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Los Alamos Technical Associates, Inc.
6501 Americas Parkway NE., Suite 900, Albuquerque, NM 87110

Independent Safety Evaluation Review of B-Plant Viability Study

Prepared by
Los Alamos Technical Associates, Inc.
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EXECUTIVE SUMMARY

Los Alamos Technical Associates Inc., (LATA) has performed an independent safety evaluation review of the B Plant viability study. This work was performed for the Defense Waste Disposal Safety Group of Westinghouse Hanford Company and constituted an independent third party review. The B Plant viability study was to identify and address concerns with B Plants' new mission for pretreatment of liquid and solid double-shell tank waste. LATA's review of the viability study was to identify the technical and safety issues that would affect the viability decision and to judge the adequacy of resolution of these issues. The review was divided into four primary areas: chemical processing, structural and seismic, balance of plant systems, and safety analysis and evaluation.

The chemical processing for the pretreatment mission was reviewed to permit an evaluation of the technical viability and safety of the plans. The current stage of the project is recognized as preliminary; as such, extensive development and pilot work is yet to be performed. The viability of the chemical operations will be established during the development and pilot work. The seven accident analysis scenarios discussed are considered a good start in determining the safety aspects and are considered to bound the problem sufficiently for the present. These accident scenarios should be updated and the approach continued throughout the development and pilot operations.

The structural analyses of B Plant, B Stack, AR Vault, and AR Stack were reviewed. The other facilities needed for pretreatment were not reviewed. Both design basis wind (DBW) and earthquake (DBE) loadings were considered; dead load only, snow, and ashfall loadings were not considered. The seismic loads controlled. The AR Vault and AR Stack are expected to remain standing and functional during and following the Moderate Hazard Facility DBW and DBE. The B Stack is expected to remain standing during and following the High Hazard Facility DBW and to collapse during the DBE. The B Plant analysis is not complete; however, all available parts were reviewed. The review conclusions are--the seismic hazard results are justifiable, the proposed B Plant inelastic direct integration dynamic analysis is appropriate, and the joint moment rotation model concept may be appropriate, but the preliminary model needs significant refinements before performing the inelastic time integration analysis. The required dynamic analysis for all the structures has not been performed, but this is expected at this stage of the viability study.

The balance of plant systems review consisted of an independent review of DOE 6430.1A and comparison of these results to SAIC, Task 3 results. A list of important criteria not addressed by SAIC was developed. Three critical items were identified--in-place testing of HEPA filter banks, single failure criterion and redundancy, and management of non-radioactive hazardous waste.

The safety analysis review examined the pertinent DOE Orders, NRC Regulations, and other codes and standards for the proposed pretreatment mission. For the most part, the requirements are applied through inclusion in DOE 6430.1A. The best listing of the necessary criteria is given in the SAIC, Task 3 documents. Four additional critical items were identified - the basis for assuming the facilities are not plutonium handling facilities, the possibility of asbestos containing materials having been used in the original construction, the management of industrial wastes, and the absence of a Design Basis Fire.

Although some issues remain to be analyzed in full depth and detail, everything found to date indicates that B Plant is a viable project which can be successfully implemented, assuming favorable findings on open questions.

1.0 INTRODUCTION

Los Alamos Technical Associates (LATA), Inc., has performed a safety evaluation review of the B Plant viability study. The results are described in this report done under contract MNP-SVV-536054, Task 2, for the Defense Waste Disposal Safety (DWDS) Group of Westinghouse Hanford Company (WHC). The DWDS Group has also reviewed the B Plant viability study. LATA's role was that of an independent third party review.

Some Hanford Site liquid and solid wastes stored in double-shell tanks must be pretreated before final disposal in cementitious grout or glass forms. Disposal of these wastes requires processing to separate liquid and solid portions and to remove selected radionuclides from the liquid portion. Under the current baseline waste management plan, the necessary pretreatment operations are performed in an upgraded B Plant facility. The B Plant viability study identifies and addresses concerns with this new mission and with the necessary upgrades. The purpose of LATA's review was to:

- Identify the technical and safety issues that would affect the viability decision,
- Judge the adequacy of resolution of these issues in the viability study and its supporting documents,
- Identify any missing or incomplete items, and
- Check the technical accuracy and appropriateness of the evaluation, with respect to safety issues.

Although all the necessary analyses and in-depth inquiries are not completed, the existing investigations are sufficiently accurate and detailed for a feasibility decision.

1.1 Description of Present B Plant Facilities

B Plant is located on the Hanford Site in the 200-East Area and is designated Building 221-B. B Plant was built in 1943 and 1944 as a Waste Fractionation Facility used for radioactive waste separation and treatment (Sewell, 1985). It orginally treated waste using a bismuth phosphate process. In 1968, it was modified to treat waste from PUREX.

The B Plant complex contains five principal structures as follows:

- Building 221-B contains all processing equipment. All waste fractionation processing is done here, as well as short-term storage of radioactive material before transfer to WESF, tank farms, or waste disposal.
- Building 271-B Annex contains offices, shops, and tanks for chemical makeup solutions.
- Building 211-B contains bulk storage for liquid chemicals used for processing.
- Building 212-B Cask Station is equipped for shipping liquid radioactive product and receiving wastes in special casks designed for overland shipment.
- Building 291-B Ventilation Exhaust System consists of buried air tunnels, HEPA filters, backup sand filter, exhaust fans, and a 200-ft stack.

B Plant's main and supporting structures are shown in Figure 1-1. Table 1-1 lists all B Plant structures and functions.

The 244 AR-Vault will be used under one pretreatment option. Completed in 1968, the AR Vault is designed as a waste handling facility for routing PUREX-generated waste between the tank farms and B Plant. The AR Vault complex is located in the 200-East Area on the Hanford Site. The main buildings and support facilities are shown in Figure 1-2.

1.2 Description of the Proposed Separation Process

Disposal of double-shell tank (DST) waste requires pretreatment to separate the waste into transuranic (TRU) waste, high-level waste (HLW), and low-level waste (LLW) fractions. The TRU waste and HLW fractions will be processed in the Hanford Waste Vitrification Plant (HWVP), and solidified into borosilicate waste glass for disposal in a geologic repository. The remaining LLW fraction will be mixed with grout at the Grout Treatment Facility (GTF) and disposed of in near-surface concrete vaults on the Hanford site. A diagram of the disposal process is shown in Figure 1-3 (Kirch, 1989).

Four waste types have been identified for feed to vitrification with pretreatment: neutralized current acid waste (NCAW), complexant concentrate (CC), Plutonium Finishing Plant (PFP) waste, and neutralized cladding removal waste (NCRW). The planned total waste volumes requiring pretreatment are shown in Table 1-2. The NCAW

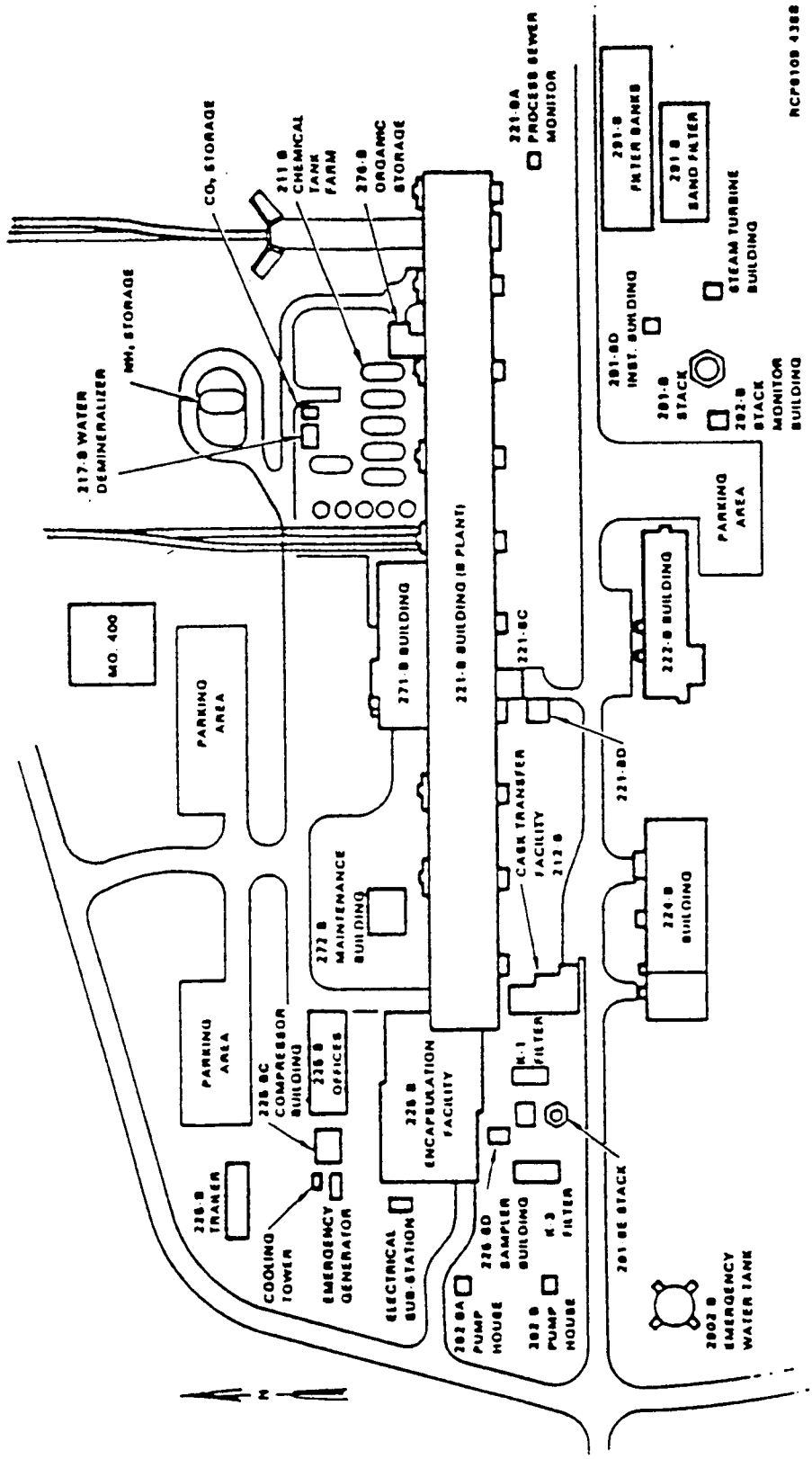

Figure 1-1. Physical Relationship of Principal Structures to B Plant

TABLE 1-1
B PLANT STRUCTURES AND THEIR FUNCTIONS

FACILITY	FUNCTION
207-B Retention Basis	Receives cooling water discharge from B Plant
211-B Chemical Tank Farm	Provides bulk storage area for liquid chemicals used for processing
212-B Cask Transfer Facility	Receives/ships batch quantities of feed or product
216-B-55 Steam Condensate Crib	Provides covered trench for the disposal of condensates from heating coils in process tanks
216-B-59 Retention Basin	Receives emergency discharge of 15-in. cooling water line
216-B-62 Process Condensate Crib	Provides covered trench for the disposal of condensates from process concentrators
216-B-63 Emergency Ditch	Receives chemical sewer effluent or 207-B emergency diversion
216-B-64 Retention Basin	Receives condensates which exceed the environmental release guidelines
217-B Water Demineralizer	Provides demineralized process water supply
221-B Waste Fractionation Plant	Provides canyon facility for processing waste to isolate selected fission products
221-BB Condensate Building	Provides housing for process and steam condensate receiving tanks
221-BC Change House	Provides clothes-change area for personnel
221-BD Laundry Shed	Provides interim storage area for all used laundry
221-BF Effluent Control Building	Provides diversion capability for liquid waste stream to tank farm to retention basin
222-B Office Building	Contains administrative office, retired facilities
224-B Retired Facility	Contains storage
225-B Waste Encapsulation and Storage Facility (WESF)	Provides processing, encapsulation, and interim storage of strontium and cesium
241-ER-151 Diversion Boxes	Routes waste and other streams to and from 221-B
241-B-154 Diversion Boxes	Retired (boxes sealed and lines blanked)
241-BX-154 Diversion Boxes	Retired (boxes sealed and lines blanked)
271-B Support Building	Contains shops, offices, and aqueous makeup facilities for waste processing, annex to 221-B
272-B Electrical Shop	Provides area for electrical maintenance
272-BA Maintenance Shop	Provides area for maintenance and material storage
272-BB Insulation Shop	Provides area for insulation work
276-B Organic Makeup and Storage	Provides are for makeup and storage of organic solvent
282-B Pump Houses	Provides pumping for emergency raw water supply
282-BA Pump Houses	Provides pumping for emergency raw water supply
291-B Fans, Stack and Filters	Provides ventilation and filtration for 221-B
292-B Instrument Building	Provides the stack monitoring station
2902-B Water Tank	Provides emergency sanitary water supply

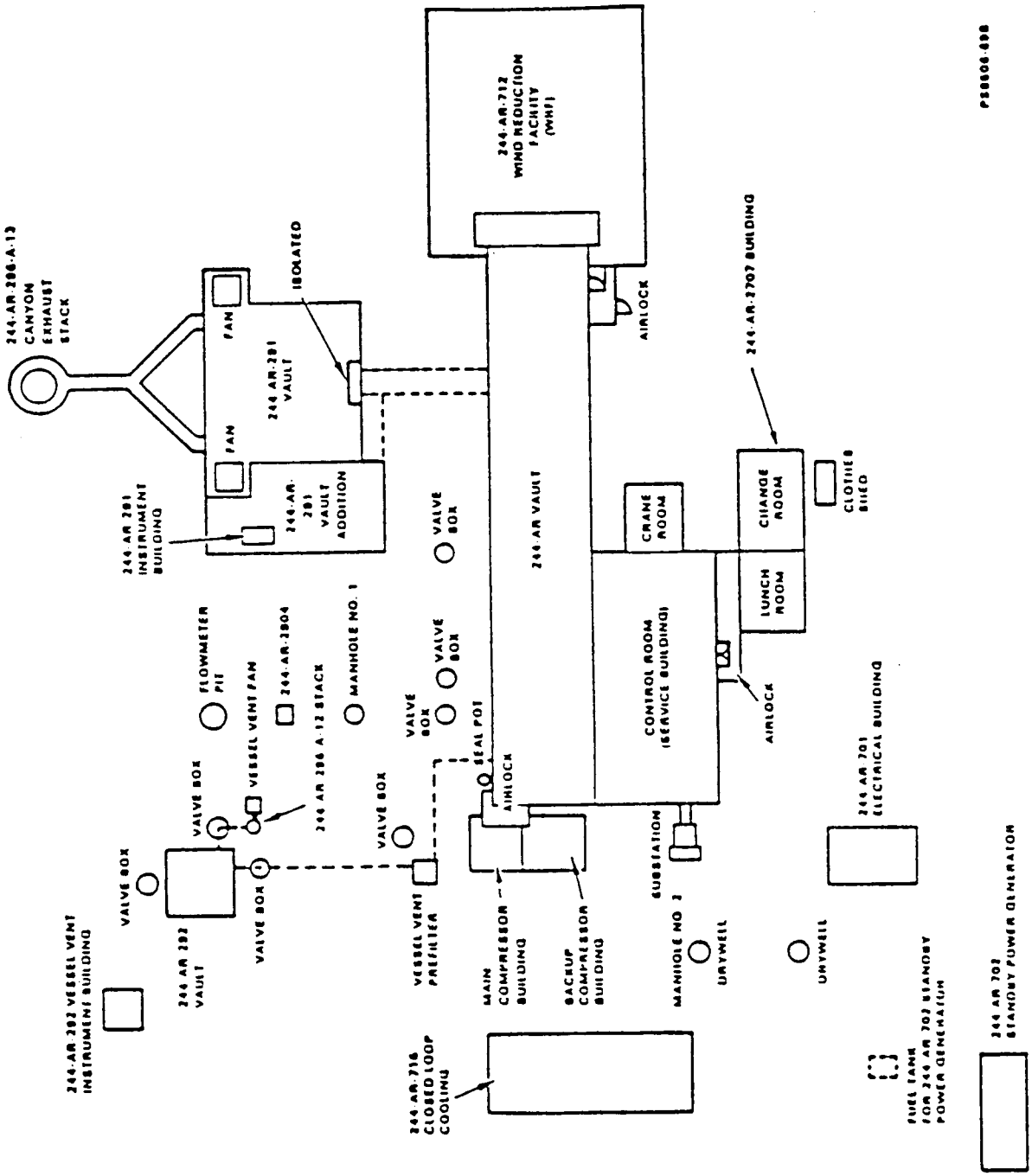

Figure 1-2. Plot Plan of 244-AR Vault Facility

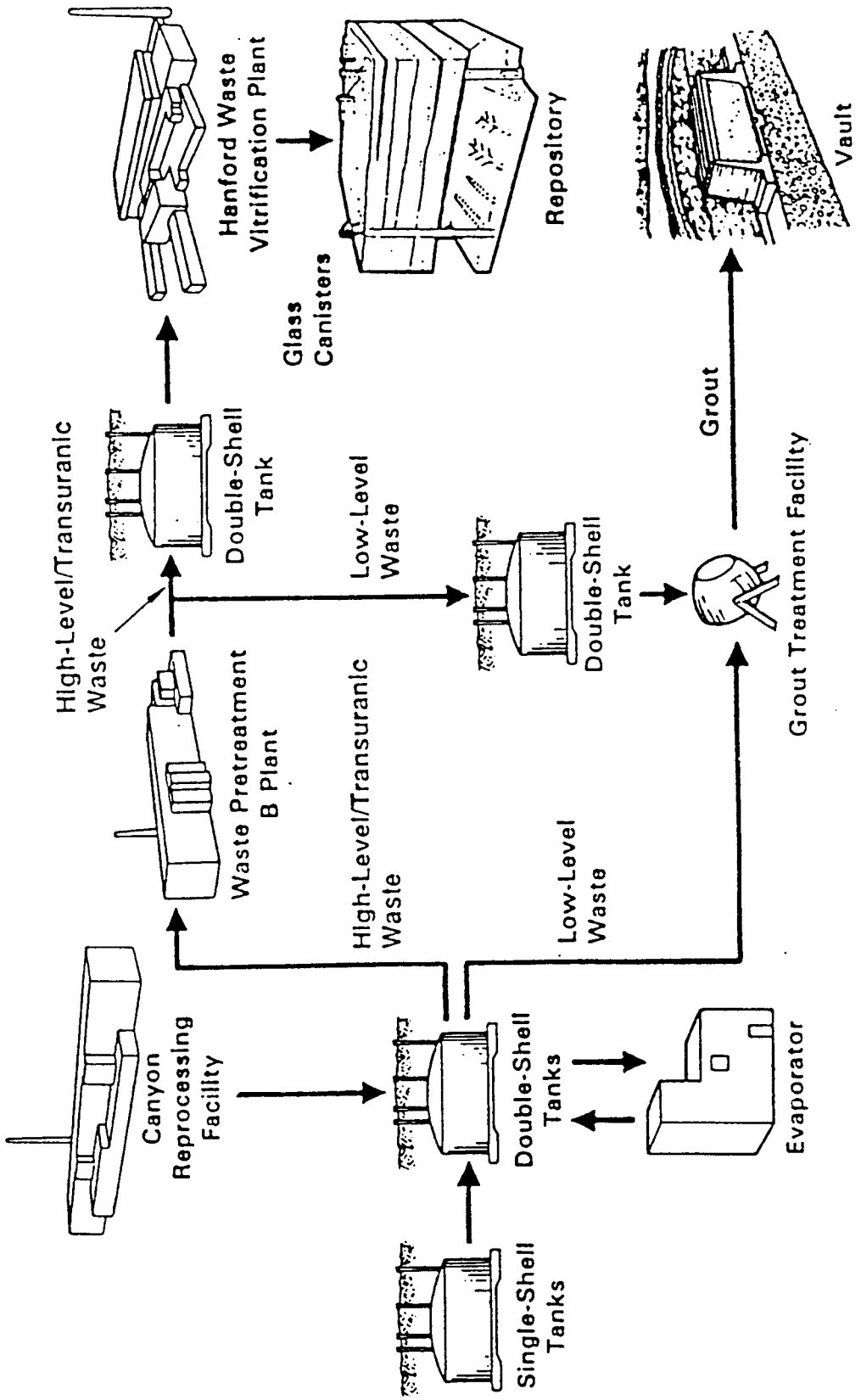

Figure 1-3. Double-Shell Tank Waste Disposal

TABLE 1-2
PLANNED VOLUME OF DOUBLE-SHELL TANK WASTE FOR PRETREATMENT

Waste Type	Total Volume (Mgal)	Composition
Neutralized current acid waste (NCAW)	1.9	Iron hydroxide sludge, contaminated with actinides and strontium; alkaline supernate, contaminated with cesium
Complexant concentrate (CC)	4.3	Waste from previous strontium and cesium recovery operations; containes actinides and organics
Plutonium Finishing Plant (PFP) Waste	0.4	Iron containing sludge contaminated with actinides
Neutralized cladding removal wastes (NCRW)	0.8	Zirconium containing sludge contaminated with actinides

will be pretreated using solids washing, solid-liquid separation, and ion exchange for cesium removal. After completion of NCAW pretreatment, CC will be pretreated using the TRUEX process coupled with organic complexant destruction. The PFP waste and then the NCRW waste will be pretreated using the TRUEX process (Assessment, 1989). All four waste types will be pretreated in the B Plant facility. The B Plant will undergo facility upgrades to perform the DST waste pretreatment mission. Outages of various lengths are required between the pretreatment of different waste streams. It is expected to take 6 to 8 years to pretreat all four wastes.

1.3 Description of Affected B Plant Systems

The major facilities required for pretreatment are:

- yard tanks where the waste is currently stored (AY-101 & 2 and AZ-101 & 2);
- yard piping for transfer of waste;
- yards tanks for temporary storage of waste awaiting transfer to B Plant or AR Vault for processing;
- AR Vault (or B Plant or yard tank) for solids settling;
- B Plant for chemical processing;

- yard tank for temporary storage of treated waste waiting transfer to HWVP; and

- yard tank for temporary storage of treated waste waiting transfer to GTF.

Present plans are for yard piping to perform all liquid and slurry transfers. An overview of the 200 East Area Waste Transfer system is shown in Figure 1-4. Certain yard tanks will be used for temporary storage before, during, and after processing.

The NCAW pretreatment process involves a solid settling step of fairly long duration. To speed the process, a proposed option is to use the larger tanks in the AR Vault, rather than B Plant tanks. A proposed second option is to perform part or all of the solid washing and settling in yard storage tanks.

