat	0			22.00	lf	5.166	114
					Eqp		0.03756	mh/lf	0.83	mh	9.89	8
	Wall mounted rail.											
	Railing, pipe											549
	7.705 Labor hours											
	1.926 Equipment hours											
092620	Partition wall											
4000	**Partition wl,5/8",int,gyp drwl**		5,665.00	sf	Lab		0.05000	mh/sf	283.25	mh	26.11	7,396
					Mat	0			5,665.00	sf	0.984	5,574
	Partition wall											12,970
	283.25 Labor hours											

Item	Description	Location	Takeoff Qty			W%	Conversion	Order Qty	Unit Price	Amount
093102	Ceramic tile									
3000	Ceramic tile, flrs, N clay, ra		1,213.00 sf		Lab		0.08743 mh/sf	106.05 mh	21.355	2,265
					Mat	0		1,213.00 sf	3.085	3,742
	Ceramic Tile on Floors									
5400	Ceramic tile, walls, interior,		820.00 sf		Lab		0.08421 mh/sf	69.05 mh	21.355	1,475
					Mat	0		820.00 sf	1.91	1,566
	Ceramic tile									9,048
	175.105 Labor hours									
095106	Suspend ceilings,complete									
0800	Suspended clg,NO carr chan,mnr		5,042.00 sf		Lab		0.02319 mh/sf	116.92 mh	26.11	3,053
					Mat	0		5,042.00 sf	1.299	6,550
	Suspend ceilings,complete									9,602
	116.924 Labor hours									
098150	Glazed coatings									
----	Floor coating, epoxy		5,625.50 sf		Lab		0.04700 mh/sf	264.40 mh	23.60	6,240
					Mat	0		5,625.50 sf	0.87	4,894
	Floors in storage and staging areas									
	Glazed coatings									11,134
	264.399 Labor hours									
099216	Doors and windows									
1000	D & w, f d & f, 3' x 7', o p,		19.00 ea		Lab		0.50000 mh/ea	9.50 mh	28.01	266
					Mat	0		19.00 ea	1.884	36
	Paint metal doors and frames, 3/0 x 7/0 doors. includes primer + 1 coat.									
	Doors and windows									302
	9.50 Labor hours									
099224	Wall and ceilings									
1240	Walls&clgs,conc,dry wl or plas,oil base,pnt 3 coats,sm fin,roller		11,330.00 sf		Lab		0.01013 mh/sf	114.77 mh	23.60	2,709
					Mat	0		11,330.00 sf	0.129	1,462
	Paint gyp board walls Primer plus 2 coats									
	Wall and ceilings									4,170
	114.773 Labor hours									

Item	Description	Location	Takeoff Qty		W%	Conversion	Order Qty	Unit Price	Amount
	09 Finishes 2,093.302 Labor hours 738.936 Equipment hours								*107,151*

10 Specialties

100001 Specialties

Item	Description	Location	Takeoff Qty		W%	Conversion	Order Qty	Unit Price	Amount
----	Computer-Operator wkstn *Includes UPS System*	Storage Tube	1.00 ea	Eqp			1.00 ea	12,300.00	12,300
----	PLC software-Operator wkstn *Wonderware FactoryLink*	Storage Tube	1.00 ea	Eqp			1.00 ea	10,000.00	10,000
----	Operating Syst software *Microsoft Windows NT*	Storage Tube	1.00 ea	Eqp			1.00 ea	350.00	350
----	PLC gateway to PC *Allen-Bradley 1784-KT*	Storage Tube	1.00 ea	Eqp			1.00 ea	1,437.75	1,438
----	Ethernet hub to B371	Storage Tube	1.00 ea	Eqp			1.00 ea	500.00	500
----	Ethernet card in workstation	Storage Tube	1.00 ea	Eqp			1.00 ea	150.00	150
----	Ethernet cable *Includes tamper indicating devices on Ethernet cable (2/cable)*	Storage Tube	1.00 ea	Eqp			1.00 ea	105.00	105
----	Computer-CAS wkstn *Includes UPS System*	Storage Tube	1.00 ea	Eqp			1.00 ea	12,300.00	12,300
----	PLC software-CAS wkstn *Wonderware FactoryLink*	Storage Tube	1.00 ea	Eqp			1.00 ea	10,000.00	10,000
----	Operating Syst software *Microsoft Windows NT*	Storage Tube	1.00 ea	Eqp			1.00 ea	350.00	350
----	PLC gateway to PC *Allen-Bradley 1784-KT*	Storage Tube	1.00 ea	Eqp			1.00 ea	1,437.75	1,438
----	Computer-IAEA wkstn *Includes UPS System*	Storage Tube	1.00 ea	Eqp			1.00 ea	12,300.00	12,300
----	PLC software-IAEA wkstn *Wonderware FactoryLink*	Storage Tube	1.00 ea	Eqp			1.00 ea	10,000.00	10,000
----	Operating Syst software *Microsoft Windows NT*	Storage Tube	1.00 ea	Eqp			1.00 ea	350.00	350
----	PLC gateway to PC *Allen-Bradley 1784-KT*	Storage Tube	1.00 ea	Eqp			1.00 ea	1,437.75	1,438
----	Computer-SAS wkstn *Including UPS system*	Storage Tube	1.00 ea	Eqp			1.00 ea	12,000.00	12,000
----	PLC software-SAS wkstn *Wonderware FactoryLink*	Storage Tube	1.00 ea	Eqp			1.00 ea	10,000.00	10,000
----	Operating Syst software *Microsoft Windows NT*	Storage Tube	1.00 ea	Eqp			1.00 ea	350.00	350
----	PLC gateway to PC *Allen-Bradley 1784-KT*	Storage Tube	1.00 ea	Eqp			1.00 ea	1,437.75	1,438
----	Set [illegible] Operator Workstation		1.00 ls	Lab		24.00000 mh/ls	24.00 mh	31.37	753
----	S[illegible] CAS Workstation		1.00 ls	L[illegible]		24.00000 mh/ls	24.00 mh	31.[illegible]	753
----	Se[illegible] SAS Workstation		1.00 ls	L[illegible]		24.00000 mh/ls	24.00 mh	3[illegible]	753

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
100001	Specialties											
----	Set up IAEA Workstation		1.00	ls	Lab		24.00000	mh/ls	24.00	mh	31.37	753
----	Bar Code Scanner, Symbol Tech *Assume unit is portable with no installation required.*		1.00	ea	Eqp				1.00	ea	100.00	100
----	Fiber optic video system *Olympus*		1.00	ea	Eqp				1.00	ea	49,500.00	49,500
----	Radioscopy system, Custom Des.		1.00	ea	Eqp				1.00	ea	500,000.00	500,000
----	Datalogger, Fluke		1.00	ea	Eqp				1.00	ea	13,000.00	13,000
----	Pressure Gauge, Ashcroft S1279		1.00	ea	Eqp				1.00	ea	100.00	100
----	Misc Calibration Equipment *Equipment only no installation required.*		1.00	ls	Eqp				1.00	ls	2,000.00	2,000
----	Install Fiber Optic Video Syst		1.00	ls	Lab		60.00000	mh/ls	60.00	mh	27.16	1,630
					Mat	0			1.00	ls	500.00	500
----	Install Radioscopy System		1.00	ls	Lab		16.00000	mh/ls	16.00	mh	28.33	453
					Mat	0			1.00	ls		
	Assume unit is portable and stand-alone, install involves unloading and setting in place.											
----	Install Datalogger		1.00	ls	Lab		16.00000	mh/ls	16.00	mh	27.16	435
					Mat	0			1.00	ls	100.00	100
	Specialties 188.000 Labor hours											667,635
101602	Partitions, toilet											
1700	Partitions, toilet, cubicles,		3.00	ea	Lab		2.28571	mh/ea	6.86	mh	26.11	179
					Mat	0			3.00	ea	330.00	990
4700	Partitions, toilet, urinal scr		1.00	ea	Lab		2.00000	mh/ea	2.00	mh	26.11	52
					Mat	0			1.00	ea	163.00	163
	Partitions, toilet 8.857 Labor hours											1,384
105054	Lockers											
0400	Lockers, steel, 2 tier, 60" or		12.00	opng	Lab		0.40000	mh/opng	4.80	mh	34.980	168
					Mat	0			12.00	opng	77.50	930
2100	Lockers, locker bench, laminat		12.00	lf	Lab		0.08000	mh/lf	0.96	mh	34.980	34
					Mat	0			12.00	lf	12.95	155
2200	Lockers, locker bench, pedesta		6.00	ea	Lab		0.32000	mh/ea	1.92	mh	34.980	67
					Mat	0			6.00	ea	24.50	147
	Lockers 7.68 Labor hours											1,501
	10 Specialties 204.537 Labor hours											*670,520*

11 Equipment

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
111601	**Loading dock**											
0850	Loading dock, bumpers, rubber		3.00	ea	Lab		0.44444	mh/ea	1.33	mh	26.11	35
					Mat	0			3.00	ea	69.00	207
4700	Loading dock, levelers, hydrau		1.00	ea	Lab		14.81481	mh/ea	14.81	mh	30.945	458
					Mat	0			1.00	ea	5,000.00	5,000
					Eqp		7.40741	mh/ea	7.41	mh	9.89	73
	Loading dock 16.148 Labor hours 7.407 Equipment hours											5,774
145501	**Material handling**											
----	Strg Tube Tranport Cart Mover		2.00	ea	Mat	0			2.00	ea	4,000.00	8,000
	Yale MPB Low Lift Walkie, 4,000 lb capacity, 24 vDC w/battery charger. Pricing obtained from Denver Yale Distributor One located in B371 and one located in ISV.											
----	Crane, Support Cage Staging		1.00	ea	Lab		80.00000	mh/ea	80.00	mh	29.28	2,342
					Mat	0			1.00	ea	5,000.00	5,000
	5 ton capacity, A-frame monorail, 2 ton capacity manual chain hoist w/safety hook, 5 ton capacity two-leg wire rope bridle sling w/pear link											
----	Storage Tube Transport Cart		2.00	ea	Lab		24.00000	mh/ea	48.00	mh	29.50	1,416
					Mat	0			2.00	ea	4,437.00	8,874
					Eqp				2.00	ea		
	Bishamon LX-200N low Profile electrohydraulic lift table											
----	Wheels, 1200# cap. phenolic		8.00	ea	Lab		1.00000	mh/ea	8.00	mh	29.50	236
					Mat	0			8.00	ea	10.00	80
					Eqp				8.00	ea		
	Wesco #053770. attach to transport cart.											
----	Wheel locks		8.00	ea	Lab		1.00000	mh/ea	8.00	mh	29.50	236
					Mat	0			8.00	ea	10.00	80
					Eqp				8.00	ea		
	Part of Tube Transport Cart											
----	Plate, 1/2" thk, 15' x 3'		2.00	ea	Lab		16.00000	mh/ea	32.00	mh	24.53	785
					Mat	0			2.00	ea	307.83	616
					Eqp				2.00	ea		
	Part of Storage Tube Transport Cart *15' x 3' x 20.42 = 918.9# @ $0.335/# = $307.83*											
----	Angle, 1"x1"x1/4", Steel		25.25	lbs	Lab		0.10000	mh/lbs	2.53	mh	24.53	62
					Mat	0			25.25	lbs	0.570	14
					Eq		0.10000	mh/lbs	2.53	mh		
	1[illegible] feet required											

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
145501	Material handling											
----	Str. Tube, 4"x4"x3/8", Steel		690.80	lbs	Lab		0.05000	mh/lbs	34.54	mh	24.53	847
					Mat	0			690.80	lbs	0.93	642
					Eqp				690.80	lbs		
	40 lineal feet required 40 x 17.27#/lf = 690.8#											
----	Pin, Ball detent locking		4.00	ea	Lab		0.50000	mh/ea	2.00	mh	29.50	59
					Mat	0			4.00	ea	50.00	200
					Eqp				4.00	ea		
	3/4" x 6", 2 required per cart											
----	Support Block, 1/2" stl plate		2.00	ea	Lab		24.00000	mh/ea	48.00	mh	24.53	1,177
					Mat	0			2.00	ea	250.00	500
					Eqp				2.00	ea		
	2 required per cart. upper fixed support block and lower pivoting support block											
----	Pivot frame, 1/2" stl plate		2.00	ea	Lab		40.00000	mh/ea	80.00	mh	24.53	1,962
					Mat	0			2.00	ea	2,000.00	4,000
					Eqp				2.00	ea		
	1 required per cart.											
----	**STRG TUBE SUPPRT CAGE FIXT**		1.00	ea	Lab				1.00	ea		
					Mat	0			1.00	ea		
					Eqp				1.00	ea		
----	Face Plate, 1/2" Stl Plate		1.00	ea	Lab		8.00000	mh/ea	8.00	mh	29.50	236
					Mat	0			1.00	ea	200.00	200
					Eqp				1.00	ea		
----	Bolts, Conical Hex Hd Captured		3.00	ea	Lab		0.50000	mh/ea	1.50	mh	29.50	44
					Mat	0			3.00	ea	10.00	30
					Eqp				3.00	ea		
	1-3/4" x 8"											
----	Alignment Pins, 1"x8", sst		3.00	ea	Lab		0.50000	mh/ea	1.50	mh	29.50	44
					Mat	0			3.00	ea	10.00	30
					Eqp				3.00	ea		
----	Screw Drive System, 16 lf		2.00	ea	Lab		80.00000	mh/ea	160.00	mh	29.50	4,720
					Mat	0			2.00	ea	10,800.00	21,600
					Eqp		80.00000	mh/ea	160.00	mh		
	Thomson Superslide 2EB, revised model number provided by Thomson Eng. only slide mechanism capable of 16 lf of travel. Labor covers all screw drive components.											
----	Motion Control Package		2.00	ea	Lab				2.00	ea		
					Mat	0			2.00	ea	5,026.00	10,052
					Eqp				2.00	ea		
	Thomson TMC-1101D Labor covered with main screw drive component.											
----	Bellows Coupling, AccuLOCK		2.00	ea	Lab				2.00	ea		
					Mat	0			2.00	ea	494.00	988
					Eqp				2.00	ea		
	Labor covered in main screw drive component											
----	Thomson Prog. Limit Swtch		2.00	ea	Lab				2.00	ea		
					Mat	0			2.00	ea	190.89	382
					Eqp				2.00	ea		
	with Resolver. Labor covered in main screw drive component.											

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
145501	Material handling											
----	Str. Tube Support Table		1.00	ea	Lab		40.00000	mh/ea	40.00	mh	24.53	981
					Mat	0			1.00	ea	2,600.00	2,600
					Eqp		40.00000	mh/ea	40.00	mh	9.89	396
	6"x6"x3/8" str tube, 16' x 3' x 36" table dim Est approx 100 lf of tube req'd @ 27.48#/lf = 2748# @ $0 93/# = $2555. Labor for table fab only.											
----	Ball Joint Manipulator		2.00	ea	Lab		120.00000	mh/ea	240.00	mh	29.50	7,080
					Mat	0			2.00	ea	10,500.00	21,000
					Eqp		120.00000	mh/ea	240.00	mh		
	Central Research Labs Ball Manipulator. Budgetary quote from CRL on 5/12/97											
----	Ovrhd Electrmech. Manipulator		1.00	ea	Lab		240.00000	mh/ea	240.00	mh	29.50	7,080
					Mat	0			1.00	ea	39,000.00	39,000
					Eqp				1.00	ea		
	CRL System 50 Telemanipulator. without wall penetration and master arm Telephone budgetary quote from CRL on 5/12/97.											
----	Monorail track & ceiling suppt		20.00	lf	Lab		4.00000	mh/lf	80.00	mh	24.53	1,962
					Mat	0			20.00	lf	50.00	1,000
					Eqp				20.00	lf		
	150# capacity											
----	Trolley, electric, 150#		1.00	ea	Lab		24.00000	mh/ea	24.00	mh	29.50	708
					Mat	0			1.00	ea	1,200.00	1,200
					Eqp				1.00	ea		
	with cushion stop/start.											
----	Fixed Electrmech. Manipulator		1.00	ea	Lab		350.00000	mh/ea	350.00	mh	29.50	10,325
					Mat	0			1.00	ea	115,000.00	115,000
					Eqp				1.00	ea		
	CRL System 50 Telemanipulator, telephone quote from CRL on 5/12/97.											
----	Grasping end-effector, 3-prong		1.00	ea	Lab		16.00000	mh/ea	16.00	mh	29.50	472
					Mat	0			1.00	ea	2,000.00	2,000
					Eqp				1.00	ea		
	with 3013 can support											
----	Support pedestal,		1.00	ea	Lab		80.00000	mh/ea	80.00	mh	29.50	2,360
					Mat	0			1.00	ea	5,000.00	5,000
					Eqp				1.00	ea		
	with 360 degree rotating turret, 1/3HP											
----	Monitoring System, CCTV, color		3.00	ea	Lab		6.15400	mh/ea	18.46	mh	27.16	501
					Mat	0			3.00	ea	2,000.00	6,000
					Eqp				3.00	ea		
	Not radiation hardened.											
----	Camera controls,		3.00	ea	Lab		10.15400	mh/ea	30.46	mh	27.16	827
					Mat	0			3.00	ea	8,525.00	25,575
					Eqp				3.00	ea		
	Power zoom, tilt and pan.											
----	Monitors, color, 13"				Lab					ea		
					Mat	0				ea		
					Eqp					ea		
	[illegible] nd equipment cost included with monitoring system [illegible] st.											
----	Monitoring Controls, MCC & CP		1.00	ls	La[illegible]		80.00000	mh/ls	80.00	mh	2[illegible]	2,173

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
145501	Material handling											
----	**Monitoring Controls, MCC & CP**		1.00	ls	Mat	0			1.00	ls	5,000.00	5,000
					Eqp				1.00	ls		
	Estimator allowance for undefined control system and power feed											
----	**Radiation det. monitors/alarms**		1.00	ls	Lab		80.00000	mh/ls	80.00	mh	27.16	2,173
					Mat	0			1.00	ls	10,000.00	10,000
					Eqp				1.00	ls		
	Estimator allowance for undefined requirements.											
----	**Barrier shield wall**		5.00	ls	Lab		6.50400	mh/ls	32.52	mh	21.805	709
					Mat	0			5.00	ls	9,500.00	47,500
					Eqp				5.00	ls		
	45' x 8' x 3" thick bolted steel structure (or equivalent mass) Estimator allowance based on weight of wall.											
----	**Leaded glass viewing windows**				Lab					ea		
					Mat	0				ea		
					Eqp					ea		
	Cost assumed to be covered in barrier shield wall costs.											
----	**Shipping tie-down system**		2.00	ea	Lab				2.00	ea		
					Mat	0			2.00	ea	300.00	600
					Eqp				2.00	ea		
	Consists of 8 - 1/2" x 16" turnbuckles, 4 - 10' lengths of 3/4" wire rope w/spliced eye loops & 8 - 1/2" shackles per tie-down system. Matl cost only.											
----	**Storage Tube Retreat Module**		1.00	ea	Lab				1.00	ea		
					Mat	0			1.00	ea	25,000.00	25,000
					Eqp				1.00	ea		
----	**Install cage Handling Fixture**		1.00	ls	Lab		80.00000	ch/ls	80.00	ch	103.68	8,294
					Mat	0			1.00	ls	1,000.00	1,000
	Material handling											428,973
	2,145.509 Labor hours											
	442.525 Equipment hours											
	11 Equipment											*434,747*
	2,161.657 Labor hours											
	449.932 Equipment hours											

13 Special Constr.

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
132151	Tanks											
320	**Tank,fbgl,ugnd,sgl wl,UL liste**		1.00	ea	Lab		40.00000	mh/ea	40.00	mh	32.013	1,281
					Mat	0			1.00	ea	35,040.00	35,040
	For man-way, fittings and hold-downs added 20% to material and 15% to labor											
----	**Pumps, P-3A&B**		2.00	ea	Lab		40.00000	mh/ea	80.00	mh	32.74	2,619
					Mat	0			2.00	ea	4,151.50	8,303

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
132151	Tanks											
	ITT/FLYGT C-3102, 150gpm/pump @ 30'Head, 3HP/1730rpm, 230v motor, submerged type.											
----	**Pumps, P-2A&B**		1.00	ea	Lab		40.00000	mh/ea	40.00	mh	32.74	1,310
					Mat	0			1.00	ea	9,353.00	9,353
	ITT/FLYGT Lift Station #CP-3102, duplex pumps, submerged type, 300 gpm/pump @ 20' head, access cover, motor starter.											
----	**Manhole, Concrete, 4' dia.**		1.00	ea	Lab		12.00000	mh/ea	12.00	mh	20.350	244
					Mat	0			1.00	ea	480.00	480
					Eqp		12.00000	mh/ea	12.00	mh	25.99	312
	8' deep based on estimate of location											
----	**Manhole cover, 24" dia.**		1.00	ea	Lab		2.75900	mh/ea	2.76	mh	20.350	56
					Mat	0			1.00	ea	145.00	145
					Eqp		2.75900	mh/ea	2.76	mh	25.99	72
	Light traffic, 300lb.											
----	**Pipe, cast iron, 6"**		1,350.00	lf	Lab		0.32900	mh/lf	444.15	mh	29.50	13,102
					Mat	0			1,350.00	lf	11.80	15,930
	Service weight, Hub & Spigot type,											
	Tanks											88,247
	618.909 **Labor hours**											
	14.759 **Equipment hours**											
	13 Special Constr.											***88,247***
	618.909 **Labor hours**											
	14.759 **Equipment hours**											

14 Bridge cranes

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
146054	Crane rail											
----	**W10x33 brdg crane support brkt**		286.00	lbs	Lab		0.02310	mh/lbs	6.61	mh	29.28	193
					Mat	0			286.00	lbs	0.84	240
	*1'-1" long per support bracket, 8 required * 1'-1" long = 8.66 lf @ 33 lbs/lf = 286 lbs. Cut & weld to plate.*											
----	**Plate, 12" x 2'-3" x 1" thick**		736.00	lbs	Lab				736.00	lbs		
					Mat	0			736.00	lbs	0.31	228
	*1' x 2'-3" = 2.25 sf/support * 8 supports = 18 sf of 1" plate @ 40.84 lbs/sf = 736 lbs. Cut to proper dimensions set in place to embed in concrete.*											
----	**Anchor studs, 3/4" x 6-3/16"**		48.00	ea	Lab				48.00	ea		
					Mat	0			48.00	ea	0.65	31
	*6 required per support * 8 supports = 48 studs required. Locate and weld to plate.*											
----	**Anglo bracket, 6"x3-1/2"x5/8"**		160.00	lbs	Lab		0.01500	mh/lbs	2.40	mh	29.28	70
					M·	0			160.00	lbs	0.[illegible]	106

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
146054	Crane rail											
	*Assume 12" long @ each support * 8 supports = 8 lf @ 20 lbs/lf = 160 lbs. Cut and weld to plate and rail support beam*											
----	**W12x40 rail support beam**		5,200.00	lbs	Lab		0.00150	mh/lbs	7.80	mh	29.28	228
					Mat	0			5,200.00	lbs	0.580	3,016
	*Length of crane supports in first & last bay = 32 5' * 4 rails = 130 lf @ 40 lbs/lf = 5,200 lbs. Set in place and weld to support bracket and angle bracket.*											
----	**Crane rail, 30#/lf**		3,900.00	lbs	Lab		0.00600	mh/lbs	23.40	mh	29.28	685
					Mat	2			3,978.00	lbs	0.47	1,870
	Length of first & last bay = 32 5' 4 rails = 130 lf @ 30 lbs/lf = 3900 lbs. Set in place and weld to support beam.*											
----	**Paint crane support bracket**		600.00	sf	Lab		0.01660	mh/sf	9.96	mh	28.01	279
					Mat	0			600.00	sf	0.550	330
	Primer + 2 coats epoxy on exposed surface of plate, support bracket, rail support beam and angle bracket. NO PAINT ON RAIL											
----	**Overhead bridge crane**		2.00	ea	Lab		100.00000	mh/ea	200.00	mh	28.068	5,614
					Mat	0			2.00	ea	50,000.00	100,000
					Eqp		100.00000	mh/ea	200.00	mh	9.89	1,978
	Whiting. 35' span, 5 ton capacity top running, trolley, controls, motors, conductors and collectors, with Yale 5 ton top running elect. trolley hoist, micro speed contrl											
	Crane rail											114,869
	250.167 Labor hours											
	200.000 Equipment hours											

14 Bridge cranes ***114,869***

250.167 Labor hours
200.000 Equipment hours

15 Mechanical

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
132151	Tanks											
----	**Drain, floor, med. duty, C.I.**		17.00	ea	Lab		1.33300	mh/ea	22.66	mh	27.195	616
					Mat	0			17.00	ea	35.50	604
	3" size											
----	**P-trap, 2" size, C.I. Serv Wt.**		17.00	ea	Lab		1.00000	mh/ea	17.00	mh	27.195	462
					Mat	0			17.00	ea	24.00	408
	Long P-trap, 18"											
----	**Comb. Y & 1/8 Bend, C.I.**		17.00	ea	Lab		2.18200	mh/ea	37.09	mh	29.50	1,094
					Mat	0			17.00	ea	61.50	1,046

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
	Tanks											4,230
	76.755 Labor hours											
151105	Backflow preventer											
5120	Backflow pvntr, incl gtv,&4 tst cocks, rdcd press, flg, brz, 6" pipe		2.00	ea	Lab		8.00000	mh/ea	16.00	mh	29.50	472
					Mat	0			2.00	ea	9,340.65	18,681
	Backflow preventer											19,153
	16.000 Labor hours											
151301	Pipe, cast iron											
2200	Pipe, CI, soil, on hgrs 5' o.c., lead & oakum jts 10' o.c., 6" dia		1,350.00	lf	Lab		0.32877	mh/lf	443.84	mh	29.50	13,093
					Mat	0			1,350.00	lf	11.788	15,914
	Pipe, cast iron											29,007
	443.840 Labor hours											
151701	Pipe, steel											
----	Pipe, 2" Blk Stl		155.00	lf	Lab		0.25000	mh/lf	38.75	mh	34.11	1,322
					Mat	0			155.00	lf	4.49	696
----	Elbow, 90, 2" Blk Stl		32.00	ea	Lab		0.88900	mh/ea	28.45	mh	34.11	970
					Mat	0			32.00	ea	6.95	222
----	Tees, 2" Str., Blk Stl		6.00	ea	Lab		1.45500	mh/ea	8.73	mh	34.11	298
					Mat	0			6.00	ea	9.800	59
----	Unions, 2", Blk Stl		6.00	ea	Lab		0.94100	mh/ea	5.65	mh	34.11	193
					Mat	0			6.00	ea	13.55	81
----	Valves, 2" Ball, Thrd, Steel		11.00	ea	Lab		0.72700	mh/ea	8.00	mh	34.11	273
					Mat	0			11.00	ea	34.50	380
----	Valves, balancing, 2", Thrd		5.00	ea	Lab		1.00000	mh/ea	5.00	mh	34.11	171
					Mat	0			5.00	ea	250.00	1,250
----	Valve, check, 2" steel		2.00	ea	Lab		0.72700	mh/ea	1.45	mh	34.11	50
					Mat	0			2.00	ea	140.00	280
----	Valve, 3-way control, 2", thrd		1.00	ea	Lab		2.00000	mh/ea	2.00	mh	34.11	68
					Mat	0			1.00	ea	500.00	500
----	Strainer, Y, 2", Steel, thrd		2.00	ea	Lab		1.00000	mh/ea	2.00	mh	34.11	68
					Mat	0			2.00	ea	34.00	68
	Pipe, steel											6,948
	100.025 Labor hours											
152116	Drinking fountain											