The primary B Plant facilities required are the B Plant canyon itself, the ventilation system with HEPA filters and stack, and all subsystems necessary for safe operation or shutdown of the radioactive chemical processing. The primary AR Vault facilities required are the AR Vault itself, its ventilation system and stack, and the necessary subsystems. In addition, all the necessary systems and subsystems of the listed facilities in directing, controlling, and monitoring the entire pretreatment operation are required.

1.4 Review and Evaluation Methods Used

The general approach was to collect the available documents on original design and construction and on current plant conditions. Next, documents describing the new mission were reviewed to understand the needed changes in the physical plant. Then, regulatory and safety documents were reviewed to identify necessary or potential upgrades. Finally, the results of the studies were combined to assess the degree to which viability was established for the technical feasibility and safety of the proposed actions.

The total review area was divided into four subareas--chemical processing, structural and seismic analyses, balance of plant systems, and safety analysis and evaluation. Of necessity, the detailed review process used in each subarea is different.

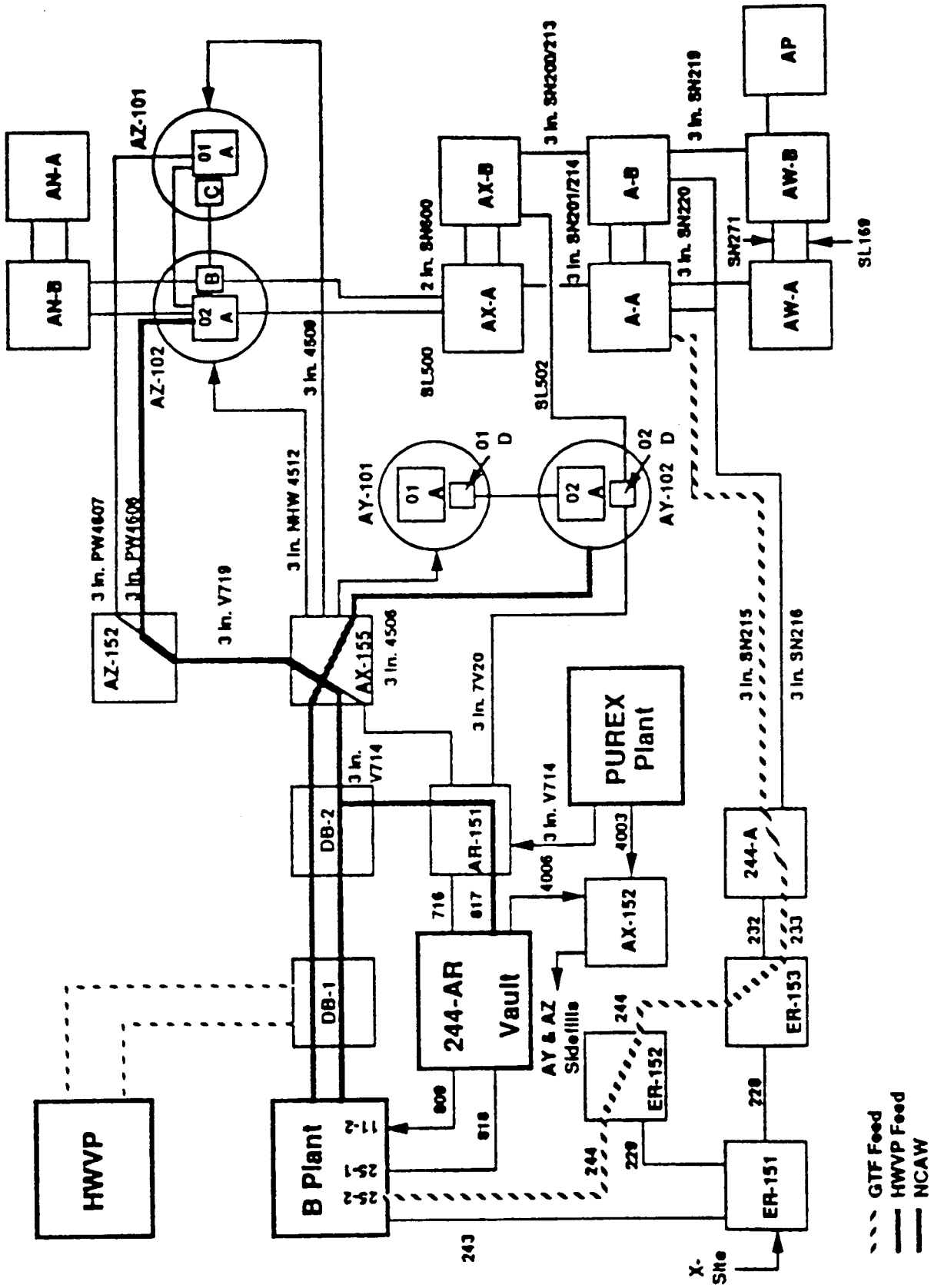

Figure 1-4. Overview of the 200 East Area Waste Transfer System

A detailed description of the individual review processes is contained in each section. The amount of material available for review is substantially different for each of the four subareas. The structural and seismic area has the most material and the most definitive material of all the subareas. As such its review was more specific and resulted in more detailed review comments.

2.0 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

LATA has performed an independent third party safety evaluation review of the B Plant viability study. The B Plant viability study identified and addressed concerns with B Plant's new mission for pretreatment of liquid and solid double-shell tank waste. LATA's review was divided into four subareas - chemical processing, structural and seismic analyses, balance of plant systems, and safety analysis and evaluation. The review results for these four areas are summarized below and are followed by the review conclusions and finally the recommendations. Although some issues remain to be analyzed in full depth and detail, everything found to date indicates B Plant is a viable project which could be successfully implemented, assuming favorable findings on open questions.

2.1 Summary and Conclusions

The chemical processing for the pretreatment mission was reviewed to permit an evaluation of the technical viability and safety of the plans. The current stage of the project is recognized as preliminary and that, as such, extensive development and pilot work is yet to be performed. Based on the work-to-date which we reviewed we concure that the processing planned is viable. However, the final viability of the chemical operations will be established during the development and pilot work. Safety of the systems will have to be developed concurrently as well as during the design engineering and preparation of operational procedures to follow. That many questions are yet to be answered is recognized in the WHC reports.

The accident analysis scenarios discussed in Marusich, 1989, were taken from the existing SAR. This is a good start in determining the safety aspects, but there was no apparent comparison of the planned process with the old. It is recommended that such examination be made and the accident analysis approach be continued throughout the development and pilot operations. There were insufficient data to determine the viability of the assumptions and figures used. The seven scenarios were considered to bound the problem sufficiently for the present; thus there was no attempt to generate scenarios of our own.

The structural analyses of B Plant, B Stack, AR Vault, and AR Stack were reviewed. These analyses represent all of the WHC structural analyses to date to

support the viability decision. Because of the present state of the study, these analyses do not consider all aspects of the problem in equal detail.

Preliminary analyses have been completed for the AR Vault, AR Stack, and B Stack. Both design basis wind and earthquake loadings were considered; dead load only, snow, and ashfall loadings were not considered. The seismic loads controlled. The AR Vault and Stack are classified as Moderate Hazard Facilities with a DBW of 80 mph and a 0.12g anchored DBE. In the calculations, the design wind was arbitrarily taken as 100 mph. The minimum structural seismic safety factors calculated are 1.05 for the AR Vault and 2.43 for the AR Stack. The AR Stack overturning analysis yields safety factors of 3.06 for wind and 1.75 for seismic. Both structures should remain standing and functional during and following the Moderate Hazard Facility DBW and DBE events. The B Plant and Stack are classified as High Hazard Facilities with a DBW of 90 mph and a 0.20g anchored DBE. In the B Stack calculations, the design wind was arbitrarily taken as 115 mph. The minimum structural safety factors calculated for B Stack are 1.59 for wind and 0.99 for seismic. The overturning analysis yields safety factors of 1.82 for wind and 0.92 for seismic. The B Stack analysis is appropriate with the exception of the influence of the liner on the stack. The B Stack should remain standing during and following the High Hazard Facility DBW, but is expected to collapse during the DBE.

A probabilistic seismic hazard study of the 200 East Area was performed. This study recommends peak ground accelerations of 0.07g and 0.20g for Moderate and High Hazard Facilities, respectively. These peak ground accelerations are to be used with a Newmark-Hall response spectrum. The seismic hazard study results are justifiable, and the results should be incorporated.

A construction joint moment-rotation model was developed for selected construction joints in B Plant. This model is inconsistent in the basic assumptions and in the different analytical methods employed, and the results of these different methods are merged. The fundamental assumptions should be reconsidered and a more coherent approach adopted.

Preliminary linear dynamic analyses of the B Plant were performed. In these analyses,, the response of B Plant to various combinations of joint spring models and their location is determined. These analyses yield valuable insight into B Plant's

response and are the forerunner of the inelastic direct integration dynamic analysis of B Plant. The proposed inelastic analysis of B Plant is appropriate and should yield the best estimate of the canyon structural behavior during the postulated DBE.

The principal balance of plant systems considered are architectural features, special facilities, and mechanical and electrical systems. These system categories were reviewed with special emphasis on their compliance with DOE 6430.1A. LATA's independent assessment of the DOE 6430.1A requirements is compared with SAIC's Task 3 detailed compliance assessment. An assessment matrix was constructed containing the results of the review. Of particular concern were those criteria having an importance value of 5 with regard to adverse effect on safety and the environment. Among the criteria not addressed and considered critical to the successful performance of the new pretreatment mission were

- in-place testing of HEPA filter banks,
- single failure criterion and redundancy, and
- management of non-radioactive hazardous waste.

The safety analysis review examined the pertinent DOE Orders, NRC Regulations, and other codes and standards for the proposed pretreatment mission. For the most part, the requirements are applied through inclusion in DOE 6430.1A. Four critical items were identified

- the basis for assuming the facilities are not plutonium handling facilities,
- the possibility of asbestos containing materials having been used in the original construction,
- the management of industrial wastes, and
- the absence of a Design Basis Fire.

2.2 Findings and Recommendations

This section is divided into three parts. The first part lists items needed to improve, correct, or complete the viability study and may be considered as findings. The second part lists items needed in the future to support the viability study. The third part lists items which would improve the viability study or clarify conflicting regulatory requirements.

Those items needed now to support the viability study are

1. Perform an inelastic direct integration dynamics analysis of B Plant for the postulated DBE.

2. Reconsider the joint moment rotation model which is inconsistent in its basic assumptions.

3. Develop and use a consistent set of basic material properties in all parts of similar analyses.

4. Reevaluate the classification of the AR Vault and Stack as Moderate Hazard Facilities for analysis. The current revision of SDC 4.1 does not allow this classification.

5. Revise SDC 4.1 to incorporate the new earthquake levels and design response spectra, to permit the Moderate Hazard Facility classification, to clarify the use of UCRL 15910 provisions in wind and earthquake loading conditions, and to state the OBE design requirements.

6. Demonstrate that the existing final HEPA filter systems complies with the in-place testing requirement and single failure criterion.

7. Perform single failure analyses on all safety class systems.

8. Demonstrate proper management of hazardous and mixed waste

9. Consider a Design Basis Fire.

Those items needed at a future date to support the viability study are:

1. Dynamic analyses per UCRL 15910 are required for the AR Vault, AR Stack, and B Stack.

2. All applicable design loading cases specified in SDC 4.1 are required for all four structures.

3. Perform full and complete analyses for those parts of structures that were not analyzed or were not analyzed in equal detail.

4. Complete a Preliminary Safety Analysis Review (PSAR) applying the proposed disposal processes and equipment to the modified facilities to complete the evaluation of the effects of the maximum credible accidents.

5. Determine the maximum amount of plutonium which might be contained in the facilities in future operations and clarify the rationale for considering the facilities to not be a plutonium handling facility.

6. Based upon work already underway, define the Safety Class Items and apply the results to determine additional modifications which might be required.

7. Determine the compliance of existing facilities to Sections 0110-5.4 (Asbestos Containing Materials) and 0275-99.0.1 (Industrial Wastes) of DOE 6430.1A and take action as appropriate.

8. Develop and maintain drawings and operational procedures on an "as-built" status.

Those items needed to improve the viability study or to clarify conflicting regulatory requirements are:

1. Clarification of the UCRL 15910 provisions requiring a UBC type analysis with importance factor of 2.0 for Moderate and High Hazard Facilities.

2. Better definition of the original design criteria for each structure.

3. A summary of the structure's performance to date, including routine and major repairs.

4. A comparison of B Plant and AR Vault to other identical or similar structures at Hanford and their performance.

5. A description and discussion of any past structural analyses on these facilities.

6. Attempt to locate members of the original design and construction teams for both structures to help complete the design and construction picture.

3.0 REVIEW OF CHEMICAL PROCESSING

3.1 Method of Review

The chemical processing for B-Plant and 244-AR Vault was reviewed to permit an evaluation of the technical viability and safety of the plans. This review consisted of:

1. A review of the following documents received from WHC, prepared by Rockwell Hanford or WHC:

Report No.	Title	Author(s) (Company)	Date
SD-WM-SAR-013 Rev 0	B Plant Safety Analysis Report	R.G. Sewell (Rockwell Hanford Co.)	7/85
SD-WM-SAR-013 Rev 1	B Plant Safety Analysis Report	Roger G. Sewell (Rockwell Hanford Co.)	3/86
SD-WM-SAR-013 Rev 2	B Plant Safety Analysis Report	J.M. Siemer (Rockwell Hanford Co.)	7/86
SD-WM-SAR-018 Rev 1	Safety Analysis Report for 244-AR Vault	(Rockwell Hanford Co.)	?
SD-WM-TA-010 Rev 0	Technology Study for the Pretreatment of Complexant Concentrate	D.E. Kurath (Rockwell Hanford Co.)	6/85
SD-WM-TPP-040 Rev 0	Technology Program Plan for the Pretreatment of Complexant	R.M. Orine (Westinghouse Hanford Co.)	11/88
SD-WM-PTR-006 Rev 0	B Plant NCAW Process Test Report	D.M. Gerboth (Rockwell Hanford Co.)	5/87
SD-WM-TA-015	Process and Facility Option for Pretreatment of Hanford Tank Waste	M.J. Kopfer (WHC) A.L. Boldt (WHC) J.L. Buelt (PNL)	9/88
WHC-EP-0229	Double Shell Tank Waste Disposal Integration Plan	N.W. Kirch (Westinghouse Hanford Co.)	2/89
WHC-SP-0464	Assessment of Double Shell Tank Waste Pretreatment Options	(Westinghouse Hanford Co.)	3/89
WHC-CM-4-30	Nuclear Safety Manual; Safety Evaluation of Facility and Process Design, Modifications and Construction	Q.L. Baird (Westinghouse Hanford Co.)	7/88

Report No.	Title	Author(s) (Company)	Date
WHC-CM-1-3 MRP 5.46 Rev 0	Management Requirements and Procedures; Safety Classification of Systems,Components, and Structures	(Westinghouse Hanford Co.)	4/89
WHC-CM-1-3 MRP 5.43 Rev 4	Management Requirements and Procedures; Impact Levels	(Westinghouse Hanford Co.)	4/89
SD-WM-SA-002 Rev 0	B Plant Safety Systems Seismic Evaluations Program	F.R. LaSalle (Westinghouse Hanford Co.)	3/89
SD-WM-ES-124	B Plant Life Extension Study	R. R. Wyer (Westinghouse Hanford Co.)	2/89
SD-XX-XX-XXX	B Plant Preliminary Accident Analysis	R. M. Marusich (Westinghouse Hanford Co.)	3/89

2. A review of the following SAIC prepared documents received from WHC:

Report No.	Title	Author(s) (Company)	Date
89-3-3-4	B Plant Compliance to DOE Order 6430.1A and Other Codes, Standards, and Regulations	(Science Applications International Corporation)	(4/89)
89-4-3-4	244-AR Vault Compliance to DOE Order 6430.1A and Other Codes, Standards, and Regulations (Task 3)	(Science Applications International Corporation)	4/89

3. A review of DOE 6430.1A (General Design Criteria Manual); Division 13, (Special Facilities).

These were reviewed for familiarization and perspective, to understand the status of development of the processes and to determine the applicable regulatory documents.

3.2 Description of Chemical Processing

The proposed process consists of disposal of double-shell tank waste through pretreatment to provide separation of the waste into transuranic waste, high level waste and low level waste so that the low level waste can be disposed of in cementitious grout while the transuranic and high level waste is disposed of in glass form.

Four different wastes have been identified for pretreatment:

- Complexant Concentrate (CC),
- Neutralized Current Acid Waste (NCAW),
- Plutonium Finishing Plant Waste (PFP), and
- Neutralized Cladding Removal Waste (NCRW).

The reviewed waste management plan calls for the necessary pretreatment operations to be performed in an upgraded B-Plant facility and an upgraded 244-AR vault. Additionally, if a future decision is made to process single-shell tank wastes, the ability to extend the DST program to SST wastes requires consideration.

Each waste has certain chemical properties that will require specialized pretreatment. The program schedule calls for commencement of pretreatment of NCAW in B-Plant in October, 1993, followed by pretreatment of CC, PFP, and NCRW in FY 2001.

The NCAW is the initial waste identified for pretreatment and disposal. A process test was successfully conducted in B-Plant in 1987 to demonstrate the pretreatment system. It is planned to further prepare B-Plant for a NCAW pretreatment demonstration starting in October, 1993 and continuing through FY 1994. Following a 12-month maintenance outage during FY 1995, operational-scale pretreatment of NCAW will commence and continue until completion FY 1999.

Upon completion of the pretreatment of NCAW, transuranic extraction (TRUEX) and CC destruction process equipment will be installed in B-Plant to permit pretreatment of CC waste in April 2001. PFP waste and NCRW pretreatment will follow with a contemplated completion in FY 2008.

NCAW processing will use sludge washing and ion exchange technology. The process consists of separation of the alkaline liquid from the sludge, water washing the sludge, and ion exchange of the combined supernatent and water washes. The NCAW is retrieved from an aging waste tank and pumped to the 244-AR vault, then transferred to B-Plant batchwise. The resultant washed solids and Cs concentrate are then transferred to the HWVP feed tank via the 244-AR Vault. The LLW stream goes to the tank farm for disposal as grout.

It has yet to be determined whether to wash the sludge in B-Plant, the DSTs, or the 244-AR Vault.

The planned process for CC waste pretreatment consists of acidification and clarification of the alkaline waste, use of TRUEX process technology for removal of TRU elements, and destruction of the organic complexants.

There is a program plan for the development efforts to support the CC pretreatment. Included in the plans are provisions for laboratory work, and a major pilot plant. The development activities extend from FY 1988 through FY 1994. The culmination of the program is the preparation of a Conceptual Design Report.

This development program is to resolve specific technology development issues including:

- acidification of CC and characterization of the residual solids,
- solid/liquid separations,
- solids dissolution,
- TRUEX process technology,
- organic destruction technology, and
- disposability in grout and glass.

Location of the Pilot Plant is yet to be determined.

The PFP waste and NCRW pretreatment processes are similar, requiring solid/liquid separation, acidification/dissolution and TRUEX process technology application.

It is planned to complete a PFP waste Pilot Plant demonstration in March 1996 and a NCRW Pilot Plant demonstration in March 1998.

3.3 Analysis

The current stage of the program is recognized as preliminary in that extensive development and pilot plant work is yet to be performed. Thus this evaluation is not in any way a final evaluation. That will be necessary in steps during the development and pilot activities and then again during design and construction of modifications to the

244-AR Vault and B-Plant and preparation of the future report documents such as Conceptual Design Reports (CDRs).

The many questions yet to be answered are recognized in the reports reviewed, particularly in the documents, SD-WM-TPP-040, "Technology Program Plans for Pretreatment of Complexant," dated 10/19/88 and WHC-SP-0464, "Assessment of Double-Shell Tank Waste Pretreatment Options," dated March 1989.

Viability of the chemical operations will be established during the development and pilot plant work. Safety of the systems will have to be developed concurrently as well as during the design engineering and preparation of operational procedures to follow.

A review of the two documents prepared by Science Applications International Corporation, "244-AR Vault Compliance to DOE Order 6430.1A and Other Codes, Standards, and Regulations," dated April 7, 1989 and "B-Plant compliance to DOE Order 6430.1A and Other Codes, Standards, and Regulations," dated April 13, 1989 indicates SAIC had access to 244-AR Vault and B-Plant details from which to draw conclusions and recommendations. SAIC has been thorough in the listing of DOE Orders and codes, standards, and regulations (CS&Rs) considered applicable to permit reactivation of the two facilities for a 20 year mission.

The SAIC review of CDRs, design criteria and drawings, SARs, technical reports, and Hanford standards resulted in a listing of non-compliance items which appear adequate and should be given full consideration.

It is not clear on what basis the two facilities were assumed to not be plutonium handling facilities. This should be clarified and confirmed.

Two documents to which particular attention was devoted were "B-Plant Preliminary Accident Analysis," authored by R. M. Marusich, March 8, 1989, and "B-Plant Life Extension Scoping Study for Comment," by R. R. Wyer, February 27, 1989.

The accident analysis scenarios were taken from the existing SAR. This is a good start in determination of the safety aspects, but there was no apparent examination to check the similarities of the planned process to the old. It is recommended that such

examination be made and the accident analysis approach be continued throughout the development and pilot operations.

There was insufficient data to determine the validity of the assumptions and figures used. The seven scenarios were considered to bound the problem sufficiently for the present; thus there was no attempt to generate scenarios of our own.

The Life Extension Scoping Study reviewed 16 systems by interviewing each system cognizant engineer. The same checklist was used for each system, i.e., direct questions. The response were quite specific to each question in most all cases. Someone then prepared the summary. We cannot tell if in-depth questions and discussions were used in addition to the direct checklist questions. Usually such interviews result in worthwhile comments beyond specific questions. It is recommended that additional interviews be conducted with a broader scope and an independent review then be conducted of the summary, unless the present summary is a result of information from the cognizant engineers beyond the direct questions.

If engineering details and drawings and operational procedures on the two facilities are not up-to-date on an "as-built" status, it is recommended that a program be instigated to bring them to the "as-built" status.

"The Double-Shell Tank Waste Disposal Integration Plan," by N. W. Kirch, January, 1989 contains Double-Shell Tank Waste Disposal Contributing End-Function Schedules. It is recommended that the following be reflected in these schedules.

- schedule for updated SAR for the 244-AR Vault,
- Readiness Reviews for B-Plant,
- designated times for safety analyses and risk assessments, and
- schedules for environmental impact statements.

3.4 Summary

SAIC's studies to identify 244-AR Vault and B-Plant compliance/non-compliance to DOE Orders and CS&Rs to permit reactivation for a 20 year mission are sufficient for the current stage of the program.

Recommendations have been made in the analysis for your consideration. The development and pilot work of the processes must be accompanied by continuing safety review and analysis and conformity to applicable CS&Rs.