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
152116	Drinking fountain											
2740	Drinking founts, wall mtd, non-recessed, SS, sgl bubbler, with back		1.00	ea	Lab		2.00000	mh/ea	2.00	mh	28.68	57
					Mat	0			1.00	ea	434.565	435
3980	Drinking founts, wl mtd, non-recessed, for rgh-in, sply and W, add		1.00	ea	Lab		3.61991	mh/ea	3.62	mh	28.68	104
					Mat	0			1.00	ea	59.94	60
	Drinking fountain											656
	5.620 Labor hours											
152136	Lavatories											
6060	Lavatories, W/trim, wl hung, v		2.00	ea	Lab		2.28571	mh/ea	4.57	mh	27.195	124
					Mat	0			2.00	ea	130.869	262
6960	Lavatories,wl hung,hosp type,r		2.00	ea	Lab		9.63855	mh/ea	19.28	mh	27.195	524
					Mat	0			2.00	ea	159.84	320
----	Miscellaneous restroom fixture		2.00	ls	Lab		8.00000	mh/ls	16.00	mh	22.49	360
					Mat	0			2.00	ls	500.00	1,000
	Fixtures include towel/paper/soap dispensers, mirrors, clothing storage racks, hooks, etc.											
	Lavatories											2,590
	39.849 Labor hours											
152148	Showers											
1560	Showers, stall, with door and		2.00	ea	Lab		8.88889	mh/ea	17.78	mh	27.195	483
					Mat	0			2.00	ea	769.23	1,538
4960	Showers, stall, rough-in, supp		2.00	ea	Lab		7.80488	mh/ea	15.61	mh	27.195	425
					Mat	0			2.00	ea	90.41	181
	Showers											2,627
	33.388 Labor hours											
152164	Toilet seats											
520	Toilet seats, molded cmpsn, wh, self-raising hinge, W/o cov, open frt		3.00	ea	Lab		0.33333	mh/ea	01.00	mh	28.68	29
					Mat	0			3.00	ea	83.417	250
	Toilet seats											279
	01.000 Labor hours											

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
152168	**Urinals**											
3000	Urinals, wall hung, vitreous china, with hanger & self-closing valve		1.00	ea	Lab		5.33333	mh/ea	5.33	mh	24.48	131
					Mat	0			1.00	ea	379.62	380
3300	Urinals, wall hung, vitreous china, rough-in, supply, waste & vent		1.00	ea	Lab		5.65371	mh/ea	5.65	mh	24.48	138
					Mat	0			1.00	ea	100.899	101
	Urinals											749
	10.987 Labor hours											
152180	**Water closets**											
0400	Water clos,tk type,vit china,i		3.00	ea	Lab		3.01887	mh/ea	9.06	mh	27.195	246
					Mat	0			3.00	ea	384.615	1,154
0960	Water clos, tk type, vit china		3.00	ea	Lab		5.86081	mh/ea	17.58	mh	27.195	478
					Mat	0			3.00	ea	177.822	533
	Water closets											2,412
	26.639 Labor hours											
153130	**Water heater storag tanks**											
3180	Water htr stor tk, 125 psi ASME, gl lined, 940 gal, 60" dia x 93" LOA		1.00	ea	Lab		6.40000	mh/ea	6.40	mh	24.48	157
					Mat	0			1.00	ea	6,543.45	6,543
	Electric water heater to supply men's and women's toilet/locker rooms.											
	Water heater storag tanks											6,700
	6.400 Labor hours											
154101	**Atmtc fire supprs systems**											
----	Install wet sprinkler system		15,430.00	sf	Sub				15,430.00	sf	2.300	35,489
	Ordinary hazard Price is based on subcontract unit price obtained from Means A8.2-110 System, increased by 10% to account for painting of fire protection system.											
	Atmtc fire supprs systems											35,489
154115	**Fire equipment cabinets**											
3200	Fire equip cabs,not equip,hose rack assy,24"x40"x5-1/2",st dor ^fr		1.00	ea	Lab		2.66667	mh/ea	2.67	mh	24.275	65
					Mat	0			1.00	ea	126.873	127
	: e assembly with hose rack cabinet											

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
	Fire equipment cabinets											192
	2.667 Labor hours											
154125	**Fire extinguishers**											
0140	Fire extinguishers, CO2, with		10.00	ea	Mat	0			10.00	ea	149.85	1,499
1060	Fire extinguishers, dry chem,		10.00	ea	Mat	0			10.00	ea	37.962	380
	Fire extinguishers											1,878
154135	**Fire hose and equipment**											
2640	Fire hose & equip, hose rack,		1.00	ea	Lab		0.80000	mh/ea	0.80	mh	24.275	19
	enamed st, 100' & 125' lgs of hose				Mat	0			1.00	ea	29.471	29
8890	F h & q, SP c, s n, 3" x 3" x		1.00	ea	Lab		8.00000	mh/ea	8.00	mh	26.98	216
					Mat	0			1.00	ea	714.285	714
	Siamese connection 3" x 3"											
	Fire hose and equipment											979
	8.800 Labor hours											
154170	**Sprnklr system components**											
9610	Sprinkler sys, vs, waterflow ind, 2"		1.00	ea	Lab		1.00000	mh/ea	1.00	mh	33.68	34
	thru 6" pipe size				Mat	0			1.00	ea	95.405	95
	Sprnklr system components											129
	1.000 Labor hours											
155440	**Heating&ventilating units**											
----	Air Handling Unit, Trane Co.		1.00	ea	Lab		60.00000	mh/ea	60.00	mh	29.50	1,770
					Mat	0			1.00	ea	72,378.00	72,378
					Eqp				1.00	ea		
	AHU-1. Material pnce is for all Trane AHU, Chiller, and BRASCH Heating Coils in addition to all FARR Co Filter Housings.											
----	Supply Fan, New York Blower Co		1.00	ea	Lab		60.00000	mh/ea	60.00	mh	33.175	1,991
					Mat	0			1.00	ea	880.00	880
					Eqp				1.00	ea		
	General Purpose Fan, Size 123 AF wheel, belt dnve, 1300 cfm @ 3 5" T.S.P. @ 6000', 1-1/2HP.											
----	Exh. Fan, New York Blower Co.		1.00	ea	Lab		60.00000	mh/ea	60.00	mh	33.175	1,991
					Mat	0			1.00	ea	880.00	880
					Eqp				1.00	ea		
	General purpose fan, size 123 AF wheel, belt drive. 1500 cfm @ 3.0" T.S P @ 6000', 1-1/2HP.											
----	Supply Fan, New York Blower Co		2.00	ea	Lab		40.00000	mh/ea	80.00	mh	33.175	2,654
					Mat	0			2.00	ea	480.00	960

Item	Description	Location	Takeoff Qty		W%	Conversion	Order Qty	Unit Price	Amount
155440	Heating&ventilating units								
----	**Supply Fan, New York Blower Co**		2.00 ea	Eqp			2.00 ea		
	Compact GI fan size 126, direct drive, 200 cfm @ 2 0" T S.P. @ 6000', 1/3HP.								
----	**Chiller, Trane Co.**		1.00 ea	Lab		86.48600 mh/ea	86.49 mh	32.013	2,769
				Mat	0		1.00 ea		
				Eqp			1.00 ea		
	Model CGA 180 B4 w/low ambient (0 deg F) option. Nominal 15 ton. Matl price included w/1st AHU in estimate.								
----	**Pump, Bell & Gosset Series 90**		2.00 ea	Lab		6.95700 mh/ea	13.91 mh	24.48	341
				Mat	0		2.00 ea	1,025.00	2,050
				Eqp			2.00 ea		
	In-line mounted pump, size 1-1/2 A, Model 90-37T, 1 HP, 45 gpm @ 40' Head.								
----	**Heater, convection, wall mtd**		8.00 ea	Lab		32.00000 mh/ea	256.00 mh	33.175	8,493
				Mat	0		8.00 ea	583.00	4,664
	Chromalox Model HCH-301, 3.0 kW.								
----	**Heating coil, BRASCH Manuf.Co.**		1.00 ea	Lab		16.00000 mh/ea	16.00 mh	28.587	457
				Mat	0		1.00 ea		
	Slip in duct heater, Ni-Chrome wire coils, built-in control panel w/SCR Controller, UL/NEC compliance, door mtd switch, 16kW, 480v/3p, 20"x14" duct size.								
----	**Heating coil, BRASCH Manuf.Co.**		1.00 ea	Lab		12.00000 mh/ea	12.00 mh	28.587	343
				Mat	0		1.00 ea		
	Slip in duct heater, Ni-Chrome wire coils, built-in control panel w/SCR Controller, UL/NEC compliance, door mtd switch, 6kW, 208v/1p, 12"x12" duct size.								
----	**Heating coil, BRASCH Manuf.Co.**		1.00 ea	Lab		16.00000 mh/ea	16.00 mh	28.587	457
				Mat	0		1.00 ea		
	Slip in duct heater, Ni-Chrome wire coils, built-in control panel w/SCR Controller, UL/NEC compliance, door mtd switch, 8kW, 208v/1p, 16"x12" duct size.								
----	**Heating coil, BRASCH Manuf.Co.**		1.00 ea	Lab		16.00000 mh/ea	16.00 mh	28.587	457
				Mat	0		1.00 ea		
	Slip in duct heater, Ni-Chrome wire coils, built-in control panel w/SCR Controller, UL/NEC compliance, door mtd switch, 10kW, 208v/1p, 20"x12" duct size.								
----	**Heating coil, BRASCH Manuf.Co.**		2.00 ea	Lab		8.00000 mh/ea	16.00 mh	28.587	457
				Mat	0		2.00 ea		
	Slip in duct heater, Ni-Chrome wire coils, built-in control panel w/SCR Controller, UL/NEC compliance, door mtd switch, 5kW, 208v/1p, 8" x 8" duct size.								
----	**Heating coil, BRASCH Manuf.Co.**		1.00 ea	Lab		8.00000 mh/ea	8.00 mh	28.587	229
				Mat	0		1.00 ea		
	Slip in duct heater, Ni-Chrome wire coils, built-in control panel w/SCR Controller, UL/NEC compliance, door mtd switch, 4kW, 208v/1p, 8" x 8" duct size.								
----	**Heating coil, BRASCH Manuf.Co.**		1.00 ea	Lab		12.00000 mh/ea	12.00 mh	28.587	343
				Mat	0		1.00 ea		
	Slip in duct heater, Ni-Chrome wire coils, built-in control panel w/SCR Controller, UL/NEC compliance, door mt[illegible]itch, 10kW, 208v/1p, 14" x 14" duct size								
----	**Fil[illegible]enum, FARR Co.**		2.00 ea	La[illegible]		16.00000 mh/ea	32.00 mh	32[illegible]	1,024
				Ma[illegible]	0		2.00 ea		

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
155440	Heating&ventilating units											
	Sidelock Housing Model SA-D-40-242412 (1 H x 2 W Filter Bank)											
	Mat'l cost included with 1st AHU for all FARR Co. Housings											
----	**Filter Plenum, FARR Co.**		2.00	ea	Lab		16.00000	mh/ea	32.00	mh	32.013	1,024
					Mat	0			2.00	ea		
					Eqp				2.00	ea		
	Sidelock Housing Model SA-D-20-20-242412 (1 H x 1 W Filter Bank)											
----	**Heater, Radiant, Chromalox**		1.00	ea	Lab		24.00000	mh/ea	24.00	mh	33.175	796
					Mat	0			1.00	ea	460.00	460
	Overhead Radiant Space Heater Model # RBC-33680, 3.6 kW.											
----	**Air Handling Unit, Trane Co.**		1.00	ea	Lab		60.00000	mh/ea	60.00	mh	32.013	1,921
					Mat	0			1.00	ea		
					Eqp				1.00	ea		
	AHU-3 Size 12C w/inlet vane damper, 5750cfm @ 4.0" T.S.P. @ 6000', 10 HP, mix box & economizer sections. Filter Section FARR Co. #SA-D-40-60-242412.											
----	**Unit heaters, Chromalox**		4.00	ea	Lab		32.00000	mh/ea	128.00	mh	33.175	4,246
					Mat	0			4.00	ea	490.00	1,960
	Horizontal unit heater Model # LUH-05-81 w/built-in Thermostat kit LUH-TK2, 5kW.											
----	**Exh. fan, New York Blower Co.**		1.00	ea	Lab		60.00000	mh/ea	60.00	mh	33.175	1,991
					Mat	0			1.00	ea	1,270.00	1,270
	EF-2, general purpose fan size 183 AF wheel, belt drive, 6500 cfm @ 1.5" T.S.P. @ 6000', 3HP.											
----	**Supply fan, New York Blower Co**		1.00	ea	Lab		60.00000	mh/ea	60.00	mh	33.175	1,991
					Mat	0			1.00	ea	1,310.00	1,310
	SF-3, general purpose fan size 183 AF wheel, belt drive, 4300 cfm @ 4" T.S.P. @ 6000', 5 HP.											
----	**Exh. fan, New York Blower Co.**		1.00	ea	Lab		60.00000	mh/ea	60.00	mh	33.175	1,991
					Mat	0			1.00	ea	1,270.00	1,270
	EF-3, general purpose fan size 183 AF wheel, belt drive, 6500 cfm @ 1.5" T.S.P. @ 6000', 3HP.											
----	**Filter plenum, FARR Co.**		2.00	ea	Lab		16.00000	mh/ea	32.00	mh	32.013	1,024
					Mat	0			2.00	ea		
	FP-3A&B Sidelock Housing Model #SA-40-40-242412 (2 H x 2 W Filter Bank).											
----	**Louver, stationary blade**		1.00	ea	Lab		32.00000	mh/ea	32.00	mh	33.175	1,062
					Mat	0			1.00	ea	1,987.00	1,987
	LV-1, 60"W x 96" H w/motorized damper mounted in 36" deep galv steel sleeve, Ruskin MFG #CD 35, 4" deep aluminum blade louver, Ruskin MFG Model ELF 375.											
	Heating&ventilating units											129,890
	1,232.400 Labor hours											
155651	Insulation											
4324	**Pipe cvr foamglass 2"thk ASJ 2**		75.00	lf	Lab		0.18824	mh/lf	14.12	mh	26.99	381
					Mat	0			75.00	lf	5.744	431
7380	**Insulation, pipe coving, fbgl,**		80.00	lf	Lab		0.08889	mh/lf	7.11	mh	26.99	192
					Mat	0			80.00	lf	3.047	244