As a result of our review, we see no reason why, if the program is followed as planned, there should be any undue risk to the health and safety of employees and the general public or the environment.

4.0 REVIEW OF STRUCTURAL AND SEISMIC ANALYSIS

4.1 General Description of Affected Systems

The structural and seismic review was limited to the B Plant canyon structure, the B Plant stack, the AR Vault structure, and the AR stack. The B Plant and AR Vault are the two major and most costly items in the list of facilities needed for pretreatment. Their major structural systems are the buildings themselves and their ventilation stacks. These four items are considered vital to the feasibility of the current B Plant study. Structural reviews of other components of these facilities or of other facilities on the pretreatment list were not thought necessary at this point, because the results would not alter the final conclusion on feasibility. These reviews remain to be done at a later date.

B Plant and B Stack were built in 1943 and 1944. The AR Vault and AR Stack were completed in 1968. All four structures are reinforced concrete. The first two were constructed under the provisions of the 1941 American Concrete Institute (ACI) code and the War Production Board's modification of it. The last two were constructed under the provisions of the 1963 ACI code.

4.2 Method of Review and Evaluation of Affected Systems

The following steps were performed in the structural and seismic review process:

- reviewed original drawings for structures,
- reviewed reports and calculations prepared by WHC,
- reviewed reports prepared by others for WHC,
- reviewed regulations by DOE and others,
- reviewed literature, especially pre-1946,
- reviewed codes of record, then and now, and
- performed independent calculations.

The items reviewed are listed in Table 4-1. The table also notes whether the review was for technical detail or general information.

Drawings

W-69566 221-B Plant - Standards Section.

W-69512 291-B Stack - Foundation Details.

H-2-62000,-2 244-AR Vault - Abovegrade Concrete Sections.

H-2-61997,-8,-9 244-AR Vault - Belowgrade Concrete Sections.

Reports and Calculations by WHC

AR Vault, AR Stack, and B Plant Stack Seismic Evaluation, March 9, 1987.

B Plant Seismic Evaluation, Preliminary Nonlinear Capacity Results, January 31, 1989.

B Plant Safety Systems Seismic Evaluation Program, March 1989.

B Plant Life Extension Scoping Study, February 1989.

B Plant Preliminary Accident Analysis, March 8, 1989.

B Plant Structural Qualification, Interim Report, December 2, 1988. (I)

Double-Shell Tank Waste Disposal Integration Plan, January 1989. (I)

Assessment of Double-Shell Tank Waste Treatment Options, March 1989. (I)

Technology Study for the Pretreatment of Complexant Concentrate, June 1985. (I)

Technology Program Plant for the Pretreatment of Complexant Concentrate, November 1988, (I)

B Plant NCAW Precess Test Report, May 1987. (I)

Process & Facility Options for Pretreatment of Hanford Tank Wastes, September 1988. (I)

Safety Analysis Reports and WHC Standard Specifications and Criteria

B Plant Safety Analysis Report, Revisions 1, 2, and 3.

AR-Vault Safety Analysis Report, Revision 1.

SDC 4.1, Design Loads for Structures, Revision 7, 1974; Revision 10, 1988.

HPS-220-W, Std. Specified for Welding Carbon Steel, Revision, 1976. (I).

HPS-230-W, Std. Specified for Welding Austenitic Stainless Steels, Revision 2, 1973. (I)

Reports by Others

SAIC Task 3 Report, B Plant Compliance, April 1989. (I)

SAIC Task 3 Report, AR-Vault Compliance, April 1989. (I)

Regulations

DOE 6430.1A.

UCRL 15910, Drafts of June 1987 and May 1989.

UCRL 53582, Revision 1.

NUREG/CR-0098.

Codes

ACI 318-41, -63, -83.

ACI 349-80.

UBC 1964, 1988.

Literature

Manual of Standard Practice for Detailing Reinforced Concrete Structures, ACI, 1946. (I)

Analysis of Rigid Frame Bridge, PCA, 1936. (I)

The Rigid Frame Bridge, Hayden, 1940. (I)

Continuous Frames of Reinforced Concrete, Cross and Morgan, 1932. (I)

Design of Reinforced Concrete Structures, Peabody, 1936 and 1946. (I)

Principles of Reinforced Concrete Structures, Turneaure and Maurer, 1935. (I)

Reinforced Concrete Construction, Hool, Vol I 1917, Vol II 1927, Vol III 1928. (I)

Reinforced Concrete Construction, Hool and Pulver, 1937. (I)

Concrete Manual, Bureau of Reclamation, 1941. (I)

(I) = Reviewed for information only.
no mark = Reviewed for technical content.

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The review process was performed in two parts where sufficient information was available. First, the structure or item was evaluated in a strict technical sense for technical accuracy, appropriateness, correlation with codes (then and now), and good engineering judgment. In other words, does it make sense and can it stand on its own merit? Second, the structure was evaluated for compliance with the regulatory positions. Often the structures would pass the first review and not the second.

In the first evaluation, the criteria were:

- code of record for the structure,
- current code,
- general engineering principles,
- general acceptance of method based on current literature, and
- performance of the item to date.

In the second evaluation, the criteria were, in descending order of importance:

- DOE 6430.1A, draft dated December 25, 1987,
- SDC 4.1,
- UCRL 15910, drafts dated June 1987, May 1989,
- UCRL 53582, Revision 1,
- WHC Nuclear Safety Manual, and
- WHC MRP.

A final assessment was made to determine whether the above studies were sufficient to support or not support viability of the project. For any study deemed insufficient, inappropriate or inaccurate, LATA developed a description of the elements needed to offset the deficiencies.

A word of caution should be given regarding the evaluations. The current stage of the project is the performance of preliminary analyses, evaluations, studies, and reviews of suitable accuracy on which to base a project feasibility decision. These analyses and evaluations are not intended to be necessarily complete or final works on which final design, safety, operating or licensing decisions will be made. Such final analyses and evaluations will be performed to support the 1993+ timeframe for operation of the proposed facility if that is the decision.

4.3 Review of Codes and Regulations

Three different concrete codes and various regulations were used in the review process. The differences and conflicts in these documents will be discussed prior to a discussion of the analysis results.

4.3.1 Variation of Codes

Three different concrete codes were used in the review process--the 1941 and 1963 ACI codes under which the structures were built, and the 1983 ACI code against which the structures are evaluated. These codes also form the basis for the Uniform Building Codes (UBC) issued after their respective dates. These codes are briefly described below. A comparison of the significant aspects of the codes follow. For the present case the flexural, shear, and bond requirements are of interest.

The 1941 ACI Code uses the Working Stress Design (WSD) method. In this method, the actual magnitude of the expected design loads is used; load factors are not used. Allowable stresses, typically about one-half of yield or ultimate values, are used for design. The safety factor in the design process is incorporated in the reserve capacity between the allowable stresses and yield or ultimate values.

The 1963 ACI Code was a split code. It allowed use of the WSD method and the Ultimate Strength Design (USD) method. It was the last issued code to formally endorse the WSD method. In the USD method, the actual magnitude of the expected design loads is increased by a load factor. Load factors vary from 0.9 to 1.8 depending upon the type of load and the load combination. Yield and ultimate stresses are used for design. The safety factor in the design process is incorporated in the load factors.

The 1983 ACI code, the latest code of issue, uses the USD method. The WSD method is designated as the "Alternate Design Method" and relegated to Appendix B.

The key code is the 1963 ACI code. This provides a direct comparison of the WSD and USD methods without the confusion of intervening years, additional research, or changing philosophy. The 1963 code was the changeover code. In contrast, the 1956 code was all WSD with USD allowed by special provision, and the 1971 code was all USD with WSD allowed by special provision. Under the provisions of the 1963 code, a

structure would possess essentially the same structural configuration and safety factor against collapse regardless of the design method used. In practice, the USD method tended to give smaller sections with slightly more reinforcement, to increase shear stress and the need for stirrups, and to increase service load deflections.

The codes following the 1963 code have become less conservative by reducing load factors and by slight increases in certain stress limits. The codes before the 1963 code were more conservative in design equations, in stress allowables, and often more detailed in specification breakdowns. The significant changes between the 1941 and 1963 codes were the substitution of d for jd in the shear equations and using $\sqrt{f'c}$ instead of f'c as the basis for the shear and bond allowables. The significant change between the 1963 and 1983 codes was in bond and anchorage. A comparison of steel and concrete allowable stresses for the various codes is given in Table 4-2. A comparison of selected working stress design equations and criteria is given in Table 4-3. A comparison of load combinations and load factors is given in Table 4-4.

In general a structure designed under the older codes will continue to pass the new codes for flexure, shear, and bond.

4.3.2 Wartime Allowable Stresses

The War Production Board modified the 1941 ACI provisions in an attempt to reduce steel usage. These modifications were in effect at the time B Plant was designed and constructed. The following paragraphs are taken from Peabody, 1946 and describe these modifications. The numerical impact of the modifications is also presented in Table 4-2.

> The War Production Board's Emergency Specifications for Reinforced Concrete Design were based on the 1941 A.C.I. Code in general. The object of these specifications is to reduce the amount of steel used as reinforcement. Therefore, it is recommended that plain concrete be used wherever possible, even though the plain concrete design does not give the most economical footing or retaining wall. The reinforced beam section should be large enough so that no compression steel is needed. For column design, it is recommended that tied columns be used instead of spiral, that the longitudinal steel should not exceed 2 per cent, and that high-strength concrete be adopted.

TABLE 4-2
COMPARISON OF STEEL AND CONCRETE ALLOWABLE STRESSES FOR VARIOUS CODES

		ACI Code (318-xx) Issued				Values for f'_c = 2,500 psi			
		1941	Wartime	1963	1988	1941	War-time	1963	1988
Steel in tension									
Rail-steel, billet-steel (intermediate & hard grades), and axle-steel (intermediate & hard grades) bars and cold-drawn steel wire	f_s	20,000	24,000	20,000	20,000				
Billet-steel (structural grade) and axle-steel (structural grade)	f_s	18,000	20,000	18,000	Not Used				
Deformed bars with yield strength of 60,000 psi or more	f_s	Not Available		24,000	24,000				
Concrete									
Modulus of elasticity (for normal weight 145 pcf concrete)	E_c	1,000 f'c		$w^{1.5}\,33\sqrt{f'c}$ or $57{,}500\sqrt{f'c}$	$w^{1.5}\,33\sqrt{f'c}$ or $57{,}000\sqrt{f'c}$	2,500,000	NC	2,880,000	2,880,00
Modulus of elasticity ratio, n	n	3,000 / f' c		29,000,000 / f'c	29,000,000 / f'c	12	NC	10	10
Flexure, fc									
Extreme fiber stress in compression	f_c	0 45 f 'c	0.35 f 'c	0.45 f 'c	0.45 f 'c	1,125	875	1,125	1,125
Extreme fiber stress in tension in plain concrete	f_t	0.03 f 'c		$1.6\sqrt{f'c}$		75		80	
Shear, v_c									
Beams with no web reinforcement	v_c	0.02 f 'c	NC	$1.1\sqrt{f'c}$	$1.1\sqrt{f'c}$	50	NC	55	55
Beams with no web reinforcement, but with special anchorage	v_c	0.03 f 'c	NC			75	NC		
Beams with web reinforcement	v	0 06 f 'c	NC	$5\sqrt{f'c}$	$5\sqrt{f'c}$	150	NC	250	275
Beams with web reinforcement and with special anchorage	v	0.12 f 'c	NC			300	NC		
Flat slabs at distance d from edge	v_c	0 03 f 'c	NC	$2\sqrt{f'c}$		75	NC	100	
Footings	v_c	0 03 f 'c ≤ 75 psi	NC	$2\sqrt{f'c}$		75	NC	100	
Bond, u									
Plain bars	u	0 04 f 'c ≤ 160	10% increase	$2.1\sqrt{f'c}$	Based on Ultimate	100	110	105	—
Deformed bars	u	0.05 f 'c ≤ 200	10% increase	$3\sqrt{f'c}$	Strength Design	125	138	150	—
Bearing, fc									
On full area	f_c	0 25 f 'c		0.25 f 'c	0.3 f 'c	625		625	750
On one-third area or less	f_c	0.375 f 'c		0.375 f 'c	0 3 f 'c	938		938	750

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TABLE 4-3
COMPARISON OF SELECTED WORKING
STRESS DESIGN EQUATIONS AND CRITERIA

	1941 ACI	1963 ACI	1983 ACI
Flexure	Same Theory	Same Theory	Same Theory
Shear			
· Concrete	$v = V/bjd$	$v = V/bd$	$v = V/bd$
· Stirrups	$A_v = V's/f_v\,jd$	$A_v = V's/f_v\,d$	$A_v = V's/f_v\,d$
Bond	$u = V/\Sigma_o\,jd$	$u = V/\Sigma_o\,jd$	USD embedment
Shrinkage & Temperature Steel			
· Plain Bars	.0025 floors .003 roofs	.0025	—
· Deformed Bars	.002 floors .0025 roof	.002	.002

V' = excess of the Total shear over that permitted on the concrete

TABLE 4-4
COMPARISON OF LOAD COMBINATIONS AND LOAD FACTORS

Loading Case	1941 ACI	1963 ACI		1983 ACI
		WSD	USD	
Dead + Live	D + L	D + L	1.5D + 1.8L	1.4D + 1.7L
Dead + Live + Wind	D + L + W*	D + L + W*	1.25 (D + L + W) 0.9D + 1.1W	0.75 (1.4D + 1.7L + 1.7W) 0.9D + 1.3W
Dead + Live + Earthquake	Not Addressed	D + L + E*	1.25(D + L + E)	0.75[1.4D + 1.7L + 1.7(1.1E)] 0.9D + 1.3(1.1E)

* One-third increase in stress allowable permitted.

To force the use of larger sections the maximum fiber stress in beams is reduced to $0.35f'_c$, instead of $0.45f'_c$. Shear and diagonal tension stresses are not changed but bond stresses are increased 10 per cent.

The tensile steel stress in the structural grade is increased 10 per cent to 20,000 lb per sq in., whereas for the other grades it is increased 20 per cent to 24,000 lb per sq in. The reduction of fiber stress in the concrete and increase in the steel will give larger sections and, also, less steel for the section chosen.

4.3.3 Variation in Regulations

The primary regulatory documents are DOE 6430.1A, SDC 4.1, and WHC MRP 5.46. These in turn reference UCRL 15910 (Kennedy and others, 1989) and 53582 (Coats and Murray, 1984) and also UBC and ACI. Several conflicts exist in these documents in classification of structures, load combinations, and loads. These are discussed below.

Classification of Structures

DOE 6430.1A classifies structures as safety class or nonsafety class. Safety class structures deal with nuclear criticality, radioactive release, or safe shutdown. The pretreatment operations would fall under the safety class structure for nonreactor nuclear facilities with section 0111-99.0 applying.

SDC 4.1 (Rev. 10) classifies structures as Category I and Non-Category I. These are in accordance with DOE 6430.1A. For nonreactor facilities, the term Category I is equivalent to the UCRL 15910 Category IV (High Hazard). In the analyses discussed in this report, the AR Vault is classified as Moderate Hazard. The current revision of SDC 4.1 does not allow this classification. We understand SDC 4.1 is presently being revised. We assume the revision will eliminate this conflict.

WHC MRP 5.46 classifies items as safety class, occupational safety, and non-safety class. These are in accordance with DOE 6430.1A. UCRL 15910 defines four categories of structures. These four categories do not agree with DOE 6430.1A, but can be made to fit. The pretreatment operations would be in either the moderate or high hazard category depending upon the processing step considered. The classifications are summarized in Table 4-5.

Earthquake Specifications

DOE 6430.1A is a general document and specifies design requirements primarily by reference to other documents and codes. However, Section 0111-99.0.4, "Earthquakes" discusses DBE and OBE for Nonreactor Nuclear Facilities. It states "... structures shall be designed to withstand a DBE and to continue to operate after the occurrence of the OBE". It references UCRL 53582 for establishing these and UCRL 15910 for guidance in applying them. The required two earthquakes can be determined from the data

presented in UCRL 53582. However, because UCRL 15910 does not consider two earthquakes, a conflict exists. SDC 4.1 defines both earthquakes and fulfills all the requirements stated in DOE 6430.1A. The peak ground acceleration associated with the earthquakes are different. The required numerical values are summarized in Table 4-6.

TABLE 4-5
CLASSIFICATION OF STRUCTURES

DOE 6430.1A	SDC 4.1 (Rev. 10)	UCRL 15910	MRP 5.46
Categories allowed: Nonsafety Class Safety Class	Non-Category I Category I (reactor or nonreactor)	I General Use II Important or Low Hazard III Moderate Hazard IV High Hazard	Non-Safety Class Occupational Safety Class Safety Class
Pretreatment: Safety Class	Category I - nonreactor	Moderate or High Hazard depending upon processing step	Safety Class

TABLE 4-6
SUMMARY OF EARTHQUAKE REQUIREMENTS

	DOE 6430 1A	UCRL 15910	SDC 4 1 (Rev 10)	Proposed SDC 4 1
Earthquakes Required	DBE & OBE	DBE	DBE & OBE	DBE & OBE
Zero Period Acceleration · DBE · OBE	≥ 0 10g * ≥ 0.05g *	0 17g High Hazard 0 12g Mod. Hazard —	0.25g 0.05g	0 20g High Hazard 0 12g Mod Hazard 0 05g

* Minimum value but otherwise not specified. References UCRL 53582 & 15910.

A potential problem arises in the OBE analysis. SDC 4.1 refers to DOE 6430.1A for this loading case. DOE 6430.1A, Section 0111-99.0.8, "Load Combinations," refers to "... appropriate load combinations provided in UCLR 15910." UCRL 15910 does not address the OBE. For the DBE, it allows considerable inelastic structural behavior, uses load factors of 1.0, and a concrete strength reduction factor of 1.0. This inelastic behavior is typically not permitted for OBE loads. The OBE may control the design under certain combinations of OBE acceleration level, lower damping ratios, no inelastic behavior, and code load factors. The lack of specific direction for the OBE case needs to be resolved.

UCRL 15910 gives the required analysis methods for each of the four categories. The May 1989 draft states in bold type "the 1988 UBC provisions with I = 2.0 provide minimum seismic requirements for Moderate and High Hazard facilities." A dynamic

analysis is also required for these classifications per UCRL 15910. However, it is not apparent from the seismic analysis provisions that this UBC analysis can be waived regardless of the type and detail of the subsequent dynamic analysis. This provision will have a major impact on the B Plant and B Stack. Clarification of this provision is required or a stated exception to it. LATA would recommend taking exception to the requirement.

4.4 Detailed Description of Reviewed B-Plant Systems

The structures discussed in this section were analyzed for Design Basis Wind and Earthquake loadings. The structures were not analyzed for dead, snow, or ashfall loading. These loading conditions should not control, but need to be included in the final analysis. The Probable Maximum Flood (PMF) does not inundate the site and need not be considered. The OBE loading case required by DOE 6430.1A and SDC 4.1 (Rev. 10) is not considered. It should not control the structural design, but should be included in the final analysis.

The wind and earthquake parameters used in the analyses are summarized in Table 4-7.

TABLE 4-7
SUMMARY OF LOADS, LOADING CONDITIONS,
AND OTHER ANALYSIS PARAMETERS

	AR Vault & AR Stack				B Stack	
	UCRL 15910	As Analyzed			UCRL 15910	As Analyzed
Structure Classification	Moderate Hazard	Moderate Hazard			High Hazard	High Hazard
Wind						
· Speed (mph)	80	100			90	115
· Loads	per ANSI A58 1 1982	Same			per ANSI A58 1 1982	Same
· Load Conditions	Same as UBC & ACI	Same			Same as UBC & ACI	Same
Earthquake						
· Zero period acceleration	0.12g	0.07g	Zone 2	0.12g	0.17g	0.20g
· Analysis method	Dynamic + UBC I = 2.0	UCRL UBC	UBC	UCRL UBC	Dynamic + UBC I = 2.0	UBC
· Importance factor (I)	2.0	2.0	1.25	2.0	2.0	1.00
· Equivalent g	—	0.06g	0.115g	0.11g	—	0.33g
· Loading condition	$U = (D + L + E)/F_u$	$U = D + E$			$U = (D + L + E)/F_u$	$U = D + E$
· Φ factor	1.0	0.9			1.0	0.9

4.4.1 221-B Canyon Structure

4.4.1.1 General Description

The 221-B Plant canyon structure is a reinforced concrete structure. Figure 4-1 shows a typical cutaway cross section. The overall length of the canyon is 810.5 ft. The canyon is 77 ft 2 in. high with partial embedments of 22.5 ft and 16 ft on the south and north sides, respectively. The building is supported on a 6-ft-thick concrete slab. The cross-sectional width is a constant 66 ft 2 in. up to a height of 59.75 ft and then increases to a maximum of 68 ft 2 in. at the roof top. The roof slab is a constant 3 ft for the center half of the span and thickens to 4 ft at the edges. The exterior walls vary in thickness from 3 to 5 ft.

The structure is divided into 20 sections with transverse section joints provided at 40-ft intervals with the exception of sections 1, 2, and 20, which are spaced at 44, 43, and 44.5 ft, respectively. All expansion joints are keyed and offset to ensure necessary shielding requirements.

There are two interior longitudinal walls, neither extending to the roof. The north exterior and interior walls support the concrete slabs for the operating, pipe, and electrical galleries. The south exterior and interior walls support the slab of the air tunnel. The cells between the two interior walls and the hot pipe trench are covered with removable concrete blocks. There is a 75-ton capacity overhead bridge crane that spans the total width of the building.

The B Plant canyon was constructed during 1943 and 1944. It was designed in accordance with the UBC, which required consideration of lateral wind forces but not earthquake forces. The concrete design followed the provisions of the 1941 ACI Code. The 1941 ACI Code is based on the WSD method. The 1941 Code was modified by the War Production Board by imposing "wartime allowable stresses."

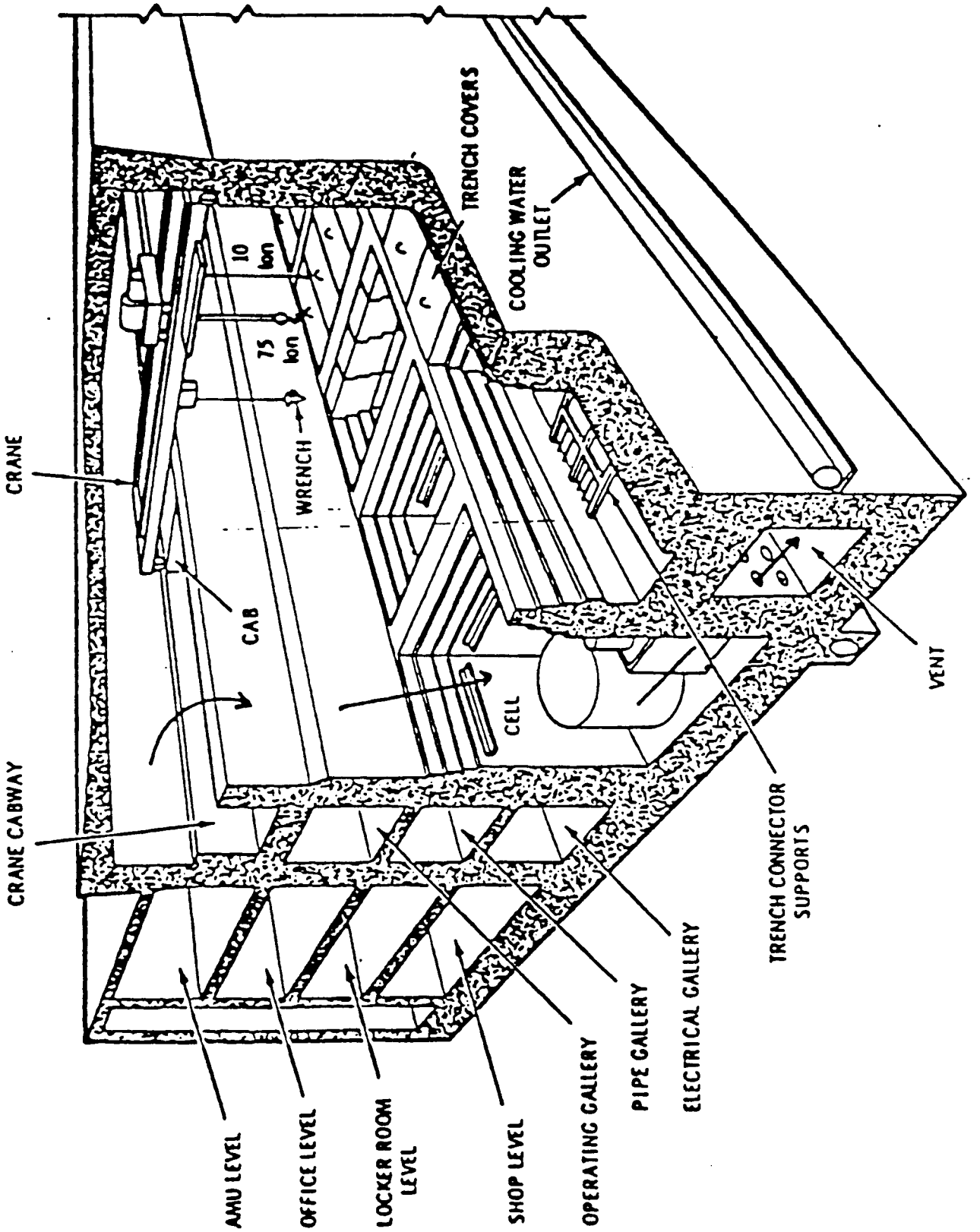

Figure 4-1. Buildings 221-B and 271-B

Reinforcement Pattern and Minimum Requirements

The steel is assumed to be intermediate grade billet steel (ASTM A-15) and is equivalent to Grade 40. The working stress allowable is 20,000 psi per the 1941 ACI Code and is increased to 24,000 psi by the War Production Board. Both round and square deformed bars are used.

The main reinforcement is heavy where required by analysis and typically consists of 1 1/8-in. and 1 1/4-in. square bars on 8 1/2-in. centers. For other areas a standard minimum steel of 1/2-in. round bars on 24-in. centers is called out. This minimum steel appears to be temperature and shrinkage steel. However, the amount specified does not meet either the minimum area of steel (.002) or maximum permitted spacings (18 in.) allowed by either the 1941 ACI Code or current codes.

Rigid Frame Bridge

The top portion of the canyon structure above the crane level looks like a rigid frame concrete bridge--an efficient highway bridge construction popular in the 1920s and 1930s. These structures with solid decks were economical up to span lengths of 70 ft for heavy highway loading (Hayden, 1940). Typical road clearance was 14 to 17 ft. The footing could be either fixed or pinned. The preliminary design and final analysis were straight forward, could utilize design charts, and were well documented (PCA, 1936; Cross and Morgan, 1932). The top portion of the canyon structure above the crane level bears an uncanny resemblance to the rigid frame bridge outline, member sizes, shapes, span, and height.

The rigid frame bridge would be a proven and quick design solution to the canyon roof. Considering the upper level of the canyon as a rigid frame concrete bridge would explain the joints and reinforcement at the crane level. The bridge simply sits atop the canyon side walls with pin connections. The pin supports isolate the parts of the structure for analysis. The pin supports are created by reducing the through steel in the joint. A true pin joint, as detailed in the highway construction (ACI 315-46), probably could not be utilized because of shielding requirements. The outward thrust of the frame legs is resisted by a shear step and by the heavy dowels. The dowels also prevent any inward movement of the legs and any walking.

It is unimportant whether the upper portion of the canyon is truly a rigid frame bridge. It does appear to be a frame of some type with extensive efforts made to isolate it from the remaining structure. It is important to keep this structural configuration in mind while evaluating the structure.

Presence and Effect of Construction Joints

The B-Canyon structure like all reinforced concrete structures contains many construction joints. WHC has some evidence that some construction joints are not fully bonded (Wagenblast, 1988). This lack of full bond on a construction joint is not an unusual occurrence and is not detrimental to the typical reinforced concrete structure. However, it does take on a special significance when considered with the lightly reinforced canyon structure. These construction joints provide preferential locations for tension cracks to form during flexure. The light amount of reinforcement permits these locations to deform more quickly than adjacent more solid or uncracked sections, thus allowing a cumulation of deformation to occur at the construction joint locations. Carried to an extreme these construction joints would act as plastic hinges in the structure if the loading were sufficient.

The location of the construction joints is shown in Figure 4-2. Extensive effort has gone into modeling the behavior of these joints. This work is described later.

4.4.1.2 Classification of Structure and Design Basis

The B Plant canyon is classified as a High Hazard Facility. The canyon contains essentially all of the chemical processing equipment for the proposed treatment process. The canyon structure must remain functional during and following the design basis events. The design basis events are an 90-mph wind and a 0.20g anchored earthquake. These design events are in accordance with or exceed the requirements of DOE 6430.1A, UCRL 15910, and proposed SDC 4.1.

4.4.1.3 Analysis Method

The B Canyon was and is being analyzed by several different methods. The B Canyon is a large complex structure and the analysis is progressing in stages. Two

Figure 4-2. 221-B Plant Construction Joint Locations

preliminary analyses and various parts of the final analysis have been completed. The two completed analyses are (1) a limit analysis (or mechanism analysis) to determine a horizontal static collapse load and (2) a linear dynamic response spectrum analysis attempting to model nonlinear behavior. The final analysis is a nonlinear time history dynamic analysis. To date the completed parts are (1) the definition of the seismic input, (2) joint moment-rotation model for the construction joints, and (3) construction of the structural finite element model.

4.4.1.4 Analysis Results

The results of WHC analyses available for review are contained in Attachments A through E of Conrads, 1989. Nondestructive testing (NDT) results of B Canyon are presented in Wagenblast, 1988 and were reviewed only from an information standpoint. The contents of the documents and their review are described below. For convenience in the discussion these various attachments are simply designated by the letter A through E.

Review of Attachment A--Seismic Exposure of B Plant

A probabilistic seismic hazard study of the 200 East Area, which includes B Plant, was performed by WHC and Woodward-Clyde Consultants (WCC). These studies were based on data compiled for the Washington Public Power Supply System, WNP No. 2, Final Safety Analysis Report (WPPSS, 1981). The results of the study are presented as a seismic hazard curve and recommended peak ground accelerations. The study indicates a peak ground acceleration of 0.17g is appropriate for high hazard facilities, but recommends use of a 0.20g value. A value of 0.07g is recommended for moderate hazard facilities. These peak ground accelerations are to be used with a Newmark-Hall response spectrum (Newmark and Hall, 1978) as recommended by UCRL-53582 and UCRL-15910.

The seismic hazard curves presented and the values recommended are reasonable. The use of the Newmark-Hall response spectrum is appropriate. The use of the peak ground acceleration values and the Newmark-Hall response spectrum will yield appropriately conservative results for structural analyses and internal equipment and systems evaluations.

The work performed by WHC and WCC constitutes an independent site specific seismic hazard evaluation as called out in DOE 6430.1A and UCRL 15910. As such it should take precedence over the more general values in UCRL 15910. UCRL 15910 describes four facility-use categories and specifies their hazard exceedance probabilities. A comparison of the peak ground accelerations for these categories determined by UCRL 15910 and this study is given below.

Category	Probability of Exceedance	Peak Ground Acceleration	
		UCRL 15910	Site Specific
General Use	2×10^{-3}	.07g	.05g
Important/Low Hazard	1×10^{-3}	.12g	.07g
Moderate Hazard	1×10^{-3}	.12g	.07g
High Hazard	2×10^{-4}	.17g	.17g

LATA concurs with the recommended values of 0.20g for the SSE and 0.07g for the moderate hazard facility. In addition LATA recommends use of 0.05g, as determined from the seismic hazard curve, for the general use category. LATA fully recommends substituting the WHC site-specific seismic hazard results for the information given in UCRL 53582 and that portion of it used in UCRL 15910.

The use of the site-specific data will remove all conflicts with UCRL 15910. DOE 6430.1A describes the design critical in general terms and does not recommend specific values. SDC 4.1 requires a SSE of 0.25g. This is a WHC document. It does not agree with UCRL 15910 in the classification of facility-use categories. We understand WHC is presently revising SDC 4.1 to include the site-specific results and to change the facility-use categories. Once this revision is complete, the site-specific study results will fully comply with DOE 6430.1A, UCRL 15910, and SDC 4.1.

Review of Attachment B--Construction Joint Moment-Rotation Model

The nonlinear dynamic seismic analysis of B-Plant proposed by WHC will require joint moment-rotation models for hinge points that will develop in the structure during the analysis. The location of these hinge points is dictated by the structures configuration and its loading. It is logical to assume these will form at the weakly

bonded construction joints. However, mechanism analyses and moment diagram checks may be performed which will identify the most critical hinge points or any missed ones.

In Attachment B, WHC has attempted to develop the joint moment-rotation model for selected possible hinge points and to define the associated moment-rotation (M-θ) curve for each location. LATA has reviewed the work and agrees with the basic plan, but not with the details of its execution. The general areas of agreement are that

- The joint model is needed.
- The M-θ curve is the proper way to define the model.
- The total joint capacity should include the dead weight restoring moment, but will require a geometry check before formation of the last hinge to determine that the dead load is still a "restoring" and not a "driving" load.

We disagree with the following items, which are discussed below:

- the yield moment assumption,
- the ultimate moment assumption,
- the lack of a strain hardening moment condition,
- the lack of a "yield plateau" portion in the M-Θ curve,
- the method of calculating rotation and the application of Lai's assumption regarding strains, and
- the overall divorced nature of the calculations.

The yield moment assumption is unnecessary. The moment capacity of the section may be calculated using elastic methods for the case of steel strain precisely at yield. For these sections the concrete is still linearly elastic. This series of computations is quite easy to perform and gives the yield moment capacity, the associated curvature, the location of the neutral axis, and the concrete stress and strain distributions. LATA performed these calculations. The resulting moment capacities compare favorably with the WHC values because all the sections are lightly reinforced. For lightly reinforced sections the compression zone is small and the compression resultant is located close to the compression face. Hence the good agreement. The state of concrete stress when the steel just yields gives the engineer a feel for how elastic or inelastic the concrete is, for how true his assumption is that "plane sections remain plane," and for the

correctness or accuracy of the curvature calculation. For these sections, the concrete stresses range from 301 to 1896 psi and the curvature calculations are good.

The ultimate moment assumption results in an incompatible strain state and is not valid. This assumption, as stated, demands that the concrete reach its ultimate strain of 0.003 in./in. and create its maximum compressive resultant exactly when the steel strain reaches 0.12 in./in. and is at its maximum tensile force. Such a balanced state is unlikely to exist. Of the 10 unique cases analyzed, five were controlled by the steel and five by the concrete. The five sections with low steel content, 0.527 sq. in. and less, all reached a steel strain of 0.12 before the concrete reached the 0.003 in./in. limit. The concrete strains ranged from 0.0010 to 0.00194 in./in., well below the 0.003 in./in. limit and all below the typical peak concrete stress value at approximately 0.002 in./in. strain. The five sections with high steel content all reached concrete strains of 0.003 in./in. before the steel could reach 0.12 in./in. strain. The actual steel strains ranged from 0.035 to 0.080 in./in. with corresponding stress values of 45 to 60 ksi.

The lack of a moment capacity when the steel strain reaches its strain hardening point is a serious flaw. The moment-rotation relationship between the yield moment point and ultimate moment capacity point should display a relatively flat zone or plateau beyond yield and then a steeper sloped portion rising to ultimate. The break in this zone is the strain hardening point. This point is reached when the concrete section has rotated sufficiently to allow the steel strain to reach its strain hardening value. Up to this point, the steel stress remains "constant" at its yield value and the only moment increase for the section is due to changes in the internal lever arm. Beyond this point, the steel stress will increase above yield value and will allow for a more rapid increase in section moment capacity.

The lack of a yield plateau in the M-θ curve may lead to violation of other basic assumptions in subsequent analyses. For example, the mechanism analysis approach described in Attachment E and elsewhere (Beedle, 1958 and Jones, 1966) assumes plastic hinges form and have a constant capacity when formed. This assumption allows the analysis to let these hinges rotate and not worry about the exact value of the rotation. Without the plateau it is necessary to update the hinge capacity with each increment of rotation. This can be done, but greatly complicates the computations.

The method of calculating rotations greatly overestimates the rotation expected of the section. The magnitude of these rotations is partially driven by one of WHC's fundamental assumptions. Compressive concrete strains are assumed equal to the calculated steel strains, and Lai, 1984 is cited to support this assumption. After reviewing Lai's paper, LATA believes one of his assumptions is being applied incorrectly.

Lai assumed the knee or yield point on the stress strain curve for his concrete material model to occur at the same strain as for the steel model. Assuming he is typically considering Grade 60 rebar with a yield stress of 60 ksi, the steel yield strain is 0.00207 in./in. The peak concrete stress typically occurs near a strain of 0.002 in./in. Thus his assumption is reasonable. He is modeling both steel and concrete materials with an elastic, perfectly plastic stress strain curve. He is positioning the knee of this curve, he has matched neither moduli nor yield stresses, and he is not assuming the strain values in the members, but is calculating them using his material property curves and other data.

The effect of the WHC assumption is to place equal magnitude tensile and compressive strains at the exterior faces of the members. This forces the neutral axis to the middepth of the member and violates all other assumptions made with regard to neutral axis location, concrete stress, stress distribution, and compressive resultant. The assumption appears to be unwarranted and unjustifiable. LATA suggest a re-evaluation of this fundamental assumption on strain distribution across the section. The primary concern is that the rotation characteristics and the moment magnitudes are the prime drivers in the joint spring models. These joint springs then become prime drivers in the inelastic frame analyses and their presence may result in a faulty conclusion.

The overall divorced nature of the calculations is a primary concern. The joint model is built in pieces and lacks a coherent and unified approach. The calculation of joint rotations is completely divorced from the previous moment calculations and their strain states. A coherent joint model may be constructed using the basic principles of elastic, inelastic, and plastic analyses. Such an approach was undertaken by LATA and the results transmitted to WHC. The unified approach gave moment capacities approximately equal to WHC values for sections with low steel content, but as the steel content increases, the methods diverge and finally lead to a maximum 45% difference,

with WHC overestimating the capacity. This overestimation of capacities was partially corrected for selected sections by the use of BIAX2 as described in Attachment C. The curvatures determined from LATA's analysis are less than the rotations determined by WHC with factors ranging from 6 to 51 times smaller. The curvatures should be smaller than the rotations because the curvature is the instantaneous angle change and the rotation is the sum of these changes over the finite hinge length. The large differences imply long hinge lengths. For example, the largest difference of 51 would imply a minimum hinge length of 51 inches assuming a constant magnitude of maximum curvature over the full length. The actual curvature will vary from the maximum value at the hinge midpoint to the curvature required for yielding at the ends of the hinge. The distribution of curvature will increase the hinge length. The large hinge lengths associated with these rotations brings into question the assumption that hinges form at the construction joints. The actual hinge length and hence the hinge rotation can be determined from the elastic moment diagram and the moment-curvature relationship as discussed in review of Attachment D. The necessary moment-rotation model may then be constructed for the inelastic analysis.

One additional concern about joint rotations will be addressed here and repeated later. It is not associated with this particular joint model, but with joint models in general. The inelastic demand and joint rotation capacities determined here are large. Severe crushing of the concrete in the extreme compressive zone will occur. Relatively large cracks will open in the tensile region. During a seismic event the compressive and tensile faces will reverse several times resulting in both compressive and tensile damage to both faces. Structurally the joint will survive. However the question must be answered--can this distressed joint still perform its pressure boundary containment function despite the strong possibility of through cracks and open gaps? At this stage it is proper to construct joint models to cover the full range of rotations that might be expected and some that are not. The analysis results will determine how much rotation each joint will be subjected to. With these analysis results in hand, a decision concerning the structural integrity and the pressure boundary confinement integrity must be made. But at the same time there is little need to construct joint capacities to such extreme distortions, when it is clear that they will not meet the pressure boundary check.

Review of Attachment C--Concrete Section Evaluation Using the BIAX2 Computer Program

The BIAX2 computer program evaluates the flexural behavior of reinforced concrete cross sections under axial and bending loads. The program was developed at the University of California at Berkeley. The program was used to check the moment capacities determined in Attachment B.

The concrete material properties used are a 5000 psi compressive strength, zero tensile strength, and a stress-strain curve based on 28-day strength of 5,000 psi. The steel material properties used are a yield stress of 40,000 psi, a modulus of elasticity of 29,000,000 psi, a strain-hardening strain of 0.03 in./in., an ultimate stress of 65,000 psi at a strain of 0.12 in./in., and a failure strain of 0.20 in./in. The program fits a curve for the region beyond strain-hardening based on internal programming and the input data. Both tensile and compressive steel areas are included in the section.

The primary result of the analyses was a moment-steel strain plot. The plot was created by repeated runs of the program. Plots were included in the report for the wall-to-roof joint in both strong and weak steel orientations. The results of our independent calculations are overplotted on these plots as shown in Figure 4-3 and 4-4.

Figure 4-3 shows the comparison for the heavy tensile steel section. The two curves agree very well up to a steel strain of 0.045 in./in. At this steel strain the independent calculations indicate a maximum concrete compressive strain of 0.003 in./in. and ultimate load and failure is reached as defined by the 0.003 in./in. strain limit criterion. The BIAX2 results extend beyond this because the stress-strain curve for concrete extends to 0.006 in./in. strain. Compressive concrete strains of this magnitude are not normally considered. The BIAX2 results for the heavy tensile steel sections should be reviewed and the ultimate values reduced as necessary based on a concrete strain criterion.

Figure 4-4 shows the comparison for the light tensile steel section. The two curves do not agree. The independent calculations determined only three points--the yield, strain-hardening, and ultimate moments. These are connected by straight lines in the plot. The yield plateau (between yield and strain hardening) is missed by the BIAX2