Item	Description	Location	Takeoff Qty		W%	Conversion	Order Qty	Unit Price	Amount
155651	Insulation								
	Insulation								1,248
	21.229 Labor hours								
157120	Air handling unit								
----	**Portable HEPA Air Mover**		1.00 ea	Lab		160.00000 mh/ea	160.00 mh	28.673	4,588
				Mat	0		1.00 ea	10,000.00	10,000
	Consists of fan & tow stage testable HEPA filter housing mounted on frame/dolly New York Blower Co. GI fan size 126 belt dnve 1000 cfm @5" T.S.P. @ 6000', 2HP								
----	**ADD. Description for Air Mover**			Eqp			ea		
	Flanders Filters Model E-5 bagout housing w/in-place DOP test inlet, combination and outlet section (1 H x 1 W Filter Bank - 2 stages)								
----	**Portable CC Hood**		1.00 ea	Lab		80.00000 mh/ea	80.00 mh	29.36	2,349
				Mat	0		1.00 ea	2,000.00	2,000
				Eqp			1.00 ea		
	11 gauge 304 SST hood approx. 3'x3'x4' w/10" dia. collar, connected to Air Mover w/Heavy Duty Flex duct mounted on SST frame w/casters.								
----	**Portable Cont. Control Cell**		128.00 sf	Lab		2.00000 mh/sf	256.00 mh	28.627	7,329
				Mat	0		128.00 sf	130.00	16,640
				Eqp			128.00 sf		
	PERMACON structure 16'L x 8'W x 8'H, feasibility to mount on based with casters to be investigated during Title I design. Used CC for Salt Residue as basis for estimate.								
	Air handling unit								42,905
	496.00 Labor hours								
157250	Ductwork								
----	**Ductwork, 18 ga, galv steel**		9,200.00 lbs	Lab		0.08400 mh/lbs	772.80 mh	30.08	23,246
				Mat	0		9,200.00 lbs	0.40	3,680
	Support Area Systems, AHU-1, SF-1 and EF-1								
----	**Intake stack, Sch 105, SST**		50.00 lf	Lab		0.68600 mh/lf	34.30 mh	34.545	1,185
				Mat	0		50.00 lf	590.00	29,500
	14" diameter pipe for SF-1. Assume 131 lbs/lf @ $4.50/lb = $590/lf.								
----	**Exhaust stack, Sch 105, SST**		50.00 lf	Lab		0.68600 mh/lf	34.30 mh	34.545	1,185
				Mat	0		50.00 lf	590.00	29,500
	14" diameter pipe for EF-1 Assume 131 lbs/lf @ $4.50/lb = $590/lf								
----	**Exhaust stack, Sch 105, SST**		100.00 lf	Lab		0.45600 mh/lf	45.60 mh	34.545	1,575
				Mat	0		100.00 lf	178.50	17,850
	8" diameter pipe for SF-2A&B. Assume 51 lbs/lf @ $3 50/lb = $178.50/lf								
----	**Duc[illegible]rk, 18 ga, galv steel**		7,600.00 lbs	Lab		0.08400 mh/lbs	638.40 mh	30.[illegible]	19,203
				M[illegible]	0		7,600.00 lbs	[illegible]	3,040
	Shi[illegible]g & Receiving Area Systems, AHU-3								

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
157250	Ductwork											
----	Ductwork, 18 ga, galv steel		1,500.00	lbs	Lab		0.09100	mh/lbs	136.50	mh	30.08	4,106
					Mat	0			1,500.00	lbs	0.50	750
	Shipping & Receiving Area Systems, SF-3 & EF-3.											
----	Exhaust stack, Sch 105, SST		50.00	lf	Lab		1.80000	mh/lf	90.00	mh	34.545	3,109
					Mat	0			50.00	lf	1,408.00	70,400
	20" diameter pipe for EF-2. Assume 256 lbs/lf @ $5.50/lb = $1,408/lf Assume .007 mh/lb @ 256 lb/lf = 1.8 mh/lf											
	Ductwork											208,329
	1,751.90 Labor hours											
157601	Balancing, air											
1100	Balancing, air, htg&vent unit		1.00	ls	Oth				1.00	ls	10,000.00	10,000
	Estimator's allowance for balancing HVAC equipment											
3100	Balancing, sub's quote incl matl&lab,sply/ret/exh, regs&diffs, hi clg		1.00	ls	Oth				1.00	ls	10,000.00	10,000
	Estimator's allowance for balancing supply/return/ exhaust, registers and diffusers.											
	Balancing, air											20,000
	15 Mechanical											***516,390***
	4,274.497 Labor hours											

16 Electrical

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
022254	Excavating, trench											
0060	Excav,trench/cont ftg,NO sht/d		240.60	cy	Lab		0.08000	mh/cy	19.25	mh	21.975	423
					Eqp		0.04000	mh/cy	9.62	mh	35.730	344
	Excavation for duct bank, 580 lf 5' deep, various widths ranging from 35" to 11".											
1700	Excavating, for tamping backfi		169.00	cy	Lab		0.08000	mh/cy	13.52	mh	17.57	238
					Eqp		0.08000	mh/cy	13.52	mh	7.53	102
3020	Excavating,backfill trench,f.e		169.00	cy	Lab		0.03000	mh/cy	5.07	mh	23.443	119
					Eqp		0.02000	mh/cy	3.38	mh	29.13	98
	Excavating, trench											1,324
	37.838 Labor hours											
	26.524 Equipment hours											

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
160110	**Cable tray**											
0280	Cable tray solid bottom, galva		1,400.00	lf	Lab		0.26667	mh/lf	373.34	mh	31.37	11,712
					Mat	0			1,400.00	lf	10.668	14,935
0380	C t s b, g s, e h 90<, 12" r,		8.00	ea	Lab		3.63636	mh/ea	29.09	mh	31.37	913
					Mat	0			8.00	ea	69.790	558
	Cable tray 90 degree horizontal elbow											
0880	C t s b, g s, t h, 12" r, 24"		10.00	ea	Lab		5.71429	mh/ea	57.14	mh	31.37	1,793
					Mat	0			10.00	ea	97.706	977
	Cable tray flat tee, 12" radius											
	Cable tray											30,887
	459.572 Labor hours											
160130	**Cabl tray cvrs and divdrs**											
0500	Cable tray, covs, ventilated g		700.00	lf	Lab		0.07273	mh/lf	50.91	mh	31.37	1,597
					Mat	0			700.00	lf	6.929	4,850
2440	Cable tray, covers, tee horizo		4.00	ea	Lab		0.30769	mh/ea	1.23	mh	31.37	39
					Mat	0			4.00	ea	54.835	219
8020	Cable tray, divider strip, str		700.00	lf	Lab		0.04444	mh/lf	31.11	mh	31.37	976
					Mat	0			700.00	lf	3.041	2,129
----	Misc. cable tray accessories		1.00	ls	Lab				1.00	ls	827.00	827
					Mat	0			1.00	ls	2,340.00	2,340
	Assume 10% of all other cable tray matenal & 5% labor											
	Cabl tray cvrs and divdrs											12,977
	83.250 Labor hours											
160205	**Conduit to ' high**											
1770	Conduit,to 15' H,incl 2 termn,	Elec Power	10,000.00	lf	Lab		0.12500	mh/lf	1,250.00	mh	31.37	39,213
					Mat	0			10,000.00	lf	1.97	19,700
	Labor & material increased by 25% to account for miscellaneous fittings not covered in item.											
1800	Conduit,to 15' H,incl 2 termn,	Lighting	5,712.00	lf	Lab		0.12308	mh/lf	703.03	mh	31.37	22,054
					Mat	0			5,712.00	lf	2.134	12,189
1800	Conduit,to 15' H,incl 2 termn,	Elec Power	5,000.00	lf	Lab		0.15380	mh/lf	769.00	mh	31.37	24,124
					Mat	0			5,000.00	lf	2.67	13,350
	Labor & material increased by 25% to account for miscellaneous fittings not covered in item.											
1850	Conduit,to 15' H,incl 2 termn,	Lighting	18,164.00	lf	Lab		0.14545	mh/lf	2,641.95	mh	31.37	82,878
					Mat	0			18,164.00	lf	3.24	58,851
1930	Conduit,to 15' H,incl 2 termn,	Elec Power	2,000.00	lf	Lab		0.40000	mh/lf	800.00	mh	31.37	25,096
					Mat	0			2,000.00	lf	11.90	23,800
	Labor & material increased by 25% to account for m[illegible]eous fittings not covered in item											
5020	Co[illegible],to 15' hi,incl 2 termn	Lighting	5,862.00	lf	La[illegible]		0.06154	mh/lf	360.75	mh	3[illegible]	11,317

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
160205	Conduit to ' high											
5020	Conduit,to 15' hi,incl 2 termn	Lighting	5,862.00	lf	Mat	0			5,862.00	lf	0.558	3,271
5040	Conduit,to 15' hi,incl 2 termn	Lighting	1,954.00	lf	Lab		0.06957	mh/lf	135.94	mh	31.37	4,264
					Mat	0			1,954.00	lf	0.828	1,618
9120	Conduit, PVC, #40, to 15' hi,	Elec Power	600.00	lf	Lab		0.08000	mh/lf	48.00	mh	31.37	1,506
					Mat	0			600.00	lf	1.120	672
	Labor & material increased by 25% to account for miscellaneous fittings not covered in item.											
----	EMT Cond. fittings for lights	Lighting	1.00	ls	Lab		125.00000	mh/ls	125.00	mh	31.37	3,921
					Mat	0			1.00	ls	1,250.00	1,250
	Estimated @ 25% of conduit labor and material costs											
----	RGS Cond. fittings for lights	Lighting	1.00	ls	Lab		830.00000	mh/ls	830.00	mh	31.37	26,037
					Mat	0			1.00	ls	17,500.00	17,500
	Estimated @ 25% of conduit labor and material costs.											
	Conduit to ' high											392,611
	7,663.674 Labor hours											
160270	Flexible metallic conduit											
1090	Flexible metallic conduit, sealtite, 3/4" diameter		2,000.00	lf	Lab		0.08000	mh/lf	160.00	mh	31.37	5,019
					Mat	0			2,000.00	lf	2.343	4,686
----	Sealtite Flex connecters		1.00	ls	Lab		80.00000	mh/ls	80.00	mh	31.37	2,510
					Mat	0			1.00	ls	1,170.00	1,170
	Labor based on 50% of flex conduit and material @ 25% of flex conduit.											
	Flexible metallic conduit											13,385
	240.00 Labor hours											
160275	Motor connections											
0020	Motor conns, flexible cnd and ftngs, 115 volt, 1 ph, up to 1 HP mot		2.00	ea	Lab		1.00000	mh/ea	2.00	mh	27.16	54
					Mat	0			2.00	ea	3.639	7
2005	Motor conns, flexible cnd & ftngs, 460 V, 5 HP mot, 3 ph, W/sealtite		9.00	ea	Lab		1.00000	mh/ea	9.00	mh	27.16	244
					Mat	0			9.00	ea	8.275	74
2010	Motor connections, flexible cnd and fittings, 460 volt, 10 HP motor		4.00	ea	Lab		1.00000	mh/ea	4.00	mh	27.16	109
					Mat	0			4.00	ea	8.275	33
	Motor connections											522
	15.00 Labor hours											
161150	Shielded cable											
----	Wire, EPR MV-90, 15kV, #2		1,740.00	lf	Lab		0.02300	mh/lf	40.02	mh	31.37	1,255
					Mat	0			1,740.00	lf	2.490	4,333
					Eqp				1,740.00	lf		

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
	Shielded cable											5,588
	40.020 Labor hours											