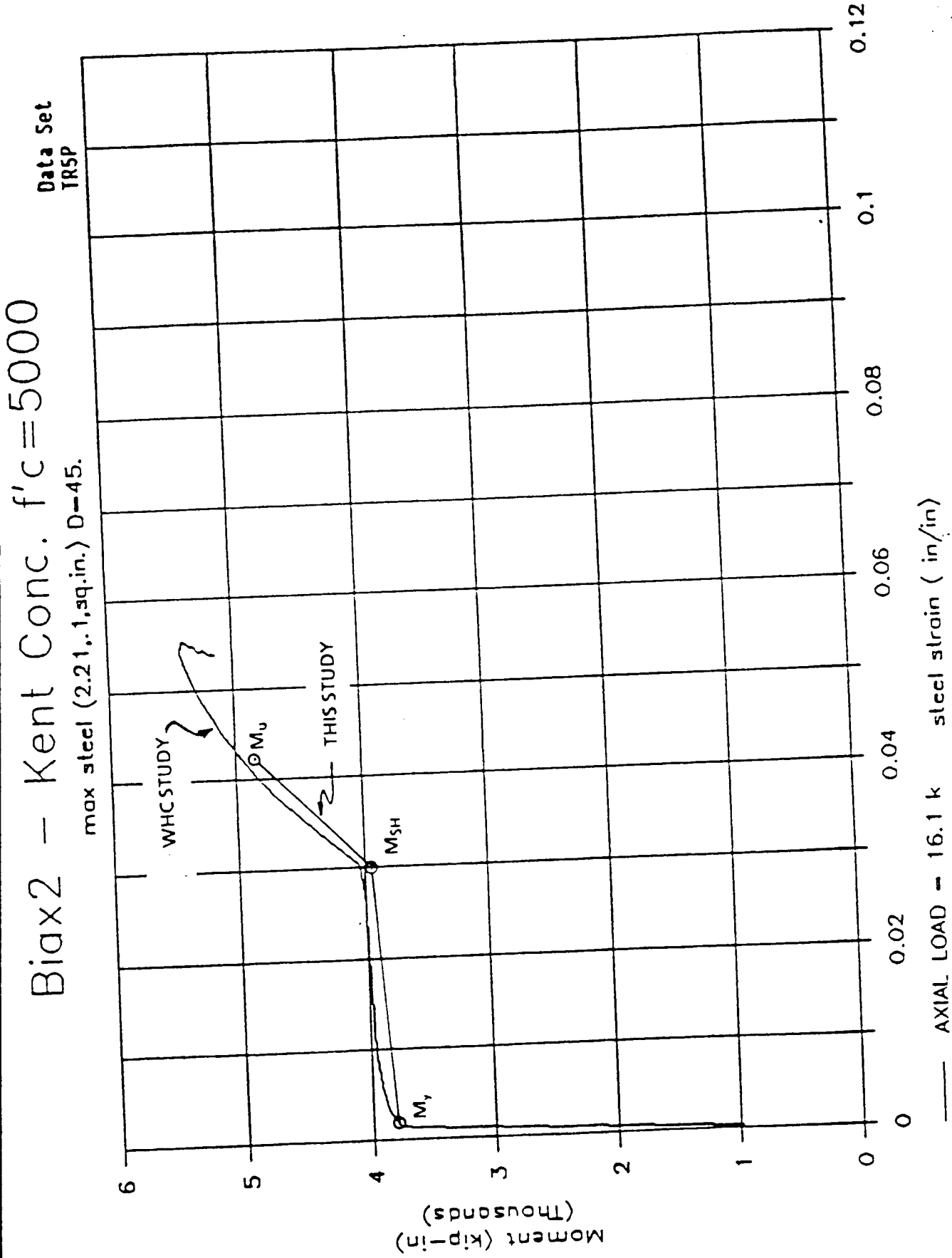

Figure 4-3. Moment-Steel Strain Comparison for Heavy Steel Section

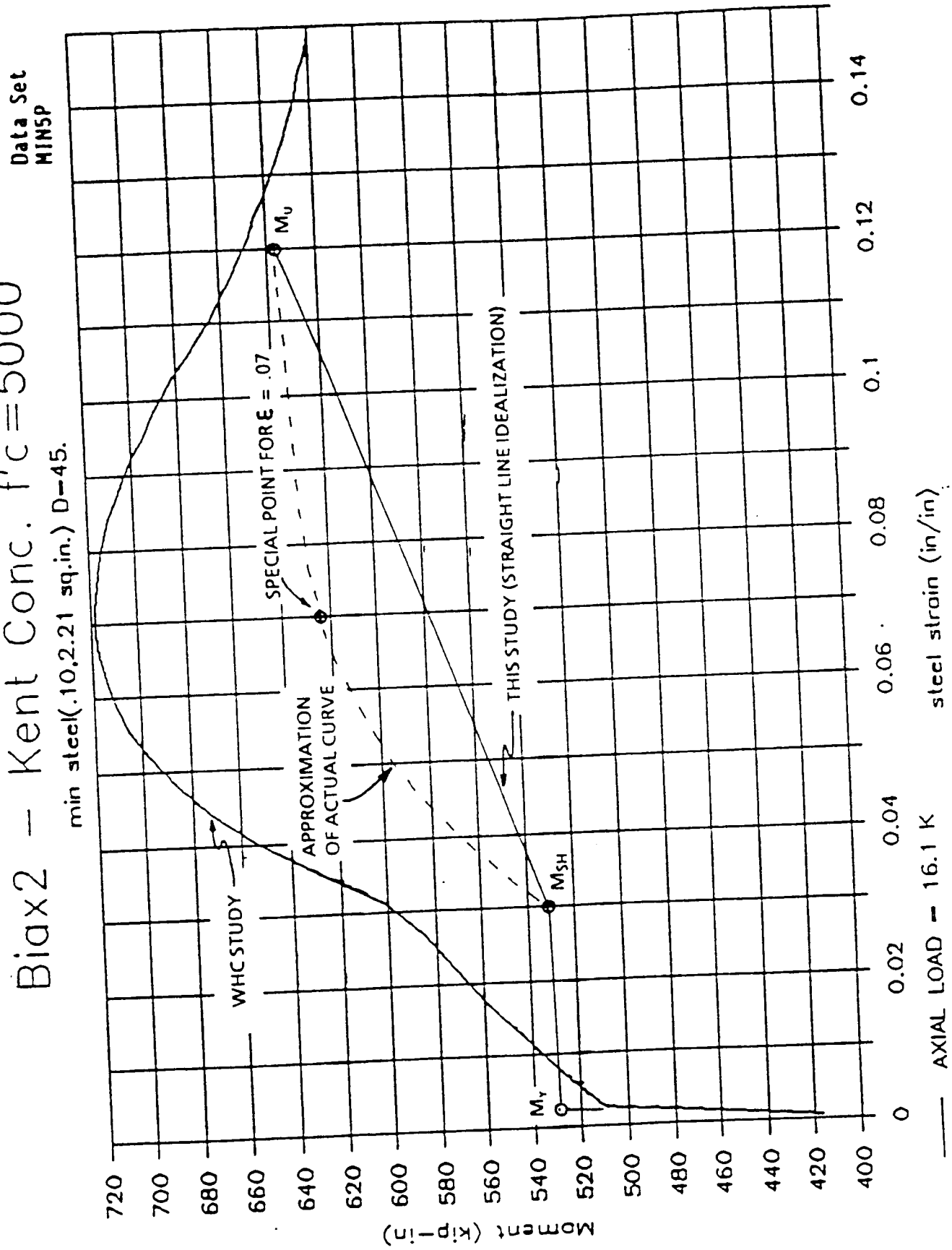

Figure 4-4. Moment-Steel Strain Comparison for Light Steel Section

results. Discussion with WHC personnel determined that this probably results from user control on the various runs rather than a defect in the program. One run produces one point on the plot and corresponds to one set of moment and axial load values. The difference between the yield and strain-hardening moments is small and could easily be missed in the incrementing process used to create the plot. The use of very small increments just above yield may resolve this problem.

Beyond the strain-hardening point there is a hump in the BIAX2 curve. This hump is not present in the independent calculations and is not expected. The independent calculations are simplified here by using a straight line. In reality the curve should rise rapidly beyond strain hardening and then asymptotically approach ultimate. It would resemble the steel curve beyond strain-hardening. This was confirmed by performing a calculation for a steel strain of 0.07 in./in., the value at the hump. This moment capacity is also shown in Figure 4-4. The hump in the BIAX2 results is due to the presence of the compression steel in the section. For these light tensile steel sections, the neutral axis is very close (less than one inch) to the compressive face. The compression steel is thus in the tension zone and acting as tension steel. This hump in the curve can be removed by neglecting the compression steel in the section. Neglecting the compression steel in these sections will not appreciably change the yield or strain hardening moments.

The material properties used in the BIAX2 analysis are inconsistent with those used in Attachment B. The concrete compressive strength used here is 5,000 psi and in Attachment B is 4,800 psi. The steel stress-strain curve generated by BIAX2 beyond strain hardening is different than the curve used in Attachment B. These inconsistencies should be corrected. The concrete stress-strain curve used is for 28-day strength. The curve for 45-year-old concrete may be different. An attempt to locate any such discussion in the available literature should be made.

Based on the review of Attachment C and the above discussion, LATA recommends the following

1. Establish a maximum concrete strain criterion to indicate failure (such as 0.003 in./in.) and limit the ultimate moment to this value. This applies to the heavy tensile steel sections for those cases considered here.

2. Define the yield plateau in the moment-steel strain plot.

3. Eliminate the hump in the curve by neglecting the compression reinforcement in the section.

4. Be consistent in the use of material properties in all parts, pieces, and phases of the analysis.

5. Investigate the available literature for discussion of variation in the concrete stress-strain relationship as the concrete ages.

Review of Attachment D--Approximate Nonlinear Response Spectrum Results

Linear finite element response spectrum analyses were performed for several different structural models of the B-Canyon. The purpose of these analyses was to understand the behavior of the construction joints and their influence on the total response. Linear springs were used to approximate the nonlinear moment-rotation relationship of the construction joints. All of these analyses and their results will be replaced by a nonlinear time history analysis to be performed later. The first steps of this analysis are underway.

A full review of the analyses was made, but a full discussion of the results is not warranted because they are to be superseded. Only some general observations on the analysis results will be made, followed by a detailed discussion of the limitations in the analyses and a set of requirements for the final analysis.

The structural model and its variations studied are reasonable for the canyon structure. The investigation of the total structural response as pins are arbitrarily located in the structure is appropriate. These early analyses yield a good understanding of the structures response and are necessary prior to formal modeling of the construction joints. The secant modulus approach to approximate the hinge behavior is satisfactory given the limitations imposed by the linear analysis requirement of the computer program used. This approach is not sufficient for the final analysis as discussed below and is recognized by WHC. The mode shapes and frequencies presented appear reasonable. Specific structural responses are not presented, but are discussed. These results also appear reasonable, except for the dead load gravity case.

The dead load gravity case shows moments slightly greater than yield moment at the crane rail construction joints. The analysis assumed these joints to be full capacity joints and not pins. This result is disturbing. The 1941 ACI Code is based on WSD. The

WSD uses actual loads (no load factors) and allowable stresses (approximately one-half of ultimate or yield values) in the design. No section of the canyon should be anywhere near yield moment using this design approach, assuming there was no error in the calculations or in the structural idealization. That the analysis has moments near yield indicates that either the WHC model of the structure is different than the one used in 1943 or one of the studies contains an error. Assuming no error, it must be the structural model.

This crane level joint was described earlier and is thought to be an attempt at a pin connection. It appears that the designers went to considerable trouble to design the joint. The steel below the joint is 7/8 in. diameter bars (No. 7 bars today) at 17-in. on center spacing and 1 1/4 in. square bars (No. 11 bars today) at 17-in. on center spacing above. The only through steel on the joint for this face is 5/8 in. diameter (No. 5 bars today) at 17-in. on center spacing. The question must be asked--why did the designer stop all of the heavy steel and use the small dowels? Such a steel placement can not be justified by any conceivable moment diagram. It must be justified on the basis of something special. The only logical explanation is a reduced moment section or a pin section. The moment capacities above, at, and below this joint can be approximated for relative values only by the product of the steel area and the section depth. The resulting values are 56.16, 11.16, and 36.00 for a ratio of 5:1:3.25. These relative moment ratios support the reduced moment or pin concept. This might be verified by a review of the original (1943) design calculations. LATA understands from WHC that these are not available. The correctness of the pin case may be confirmed by performing a dead load analysis and checking the section moments. All moments should be well below yield. The impact of this on the final analysis is that the structural configuration should not indicate a full capacity joint at this location. Two structural configurations then arise--one with a true pin and one with a reduced moment section or a hinge. Both must be considered.

The limitations in the present analyses which should not be carried over to the final analysis are described below.

- The secant approach for approximating the nonlinear joint behavior is undesirable. The iterative nature of this approach will be expensive. The lack of adjustment in the joint capacity during one analysis is an important drawback. The secant modulus requires the hinge stiffness be based on the maximum moment seen in the last analysis. This effective stiffness will over deform the structure for the many oscillations below the maximum value. WHC recognizes these limitations.

- The modal analysis technique cannot be used. In a modal analysis, the mode shapes and frequencies used throughout the analysis are determined from the original structural configuration. No updating of the configuration during the analysis is possible.

- The response spectrum technique cannot be used because there is no time phasing in the analysis process. Thus the hinges (spring models) cannot track response in time and open or close as necessary.

The analytical requirements for the final analysis are described below.

- A time history analysis using direct integration is required. A modal analysis is not permitted. The direct integration will allow constant tracking of all spring models for every time point during the analysis.

- The hinge spring models must be multilinear and at least bilinear. Unsymmetrical positive and negative capacities are required.

- The hinge springs must be able to load and unload during the analysis.

- The hinge elastic curvature portion of the rotation must be removed from the hinge model. This distortion is contained in the beam beyond the theoretical point hinge. To include it in the hinge would be to account for it twice.

- The spring stiffness must be determined from a moment rotation relationship where the rotation is the sum of the curvatures over the hinge length. The hinge length must be determined accurately and is related to the amount of yield moment exceedance in the elastic moment diagram. This procedure will give different hinge lengths for a joint just beyond yield and one considerably beyond yield. This will help control the rotation and associated distortions due to the hinges.

The number of different analysis cases required are between four and six. These cases are generated as follows.

- An artificial accelerogram is required. It should envelop the specified top of ground design spectrum as closely as possible to remove all unnecessary conservatism.

- A soil structure interaction (SSI) analysis is required to generate the needed foundation level motion. Three soil property sets must be considered--the expected or average set, a lower bound set, and an upper bound set. This will result in three different foundation level motions.

- The structural configuration should include a limited moment hinge and a pin at the crane level. These two cases should be run for the average soil conditions. Possibly, one case can be selected and run for the upper and lower bound soil conditions. As a last resort, both cases may need to be run for all soil cases.

Review of Attachment E--Static Collapse Load Predictions

The static horizontal load capacity of the 221-B Plant canyon structure was determined using limit analyses (also called mechanism analysis). The horizontal load was to simulate the earthquake and was applied as a uniform horizontal g force to the structure. The magnitude of the g force to cause collapse was the unknown in the analysis. The possible hinge point moment capacities were taken from the joint moment capacities previously calculated in Attachments B and C.

LATA has reviewed the work by WHC and has also completed an independent set of review calculations. Based on this review, we conclude the following.

1. We agree with the method of analysis and with its execution. The only difficulty encountered was in tracking the eccentricities used in the north direction mechanism. LATA was unable either to follow them or to duplicate them. This prompted our set of independent calculations. However the effect of the eccentricities on the overall answer is small.

2. The so called north and south direction mechanisms presented by WHC appear reasonable and should be the controlling mechanisms. That these are indeed the controlling mechanisms was not confirmed by LATA, but is stated by WHC in Attachment E.

The limit analysis was performed as a preliminary calculation to obtain an early prediction on the canyon structures performance during an earthquake. Should these calculations be used in further supporting the canyons' performance, LATA suggests the following improvements to the calculations.

1. Limit the hinge moment capacity to the yield moment or a strain hardening moment rather than the ultimate moment value. The joint rotations needed to develop the ultimate moment capacity are quite severe. It is also common practice not to include the capacity beyond strain-hardening (Ferguson, 1967). The lack of the typical yield plateau will also complicate the numerical computations.

2. The capacity of all the active hinges in the mechanism should be included. In the present WHC analyses the secondary joints (those with small moment capacities) were not included. This is a conservative assumptions, and an unnecessary one.

determine the average or any particular percentile value for concrete strength from these data. It is not a statistical problem that needs to be solved, but rather a very basic engineering problem dealing with how the concrete strength value will be used.

The ACI code bases most of its design formuli on a 28-day concrete strength with the full knowledge that this strength will continue to increase as the concrete ages. The acceptance of concrete cylinder test data is also based on this knowledge. The B Canyon concrete will not significantly increase in strength due to its present age. This fact needs to be considered in light of the ACI Code use of concrete strength. We would suggest as a reasonable approach to follow the steel industry example and use a 90th percentile value. It may even be advantageous to identify different strengths for the wall and the roof. Whatever value of concrete strength is selected, it should be used consistently in all parts, pieces, and phases of the structural evaluation.

The modulus of elasticity may also be determined from the in-situ data or from the ACI Code correlation of concrete strength and modulus. Whatever method is chosen the values should be compatible and used consistently.

4.4.2 244-AR Vault

4.4.2.1 General Description

The 244-AR Vault is a box-shaped, reinforced concrete structure. A longitudinal section through the AR vault is shown in Figure 4-5. The aboveground structure is 97 ft long, 21 ft wide, and 37 ft high. The roof is 12 in. thick along the long walls, thickening to 14.5 in. at the midspan, and is topped with a 2-in.-thick built-up roofing. The walls are 18 in. thick. There is only one major opening in the structure, a 12-ft-wide by 14-ft-high truck door in the east end wall. The structure is a one-bay box with no interior columns, exterior columns, or beams.

The underground portion of the structure consists of three pits containing a total of four tanks. The below ground walls, exterior and interior, are a minimum of 2 ft thick. The foundation mat is 2 ft 6 in. thick. The bottom of the structure is 42 ft below grade.

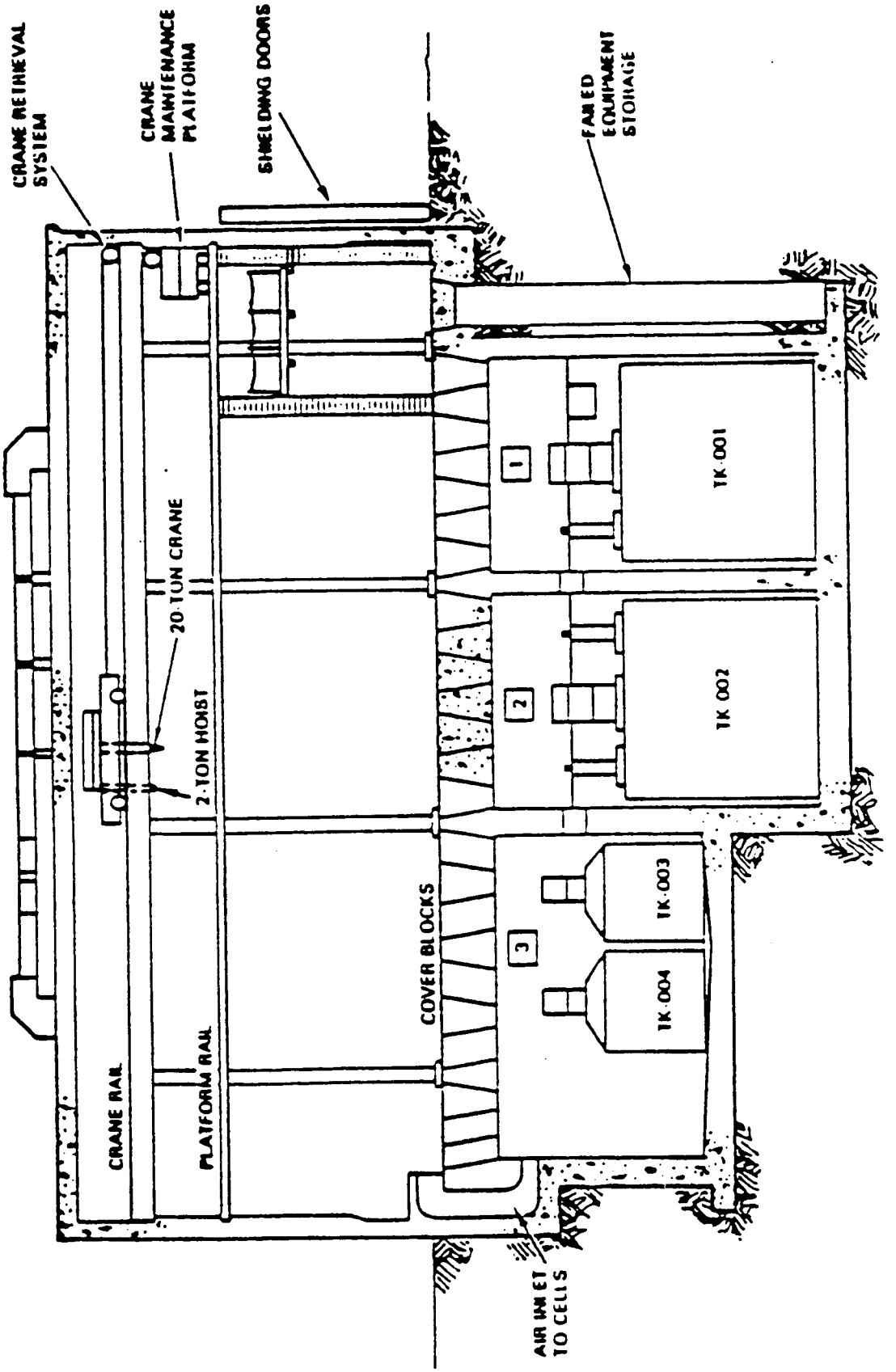

Figure 4-5. The 244-AR Vault Complex

The AR Vault was authorized by the AEC in January 1966 and completed in April 1968. The design was in accordance with the 1964 UBC. The concrete design followed the provision of the 1963 ACI Code. The 1963 ACI Code allowed two equal design procedures--the WSD method and the USD method. It is not known which design method was used.

4.4.2.2 Classification of Structure and Design Basis

The AR Vault is classified as a Moderate Hazard Facility. Its tanks are an essential part of the proposed chemical processing system and the AR Vault structure is necessary for containment. The AR Vault structure, above and below ground, must remain functional during and following the design basis events.

The design basis events are an 80 mph wind and a 0.12 g anchored earthquake. These design basis events are in accordance with the requirements of DOE 6430.1A, UCRL 15910, and proposed SDC 4.1. In the structural evaluation calculations performed by WHC, the design wind was conservatively taken as 100 mph rather than the required 80 mph.

4.4.2.3 Analysis Method

The AR Vault superstructure was analyzed as a box system. The roof section was analyzed as a diaphram resisting the seismic and wind lateral loads. The end walls were analyzed as shear beams resisting the roof loads. A typical 1 ft section through the center of the structure was analyzed as a rigid frame with an imposed displacement equal to the roof displacement at midspan. Dead load only conditions were not evaluated.

The wind forces were determined in accordance with ANSI A58.1 based on a 100-mph-wind speed. The earthquake forces were determined as equivalent seismic lateral loads. Three methods were used: the 1988 UBC with a Zone 2 loading, the UCRL 15910 modification of the UBC method with a 0.12 g zero period acceleration (ZPA), and the UCRL 15910 dynamic determination (using the peak acceleration from a 10% damped response spectrum curve anchored at 0.07g). All three methods resulted in an equivalent lateral load of 0.115g. The dynamic analysis also required by UCRL 15910 has not been performed.

The underground portion of the AR Vault was not analyzed. It is not subject to wind forces or to seismic collapse. The containment function of the structure would be jeopardized should breaching or severe cracking of the underground walls occur. However, based on the nature of these walls and their expected performance during an earthquake, an engineering judgment was made by WHC and concurred with by LATA, that it is not necessary to evaluate these walls at this stage in the feasibility study. They will need to be evaluated during the design and analysis phase of this project.

4.4.2.4 Analysis Results

The AR Vault was analyzed for both seismic and wind loadings. The seismic loads controlled. A comparison of the seismic-induced demands, the section capacities, and the resulting safety factors are presented in Table 4-8. The minimum safety factor determined is 1.05 and is for inplane diaphram bending of the roof. The inplane diaphram bending capacity of the roof and the west wall do not consider all the steel present. These are large diaphrams with large distances from the compression face to the extreme tensile face. Only the steel necessary to exceed the demand moment was used in calculating the section capacity; the rest of the steel was ignored. The first three (of 17) rows of steel were utilized for the west wall and the first seven (of 15) rows for the roof. These safety factors may be increased by considering more rows of steel in each case. The east end wall sections on each side of the 12 by 14 door are analyzed using the USD method. The analysis assumes all available steel is used. A strain state is thus created that imposes excessively large stains on the extreme tension steel. This analysis would not be acceptable in a final evaluation, but is provisionally acceptable in this preliminary analysis. The resulting factor of safety is 1.08. The final analysis should contain a strain state analysis for this section. The horizontal midspan roof deflection is 0.0923 in. The permitted roof deflection was not calculated. The allowable story drift permitted by the 1988 UBC is 0.005 times the story height or 2.22 in. which is well above the calculated value.

The steel reinforcing pattern shown on drawings H-2-62001 and 002 and H-2-61997, 998, and 999 was reviewed. Ample steel is present as indicated by the capacity and demand loads given in the table. The adequacy of the abovegrade walls steel reinforcement embedment into the belowgrade walls is questioned in Section 5.5.1.2 of

TABLE 4-8
AR VAULT ANALYSIS RESULTS

Location	Capacity		Demand		Safety Factor	
Longitudinal Shear in End Wall						
at 36' (wall-to-roof)	337.6 k		64.6 k		5.23	
at 24'	337.6 k		71.1 k		4.75	
at 12'	337.6 k		77.6 k		4.35	
at 0'	337.6 k		84.2 k		4.01	
at 0' east wall (each side of door)	80.4 k		39.9 k		2.02	
Inplane diaphram bending						
Roof	19,774 in-k		18,800 in-k		1.05	
West end wall (solid)	37,045 in-k		32,130 in-k		1.15	
East end wall (with door)	3,616 in-k		3,352 in-k		1.08	
Unit 1 ft Strip Results						
Bending Moments	Tension		Tension		Tension	
	Outside (in-k)	Inside (in-k)	Outside (in-k)	Inside (in-k)	Outside	Inside
Roof at centerline	97.6	147.6	—	46.1	—	3.20
at quarter point	87.4	133.9	—	33.3	—	4.02
at wall	153	119.4	64.4	—	2.38	—
Wall at 36'	186.3	138.7	64.4	—	2.89	—
at 24'	186.3	138.7	50.1	—	3.72	—
at 12'	138.7	138.7	9.0	9.0	15.4	15.4
at 0'	138.7	138.7	60.1	112.7	2.31	1.23
Horizontal Midspan Roof Deflection			0.0923"			

the 244-AR Vault Safety Analysis Report (Villaba, 1986). We find no evidence to support this judgement. The abovegrade and belowgrade steel is connected by number 5 dowels 48 in. long on 16 in. centers. This is the same steel area, bar size, and spacing as the main steel in the abovegrade wall. The 48 in. dowels as shown on drawing H-2-61998 Section 313 are embedded for 24 in. into the belowgrade walls. The 24 in. embedment length exceeds the ACI 318-63 code, the ACI 318-83 Code, the ACI 318-83 Code

Appendix A, and the ACI 349-80 requirements. The required embedments are 15 in., 14 in., 18 in., and 14 in. respectively.

4.4.2.5 Conclusions

The analysis method used and the assumptions made are appropriate for this preliminary evaluation. The calculated factors of safety are adequate. The AR Vault aboveground portion should perform satisfactorily during the design wind and earthquake events based on these analysis results. The belowground portion should also perform satisfactorily, based on engineering judgement. The AR Vault should remain standing and functional during and following a Moderate Hazard Facility design basis wind and earthquake.

The final anaysis and evaluation of the AR Vault should include a design check on the belowgrade portion of the structure and the dynamics anaysis required by UCRL 15910. Otherwise, this preliminary evaluation fulfills the regulatory and code requirements given in DOE 6430.1A, UCRL 15910, 1988 UBC, 1983 ACI Code, and proposed SDC 4.1.

4.4.3 244-AR Stack

4.4.3.1 General Description

The AR Stack is a reinforced concrete chimney with a total stack height of 63 ft, a height above ground of 61 ft, and total height of 65 ft from the base of the foundation to top of the stack. The stack has a base diameter of 60.5 in. with a wall thickness of 12.25 in. and a top diameter of 48 in. with a wall thickness of 6 in. The stack foundation is an octagon-shaped base 9.5 ft wide (across the flats) and 2 ft thick. The bottom of the foundation is set 4 ft below the ground surface. The stack and foundation are constructed of 3,000 psi concrete and Grade 40 reinforcing steel. The longitudinal steel ratio is approximately 0.0051 up to a height of 13 ft and 0.0025 thereafter. The stack has no liner.

The AR Stack was completed in 1968. The design of the stack was in accordance with the 1964 UBC and used the provisions of the 1963 ACI Code. The 1963 ACI Code

allowed two equal design procedures--the WSD and the USD methods. It is not known which design method was used.

4.4.3.2 Classification of Structure and Design Basis

The AR Stack is classified as a Moderate Hazard Facility. It is a necessary part of the ventilation system for the AR Vault structure and must remain functional during and after the design basis events.

The design basis events are an 80 mph wind and a 0.12 g anchored earthquake. These design basis events are in accordance with the requirements of DOE 6430.1A, UCRL 15910, and proposed SDC 4.1. In the structural evaluation calculations performed by WHC the design wind was arbitrarily taken as 100 mph, rather than the required 80 mph.

4.4.3.3 Analysis Method

The AR Stack was analyzed as a beam cantilevered from the foundation and subjected to seismic and extreme wind forces; dead load only conditions were not evaluated. The wind forces were determined in accordance with ANSI A58.1 based on a 100-mph wind speed. The earthquake forces were determined to be an equivalent lateral load of 0.115g, as described in the AR Vault section.

4.4.3.4 Analysis Results

The AR Stack was checked for overturning resulting from wind and earthquake forces and the induced soil bearing stresses. Stack cross sections were checked for moment and shear capacity. The stack foundation was not analyzed.

The overturning analysis yielded safety factors of 3.06 of wind (based on 100 mph) and 1.75 for seismic. The 1988 UBC Sec. 2311(e) requires a safety factor of 1.5 for wind, but does not specifically call out seismic. The force resultant of the seismic overturning moment falls outside (1.25 ft) the center third of the foundation and results in some uplift on the tension side. The maximum soil pressure induced is 6.4 ksf. The ultimate soil bearing capacity was calculated by three methods--the method used by URS Blume in the Hanford report (Blume, 1987) and by Meyerhoff's and Bell's

approaches as described by Sowers, 1970. The URS Blume approach, which is Carl Terzaghi's classical bearing capacity equation (Terzaghi and Peck, 1968), controlled and gives an ultimate bearing capacity of 17.4 ksf and, with a factor of safety of 3, an allowable bearing capacity of 5.8 ksf. The 1988 UBC Sec. 2303(d) allows for a one-third increase in allowable working stresses for wind and earthquake conditions. Thus, the UBC would permit an increased allowable bearing capacity of 7.7 ksf which is greater than the induced 6.4 ksf. The ultimate bearing capacity factor of safety is 2.72 for seismic conditions.

Internal stack cross sections were analyzed at the base, the flue opening, and 16 ft elevations. The calculated ultimate moment capacities for these sections are 735, 581, and 284^{k-f} respectively. The seismic demand moments at the same elevations are 302, 109, and 22.5^{k-f} respectively. The resulting safety factors are 2.43, 5.35, and 12.6, respectively. The base section was checked for shear. The section shear capacity of just the concrete is 198^{k} with a seismic shear of 9.9^{k} resulting in a shear safety factor of 20. The other elevations were not checked for shear.

4.4.3.5 Conclusions

The analysis method used and the assumptions made are appropriate for this preliminary evaluation. The calculated factors of safety are adequate for overturning, bearing, and structural sections. The AR Stack should perform satisfactorily during the design events based on these analysis results. The AR Stack should remain standing and functional during and following a Moderate Hazard Facility design basis wind and earthquake.

The final analysis and evaluation of the AR Stack must include a check on the foundation mat and the dynamic analysis required by UCRL 15910. LATA expects the results from these additional studies to continue to show satisfactory performance. Otherwise, this preliminary evaluation fullfills the regulatory and code requirements given in DOE 6430.1A, UCRL 15910, 1988 UBC, and 1983 ACI Code, and proposed SDC 4.1.

4.4.4 291-B Stack

4.4.4.1 General Description

The 291-B Stack is a reinforced concrete chimney with a total stack height of 200 ft, a height above the ground of 200 ft, and a total height of 207 ft from the base of the foundation to top of the stack. The stack has a base diameter of 166 in. with a wall thickness of 12 in. and a top diameter of 90 in. with a wall thickness of 6 in. The base wall thickness of 12 in. is maintained to elevation 15 ft 0 in. and then tapers rapidly to 8 in. thickness at elevation 22 ft 6 in. Above elevation 22 ft 6 in. the 8-in. wall thickness tapers uniformly to 6 in. at the top of stack. The stack foundation is an octagon-shaped base 23 ft wide (across the flats) and 7 ft thick. This is a stepped foundation with the upper 2.5 ft being octagon shaped also, but with a width of only 17 ft. The bottom of the foundation is set 7 ft below the ground surface, putting the top of the foundation at ground surface. The stack and the foundation are constructed of 2,500 psi concrete and Grade 40 reinforcing steel. The longitudinal steel ratio is approximately 0.0054 at the flue opening, 0.010 at 30 ft, and 0.0060 at 90 ft. The reinforcing consists of both round and square deformed bars.

The stack has an internal free standing brick liner for the complete 200-ft height. The liner has a base diameter of 111 in. with a wall thickness of 13.5 in. and a top diameter of 69 in. with a wall thickness of 4.5 in.

The B Stack was completed in 1944. The stack was designed in accordance with the 1940 UBC and used the provisions of the 1941 ACI Code. The 1941 ACI Code is based on the WSD method. The 1941 ACI Code was modified by the War Production Board's Emergency Specifications for Reinforced Concrete Design by imposing "wartime allowable stresses."

4.4.4.2 Classification of Structure and Design Basis

The B Stack is classified as a High Hazard Facility. It is a necessary part of the ventilation system for B Plant. The free standing brick liner is assumed to collapse during the design earthquake and perhaps plug the stack. Blowout panels are to be constructed to provide a ventilation path should this occur. The presence of the blowout panels then removes B Stack from the necessary list. However, the B Stack proximity

to other parts of the ventilation system puts the stack in a 3/1 category and gives the stack the High Hazard Facility classification. B Stack must remain standing during and following the design basis events, but need not be functional.

The design basis events are a 90-mph wind and a 0.20 g earthquake. These design basis events are in accordance with the requirements of DOE 6430.1A, UCRL 15910, and proposed SDC 4.1. In the structural evaluation calculation performed by WHC, the design wind was arbitrarily taken as 115 mph, rather than the required 90 mph.

4.4.4.3 Analysis Method

The B Stack was analyzed as a beam cantilevered from the foundation and subjected to seismic and extreme wind forces; dead load only conditions were not evaluated. The wind forces were determined in accordance with ANSI A58.1 based on a 115-mph wind speed. The earthquake forces were determined as equivalent seismic lateral loads. The peak acceleration from a 10% damped response spectrum curve anchored at 0.20g results in an equivalent lateral load of 0.33g.

4.4.4.4 Analysis Results

The B Stack was checked for overturning resulting from wind and earthquake forces and the induced soil bearing stresses. Internal stack cross sections were checked for moment capacity. The stack foundation was not analyzed, nor were stack cross section shears considered.

The overturning analysis yielded safety factors of 1.82 for wind (based on 115 mph) and 0.92 for seismic. The 1988 UBC Sec. 2311(e) requires a safety factor of 1.5 for wind, but does not specifically call out seismic. The seismic value is less than one and indicates overturning of the stack. The force resultant of the wind overturning moment falls outside (1.34 ft) the center third of the foundation and results in some uplift on the tension side. The maximum soil pressure induced is 12.0 ksf. The ultimate soil bearing capacity was calculated as described in the AR Stack section and is 36.7 ksf. With a safety factor of 3, the allowable bearing capacity is 12.2 ksf. The UBC Sec. 2303(d) allows for a one-third increase in allowable working stresses for wind and earthquake conditions, which would yield an increased allowable bearing capacity of 16.3 ksf. The ultimate bearing capacity factor of safety is 3.1 for wind conditions.

Internal stack cross sections were analyzed at the flue opening and at elevations of 30 ft and 90 ft. The calculated ultimate moment capacities for these sections are 13146, 8755, and 2841^{k-f} respectively. The seismic demand moments at the same elevations are 11783, 7971, and 2869^{k-f} respectively. The resulting safety factors are 1.12, 1.10, and 0.99 respectively. The wind demand moments at the 30 and 90 ft elevations are 4761 and 2840^{k-f} respectively. The resulting safety factors are 1.84 and 1.59 respectively.

4.4.4.5 Conclusions

The analysis method used and the assumptions made are appropriate for this preliminary evaluation. The extent of the work performed is reasonable considering the negative result obtained. The calculated factors of safety for overturning, bearing, and structural performance are adequate for the wind case, but are not adequate for the seismic case. The B Stack is expected to overturn and fall during a design seismic event. The structural sections considered have seismic safety factors very close to 1.0 and indicate unsatisfactory performance. These section capacities were determined using a concrete strength reduction of factor of 0.9 and assuming a value for Fu of 1.0. These calculations are more conservative than the current UCRL 15910 (May 1989 draft) requirements. This may grant some numerical relief in the values of safety factors. The 291 B Stack should remain standing during and following a High Hazard Facility design basis wind, but is expected to collapse during a design basis earthquake.

The final analysis and evaluation should include the following:

1. dynamic analysis as required by UCRL 15910;
2. shear checks on selected stack cross sections;
3. design check for the foundation mat;
4. consideration of the collapsing and collapsed liner in the dynamic analysis, with particular attention to the impact of the liner as it falls on the stack wall, the loading (bulging) on the stack walls due to the liner impact on the base, and the additional mass of the liner; and
5. a UBC static force method analysis with an importance factor of 2.0 which is required per UCRL 15910. This will effectively double the previously determined seismic loads.

The final dynamic analysis may show that the section capacities are satisfactory, but that overturning is still a problem. The issue may be resolved by enlarging the B Stack foundation mat.

Although all structural performance is not satisfactory, this preliminary evaluation meets the regulatory and code requirements given in DOE 6430.1A, 1988 UBC, 1983 ACI Code, and proposed SDC 4.1. It also meets the requirements given in UCRL 1590, except for the dynamic analysis and the importance factor of 2.0 UBC type analysis.

4.5 Conclusions and Overall Assessment of Findings

The B Plant, B Stack, AR Vault, and AR Stack analyses were discussed in the previous sections. The conclusion drawn from the analyses, the review findings, and general comments are presented in this section. The overall performance and compliance of the structures are summarized in Table 4-9.

The following conclusions are based on previously discussed information.

1. The seismic hazard study results are justifiable. The results should be adopted and incorporated in the necessary documents to lower the DBE.

2. The proposed inelastic direct integration dynamic analysis of B Plant is appropriate and should yield the best estimate of the canyon structural behavior during the postulated DBE. The fundamental requirements for such an analysis are recognized by WHC.

3. The AR Vault and AR Stack analyses are appropriate and the results generally acceptable. Certain parts of these structures were not analyzed and should be included in the final analysis. These deletions were deliberate, and are appropriate for a feasibility study. The structures should remain standing during and following the Moderate Hazard Facility DBW and DBE events.

4. The B Stack analysis is appropriate with the exception of the influence of the liner on the stack. The results are generally acceptable, even though the structures behavior is unsatisfactory. Again, certain parts of the structure were not analyzed and should be included in the final analysis. The B Stack should remain standing during and following the High Hazard Facility DBW, but is expected to collapse during the DBE. The performance of the liner was not evaluated.

TABLE 4-9
OVERALL STRUCTURAL COMPLIANCE AND RESULTS SUMMARY

	AR Vault	AR Stack	B Stack
DOE 6430.1A			
Classification	Safety Class	Safety Class	Safety Class
General Provisions, Except Eq.	Yes	Yes	Yes
DBE	Yes	Yes	Yes
OBE	NP	NP	NP
UCRL 15910			
Classification	Mod. Hazard	Mod. Hazard	High Hazard
Wind			
Speed	Exceed	Exceed	Exceed
Loads	Yes	Yes	Yes
Load Combinations	Yes	Yes	Yes
Earthquake			
ZPA Level	Yes	Yes	Exceed
UBC I = 2.0 Analysis	Yes	Yes	Partial
Dynamic Analysis	NP	NP	NP
SDC 4.1			
Classification	Cat. I Nonreactor	Cat. I Nonreactor	Cat. I Nonreactor
Loading			
DBE .25 g*	No .12g Yes	No .12 g Yes	No .20 g Yes
OBE .05 g*	NP	NP	NP
Dead and Live	NP	NP	NP
Ashfall	NP	NP	NP
Snow	NP	NP	NP
Tornado**	NP/Yes	NP/Yes	NP/Yes
Analysis			
Dynamic or other with justification	Partial	Partial	Partial
Performance Criteria	Standing & Funct.	Standing & Funct.	Stdg. - Need Not Function
Structural Behavior			
Wind			
Overturning	Seismic Controls	3.06	1.82
Bearing	Seismic Controls	Seismic Controls	3.1
Structural	Seismic Controls	Seismic Controls	1.59
Earthquake			
Overturning	NA	1.75	0.92
Bearing	NA	2.72	Not calculated
Structural	1.05 / 1.23	2.43	0.99
Overall Performance	Satisfactory	Satisfactory	Unsatisfactory

NA = Not applicable; NP = Not performed.

* Value for current revision (10), proposed revision will be 0.12 g for moderate and 0.20 g for high hazard.

** Tornado winds in current revision (10) exceed wind speeds used in analyses. Wind speeds used in the analysis exceed UCRL 15910 values.

The following findings are based on the previously discussed information.

1. The joint moment rotation model is inconsistent in the basic assumptions used in the different analytical methods employed, and then merges the results of the dissimilar analyses. These fundamental assumptions should be reconsidered and a more coherent approach adopted.

2. The basic material properties used are not consistent between the various analyses. This should be corrected.

3. The required dynamic analysis per UCRL 15910 has not been performed for the AR Vault, AR Stack, or B Stack. This was a deliberate and appropriate decision by WHC. However, these analyses need to be completed at a later date.

4. All of the required design loading cases specified in SDC 4.1 have not been performed. Again, this was a deliberate and appropriate decision by WHC. However, these analyses need to be completed at a later date, also.

5. All parts of the structures were not analyzed or were not analyzed in equal detail. Again, this was a deliberate and appropriate decision by WHC. Full and complete analyses need to be performed at a later date.

6. The AR Vault and AR Stack were classified as Moderate Hazard Facilities and analyzed accordingly. The current revision of SDC 4.1 does not allow this classification.

The following observations are based on the previously discussed analyses and the review of the regulatory documents.

1. The importance factors presented for the Moderate and High Hazard Facilities in UCRL 15910 are inconsistent. The value for wind is 1.0 and for earthquake is 2.0. The wind and earthquake design input values are tied to specific probabilities of exceedance. The structural performance goals have stated (though not necessarily realized) probabilities of exceedance. The wind and earthquake analyses, with the different importance factors, are not formulated to yield the same degree of conservatism. This is contrary to an objective in UCRL 15910 stating that "the guidelines are intended to control the level of conservatism introduced in the design/evaluation process such that: (1) earthquake, wind, and flood hazards are treated on a reasonably consistent and uniform basis; ... ." LATA suggests that WHC evaluate this impact and comment as appropriate to Murray, Kennedy, and DOE.

2. For Moderate and High Hazard Facilities, UCRL 15910 requires a UBC type analysis with importance factor, I, of 2.0. From the current wording in UCRL 15910, it is unclear whether this requirement can be waived regardless of the degree of detail in the also required dynamic analysis. This required UBC I=2.0 analysis will have a significant impact on the B Stack and B Plant. It will effectively double the present loads on B Stack and may negate the planned inelastic dynamic analysis for B Plant. This point needs clarification. LATA suggests WHC evaluate and comment as appropriate to Murray, Kennedy, and DOE.

3. A 0.05g OBE may control the response for some Moderate Hazard Facilities where the DBE is 0.12g. WHC should investigate this and carefully evaluate the material damping ratios and load factors used in these two seismic loading cases. The level assigned to the OBE should be an economic decision and should not necessarily control the structures required strength.

4. The OBE and DBE response spectra should have the same shape. They should simply be scaled versions of each other. This has not always been the case in past revisions of SDC 4.1.

5. Preliminary Accident Analysis (Marusich, 1989) lists possible consequences of a seismic event and references Conrads, 1989. The events listed are "all possible," however, no such list is contained in Conrads or able to be inferred from the work in Conrads. The reference cited may be incorrect.

6. SDC 4.1 needs to be revised to incorporate the new earthquake levels and design response spectra, to permit the Moderate Hazard Facility Classification, to clarify the use of UCRL 15910 provisions in wind and earthquake loading conditions, and to state the OBE design requirements.

The following additional observations are made in an attempt to improve the future presentation of the B Plant studies.

1. Better definition of the original design criteria for each structure would be very helpful. We realize all of this information is not available, but a reasonable effort should be made to gather what is available. For example, the AR Stack was designed and constructed during 1966 through 1968. It could have been designed in accordance with the chimney code ACI 505-54 (committee 505 was renumbered to 307 by the next issue in 1969) or the general concrete code ACI 318-63. SDC 4.1 was originally issued in 1957 and the governing revision for the AR Vault construction should be available. This revision may also state that the WSD or USD or both methods are allowed.

2. A summary of the structural performance to date including routine and major repairs would be helpful. Any indication of structural conditions uncovered during modifications should be noted.

3. A comparison of B Plant or AR Vault to other identical or very similar structures at Hanford and their performance would be helpful.

4. A discussion of any past structural analysis on these structures or similar ones should be described and discussed. The basic assumptions, analysis methods, results, and objectives should be presented.

5. Attempt to locate members of the original design and construction teams for both structures. These people can help complete the design or construction picture. Their first hand knowledge may prove invaluable.

5.0 REVIEW OF BALANCE OF PLANT SYSTEMS

5.1 Description of BOP Systems

Systems principally considered as Balance of Plant (BOP) for purposes of this report include: 1) those architectural features not of a structural nature and not part of the building foundation and containment structure, 2) special facilities, 3) mechanical systems, and 4) electrical systems. Site and civil engineering features were selectively included. Table 5-1 shows the major BOP systems considered in the evaluation together with a brief description of their importance.

5.2 Method of Review and Evaluation

It is recognized that the proposed pretreatment facilities must meet a variety of regulatory requirements and reference standards and guides as set forth in DOE 6430.1A. Many of the regulatory requirements may be met by implementing operational and administrative procedures and are not dependent on characteristics of the physical plant. Reference standards and guides, on the other hand, deal largely with the design of physical elements of a facility. It must be demonstrated, therefore, that B Plant and the 244-AR Vault can be made to conform to the intent of the criteria set forth in DOE 6430.1A--including applicable standards and guides--for the proposed use of these facilities before it would be reasonable to suggest using them for pretreatment operations.

Science Applications International Corporation (SAIC), in their Task 3 reports, demonstrated compliance to DOE 6430.1A by making a detailed compliance assessment of event systems. In order to ensure that no major area of concern was overlooked, LATA made an independent assessment of DOE 6430.1A requirements and compared their findings to the those of SAIC. The results of the assessment and the comparison are described in the following sections.