161165 Wire

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
920	Wire, type thwn-thhn, copper, solid, #14		80.600	clf	Lab		0.61538	mh/clf	49.60	mh	27.16	1,347
					Mat	0			80.60	clf	4.138	334
940	Wire, type thwn-thhn, copper, solid, #12		79.58	clf	Lab		0.72727	mh/clf	57.88	mh	27.16	1,572
					Mat	0			79.58	clf	5.882	468
1250	Wire, 600V, type thwn-thhn, copper stranded, #10		43.93	clf	Lab		0.80000	mh/clf	35.14	mh	31.37	1,102
					Mat	0			43.93	clf	11.715	515
1250	Wire, 600V, type thwn-thhn, copper stranded, #10	Lighting	304.81	clf	Lab		0.80000	mh/clf	243.85	mh	31.37	7,650
					Mat	0			304.81	clf	11.715	3,571
1300	Wire, type thwn-thhn, stranded, #8		13.40	clf	Lab		1.00000	mh/clf	13.40	mh	31.37	420
					Mat	0			13.40	clf	18.295	245
1300	Wire, type thwn-thhn, stranded, #8	Lighting	222.78	clf	Lab		1.00000	mh/clf	222.78	mh	31.37	6,989
					Mat	0			222.78	clf	18.295	4,076
1350	Wire, type thwn-thhn, stranded, #6		18.16	clf	Lab		1.23077	mh/clf	22.35	mh	31.37	701
					Mat	0			18.16	clf	25.424	462
	Quantity represents #6 wire for 3013 storage only.											
1350	Wire, type thwn-thhn, stranded, #6	Lighting	944.53	clf	Lab		1.23077	mh/clf	1,162.50	mh	31.37	36,468
					Mat	0			944.53	clf	25.424	24,014
1450	Wire, type thwn-thhn, stranded, #3		5.70	clf	Lab		1.60000	mh/clf	9.12	mh	31.37	286
					Mat	0			5.70	clf	50.847	290
	Accounts for cable in North Hall Only.											
1500	Wire, type thwn-thhn, stranded, #2		1.80	clf	Lab		1.77778	mh/clf	3.20	mh	31.37	100
					Mat	0			1.80	clf	63.808	115
1650	Wire, type thwn-thhn, stranded, 2/0		0.30	clf	Lab		2.75862	mh/clf	0.83	mh	31.37	26
					Mat	0			0.30	clf	120.637	36
1700	Wire, type thwn-thhn, stranded, 3/0		0.35	clf	Lab		3.20000	mh/clf	1.12	mh	31.37	35
					Mat	0			0.35	clf	154.535	54
2600	Wire, type thwn-thhn, stranded, 350 MCM		7.60	clf	Lab		4.44444	mh/clf	33.78	mh	31.37	1,060
					Mat	0			7.60	clf	299.100	2,273
----	Wire, Belden #9463, 2-C, 20ga		280.00	lf	Lab		0.01143	mh/lf	3.20	mh	27.16	87
					Mat	0			280.00	lf	0.30	84
----	Wire, Belden #YR28762, d.b.		2,100.00	lf	Lab		0.01500	mh/lf	31.50	mh	27.16	856
					Mat	0			2,100.00	lf	0.373	783
	Wire											96,017
	1,890.243 Labor hours											

161520 Cable terminations

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
50	Cable terminations, terminal lugs, solderless, #16 to #10		300.00	ea	Lab		0.16000	mh/ea	48.00	mh	27.16	1,304
					Mat	0			300.00	ea	0.399	120
100	Cable terminations, terminal lugs, sold--less, #8 to #4		100.00	ea	Lab		0.26667	mh/ea	26.67	mh	27.16	724
					Mat	0			100.00	ea	1.246	125
150	Ca rminations, terminal lugs, solo..less, #2 to #1		12.00	ea	La		0.36364	mh/ea	4.36	mh	27	119
					Ma.	0			12.00	ea	2..	35

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
161520	Cable terminations											
150	Cable terminations, terminal lugs, solderless, #2 to #1		28.00	ea	Lab		0.36364	mh/ea	10.18	mh	27.16	277
					Mat	0			28.00	ea	2.891	81
200	Cable terminations, terminal lugs, solderless, 1/0 to 2/0		12.00	ea	Lab		0.50000	mh/ea	6.00	mh	27.16	163
					Mat	0			12.00	ea	5.583	67
0250	Cable terminations, terminal lugs, solderless, 3/0		48.00	ea	Lab		0.66667	mh/ea	32.00	mh	27.16	869
					Mat	0			48.00	ea	5.583	268
0400	Cable terminations, terminal lugs, solderless, 350 MCM		92.00	ea	Lab		1.14286	mh/ea	105.14	mh	27.16	2,856
					Mat	0			92.00	ea	13.21	1,215
	Cable terminations 232.356 Labor hours											8,221
161525	Cable terminations,											
2300	Cable terminations, outdoor systems, #1 solid to 4/0 stranded, 15 KV		12.00	ea	Lab		1.60000	mh/ea	19.20	mh	27.16	521
					Mat	0			12.00	ea	129.610	1,555
	Cable terminations, 19.20 Labor hours											2,077
161810	Grounding											
0100	Grounding, rod, copper clad, 10' long, 3/4" diameter		10.00	ea	Lab		1.81818	mh/ea	18.18	mh	31.37	570
					Mat	0			10.00	ea	29.412	294
1000	Grounding, bare copper wire stranded, 4/0		800.00	clf	Lab		2.80702	mh/clf	2,245.62	mh	31.37	70,445
					Mat	0			800.00	clf	179.46	143,568
2760	Grounding, cadweld, 4/0 wire to 4/0 wire		20.00	ea	Lab		1.14286	mh/ea	22.86	mh	31.37	717
					Mat	0			20.00	ea	5.783	116
3710	Grounding, insulated ground wire, copper #12		100.00	clf	Lab		0.72727	mh/clf	72.73	mh	31.37	2,281
					Mat	0			100.00	clf	7.428	743
----	Ground connections, bolted		1.00	ls	Lab		40.00000	mh/ls	40.00	mh	31.37	1,255
					Mat	0			1.00	ls	500.00	500
	Grounding 2,399.382 Labor hours											220,489
162320	Wiring devices											
----	480V welding receptacle	Elec Power	2.00	ea	Lab		2.50000	mh/ea	5.00	mh	31.37	157
					Mat	0			2.00	ea	121.06	242

Crouse-Hinds #AR3422, 30 amp, 3wire, 4pole Style 2 Arktite hvy duty ckt breaking receptacle w/ spring door for weather proof applications mtd on Type AR back box.

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
	Wiring devices											399
	5.00 Labor hours											
163110	**Motor control center**											
----	Motor Control Center, Emerg.		1.00	ea	Lab		40.00000	mh/ea	40.00	mh	27.16	1,086
					Mat	0			1.00	ea	15,438.00	15,438
	Dead front construction, 600A horz. bus, 300A vert. bus w/9 feeder breakers, 100A max, NEMA 12 encl. contrl pwr xfmr. metering & bus under voltage relay.											
----	Motor Control Center, Normal		1.00	ea	Lab		60.00000	mh/ea	60.00	mh	27.16	1,630
					Mat	0			1.00	ea	25,258.00	25,258
	Dead front construction, 600A horz. bus, 300A vert. bus w/10 feeder breakers, 100A max & 7 NEMA 1 Comb. Strs., NEMA 12 encl. cntrl pwr xfmer, metering											
----	Uninterruptable Power Supply		1.00	ea	Lab		180.00000	mh/ea	180.00	mh	27.16	4,889
					Mat	0			1.00	ea	77,500.00	77,500
----	Uninterruptable Power Supply		1.00	ea	Lab		180.00000	mh/ea	180.00	mh	27.16	4,889
					Mat	0			1.00	ea	77,500.00	77,500
	Motor control center											208,190
	460.00 Labor hours											
163245	**Panelboards**											
2050	Panelboards, NQOD, 4 wire, 120/208 volts, 100 amp main, 24 circuits		3.00	ea	Lab		17.02128	mh/ea	51.06	mh	31.37	1,602
					Mat	0			3.00	ea	872.375	2,617
2250	Panelboards, NQOD, 4 wire, 120/208 volts, 225 amp main, 42 circuits		2.00	ea	Lab		28.57143	mh/ea	57.14	mh	31.37	1,793
					Mat	0			2.00	ea	1,570.275	3,141
	Emergency Distribution Panelboard, 3 phase, North vault area and staging/overpack area											
2250	Panelboards, NQOD, 4 wire, 120/208 volts, 225 amp main, 42 circuits		2.00	ea	Lab		28.57143	mh/ea	57.14	mh	31.37	1,793
					Mat	0			2.00	ea	1,570.275	3,141
	Power and Lighting Distribution Panelboard, 3 phase North vault area and staging/overpack area.											
2500	Panelboards, NEHB, 4 wire, 277/480 volts, 100 amp main, 24 circuits		1.00	ea	Lab		19.04762	mh/ea	19.05	mh	31.37	598
					Mat	0			1.00	ea	1,919.225	1,919
	Distribution panel for Yard lighting.											
	Panelboards											16,602
	184.397 Labor hours											

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
163262	Switchboard											
----	**Switchgear, Primary, 6-800A**		1.00	ea	Lab		96.00000	mh/ea	96.00	mh	27.16	2,607
					Mat	0			1.00	ea	45,585.00	45,585
					Eqp				1.00	ea		
	Westinghouse type DSII. Frame breakers, 4 feeder sections, 1 main section & 1 tie breaker, 3 Elec Op. & 3 Manual breakers, NEMA 12 Enclosure. Pricing from Rich.											
----	**Switchgear, Alternate, 6-800A**		1.00	ea	Lab		96.00000	mh/ea	96.00	mh	27.16	2,607
					Mat	0			1.00	ea	45,585.00	45,585
					Eqp				1.00	ea		
	Westinghouse type DSII. Frame breakers, 4 feeder sections, 1 main section & 1 tie breaker, 3 Elec Op. & 3 Manual breakers, NEMA 12 Enclosure. Pricing per Rich.											
	Switchboard											96,385
	192.000 Labor hours											
163320	Control stations											
----	**I/O Power Supply Enclosure**		1.00	ea	Lab		40.00000	mh/ea	40.00	mh	27.16	1,086
					Mat	0			1.00	ea	5,000.00	5,000
	72"Hx36"Wx24"D NEMA 12 enclosure w/backpanel & 2 sidepanels, 6-1500VA power supplies, 4-75 point term. blks-2/side and 2-6 point power blks.											
----	**I/O Power Supply Enclosure**		1.00	ea	Lab		40.00000	mh/ea	40.00	mh	27.16	1,086
					Mat	0			1.00	ea	4,500.00	4,500
	72"Hx36"Wx24"D NEMA 12 enclosure w/backpanel & 2 sidepanels, 5-1500VA power supplies, 4-75 point term. blks-2/side and 2-6 point power blks.											
	Control stations											11,673
	80.00 Labor hours											
163360	Safety switches											
8320	**Safety switches, fused heavy duty, 600 volt, 3 pole NEMA 4, 60 amp**		10.00	ea	Lab		3.63636	mh/ea	36.36	mh	27.16	988
					Mat	0			10.00	ea	717.84	7,178
	Fused safety switches for various HVAC equipment											
----	**Disconnect-Fused Safety Switch**		6.00	ea	Lab		4.00000	mh/ea	24.00	mh	27.16	652
					Mat	0			6.00	ea	500.00	3,000
	Safety switches											11,818
	60.364 Labor hours											

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
164120	Dry type transformer											
3300	Dry type XFMR, 3 ph, 240/480 V pri		2.00	ea	Lab		17.77778	mh/ea	35.56	mh	27.16	966
	120/208 V secary, vent, 30 KVA				Mat	0			2.00	ea	1,271.175	2,542
5050	Dry type XFMR, 3 ph, 480 V pri		3.00	ea	Lab		22.85714	mh/ea	68.57	mh	31.37	2,151
	120/208 V secary, nonvent, 45 KVA				Mat	0			3.00	ea	1,582.00	4,746
	Pricing from Trade Service, Westinghouse Xfmer											
5050	Dry type XFMR, 3 ph, 480 V pri		3.00	ea	Lab		22.85714	mh/ea	68.57	mh	31.37	2,151
	120/208 V secary, nonvent, 45 KVA				Mat	0			3.00	ea	1,582.00	4,746
	Pricing from Trade Service, Westinghouse Xfmer											
----	Transformer, 480Y/277V, 45KVA		1.00	ea	Lab		22.85700	mh/ea	22.86	mh	31.37	717
					Mat	0			1.00	ea	1,765.00	1,765
	Material pricing from Trade Service.											
	Wall mounted, dry type transformer.											
	Dry type transformer											19,784
	195.555 Labor hours											
164160	Oil filled transformer											
----	Transformer, 500KVA, 13.8-480V		2.00	ea	Lab		60.00000	mh/ea	120.00	mh	33.684	4,042
					Mat	0			2.00	ea	22,217.00	44,434
					Eqp		60.00000	mh/ea	120.00	mh	27.06	3,247
	3 phase, delta-wye connected, oil filled, includes 2 position primary air disconnect fused switch, one set of 3 lightning arresters											
	Oil filled transformer											51,723
	120.000 Labor hours											
	120.000 Equipment hours											
165110	Automtc transfer switches											
800	Automatic transfer switches, s		1.00	ea	Lab		16.00000	mh/ea	16.00	mh	31.37	502
					Mat	0			1.00	ea	9,500.00	9,500
	Added allowance to base ATS for undefined accessories.											
	Automtc transfer switches											10,002
	16.000 Labor hours											
165120	Generator set											
3200	G s, DL n, i b, c, m, x s& t,		1.00	ea	Lab		111.11111	mh/ea	111.11	mh	33.684	3,743
					Mat	0			1.00	ea	76,000.00	76,000
					Eqp		22.22222	mh/ea	22.22	mh	27.06	601

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
	Generator set 111.111 Labor hours 22.222 Equipment hours											80,344
166130	Interr lighting fixtures											
----	Lamp, 40W, Fluorescent Lamp	Lighting	478.00	ea	Lab		0.08880	mh/ea	42.45	mh	27.16	1,153
					Mat	0			478.00	ea	2.70	1,291
	GE Type F-40 T-12 Rapid Start Preheat, 48" long.											
----	Fixture Type C	Lighting	31.00	ea	Lab		1.14300	mh/ea	35.43	mh	27.16	962
					Mat	0			31.00	ea	57.00	1,767
	2 Lamp Industrial Fluorescent Fixture 2-F40CW											
----	Fixture Type C/B	Lighting	10.00	ea	Lab		1.14300	mh/ea	11.43	mh	27.16	310
					Mat	0			10.00	ea	150.00	1,500
	Emergency/Battery Backed 2 Lamp Industrial Fluorescent Fixture, 2-F40CW.											
----	Fixture Type F	Lighting	76.00	ea	Lab		1.50900	mh/ea	114.68	mh	27.16	3,115
					Mat	0			76.00	ea	52.00	3,952
	2 Lamp Fluorescent Troffer (Recessed) 2-F40CW w/ Prismatic Lens.											
----	Fixture Type F/B	Lighting	25.00	ea	Lab		1.50900	mh/ea	37.73	mh	27.16	1,025
					Mat	0			25.00	ea	150.00	3,750
	Emergency/Battery Backed 2 Lamp Fluorescent Troffer (Recessed) 2-F40CW w/Prismatic Lens.											
----	Fixture Type H	Lighting	45.00	ea	Lab		1.70200	mh/ea	76.59	mh	27.16	2,080
					Mat	0			45.00	ea	65.00	2,925
	4 Lamp Flurorescent Troffer (Recessed) 4-F40CW w/Prismatic Lens.											
----	Fixture Type H/B	Lighting	15.00	ea	Lab		1.70200	mh/ea	25.53	mh	27.16	693
					Mat	0			15.00	ea	165.00	2,475
	Emergency/Battery Backed 4 Lamp Fluorescent Troffer (Recessed) 4-F40CW w/Prismatic Lens.											
----	Fixture Type K	Lighting	8.00	ea	Lab		3.47800	mh/ea	27.82	mh	27.16	756
					Mat	0			8.00	ea	181.00	1,448
	High Bay Fixture w/175W Mercury Vapor Clear Lamp, 7000 Lumen, Holophane Enduralume Compact Enclosure Cat. No. ENDR-175MV27-A418, 277 Volt.											
----	Fixture Type Y1	Lighting	27.00	ea	Lab		2.00000	mh/ea	54.00	mh	27.16	1,467
					Mat	0			27.00	ea	205.00	5,535
	Wall Mounted Outdoor Fixture w/100 W High Pressure Sodium Clear Lamp, 8550 Lumen, Holophane Wallpack 2, Cat. No. WL2K-100HP27-GR, 277 Volt.											
----	Fixture Type Y2	Lighting	36.00	ea	Lab		16.00000	mh/ea	576.00	mh	27.16	15,644
					Mat	0			36.00	ea	1,997.00	71,892
	Outdoor Fixture w/250W High Pressure Sodium Clear Lamps - (Two), 27,500 Lumen each, 35 Ft Pole, Holophane Expressway/Security Light, Cat. No. SGRT35J-2-1235-480.											
----	Fixture Type Q	Lighting	24.00	ea	Lab		1.00000	mh/ea	24.00	mh	27.16	652
					Mat	0			24.00	ea	137.200	3,293
	LED Exit Light Fixture, Single Faced, Exitronix Model #602 w/battery.											
----	Fixture Type Q/S	Lighting	8.00	ea	Lab		2.00000	mh/ea	16.00	mh	27.16	435
					Mat	0			8.00	ea	187.91	1,503

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
166130	Interr lighting fixtures											
	LED Exit Light Fixture w/PAR36 Spotlights (Two), Single Faced, Exitronix Model 602-2F, w/battery											
----	Fixture Type R	Lighting	5.00	ea	Lab		1.19400	mh/ea	5.97	mh	27.16	162
					Mat	0			5.00	ea	219.77	1,099
	LED Exit Light Fixture, Double Faced, Exitronix Model #603 w/battery.											
----	Fixture Type S1	Lighting	24.00	ea	Lab		2.00000	mh/ea	48.00	mh	27.16	1,304
					Mat	0			24.00	ea	37.770	906
	Emergency Spotlight Fixture, Exitronix Model #LL40, battery backed w/two spotlights											
----	Receptacle, Type R1	Lighting	231.00	ea	Lab		0.20000	mh/ea	46.20	mh	27.16	1,255
					Mat	0			231.00	ea	12.00	2,772
	Hubbel Cat No. 5262, 15A, 125V, 2 Pole											
----	Switch, Type S2		52.00	ea	Lab		0.20000	mh/ea	10.40	mh	27.16	282
					Mat	0			52.00	ea	11.40	593
	Hubbell Cat. No. 1222, 20A, 120V, Double Pole.											
	Interr lighting fixtures											137,995
	1,152.232 Labor hours											
167110	Electrc&telephn sitework											
5000	Ductbank, 2-3" cond. 18"x18"		320.00	lf	Lab		0.08000	mh/lf	25.60	mh	31.37	803
					Mat	0			320.00	lf	1.276	408
	18" wide trench x 320 lf x 5' deep = 88.9 cy											
5200	Ductbank, 15-3" cond. 35"x23"		140.00	lf	Lab		0.60000	mh/lf	84.00	mh	31.37	2,635
					Mat	0			140.00	lf	9.60	1,344
	Trench 35" wide x 140 lf x 5' deep = 75.6 cy.											
5800	Ductbank, 3-3" cond. 23"x11"		150.00	lf	Lab		0.12000	mh/lf	18.00	mh	31.37	565
					Mat	0			150.00	lf	1.92	288
	23" wide x 50 lf x 5' deep = 17.8 cy x 3 = 53.4 cy.											
5800	Ductbank, 1-3" cond. 11"x11"		200.00	lf	Lab		0.12000	mh/lf	24.00	mh	31.37	753
					Mat	0			200.00	lf	1.92	384
	11" wide x 100 lf x 5' deep = 17.0 cy x 2 = 34 cy.											
7830	Concrete encsasement over cond		71.600	cy	Lab		2.00000	mh/cy	143.20	mh	22.10	3,165
					Mat	0			71.60	cy	62.811	4,497
					Eqp		0.66667	mh/cy	47.73	mh	2.97	142
	(35"w x 23"d x 140')+(23"w x 11"d x 150')+(11"d x 11"w x 200')+(18"w x 18"d x 320')											
8200	Ftgs, PVC type EB, Elbow, 3"		56.00	ea	Lab		0.57143	mh/ea	32.00	mh	31.37	1,004
					Mat	0			56.00	ea	9.671	542
	*Assume 2 elbows per run of conduit (15+9+2+2)*2 = 56*											
9600	End Bell, PVC , 3"		56.00	ea	Lab		0.57143	mh/ea	32.00	mh	31.37	1,004
					Mat	0			56.00	ea	4.487	251
	*Assume 2 end bells required per run of conduit, (15+9+2+2)*2=56.*											
	Electrc&telephn sitework											17,784
	358.800 Labor hours											
	47.734 Equipment hours											

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
168120	Detection systems											
----	Criticality Alarm Panel	Control Rm	1.00	ea	Lab		100.00000	mh/ea	100.00	mh	27.16	2,716
					Mat	0			1.00	ea	25,000.00	25,000
	10 detector inputs w/internal battery power supply. LED status indicator, audible/visual alarms & coincidence logic ckts.											
----	Fire Alarm Panel	Control Rm	1.00	ea	Lab		48.00000	mh/ea	48.00	mh	27.16	1,304
					Mat	0			1.00	ea	31,500.00	31,500
	60 alarm points w/120 LED status indicators, 5 alarm & status lights w/audible alarm horn.											
----	Utility Control & Monitor Pnl	Control Rm	1.00	ea	Lab		500.00000	mh/ea	500.00	mh	27.16	13,580
					Mat	0			1.00	ea	50,000.00	50,000
	Estimator allowance for undefined system.											
----	Leak Detection Syst. Op. Wkstn	Control Rm	1.00	ea	Lab		24.00000	mh/ea	24.00	mh	27.16	652
					Mat	0			1.00	ea	24,587.00	24,587
----	LS/DW Control Panel	Control Rm	1.00	ea	Lab		23.00000	mh/ea	23.00	mh	27.16	625
					Mat	0			1.00	ea	1,985.00	1,985
	Includes 2 microphones, audio tone generator and preamplifier.											
----	Printer (Leak Detection Syst)	Control Rm	2.00	ea	Lab		4.00000	mh/ea	8.00	mh	27.16	217
					Mat	0			2.00	ea	500.00	1,000
----	Security Door Status Panel	Control Rm	1.00	ea	Lab		240.00000	mh/ea	240.00	mh	27.16	6,518
					Mat	0			1.00	ea	10,000.00	10,000
----	PLC Comm. Hrdwr Link Cabinet	Control Rm	1.00	ea	Lab		8.00000	mh/ea	8.00	mh	27.16	217
					Mat	0			1.00	ea	1,000.00	1,000
----	CCTV Panel	Control Rm	1.00	ea	Lab		40.00000	mh/ea	40.00	mh	27.16	1,086
					Mat	0			1.00	ea	2,000.00	2,000
----	CCTV Monitor Panel	IAEA Cntrl Rm	1.00	ea	Lab		40.00000	mh/ea	40.00	mh	27.16	1,086
					Mat	0			1.00	ea	2,000.00	2,000
----	3013 Leat Det. Syst Op. Wkstn	IAEA Cntrl Rm	1.00	ea	Lab		24.00000	mh/ea	24.00	mh	27.16	652
					Mat	0			1.00	ea	24,587.00	24,587
----	Printer (Leak Detection Syst)	IAEA Cntrl Rm	1.00	ea	Lab		4.00000	mh/ea	4.00	mh	27.16	109
					Mat	0			1.00	ea	500.00	500
----	Security Supervisory Panel	Guard Rm/CAS	1.00	ea	Lab		40.00000	mh/ea	40.00	mh	27.16	1,086
					Mat	0			1.00	ea	10,000.00	10,000
----	Criticality Accident Alarm Pnl	Guard Rm/CAS	1.00	ea	Lab		24.00000	mh/ea	24.00	mh	27.16	652
					Mat	0			1.00	ea	5,000.00	5,000
	w/15 alarm and status lights											
----	CAS Fire Alarm Panel	Guard Rm/CAS	1.00	ea	Lab		24.00000	mh/ea	24.00	mh	27.16	652
					Mat	0			1.00	ea	5,000.00	5,000
	w/60 LED status indicators, 5 alarm lights & audible alarm.											
----	LS/DW Speaker	Guard Rm/CAS	25.00	ea	Lab		1.00000	mh/ea	25.00	mh	27.16	679
					Mat	0			25.00	ea	77.00	1,925
----	CCTV Monitor	Guard Rm/CAS	10.00	ea	Lab		1.00000	mh/ea	10.00	mh	27.16	272
					Mat	0			10.00	ea	200.00	2,000
----	Guard & CAS Workstation	Guard Rm/CAS	1.00	ea	Lab		4.00000	mh/ea	4.00	mh	27.16	109
					Mat	0			1.00	ea	1,000.00	1,000
----	Printer	Guard Rm/CAS	1.00	ea	Lab		4.00000	mh/ea	4.00	mh	27.16	109

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
168120	Detection systems											
----	Printer	Guard Rm/CAS	1.00	ea	Mat	0			1.00	ea	500.00	500
----	Portable SAAM		3.00	ea	Lab		2.00000	mh/ea	6.00	mh	27.16	163
					Mat	0			3.00	ea	15,000.00	45,000
	RADEC Model 452											
	Detection systems											277,067
	1,196.000 Labor hours											
169110	Line poles & fixtures											
----	Single Ckt Tangent, Type B *Wood Pole Structure w/all insulators and hardware.*		12.00	ea	Sub				12.00	ea	1,100.00	13,200
----	Double Ckt Deadend (Riser), *Type C, Wood Pole Structure w/all insulators and hardware.*		1.00	ea	Sub				1.00	ea	7,200.00	7,200
----	Double Ckt Deadend (Corner), *Type D, Wood Pole Structure w/all insulators and hardware.*		7.00	ea	Sub				7.00	ea	6,000.00	42,000
----	Double Ckt Tangent, Type E *Wood Pole Structure w/all insulators and hardware*		11.00	ea	Sub				11.00	ea	1,400.00	15,400
----	Single Ckt Deadend (Corner), *Type F, Wood Pole Structure w/all insulators and hardware.*		3.00	ea	Sub				3.00	ea	2,400.00	7,200
----	Single Ckt Deadend (Riser), *Type G, Wood Pole Structure w/all insulators and hardware.*		2.00	ea	Sub				2.00	ea	4,000.00	8,000
----	Conductor, #3/0 ACSR		21,000.00	lf	Lab		0.00840	mh/lf	176.40	mh	25.185	4,443
					Mat	0			21,000.00	lf	0.550	11,550
					Eqp		0.00840	mh/lf	176.40	mh	40.307	7,110
	Phase Conductor											
----	Conductor, #1/0 ACSR,		4,550.00	lf	Lab		0.00840	mh/lf	38.22	mh	25.185	963
					Mat	0			4,550.00	lf	0.35	1,593
					Eqp		0.00840	mh/lf	38.22	mh	40.307	1,541
	Static Line											
----	Anchors and Anchor Rods		16.00	ls	Lab		12.50000	mh/ls	200.00	mh	25.185	5,037
					Mat	0			16.00	ls	330.00	5,280
					Eqp		12.50000	mh/ls	200.00	mh	40.307	8,061
	Guys, anchors and hardware for pole in earth											
	Line poles & fixtures											138,577
	414.62 Labor hours											
	414.62 Equipment hours											
	16 Electrical											***1,862,441***
	17,626.615 Labor hours											
	631.100 Equipment hours											