5.2.1 Independent Assessment of DOE 6430.1A Requirements

The first step in demonstrating conformance to DOE 6430.1A was to identify which criteria should be applied to the pretreatment functions. Clearly, those criteria which apply generally to all types of facilities should be applied. Further, criteria

TABLE 5-1
MAJOR BOP SYSTEMS EVALUATED

ARCHITECTURAL

Walls & Partitions	Serve to divide the facility into different fire areas & into different HVAC zones. They are important elements in controlling spread of contamination after an accident or extreme natural phenomenon.
Doors & Windows	Doors provide the means for maintaining the integrity of fire areas and HVAC zones. Exterior windows, if they exist, provide a means for breaching the building containment.
Finishes	In areas subject to radioactive contamination, serve as a barrier to prevent contamination from penetrating the structure & serve as an aid to decontamination procedures.
Hoods & Glove Boxes	Serve as confinement barriers for preventing the spread of contamination within the facility.

SPECIAL FACILITIES

General Requirements	As nonreactor nuclear facilities, B Plant & 244-AR Vault qualify as special facilities.
Plutonium Processing Handling Facilities	Included in case the intended use of B Plant or 244-AR Vault classifies either structure as a plutonium facility.
Radioactive Liquid Waste Facilities	Clearly applies to B Plant and 244-AR Vault.

MECHANICAL

Fire Protection	An important element in ensuring integrity of confinement systems, under improved risk criteria.
Process Vessels & Piping	Serve as the primary confinement barriers for all process operation.
HVAC	Systems which prevent the release of airborne effluents are classified as safety class systems and are part of the confinement system.
Controls	An important part of safety class systems and active confinement systems.

ELECTRICAL

Exterior Utility Service	Provides a source of power to safety class systems and active confinement systems.
Interior Systems	Includes communications and alarm systems as well as power distribution systems.
Special Systems	Includes emergency power systems and uninterruptible power systems.

outlined in the following "-99" should be applied: -99.0, Nonreactor Nuclear Facilities and -99.17, Radioactive Liquid Waste facilities. In addition, Section 1300, General Requirements of Division 13 should be applied as well as Section 1323, Radioactive Liquid Waste Facilities. For reasons stated in the next paragraph, LATA also applied the criteria from Section 1304, Plutonium Processing and Handling Facilities.

Even though it had been assumed in all of the documents reviewed that criteria for Plutonium Processing and Handling Facilities would not apply to pretreatment operations, it was included in LATA's assessment on a "better safe than sorry" basis. As stated in DOE 6430.1A, "Plutonium Processing and Handling Facilities include facilities principally dedicated to the processing and handling of plutonium in substantial quantity, e.g., to be used in nuclear explosives production, nuclear reactor fuel assemblies, or heat source packages. What constitutes a "substantial quantity" or a "small quantity" depends on the quantity of each isotope, the physical and chemical form and the specific process involved. A consideration of the hazard determines whether the facility should be classified a Plutonium Processing and Handling Facility." This statement is sufficiently nebulous that some doubt exists as to its applicability to the pretreatment operations. Applying the plutonium facility criteria should not present insurmountable problems as that criteria is not appreciably more stringent than the criteria for other nonreactor radioactive facilities.

Once the criteria to be applied were selected, each numbered section and subsection in DOE 6430.1A was reviewed for applicability to the pretreatment operations and noted as either applicable or not applicable. Those sections and subsections determined to be applicable were further reviewed to determine whether a safety or environmental related issue was involved. If it was determined that safety or environmental issues were involved, the relative importance of that particular issue was noted based on the following scale:

1. of only minor safety importance,
2. required to meet standards and guides not covered by 3, 4, or 5 below,
3. required to protect property,
4. required to protect workers, or
5. required to protect the public or the environment.

A matrix showing the result of the assessment is contained in Appendix A. Those DOE 6430.1A criteria which SAIC cited in their Task 3 reports are also noted on the matrix.

5.2.2 Comparison to SAIC Task 3

Those criteria in DOE Order 6430.1A which are considered by LATA to be of major concern are those judged to result in adverse impact on safety or the environment if not implemented, i.e., those criteria having an importance value of 1 through 5. It is felt that those criteria which were judged to have an importance value of 1, 2, or 3 could probably be waived if compliance cannot be demonstrated. Further, it can be shown historically that both the 244-AR Vault and B Plant have been operated for many years without unfavorable impact on worker health and safety. From this, it was assumed that those criteria of value 4 can probably be implemented. Therefore, principle emphasis was placed on those criteria of importance value 5. This decision is in keeping with current emphasis on protection of the public and the environment.

Those criteria which LATA considered to be of importance 5, but which were not addressed by SAIC in the Task 3 reports, were then listed. With only minor exceptions, if a criterion was listed in the B Plant report, it also was listed in the 244 AR Vault report.

The list of important criteria not addressed by SAIC follows with a brief discussion as to the importance of the criteria. Those criteria which deal with abstract notions such as objectives, coverage, general statements, etc. and those items which deal with safety analysis are marked with an asterisk (*). No discussion is offered for the criteria so marked.

0110-5.1 Performance Objectives *

0110-5.2 Safety Analysis *

0110-7 ENVIRONMENTAL PROTECTION AND POLLUTION CONTROL - This section lists various DOE Orders which deal with environmental protection and control. While these orders and the other references cited deal primarily with non-radioactive contaminants, the requirements therein must be complied with. See also the discussion of Section 1589 below.

0110-99.0.8 Personnel and Public Safety - In this section, ALARA concepts relative to Design Basis Accidents (DBAs) are discussed. Section 1300-1.4, which is discussed

below, is also referenced. The need for giving proper consideration to chemical toxicity protection as well as radiation protection is emphasized.

0200-1.1 Radiological Siting Requirements *

0200-1.2 Radiological Siting Guidelines *

0275-99.0.3 Nonradioactive Liquid Effluents *

0285-99.0 Nonreactor Nuclear Facilities -- General *

1300-1.4.1 General *

1300-1.4.2 Accidental Releases *

1300-1.4.3 Routine Releases *

1300-2 SAFETY ANALYSIS *

1300-3.3 Single Failure Criterion and Redundancy - Single failure criteria is an important concept in ensuring the continued performance of safety class systems. HEPA filter banks are a good example of a system subject to single failure. The failure of a single filter in a bank will prevent the entire bank from performing its intended safety function. Electrical systems are also subject to single failures as are many other types of systems.

1300-3.4.1 General *

1300-3.4.2 Environmental Qualification of Equipment - Safety class items must continue to perform their safety function in the most extreme environment (temperature, pressure, and humidity) resulting from a DBA.

1300-3.6 Testing - In addition to a number of requirements placed on safety class and other important systems, this section requires that HEPA filter systems be designed to allow for routine in-place testing of the system. Most older HEPA filter systems were not designed with this provision. Because of the potential for failure of a single filter (see single failure discussion above), it is extremely important that those HEPA filter banks which form a part of the confinement system be capable of periodic in-place testing.

1300-7.1 Objectives *

1300-8 WASTE MANAGEMENT - Of the six subsections in this section, only one, 1300-8.1 General, was addressed in the SAIC Task 3 reports and only one criterion, consideration of volume reduction, was selected to demonstrate compliance. It is felt that all of the criteria should be addressed and a waiver sought if compliance cannot be demonstrated and that demonstrated compliance with the other five subsections should also be demonstrated. The other five subsections are listed below.

1300-8.2 Hazardous Waste Requirements

1300-8.3 Mixed Waste

1300.8.4 Waste Segregation

1300-8.5 Spill Protection and Control

1300-8.6 Approvals and Permits

It is particularly important that all required approvals and permits be obtained before start of operations.

1304 PLUTONIUM PROCESSING AND HANDLING FACILITIES - As discussed in 5.2.1 above, it is questionable whether the criteria for plutonium processing and handling facilities should be applied to B Plant or 244-AR Vault. The protection requirements for the worker, the public, or the environment are the same for all nonreactor nuclear facilities differing only in the degree of protection required based on the hazard. Therefore, it may well be worthwhile to demonstrate compliance with plutonium facility criteria. Comparison of the criteria in 1304 to the criteria for radioactive liquid waste facilities, Section 1323, shows that one closely parallels the other.

1323-1 COVERAGE *

1323-5.3 Low-Level Waste Disposal Facility Confinement - In some cases, it may be advantageous to apply this criteria, if applicable.

1323-5.4 Transuranic-Contaminated Liquid Waste Confinement - See discussion in 1323-5.3 above.

1540-99.0.5 Water Supplies and Other Utility Services - It is not clear what water supplies are being referred to in this sub-section. Dedicated water supplies should be installed to provide water for sprinkler systems which protect those filter banks which are a part of the confinement system. These supplies must be designed to withstand those DBAs and natural phenomena which could result in fire.

1550-99.0.2 Confinement Ventilation Systems - All applicable criteria in this subsection should be complied with. In the opinion of the writer, it is good engineering practice to provide redundant, parallel filter systems so that filter banks can be serviced off line. (For facilities processing plutonium, this is a requirement. This is one area where plutonium facility criteria is more stringent.) Further, an extra bank of HEPA filters should be installed in series--in addition to the number required by safety analysis--to protect against single failure.

1550-99.0.3 Off-Gas System - Compliance with the criteria set forth in this subsection should be demonstrated.

1589-99.0.2 Nonradioactive Airborne Effluents *

1660-99.0.1 Safety Class Electrical Systems - This is one subsection which was addressed in the 244-AR Vault Task 3 report, but not in the B Plant report. It is important that all safety class electrical systems be identified and compliance with the criteria in this subsection be demonstrated.

5.3 Findings

The two documents primarily considered in the review were B Plant Compliance to DOE Order 6430.1A and Other Codes, Standards, and Regulations, Task 3 (SAIC, 1989b) and 244-AR Vault compliance to DOE Order 6430.1A and Other Codes, Standards, and Regulations, Task 3 (SAIC, 1989a) prepared by Science Applications International Corporation (SAIC). SAIC did a very thorough job of assessing compliance with DOE Order 6430.1A as can be seen in the Appendix by observing the number of criteria addressed. However, as outlined in 5.2 above, it is LATA's opinion that criteria critical to the successful performance of the new missions being considered for the two facilities were not addressed. Those criteria which should be given further consideration are discussed in the following paragraphs in order of importance.

5.3.1 In-Place Testing of HEPA Filter Banks

SAIC addressed compliance with selected criteria from Section 1550-2.5.5 of DOE Order 6430.1A. One criterion that was not addressed was the requirement for in-place testing of HEPA filter banks.

That portion of the ventilation system that includes the final HEPA filter banks is a part of the confinement system. As such, it is a safety class system. Because it is an active system, it requires continual surveillance and maintenance to ensure that it performs its intended functions. The most important surveillance and maintenance activity associated with HEPA filter banks is in-place testing. HEPA filter banks must be tested when the filters are originally installed and when replaced to ensure that the required efficiency of 99.95% for the bank is achieved. Even though the efficiency of individual filters is confirmed at one of the DOE HEPA filter testing stations, the efficiency of the filter must be confirmed in-place to ensure that the filter seal is performing properly. Once placed in operation, the filter bank must be tested periodically to confirm that the bank is continuing to operate at rated efficiency, ERDA 76-21 recommends that filter banks be tested annually for most operations and more frequently under certain conditions.

Early HEPA filter systems do not provide for in-place testing of multiple filter banks without requiring testing personnel to enter the filter plenum. Section 1550-2.5.5 requires that the system be designed to preclude testing personnel from entering the

plenum. For multiple filter banks (any final HEPA filter bank would require that at least two banks be installed because of single failure requirements), this would require that provisions temporarily bypassing filter banks be provided. A temporary bypass is required because two or more banks in series cannot be tested because of the extremely high efficiency of the individual banks.

In lieu of bypass, at least one filter manufacturer has developed a concept for in-place testing individual filters in a bank without entry by testing personnel. If this system has been adequately field tested, it may be an acceptable alternative to a bypass system.

If redundant parallel filter systems are not provided, the entire facility must be shut down -- and all sources of air-borne contamination secured to preclude a release due to any event -- before in-place testing with a bypass system is performed or while replacing filters in a filter bank. For continuous facility operation, this dictates that redundant parallel filter systems be installed.

Because the final ventilation system is the most important active system in a nonreactor nuclear facility, it is vital that all criteria which ensures operation of the system be complied with.

5.3.2 Single Failure Criterion and Redundancy

Section 1300-3.3 of DOE Order 6430.1A which requires that the design must ensure that a single failure will not result in the loss of capability of a safety class system to accomplish its required safety functions was not addressed by SAIC. Adherence to this criterion requires that not only must the safety class system be redundant, but those systems serving the safety class system, such as electrical systems and control systems, must also be redundant. Each safety class system must be carefully analyzed to ensure that a single failure cannot cause failure of the entire safety class system.

For example, common electrical supply to both the primary safety class system and the redundant system could result in a failure of the electrical supply causing failure of the safety class system. In this regard, emergency power systems must be completely independent from the primary electrical supply system.

5.3.3 Management of Non-Radioactive Hazardous Waste

The management of non-radioactive hazardous waste and mixed waste is as important as management of radioactive waste. In particular, compliance with all subsections of Section 1300-8, Waste Management, should be demonstrated.

All of the Waste Management criteria should be addressed and a waiver sought if compliance cannot be demonstrated. One simple, straight forward way to ensure compliance with the release of hazardous and non-hazardous waste is to obtain approval from the EPA or authorized State agency, through the permit procedure, to release waste. Of course all effluents must be identified and approval for release obtained.

5.4 Summary, Overall Assessment, and Recommendations

Summary

The most important criterion not addressed by SAIC was compliance with the requirement for in-place testing of HEPA filter banks. Of secondary importance is the need to demonstrate compliance with single failure criterion and the need to demonstrate satisfactory management of hazardous and mixed waste.

Overall Assessment

From the standpoint of the BOP assessment, in order to demonstrate that B Plant and the 244-AR Vault can safely perform the new missions being proposed, it is vital that continued operation of the final filter system be ensured. As a matter of fact, it could probably be demonstrated that if the final filter system continues to function, the confinement structure could fail -- short of total collapse -- without release of air-borne radioactive contaminants above allowable levels.

It is also important for Westinghouse to carefully consider those items which SAIC found to be non-compliant -- not only with DOE Order 6430.1A, but with other codes, standards, and regulations -- before proceeding with plans to use B Plant or the 244-AR Vault for the new mission.

Recommendations

If it cannot be demonstrated that the existing final HEPA filter system(s) complies with the in-place testing requirement and single failure criterion, it is recommended that new filter facilities be considered which can comply with all requirements of DOE Order 6430.1A.

The new facilities could standalone and not be structurally connected to the existing facilities. The facility would logically contain the necessary filter banks and fans and, if required, could also contain emergency power systems.

Single failure analyses needs to be performed on all safety class systems and proper management of hazardous and mixed waste needs to be demonstrated.

6.0 REVIEW OF SAFETY ANALYSIS

6.1 Method of Review and Evaluation

Documents related to the proposed modifications of B-Plant and the 244-AR Vault for a 20 year mission to process and dispose of stored and future generation of high level liquid wastes were reviewed. A list of the documents reviewed is given in Table 6-1. The information contained in the documents was considered for consistency, thoroughness, accuracy, and level of detail appropriate to the subject under review. The application of DOE Orders and other codes, standards, and regulations was also surveyed.

No attempt was made to perform detailed calculations of technical questions, nor to pursue an independent evaluation of the condition of facilities and equipment, or of their suitability to meet the requirements of the various codes and regulations. Rather, the effort was focused on determining whether those calculations and evaluations had been adequately done and whether the results were reasonable, consistent, and were given appropriate treatment in the development of the plans for the facility modifications.

6.2 Determination of Orders, Codes, Standards, and Regulations

A review was made of the various DOE Orders, NRC Regulations, and various other codes and standards which might be considered applicable to the modification of B-Plant and the 244-AR Vault system. This review emphasized the national requirements deriving from the federal government orders and regulations or from nationally recognized codes (e.g., ASME). Only limited consideration was given to Washington state requirements or to specific Hanford site rules and procedures.

While insufficient design data on the new process exists for a comprehensive safety analysis to be developed now, the existing information was examined to determine if there were any significant omissions made in the preliminary plans for B-Plant and AR Vault modifications which might have a major impact on the proposed project.

TABLE 6-1
DOCUMENTS RELATED TO SAFETY ASSESSMENT OF
B-PLANT AND 244-AR VAULT MODIFICATIONS

Report No.	Title	Author(s) (Company)	Date
SD-WM-TA-010 Rev 0	Technology Study for the Pretreatment of Complexant Concentrate	D.E. Kurath (Rockwell Hanford Co.)	6/85
SD-WM-SAR-013 Rev 0	B Plant Safety Analysis Report	R.G. Sewell (Rockwell Hanford Co.)	7/85
SD-WM-SAR-013 Rev 1	B Plant Safety Analysis Report	Roger G. Sewell (Rockwell Hanford Co.)	3/86
SD-WM-SAR-013 Rev 2	B Plant Safety Analysis Report	J.M. Siemer (Rockwell Hanford Co.)	7/86
SD-WM-PTR-006 Rev 0	B Plant NCAW Process Test Report	D.M. Gerboth (Rockwell Hanford Co.)	5/87
WHC-CM-4-30	Nuclear Safety Manual; Safety Evaluation of Facility and Process Design, Modifications and Construction	Q.L. Baird (Westinghouse Hanford Co.)	7/88
SD-WM-TA-015	Process and Facility Option for Pretreatment of Hanford Tank Waste	M.J. Kopfer (WHC) A.L. Boldt (WHC) J.L. Buelt (PNL)	9/88
CAPA-88-039	Capabilities to Recommission DOE Nuclear Facilities	(LATA)	11/88
SD-WM-TPP-040 Rev 0	Technology Program Plan for the Pretreatment of Complexant	R.M. Orine (Westinghouse Hanford Co.)	11/88
SA-BVW-89-7	B Plant Seismic Evaluation, Preliminary Nonlinear Capacity Results	T.J. Conrads	1/89
WHC-EP-0229	Double Shell Tank Waste Disposal Integration Plan	N.W. Kirch (Westinghouse Hanford Co.)	2/89
SA-GRW-89-15	AR Vault, AR Stack, & B Plant Stack Seismic Evaluation	G.R. Wagenblast	3/89
SD-WM-SA-002 Rev 0	B Plant Safety Systems Seismic Evaluations Program	F.R. LaSalle (Westinghouse Hanford Co.)	3/89
WHC-SP-0464	Assessment of Double Shell Tank Waste Pretreatment Options	(Westinghouse Hanford Co.)	3/89
89-3-3-4	B Plant Compliance to DOE Order 6430.1A and Other Codes, Standards, and Regulations	(Science Applications International Corporation)	(4/89)

TABLE 6-1
DOCUMENTS RELATED TO SAFETY ASSESSMENT OF
B-PLANT AND 244-AR VAULT MODIFICATIONS
(concluded)

Report No.	Title	Author(s) (Company)	Date
89-3-3-4	B Plant Compliance to DOE Order 6430.1A and Other Codes, Standards, and Regulations	(Science Applications International Corporation)	(4/89)
89-4-3-4	244-AR Vault Compliance to DOE Order 6430.1A and Other Codes, Standards, and Regulations (Task 3)	(Science Applications International Corporation)	4/89
WHC-CM-1-3 MRP 5.46 Rev 0	Management Requirements and Procedures; Safety Classification of Systems. Components and Structures	(Westinghouse Hanford Co.)	4/89
WHC-CM-1-3 MRP 5.43 Rev 4	Management Requirements and Procedures; Impact Levels	(Westinghouse Hanford Co.)	4/89
SD-WM-SAR-018 Rev 1	Safety Analysis Report for 244-AR Vault	(Rockwell Hanford Co.)	?
SD-WM-ES-124 Rev 0	B-Plant Life Extension Scoping Study	R. R. Wyer (Westinghouse Hanford Co.)	2/89
SD-XX-XX-XXX (Preliminary)	B-Plant Preliminary Accident Analysis	R. M. Marusich (Westinghouse Hanford Co.)	3/89

It is pointed out that there are few orders, codes, standards, or regulations which have a direct impact on process selection or process development. For the most part, the influence of these requirements is indirect in nature. For instance, the use of flammable solvents or reagents in a process might be limited or even prohibited by the various fire safety codes; the use and/or disposition of hazardous or toxic substances might be significantly influenced by EPA regulations relating to workplace concentrations or waste emissions; certainly the facilities and equipment used for processing are affected in a major way by the requirements of Order 6430.1A and references included therein.

From this standpoint then, it is not possible to determine whether a given process can be said to meet all of the safety requirements imposed by codes, standards, and regulations. The application of the code requirements to the process is normally done by the performance of a Safety Analysis Review (SAR) to a design (Preliminary) or completed facility (Final).

For the B-Plant and AR Vault, SARs have been conducted on the facilities in the past, but the process operation was not the process which would be used for the disposal of the DST solutions. However, these SARs were reviewed to assess the likelihood that the proposed process could be installed in the facilities with acceptable results from the standpoint of safety.

6.3 Evaluation

In all of the cases examined, the pertinent orders, codes, standards, and regulations have been given consideration in proposals for B-Plant and AR Vault modifications. In some cases, discussed below, there may be some questions concerning the interpretation of the requirements or their specific applicability to those facilities.

For the most part, the requirements are applied through inclusion in DOE Order 6430.1A. This order directly incorporates the requirements of some other codes and standards, and incorporates by reference the content of hundreds of others. It mandates that where an inconsistency occurs between two or more references, the most conservative (from a safety standpoint) shall apply.

A few other codes, standards, and regulations which might be applicable to the proposed modifications, but which were not referenced in Order 6430.1A, were identified. In those cases, the plans for B-Plant modification have recognized and incorporated them into the overall program.

The best listing of the necessary changes to meet CS&R requirements and the actions proposed to meet those requirements, is given in two documents issued by Science Applications International Corporation. These are (1) "B-Plant Compliance to DOE Order 6430.1A and Other Codes, Standards, and Regulations," dated April 13, 1989; and (2) "244-AR Vault Compliance to DOE Order 6430.1A and Other Codes, Standards, and Regulations," dated April 7, 1989. Completion of all the recommendations listed in these reports will ensure that the facilities meet all the safety requirements of applicable orders, codes, standards, and regulations. In addition to these, a number of points are suggested for modifying or supplementing the intended changes.

1. The description of the method (Section 2) of analysis for both the B-Plant and 244-AR Vault compliance reports, described in the above paragraph states that, "it is assumed that . . . will not be a plutonium handling facility." This assumption makes it possible to disregard the requirements of Section 1304 of DOE Order 6430.1A and any other codes referenced therein. Neither DOE Order 6430.1A or DOE Order 5480.5 provides a very specific definition of what is and what is not a plutonium handling facility. At the same time, it appears that by using the maximum of the estimates of plutonium concentration in DST waste, a significant amount of plutonium could accumulate in B-Plant. It is suggested that the basis for ensuring that the facilities do not need to be designed as plutonium handling facilities should be quantified and validated.