Estimate Totals

Labor	15,746,137		319,103.595	hrs	
Material	6,721,161				
Subcontract	530,323				
Equipment	2,232,293		116,860.933	hrs	
Other	20,000				
	25,249,914	25,249,914			
Negative Spreadsheet Balance	-25,249,914		-100.000	%	T
	-25,249,914				
Fixed Price Base Construction	11,760,422		100.000	%	C
Fixed Price Misc. Labor & Matl	365,475		5.000	%	C
Fixed Price Subcontracted Cost	4,290,722		100.000	%	C
Fixed Price Subcontract Markup	429,072		10.000	%	C
Fixed Price OH&P	4,261,960		25.300	%	O
	21,107,651	21,107,651			
AECCM Non Manual Serv On-site	193,211		100.000	%	C
AECCM Non Manual Serv Off-site	52,960		100.000	%	C
AECCM Materials	300,235		100.000	%	C
AECCM Craft Labor	481,292		100.000	%	C
AECCM Support Craft Labor	27,421		100.000	%	C
AECCM Construction Management	91,494		100.000	%	C
AECCM F.U.R. Fee	71,942		8.500	%	C
	1,218,555	22,326,206			
Escalation on Construction	2,408,998		10.790	%	T
	2,408,998	24,735,204			
A/E Design Base Costs	4,493,496		100.000	%	C
A/E Subcontracted Costs	957,500		100.000	%	C
	5,450,996	30,186,200			
Escalation on TI/II Eng.	233,662		5.200	%	C
	233,662	30,419,862			
Site G&A	4,319,620		14.200	%	T
	4,319,620	34,739,482			
KH Company Labor	2,601,160		100.000	%	C
	2,601,160	37,340,642			
Escalation on Proj. Mgmt.	234,625		9.020	%	C
	234,625	37,575,267			
Contingency	7,515,054		20.000	%	T
Adjustment to meet DOE 5100.4	9,679				L
	Total	***45,100,000***			

Interim Storage Vault

Detailed "Per Bay" Cost Estimate

INTERIM STORAGE VAULT (ISV)
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
COST PER BAY (DOE 3013 CONTAINERS)

Client	B.B. MELTON
	T-130F
Estimator	K.R. BRUSEGAARD
Report format	Sorted by 'PROJECT/Phase'
	'Detail' summary
	Print item notes
	Print PROJECT notes

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount

02 Sitework

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
022212	Borrow											
----	**Washed river rock, 1-1/2" diam**		1,171.20	cy	Lab		0.04700	mh/cy	55.05	mh	22.266	1,226
					Mat	0			1,171.20	cy	14.30	16,748
					Eqp		0.04700	mh/cy	55.05	mh	54.55	3,003
	Quantity accounts for one storage bay width/length.											
----	**Geomembrane betwn rock & clay**		3,585.60	sf	Lab		0.01000	mh/sf	35.86	mh	20.51	735
					Mat	0			3,585.60	sf	0.11	394
					Eqp		0.01000	mh/sf	35.86	mh		
	Geomembrane placed between river rock layer and clay fill layer. Quantities account for one storage bay width/length											
----	**Select clay fill**		332.00	cy	Lab		0.04700	mh/cy	15.60	mh	22.266	347
					Mat	0			332.00	cy	7.80	2,590
					Eqp		0.04700	mh/cy	15.60	mh	54.55	851
----	**Common fill**		332.00	cy	Lab		0.04700	mh/cy	15.60	mh	22.266	347
					Mat	0			332.00	cy	3.55	1,179
					Eqp		0.04700	mh/cy	15.60	mh	54.55	851
	Common fill placed over tope of select clay fill Quantities account for one storage bay width/length.											
	Borrow											28,272
	122.110 Labor hours											
	122.110 Equipment hours											
022262	Fill											
----	**Structural fill beneath mat**		381.60	cy	Lab		0.04700	mh/cy	17.94	mh	22.266	399
					Mat	0			381.60	cy	3.55	1,355
					Eqp		0.04700	mh/cy	17.94	mh	54.55	978
	Based on 6" of sand w/polyethylene barrier and 6" of granular fill											
	Fill											2,732
	17.935 Labor hours											
	17.935 Equipment hours											
	02 Sitework											***31,004***
	140.046 Labor hours											
	140.046 Equipment hours											

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount

03 Concrete

031142 Forms in place, columns

Item	Description	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
----	Cast-in-place columns-formwork	576.00	sfca	Lab		0.06000	mh/sfca	34.56	mh	23.975	829
				Mat	0			576.00	sfca	1.090	628
				Eqp		0.06000	mh/sfca	34.56	mh	1.150	40
											1,496

Column formwork
Forms in place, columns
34.56 Labor hours
34.56 Equipment hours

031150 Fip,elevated slabs

Item	Description	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
----	Cast-in-place elev slab-frmwrk	2,508.800	sfca	Lab		0.14600	mh/sfca	366.28	mh	27.42	10,044
				Mat	0			2,508.80	sfca	1.51	3,788
				Eqp		0.14600	mh/sfca	366.28	mh	1.150	421
											14,253

Fip,elevated slabs
366.285 Labor hours
366.285 Equipment hours

031166 Fip,mat foundation

Item	Description	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
----	Cast-in-place found mat-formwk	201.60	sfca	Lab		1.05000	mh/sfca	211.68	mh	26.452	5,599
				Mat	0			201.60	sfca	3.93	792
				Eqp		1.05000	mh/sfca	211.68	mh	1.150	243
											6,635

Foundation mat formwork
Fip,mat foundation
211.68 Labor hours
211.68 Equipment hours

031182 Forms in place, walls

Item	Description	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
----	Cast-in-place walls-formwork	7,964.80	sfca	Lab		0.39000	mh/sfca	3,106.27	mh	28.163	87,482
				Mat	0			7,964.80	sfca	2.06	16,407
				Eqp		0.39000	mh/sfca	3,106.27	mh	1.150	3,572
											107,462

Forms in place, walls
3,106.272 Labor hours
3,106.272 Equipment hours

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
032107	Reinforcing in place											
----	Cast-in-place columns-reinf.		6.40	ton	Lab		16.00000	mh/ton	102.40	mh	27.10	2,775
					Mat	0			6.40	ton	420.00	2,688
					Eqp				6.40	ton		
----	Cast-in-place found mat-reinf		63.20	ton	Lab		23.46000	mh/ton	1,482.67	mh	27.10	40,180
					Mat	0			63.20	ton	483.08	30,531
					Eqp				63.20	ton		
----	Cast-in-place walls-reinf		88.80	ton	Lab		8.67000	mh/ton	769.90	mh	27.10	20,864
					Mat	0			88.80	ton	400.00	35,520
					Eqp				88.80	ton		
----	Cast-in-place elev. slab-reinf		68.80	ton	Lab		14.00000	mh/ton	963.20	mh	27.10	26,103
					Mat	0			68.80	ton	400.00	27,520
					Eqp				68.80	ton		
	Reinforcing in place 3,318.168 Labor hours											186,181
033130	Concrete in place											
----	Cast-in-place found mat-conc		327.20	cy	Lab		0.44000	mh/cy	143.97	mh	22.069	3,177
					Mat	5			343.56	cy	64.83	22,273
					Eqp		0.44000	mh/cy	143.97	mh	25.983	3,741
----	Cast-in-place columns-concrete		20.00	cy	Lab		2.48000	mh/cy	49.60	mh	22.069	1,095
					Mat	5			21.00	cy	64.80	1,361
					Eqp		2.48000	mh/cy	49.60	mh	25.983	1,289
----	Cast-in-place walls-concrete		352.80	cy	Lab		1.80000	mh/cy	635.04	mh	22.069	14,015
					Mat	5			370.44	cy	65.81	24,379
					Eqp		1.80000	mh/cy	635.04	mh	25.983	16,500
----	Cast-in-place elev. slab-conc		259.20	cy	Lab		1.35600	mh/cy	351.48	mh	22.069	7,757
					Mat	5			272.16	cy	57.63	15,685
					Eqp		1.35600	mh/cy	351.48	mh	25.983	9,132
	Concrete in place 1,180.083 Labor hours 1,180.083 Equipment hours											120,402
	03 Concrete 8,217.048 Labor hours 4,898.88 Equipment hours											*436,429*

05 Metals

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
050001	**Metals**											
----	**Type A tube bundle-TS 6x6x1/2"**		146,598.40	lbs	Lab				146,598.40	lbs		
					Mat	0			146,598.40	lbs	0.86	126,075
	*Requires 25 x 26 TS each way @ 4' long = 2,600 lf @ 35.24 lbs/lf = 91,624 lbs. 2 bundles req'd per bay. 91,624 * 2 = 183,248 lbs.*											
----	**Type B tube bundle-TS 6x6x1/2"**		70,367.20	lbs	Lab				70,367.20	lbs		
					Mat	0			70,367.20	lbs	0.86	60,516
	*Requires 24 x 26 TS each way @ 4' long = 2,496 lf @ 35 24 lbs/lf = 87,959 lbs 1 bundle req'd per bay. 87,959lbs * 1 = 87,959 lbs*											
----	**Type C tube bundle-TS 6x6x1/2"**		64,954.40	lbs	Lab				64,954.40	lbs		
					Mat	0			64,954.40	lbs	0.86	55,861
	*Requires 24 x 24 TS each way @ 4' long = 2,304 lf @ 35 24 lbs/lf = 81,193 lbs. 1 bundle req'd per bay, 81,193 lbs * 1 = 81,193 lbs.*											
----	**Type A tube bundle-Plate 1/2"**		6,714.40	lbs	Lab				6,714.40	lbs		
					Mat	0			6,714.40	lbs	0.335	2,249
	4'-1" wide x 50'-4" long = 205.51 sf/location x 2 bundles req'd per bay = 411 sf @ 20.42 lbs/sf = 8,393 lbs.											
----	**Type B tube bundle-Plate 1/2"**		3,290.40	lbs	Lab				3,290.40	lbs		
					Mat	0			3,290.40	lbs	0.335	1,102
	4'-1" wide x 49'-4" long = 201 43 sf/location x 1 bundle req'd per bay = 201.4 sf @ 20.42 lbs/sf = 4,113 lbs.											
----	**Type C tube bundle-Plate 1/2"**		3,201.60	lbs	Lab				3,201.60	lbs		
					Mat	0			3,201.60	lbs	0.335	1,073
	4'-1" wide x 48' long = 196 sf/location x 1 bundle req'd per bay = 196 sf @ 20.42 lbs/sf = 4,002 lbs.											
----	**Type A tube bundle-Anchor Stud**		307.20	ea	Lab				307.20	ea		
					Mat	0			307.20	ea	0.23	71
	12 required each side x 4 wide = 192 @ 2 bundles req'd per bay = 384 - 1/2" x 4-1/8" H4L. Nelson Stud.											
----	**Type B tube bundle-Anchor Stud**		153.60	ea	Lab				153.60	ea		
					Mat	0			153.60	ea	0.23	35
	12 required each side x 4 wide = 192 @ 1 bundle req'd per bay = 192 - 1/2" x 4-1/8" H4L, Nelson Stud.											
----	**Type C tube bundle-Anchor Stud**		153.60	ea	Lab				153.60	ea		
					Mat	0			153.60	ea	0.23	35
	12 required each side x 4 wide = 192 @ 1 bundle req'd per bay = 192 - 1/2" x 4-1/8" H4L, Nelson Stud.											
----	**Assemble Type A bundle**		6,240.00	lf	Lab		0.10000	mh/lf	624.00	mh	30.945	19,310
					Mat	0			6,240.00	lf	0.36	2,246
					Eqp		0.10000	mh/lf	624.00	mh	9.89	6,171
	Assume 3" stitch weld every 6" along each joint (1/4" fillet weld). Weld tube stl together, weld to 1/2" plate along edges 1.5' weld/lf of tube - 5,200 lf of tube.											
----	**Assemble Type B bundle**		2,995.20	lf	Lab		0.10000	mh/lf	299.52	mh	30.945	9,269
					Mat	0			2,995.20	lf	0.36	1,078
					Eqp		0.10000	mh/lf	299.52	mh	9.89	2,962
	Assume 3" stitch weld every 6" along each joint (1/4" fillet weld). Weld tube stl together, weld to 1/2" plate along edges. 1.5' of weld/lf of tube - 2,496 lf of tube											

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
050001	Metals											
----	**Assemble Type C bundle**		2,764.80	lf	Lab		0.10000	mh/lf	276.48	mh	30.945	8,556
					Mat	0			2,764.80	lf	0.36	995
					Eqp		0.10000	mh/lf	276.48	mh	9.89	2,734
	Assume 3" stitch weld every 6" along each joint (1/4" fillet weld) Weld tube stl together, weld to 1/2" plate along edges. 1.5' weld/lf of tube - 2,304 lf of tube											
----	**Weld anchor studs to plate**		614.40	ea	Lab		0.01600	mh/ea	9.83	mh	30.945	304
			0		Eqp		0.01600	mh/ea	9.83	mh	12.214	120
----	**Set bundles into formwork**		3.20	ea	Lab		4.00000	ch/ea	12.80	ch	110.78	1,418
					Eqp				3.20	ea		
----	*****3013 Tube Support Embed*****				Oth					ea		
----	**Plate, 1" thick A35, 27" Dia**		1.00	ea	Lab		0.10000	mh/ea	0.10	mh	29.28	3
					Mat	0			1.00	ea	34.67	35
	Quantity is for one 3013 tube. Cut plate to 27" diameter, grind edges. Assume a 27" square plate is required in order to provide a circular plate-103.5 lbs											
----	**Ring, 28" O.D. x 1.5", 3/8"thk**		1.00	ea	Lab		1.00000	mh/ea	1.00	mh	29.28	29
					Mat	0			1.00	ea	7.80	8
	Quantity is for one storage tube. Cut and bend 3/8" plate and weld to part #3. 14.1 lbs of 3/8" plate required.											
----	**Ring, 27.25" O.D. x 15",**		1.00	ea	Lab		4.00000	mh/ea	4.00	mh	29.28	117
					Mat	0			1.00	ea	62.50	63
	1/2" thick A36 plate. Quantity is for one storage tube Cut, roll and weld 27.25" diameter ring from 1/2" thick plate, weld seam 185 lbs of 1/2" plate required.											
----	**Ring, 26.5" O.D. x 19.5" I.D.**		1.00	ea	Lab		1.50000	mh/ea	1.50	mh	29.28	44
					Mat	0			1.00	ea	23.90	24
	3/8" thick A36 Plate Quantity is for one Storage tube. Cut plate to proper inside and outside dimensions, weld to Part #3. 58.5 lbs of 3/8" plate required											
----	**Pipe, 20" dia, Sch 10, A53**		1.00	ea	Lab		1.00000	mh/ea	1.00	mh	29.28	29
					Mat	0			1.00	ea	80.00	80
	1'-3" required for one storage tube. Weld 20" Sch10 pipe to Part #4.											
----	**Nelson Stud, 3/8" x 4-1/8" H4L**		8.00	ea	Lab		0.01600	mh/ea	0.13	mh	29.28	4
					Mat	0			8.00	ea	0.21	2
	Nelson Part No. 101-053-043. Locate and attach weld studs to 20" Sch10 pipe.											
----	**Hoist Ring,**		2.00	ea	Lab		0.25000	mh/ea	0.50	mh	29.28	15
					Mat	0			2.00	ea	274.95	550
	American Drill Bushing Co Part No. 23327 Bolt to storage tube flange.											
----	***** 3013 Storage Tube *****				Lab					ea		
					Mat	0				ea		
----	**Flange, Slip-on, 150#, 18",PL1**		1.00	ea	Lab		10.00000	mh/ea	10.00	mh	29.28	293
					Mat	0			1.00	ea	544.00	544
	Cost increase by 35% to account for PL1 Safety Class Criteria.											
----	**Pipe, A53, Gr B, 18" XS, PL1**		13.75	lf	Lab				13.75	lf		
					Mat	0			13.75	lf	50.00	688
	1' ng pipe Cost increased by 35% to account for I ety Class Criteria.											
----	**Pla.., 1" Thick, A36, 18", PL1**		1.00	ea	La..				1.00	ea		

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
050001	Metals											
----	Plate, 1" Thick, A36, 18", PL1		1.00	ea	Mat	0			1.00	ea	42.00	42
	Cut plate to circular diameter, bevel edge for welding and weld to 18" diameter pipe											
	Cost increased by 35% for PL1 Safety Class Criteria reqmn											
----	*** 3013 Tube Base Support ***				Lab					ea		
					Mat	0				ea		
----	Plate, 27"x27"x5/8", SST, 304		1.00	ea	Lab		0.75000	mh/ea	0.75	mh	29.28	22
					Mat	0			1.00	ea	271.00	271
	Quantity is for one storage tube.											
	*25 53#/sf * 5.0625 = 129 25# @ $2 10/# = $271 00. Cut plate to proper dimension, locate/drill bolt holes*											
----	Kwik Bolt II, Hilti #00045396		4.00	ea	Lab		0.73800	mh/ea	2.95	mh	29.28	86
					Mat	0			4.00	ea	17.96	72
	5/8" x 6" 304 SST											
----	Pipe, 6", Sch120, A106, Gr B		4.00	ea	Lab		1.00000	mh/ea	4.00	mh	29.28	117
					Mat	0			4.00	ea	30.00	120
	8" required, cut pipe to 8" lengths, locate and weld to SST base plate.											
----	Structural Tee, 3 x 8, A36		4.00	ea	Lab		1.00000	mh/ea	4.00	mh	29.28	117
					Mat	0			4.00	ea	20.00	80
	1'-0" required, cut/bevel corner, locate & weld CS Structural tee to SST base plate											
----	Plate, 3/8", 4"x6" A36		4.00	ea	Lab		0.25000	mh/ea	1.00	mh	29.28	29
					Mat	0			4.00	ea	0.95	4
	*4" * 6" = 24"/144" = .167sf * 15.52#/sf = 2.6# * .365/# = $0.95*											
	Weld to beveled corner of structural tee.											
----	Plate, 3/4", 18"x18", A36		1.00	ea	Lab		0.50000	mh/ea	0.50	mh	29.28	15
					Mat	0			1.00	ea	23.12	23
	*18" * 18" = 324si/144si/sf = 2.25sf * 30.63#/sf = 69# * .335/# = $23.12*											
	Cut plate to proper dimension, set in place.											
----	Structural S, 5x10, A36		4.00	ea	Lab		1.00000	mh/ea	4.00	mh	29.28	117
					Mat	0			4.00	ea	1.90	8
	12 pounds required for one storage tube assembly											
----	*** 3013 Instrument Well ***				Lab					ea		
----	Flange, Slip-on, 18", 125#		1.00	ea	Lab		4.00000	mh/ea	4.00	mh	29.28	117
					Mat	0			1.00	ea	393.00	393
	Quantity is for one storage tube. Flange to be bored out to 16.16" inside diameter, weld to 16" pipe w/2-3/8" fillet welds.											
----	Pipe, 16" diameter, Std. A53		1.00	ea	Lab		2.00000	mh/ea	2.00	mh	29.28	59
					Mat	0			1.00	ea	129.140	129
	1'-10" required per instrument well.											
	Weld pipe to 2" thick plate.											
----	Plate, 2" thk, A36, 16-3/4" rd		1.00	ea	Lab		1.50000	mh/ea	1.50	mh	29.28	44
					Mat	0			1.00	ea	58.00	58
	*17" * 17" = 289 si/144 si/sf =2.0 sf * 81 68 #/sf = 163 4# * .355/# = $58.00*											
	Cut plate to 16-3/4" diameter, put radius on both edges.											
----	Valve, 1/4", SST, Tubing		1.00	ea	Lab		0.50000	mh/ea	0.50	mh	34.11	17
					Mat	0			1.00	ea	625.00	625
	Varian Vacuum 951-5014. Valve on 1/4" Helium detector tubing.											

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
050001	**Metals**											
----	**Tubing, 1/4" x .035"**		2.00	lf	Lab		0.02600	mh/lf	0.05	mh	34.11	2
					Mat	0			2.00	lf	0.61	1
	Quantity required for one instrument well.											
----	**Tube Coupling, Full, 316 SST**		1.00	ea	Lab		1.00000	mh/ea	1.00	mh	34.11	34
					Mat	0			1.00	ea	50.00	50
	Per Detail 5 on referenced drawing One required per instrument well. Locate/drill/insert coupling into 2" thick bottom plate, weld in place.											
----	**Bolt w/Nut, 1-1/8" x 5" Hex**		13.00	ea	Lab		0.08300	mh/ea	1.08	mh	29.28	32
					Mat	0			13.00	ea	4.32	56
----	**Bolt w/Nut, 1-1/8" x 6" Hex**		2.00	ea	Lab		0.08300	mh/ea	0.17	mh	29.28	5
					Mat	0			2.00	ea	4.640	9
----	**Plug, 4" Threaded, A36**		1.00	ea	Lab		0.25000	mh/ea	0.25	mh	29.28	7
					Mat	0			1.00	ea	20.00	20
	Fab from Bar Stock per Detail 6 on referenced drawing.											
----	**Plug, 2" Threaded, A36**		1.00	ea	Lab		0.25000	mh/ea	0.25	mh	29.28	7
					Mat	0			1.00	ea	10.00	10
	Fab from Bar Stock per Detail 7 on referenced drawing.											
----	***** 3013 Tube Support Cage *****				Lab					ea		
----	**Angle, A36, 3"x3"x3/8"**		35.00	lf	Lab		1.00000	mh/lf	35.00	mh	29.28	1,025
					Mat	0			35.00	lf	3.96	139
	Fab per Detail 1 on drawing C408.											
----	**Plate, 3/8", 8" x 6", A36**		1.00	ea	Lab		1.00000	mh/ea	1.00	mh	29.28	29
					Mat	0			1.00	ea	1.86	2
	*8" * 6" = 48 si/144 si/sf = .333sf * 15.32#/sf = 5.1 # * $0.365/# = $1.86*											
----	**Plate, 1", 16.25" Dia., A36**		1.00	ea	Lab		4.00000	mh/ea	4.00	mh	29.28	117
					Mat	0			1.00	ea	25.86	26
	*Fabricate Part per detail 2 on drawing C408. 16.5" * 16.5" = 272.25 si / 144 si/sf = 1.89 sf * 40.84#/sf = 77.2# * $0.335/sf = $25.86*											
----	**Tubing, 4"x2"x1/4", A500**		16.00	lf	Lab		1.00000	mh/lf	16.00	mh	29.28	468
					Mat	0			16.00	lf	8.200	131
	*8.81#/lf * $0.93/# = $8 20/lf*											
----	**Pipe, 3/4", A106,**		7.00	lf	Lab		0.20000	mh/lf	1.40	mh	29.28	41
					Mat	0			7.00	lf	2.96	21
----	**Plate, 3/8", 6" dia., SST-A240**		8.00	ea	Lab		0.50000	mh/ea	4.00	mh	29.28	117
					Mat	0			8.00	ea	8.67	69
	*8 plates required for one storage tube support cage. 6" * 6" = 36 si / 144 si/sf = .25sf * 16 5#/sf = 4.13 # * $2.10/# = $8.67*											
----	**Plate, 5/16"x3"x53", A36**		2.00	ea	Lab		2.00000	mh/ea	4.00	mh	29.28	117
					Mat	0			2.00	ea	5.43	11
	*Fabricate ring per Section D-D on referenced drawing. 3" * 53" = 159 si / 144 si/sf = 1.1 sf * 12 76#/sf = 14.1# * $0.385/# = $5.43*											
----	**Hinge, 4"x4" Blnk Full Surface**		8.00	ea	Lab		0.25000	mh/ea	2.00	mh	29.28	59
					Mat	0			8.00	ea	3.56	28
----	**Sheet, 1/8"x3/4"x3/4", A36**		8.00	ea	Lab		0.10000	mh/ea	0.80	mh	29.28	23
					Mat	0			8.00	ea	0.25	2
----	**Sh' 6 Ga. SST-A240, 316**		1.00	ls	La'		40.00000	mh/ls	40.00	mh	34.9?	1,399
					Ma	0			1.00	ls	120.0,	120

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
050001	**Metals**											
	Requires approximately 22.25 SF of sheet Fabricate sheetmetal components per Section E-E of referenced drawing.											
----	**Fab. remaining 55 Strg Tubes**		55.00	ea	Lab		154.27000	mh/ea	8,484.85	mh	30.804	261,367
					Mat	0			55.00	ea	4,514.00	248,270
	Fabrication remaining number of storage tubes, embeds, instr wells & support cages for one bay of 3013 contain. Cost obtained from build-up of one complete strg tube.											
----	**Hvy Duty Grating @ Inlet/Outlt**		656.00	sf	Lab		0.10000	mh/sf	65.60	mh	30.945	2,030
					Mat	0			656.00	sf	21.00	13,776
					Eqp		0.10000	mh/sf	65.60	mh	9.89	649
	Pricing based on IKG/Greulich Bridge Decking 5" - 4 way Standard w/ 5 51 lb main bar. Located @ air inlet and outlet openings											
----	**Tubing, Str. 5"x3"x1/4", A500**		272.00	lbs	Lab		0.10000	mh/lbs	27.20	mh	30.945	842
					Mat	0			272.00	lbs	0.86	234
					Eqp		0.10000	mh/lbs	27.20	mh	9.89	269
	Frame-work for weather cover over air outlets.											
----	**Tubing, Str. 3"x3"x1/4", A500**		48.00	lbs	Lab		0.10000	mh/lbs	4.80	mh	30.945	149
					Mat	0			48.00	lbs	0.86	41
					Eqp		0.10000	mh/lbs	4.80	mh	9.89	47
	Framework for weather cover over air outlet duct.											
----	**Corrugated metal arch, 10 ga**		250.40	sf	Lab		0.10000	mh/sf	25.04	mh	30.945	775
					Mat	0			250.40	sf	40.00	10,016
					Eqp		0.10000	mh/sf	25.04	mh	9.89	248
	Weather cover over air outlet ducts											
	Metals											850,163
	10,022.947 Labor hours											
	1,332.470 Equipment hours											
	05 Metals											*850,163*
	10,022.947 Labor hours											
	1,332.470 Equipment hours											

09 Finishes

Item	Description	Location	Takeoff Qty			W%	Conversion		Order Qty		Unit Price	Amount
033454	**Finishing floors**											
2100	**Finishing floors, hardeners, metallic, heavy service, 1.0 psf, add**		5,257.76	sf	Lab		0.01231	mh/sf	64.72	mh	22.35	1,447
					Mat	0			5,257.76	sf	0.427	2,245
					Eqp		0.01231	mh/sf	64.72	mh	5.04	326
	Hardeners on interior walls and ceilings.											
3850	**Finishing floors, dustproofing, silicate liquids, 2 coats**		5,257.76	sf	Lab		0.00615	mh/sf	32.34	mh	22.35	723
					Mat	0			5,257.76	sf	0.051	268
	Dustproofing on interior walls and ceilings											