2. The same reports also state the assumption that only two safety class items exist in each facility. As stated, this assumption is subject to question. This issue should be clarified as it could have a significant bearing on the plans for modification.

3. Probably the largest unresolved question relating to safety is the definition of the magnitude of the Design Basis Earthquake, and the translation of this to structural strength, contamination, containment, and related issues. This issue is addressed in detail in Section 4 of this report.

4. It appears that the requirements of Section 0110-5.4, DOE Order 6340.1A (Asbestos Containing Materials) were overlooked. It is likely that facilities more than 20 years old would contain asbestos and that modification efforts could expose workers to the material if no precautions were taken.

5. Similarly, the requirements of Section 0275-99.0.1 (Industrial Wastes) appear not to have been considered. Although minor, some such wastes would be expected.

The absence of a Design Basis Fire (DBF) and required separation of fire areas in the present study raises some concerns. A DBF has the capability to affect the relative merits of a new versus existing facility. A fire was considered in the Preliminary Accident Analysis (Marusich, 1989) study, however it was a localized fire in a specific

target source used to initiate a radioactive aerosol release and subsequent effective dose equivalent calculations. Fires of this type are limited in value to an evaluation of a release mechanism rather than the full impact of a "design basis."

The details of a DBF are not considered a safety issue but rather a less limiting issue. Whether a new or existing facility, the pretreatment facility must be able to withstand the effects of a DBF without adverse impact to the public environment. As indicated in Appendix A, WHC must comply with the requirements of DOE 6430.1A, 011-5.2 Safety Analysis which requires that a DBF be defined. Separation of fire areas only serves to limit the loss and the amount of radioactive contaminants to be contained in the event of a fire; it has little or no effect on the impact to the public environment. (See also DOE 6430.1A, 0110-6.2 Fire Protection Design Analysis requirements).

The absence of a DBF has a potential for strong negative impact on the B-Plant viability study. As an independent reviewer of this study, we suggest a DBF be considered.

6.4 Summary of Findings

The program established to evaluate the feasibility of utilizing B-Plant and 244-AR Vault facilities for the permanent disposal of selected liquid and solid wastes appears to be complete and thorough, from the standpoint of meeting safety objectives, including the compliance with applicable orders, codes, standards, and regulations. Although some issues remain to be analyzed in full depth and detail, nothing found to date indicates that this is not a viable project which could be successfully implemented assuming favorable findings on open questions.

In order to ensure that the study is complete and covers all the appropriate issues, the following actions are recommended:

1. At the earliest practical time, a Preliminary Safety Analysis Review (PSAR) should be completed applying the proposed disposal processes and equipment to the modified facilities to complete the evaluation of the effects of the maximum credible accidents.

2. Determine the maximum amount of plutonium which might be contained in the facilities in future operations and clarify the rationale for not considering the facilities to be plutonium handling facilities.

3. Based upon work already underway, define the Safety Class Items and apply the results to determine additional modifications which might be required.

4. Complete the analysis of the magnitude of the Design Basis Earthquake and the resulting impact on structural integrity and related questions. Apply these findings to determine further changes that might be required.

5. Determine the compliance of existing facilities to Sections 0275-99.0.1 and 0110-5.4 of DOE Order 6340.1A and take action as appropriate.

6. Consider a Design Basis Fire, complete the associated safety analyses, and determine any additional modifications which might be required.

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APPENDIX A

APPLICABILITY MATRIX OF DOE 6430.1A CRITERIA FOR BALANCE OF PLANT (BOP) SYSTEMS

Each numbered section and subsection in DOE 6430.1A was reviewed for applicability to the pretreatment operations and noted as either applicable or not applicable. Those sections and subsections determined to be applicable were further reviewed to determine whether a safety or environmental related issue was involved. If it was determined that safety or environmental issues were involved, the relative importance of that particular issue was noted based on the following scale:

1. of only minor safety importance,
2. required to meet standards and guides not covered by 3, 4, or 5 below,
3. required to protect property,
4. required to protect workers, or
5. required to protect the public or the environment.

A matrix showing the result of the assessment was constructed and is contained in this Appendix. Those DOE 6430.1A criteria which SAIC cited in their Task 3 reports are also noted on the matrix.

Balance of Plant - Compliance with DOE 6430.1A

In SAIC		Applicable?	Safety or Environs Impact?	Importance?	Remarks
	Division 1 - General Requirements				
	0101 Criteria Purpose and Application				
	0101-1 General	Yes	No		UBC cited
	0101-2 Criteria Deviations	Yes	No		Deviations for existing facilities noted. Engineering judgement allowed. Deviation for safety-class facilities recognized.
	0101-3 Organization and Use of These Criteria				
	0101-3.1 General	Yes	No		
	0101-3.2 "Shall" and "Shall Consider"	Yes	No		
	0101-3.3 References to Other Sections and Documents	Yes	No		
	0101-3.4 Special Facilities				
	0101-3.4.1 "-99" Sections	Yes	No		"-99" Sections defined
	0101-3.4.2 Division 13	Yes	No		
	0101-3.5 Indexes and Glossary	Yes	No		
	0101-3.6 Document and Improvement Control	No			
	0101-4 Handicapped Provisions	No			Existing facilities are exempt. Further, handicapped personnel should not be in the plant.
	0106 Regulatory Requirements	Yes	Yes	1-5	
	0109 Reference Standards and Guides	Yes	Yes	1-5	
	0110 Architectural and Special Requirements				
	0110-1 Design, Programmatic, & Operating Rqmts				
	0110-1.1 General				
	0110-1.1.1 Design	Yes	No		Design already established
	0110-1.1.2 Programming	Yes	No		Design already established
	0110-1.2 Systems Integration	Yes	No		
	0110-1.3 Emergency Procedures	Yes	Yes	1	Can be retrofit
	0110-2 Alternative Design	Yes	No		Design already established
	0110-3 Flexibility	Yes	No		Design already established
	0110-4 Operational Efficiency	Yes	No		Design already established
	0110-5 Health & Safety				
	0110-5.1 Performance Objectives	Yes	Yes	5	Implemented by other Divisions
	0110-5.2 Safety Analysis	Yes	Yes	5	Being implemented
	0110-5.3 Asbestos-Containing Materials	Yes	Yes	4	Upgrading to bring plant into compliance
	0110-5.4 Polychlorinated Biphenyls (PCBs)	Yes	Yes	4	
	0110-6 Fire Protection				
B,V	0110-6.1 General	Yes	Yes	3	
B,V	0110-6.2 Fire Protection Design Analysis	Yes	Yes	4	
B,V	0110-6.3 Fire Resistance Ratings	Yes	Yes	3	
B,V	0110-6.4 Hazardous Areas	Yes	Yes	4	
	0110-7 Environmental Protection and Pollution Control	Yes	Yes	5	
	0110-8 Accommod. for the Physically Handicapped	Yes	No		
	0110-9 Operation, Main., Repair, & Replacement	Yes	No		
	0110-10 Fallout Shelters	No			
	0110-11 Work Space Management Standards	Yes	No		
	0110-12 Energy Conservation				

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B = B Plant, V = 244-AR Vault

Balance of Plant - Compliance with DOE 6430.1A

In SAIC		Appli-cable?	Safety or Environs Impact?	Impor-tance?	Remarks
	0110-12.1 Coverage	Yes	No		
B,V	0110-12.2 General	Yes	No		
	0110-12.3 Building Envel. Thermal Transmit. Values	Yes	No		
	0110-12.4 Building Envelope Air Leakage Criteria	Yes	No		
	0110-12.5 Use of Renewable Energy Systems				
	0110-12.5.1 Active Solar Systems	Yes	No		
	0110-12.5.2 Passive Solar Tech. & Daylighting Tech.	Yes	No		
	0110-12.5.3 Other Renewable Systems	Yes	No		
	0110-12.6 Energy Monitoring & Control Systems	Yes	No		
	0110-12.7 Building Analysis Procedures				
	0110-12.7.1 LCC Analysis Procedures	Yes	No		
	0110-12.7.2 Use of Comp. or Other Engy. Anal. Tech.	Yes	No		
	0110-12.7.3 Design Analysis Procedures	Yes	No		
	0110-12.7.4 Waivers of Design Analysis Rqmts.	Yes	No		
	0110-12.8 Energy Conservation Report Rqmts.				
	0110-12.8.1 General	Yes	No		
	0110-12.8.2 Distrib. of 'Energy Conser. Reports"	Yes	No		
	0110-13 Physical Protection				
	0110-13.1 General	Yes	No		
	0110-13.2 Access Control & Security Areas				
	0110-13.2 1 General	Yes	No		
	0110-13.2.2 Limited-Area Requirements	Yes	No		
	0110-13.2.3 Exclusion Area Requirements	Yes	No		
	0110-13.3 Physical Barriers	Yes	No		
	0110-13.4 Intrusion Detection	Yes	No		
	0110-13.5 Communications Equipment	Yes	No		
	0110-99 Special Facilities				
	0110-99 0 Nonreactor Nuclear Facilities - General				
	0110-99 0.1 General	Yes	Yes	3	
B,V	0110-99.0.2 Building Services and Distribution	Yes	Yes	1	
	0110-99.0.3 Utilization Schedule	Yes	No		
	0110-99 0.4 Building Layout	Yes	Yes	6	
	0110-99.0 5 Interior Walls & Partitions	Yes	No		
B,V	0110-99 0.6 Fire Resistance	Yes	No		
	0110-99.0.7 Loss Limitations	Yes	No		
	0110-99.0.8 Personnel and Public Safety	Yes	Yes	5	
	0110-99 2 Emergency Preparedness Facilities	No			
	0110-99 7 Occupations Health Facilities	No			
	0110-99.8 Telcom., Alarm, & ADP Ctr. & Rad Rp. Sta.	No			
	0110-99.9 Vlt. & Vlt.-Type Rm. for Str. of Clas. Mttr.	No			
	0110-99.10 Secure Conference Rooms	No			
	0110-99.11 Secure Offices	No			
	0110-99.11.2 Room Envelope				
	0111 Structural Design Requirements				Not Balance of Plant
	0140 Quality Assurance	Yes	Yes	3	
	0150 Construction Facilities & Temporary Controls	No			

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B = B Plant, V = 244-AR Vault

Balance of Plant - Compliance with DOE 6430.1A

In SAIC		Applicable?	Safety or Environs Impact?	Importance?	Remarks
	0170 Construction Contract Closeout	No			
	Division 2 - Site and Civil Engineering				
	0200 Site Development				
	0200-1 Facility Siting				
	0200-1.1 Radiological Siting Requirements	Yes	Yes	S	
	0200-1.2 Radiological Siting Guidelines	Yes	Yes	S	
	0200-2 Building Location	No			
	0200-99 Special Facilities				
	0200-99.0 Nonreactor Nuclear Facilities - General				
	0200-99.0.1 General	Yes	No		
	0200-99.0.2 Other Facilities & Operations				Not Balance of Plant
B,V	0200-99.0.3 Services	Yes	Yes	S	244-AR Vault not in compliance per SAI
	0200-99.0.4 Meteorology				Not Balance of Plant
	0200-99.0.5 Hydrology				Not Balance of Plant
	0200-99.0.6 Seismology				Not Balance of Plant
	0200-99.8 Telcom., Alm, & ADP Ctr. & Rad. Rep. Sta.	No			
	0201 Subsurface Investigations				Not Balance of Plant
	0202 Surveying				Not Balance of Plant
	0203 Utilities Within Easements or Corridors				
	0203-1 Utility Locations				
	0203-1.1 General	Yes	No		
	0203-1.2 Underground	Yes	No		
	0203-1.3 Aboveground	Yes	No		
	0203-1.4 Security Areas	Yes	No		
	0203-1.5 Record Drawings	Yes	No		
	0205 Demolition and Decommissioning				Not Balance of Plant
	1210 Site Preparation				Not Balance of Plant
	0214 Dewatering				Not Balance of Plant
	0215 Shoring and Underpinning				Not Balance of Plant
	0220 Earthwork				Not Balance of Plant
	0235 Building Foundations				Not Balance of Plant
	0245 Railroad Designs	No			
	0250 Paving and Surfacing				Not Balance of Plant
	0256 Airfields and Heliports	No			
	0260 Piped Utility Materials				

B = B Plant, V = 244-AR Vault

Balance of Plant - Compliance with DOE 6430.1A

In SAIC		Applicable?	Safety or Environs Impact?	Importance?	Remarks
	0260-1 Coverage	Yes	No		
	0260-2 Exterior Utilities	Yes	No		
	0262 Corrosion Control				
	0262-1 General	Yes	No		
	0262-2 Corrosion Control Tests	Yes	No		
	0262-3 Cathodic Protection Systems	Yes	No		
	0266 Water Distribution Systems	No			
	0267 Industrial Waste Treatment	No			
	0270 Sanitary Wastewater Collection and Storm-water Management Systems	No			
	0273 Water Pollution Controls				
	0273-1 General	Yes	No		
	0273-2 Regulatory Overview	Yes	No		
	0275-3 Plnng for San. Wastewater Treat. & Dis Sys.	No			
B,V	0273-4 Sel. of San. Wastewater Treat. & Dis. Meth.	No			
	0273-99 Special Facilities				
B,V	0273-99.0 Nonreactor Nuclear Facilities - General	Yes	Yes	5	
	0275 Industrial Waste Water Treatment				
	0275-1 General				Not Balance of Plant
	0275-2 Regulatory Overview				Not Balance of Plant
	0275-3 Plnng for Ind. Wastewater Treat. & Dis. Sys				Not Balance of Plant
	0275-3.1 General				Not Balance of Plant
	0275-3.2 Alt. Prod. Flow Control Methods				Not Balance of Plant
	0275-3.3 Recycl./Recvy. Sys & Alt. Wst Treat. Tech.				Not Balance of Plant
	0275-3.4 Disposal of Solids	Yes	Yes	5	
B,V	0275-4 Control of Pollution From Other Sources				Not Balance of Plant
	0275-5 Sel. of Ind. Wastewater Trt. & Dispos. Mthds.				
	0275-99 Special Facilities				
	0275-99.0 Nonreator Nuclear Facilities - General				
B,V	0275-99.0.1 Industrial Wastes	Yes	Yes	5	B Plant not in compliance for non sinks SAIC.
B,V	0275-99.0.2 Process Wastes	Yes	Yes	5	B Plant and 244-AR Vault not in complete compliance per SAIC.
	0275-99.3 Nonradioactive Liquid Effluents	Yes	Yes	5	
	0276 Construction in Floodplains or on Wetlands	No			
	0278 Power and Lighting	Yes	No		
	0279 Exterior Communications and Alarm System	Yes	No		
	0280 Site Improvements				Not Balance of Plant
	0281 Vehicular and Pedestrian Circulation				Not Balance of Plant

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B = B Plant, V = 244-AR Vault

Balance of Plant - Compliance with DOE 6430.1A

In SAIC	Applicable?	Safety or Environs Impact?	Importance?	Remarks
0283 Physical Protection				Not Balance of Plant
0285 Solid Waste Systems	No			
0285-1 Regulatory Overview	No			
0285-2 Site Selection	No			
0285-3 Site Design				
0285-99 Special Facilities				
0285-99.0 Nonreactor Nuclear Facilities - General	Yes	Yes	5	
0290 Landscaping				Not Balance of Plant
0291 Irrigation Systems				Not Balance of Plant
Division 3 - Concrete				Not Balance of Plant
Division 4 - Masonry				Not Balance of Plant
Division 5 - Metals				Not Balance of Plant
Division 6 - Wood and Plastics				Not Balance of Plant
Division 7 - Thermal and Moisture Protection	Yes	No		
Division 8 - Doors and Windows				
0800 General	Yes	No		
0800-1 Doors	Yes	No		
0800-1.1 General	Yes	Yes	2	
0800-1.2 Fire Protection	Yes	No		
0800-1.3 Security				
0800-2 Windows	Yes	No		
0800-2.1 General	Yes	Yes	2	
0800-2.2 Fire Protection	Yes	Yes	2	
0800-2.3 Safety	Yes	No		
0800-2.4 Maintenance and Repair	Yes	No		
0800-2.5 Screens	Yes	No		
0800-2.6 Security				
0810 Metal Doors and Frames	Yes	No		
0810-1 Steel Doors and Frames	Yes	No		
0810-2 Aluminum Doors and Frames				
0820 Wood and Plastic Doors	Yes	No		
0820-1 Wood Doors				

B = B Plant, V = 244-AR Vault

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Balance of Plant - Compliance with DOE 6430.1A

In SAIC	Applicable?	Safety or Environs Impact?	Importance?	Remarks
0830 Special Doors	Yes	Yes	1	
0833 Coiling Doors	Yes	No		
0836 Sectional Overhead Doors	Yes	No		
0839 Screen and Storm Doors	Yes	No		
0850 Metal Windows				
0850-1 Steel Windows	Yes	No		
0850-2 Aluminum Doors and Frames	Yes	No		
0860 Wood and Plastic Doors				
0860-1 Wood Doors	Yes	No		
0870 Hardware	Yes	No		
0880 Glazing	Yes	No		
Division 9 - Finishes				
0900 General				
0900-1 General	Yes	No		
0900-2 Fire Protection	Yes	No		
0900-3 Hazardous Materials Contamination	Yes	Yes	1	
0900-4 Indoor Air Quality	Yes	Yes	3	
0900-99 Special Facilities				
0900-99.0 Nonreactor Nuclear Facilities - General	Yes	Yes	3	
0900-99.4 Explosives Facilities				
0900-99.4.1 Radiological Design Requirements	No			
0900-99.7 Occupational Health Facilities				
0900-99.7.1 General	No			
0900-99.7.2 Floors	No			
0900-99.7.3 Walls	No			
0900-99.7.4 Ceilings	No			
0900-99.7.5 Doors and Frames	No			
0910 Metal Support Systems				
0910-1 Non-Load Bearing Wall Framing Systems	Yes	No		
0910-2 Ceiling Suspension Systems	Yes	Yes	3	
0920 Lath and Plaster				
0920-15 Veneer Plaster	Yes	No		
0925 Gypsum Board	Yes	No		
0930 Tile				
0930-1 Ceramic Tile	Yes	No		

B = B Plant, V = 244-AR Vault

Balance of Plant - Compliance with DOE 6430.1A

In SAIC	Applicable?	Safety or Environs Impact?	Importance?	Remarks
0950 Acoustical Treatment				
0950-1 General	Yes	No		
0950-99 Special Facilities				
0950-99.10 Secure Conference Rooms	No			
0950-99.11 Secure Offices	No			
0965 Resilient Flooring	Yes	No		
0968 Carpet	Yes	No		
0970 Special Flooring				
0970-5 Resinous Flooring	Yes	Yes	2	
0970-99 Special Facilities				
0970-99.4 Explosives Facilities	No			
0980 Special Coatings	Yes	No		
0990 Painting	Yes	No		
0995 Wall Coverings	Yes	No		
Division 10 - Specialities				
1015 Compartments and Cubicles	Yes	No		
1020 Louvers and Vents	Yes	No		
1024 Grilles and Screens	Yes	No		
1027 Access Flooring	Yes	No		
1030 Fireplaces and Stoves	No			
1040 Identifying Devices				
1040-1 General	Yes	No		
1040-2 Naming DOE Buildings After Individuals	Yes	No		
1050 Lockers	Yes	No		
1052 Fire Protection Specialities	Yes	Yes	1	
1053 Protective Covers	Yes	No		
1055 Postal Specialities	No			
1060 Partitions	Yes	No		
1065 Operable Partitions	Yes	No		
1070 Exterior Sun Control Devices	Yes	No		

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B = B Plant, V = 244-AR Vault

Balance of Plant - Compliance with DOE 6430.1A

In SAIC	Applicable?	Safety or Environs Impact?	Importance?	Remarks
1075 Telephone Facilities	Yes	No		
1080 Toilet and Bath Accessories	Yes	No		
Division 11 - Equipment				
1100 General	Yes	No		
1161 Enclosures, Hoods, and Glove Boxes				
1161-1 General Considerations	Yes	Yes	3	
1161-2 Construction	Yes	Yes	3	
1161-3 Fire Protection	Yes	Yes	3	
1161-4 Ventilation	Yes	Yes	3	
1161-5 Operational Compatibility	Yes	No		
Division 12 - Furnishings				
1201 General	Yes	Yes	3	
1230 Manufactured Casework	Yes	Yes	1	
1250 Window Treatment	Yes	No		
1250-3 Drapery and Curtain Hardware	Yes	No		
1260 Furniture and Accessories				
1260-1 Landscape Partitions and Components	Yes	No		
1260-2 Furniture	Yes	No		
1260-3 Furniture Systems	Yes	No		
1260-4 Rugs and Mats	Yes	No		
1260-99 Special Facilities				
1260-99.1 Laboratory Facilities (Incl. Hot Labs.)	No			
1270 Multiple Seating	Yes	No		

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B = B Plant, V = 244-AR Vault

Balance of Plant - Compliance with DOE 6430.1A

In SAIC		Applicable?	Safety or Environs Impact?	Importance?	Remarks
	Division 13 - Special Facilities				
	1300 General Requirements				
	1300-1 Coverage and Objectives				
	1300-1.1 Coverage	Yes	No		
	1300-1.2 Using Division 13	Yes	No		
	1300-1.3 Objectives	Yes	No		Design objectives for nuclear facilities.
	1300-1.4 Guidance on Limit. Exp. of the Public	Public			
	1300-1.4.1 General	Yes	Yes	5	
	1300-1.4.2 Safety Analysis	Yes	Yes	5	Refers to DOE-1. Siting is fixed.
	1300-1.4.3 Routine Releases	Yes	Yes	5	Releases combined with other facilities.
	1300-2 Safety Analysis	Yes	Yes	5	Discusses SARs
	1300-3 Safety Class Criteria				
	1300-3.1 General	Yes	No		
B,V	1300-3.2 Safety Class Items	Yes	Yes	5	1300-1.4.2 referenced. ASME Boiler & Pressure Vessel Code referenced.
	1300-3.3 Single Failure Criterion and Redundancy	Yes	Yes	5	
	1300-3.4 Equipment Environment Considerations				
	1300-3.4.1 General	Yes	Yes	5	
	1300-3.4.2 Environmental Qualification of Equip	Yes	Yes	5	
B,V	1300-3.4.3 Equipment Operability Considerations	Yes	Yes	5	Testing preferred method.
	1300-3.5 Maintenance	Yes	Yes	1	
	1300-3.6 Testing	Yes	Yes	5	In-place testing of HEPA filtration syste covered.
B,V	1300-4 Nuclear Criticality Safety	Yes	Yes	4	
	1300-5 Source and Special Nuclear Material	Yes	Yes	4	
	1300-6 Radiation Protection				
B,V	1300-6.1 General	Yes	Yes	4	
	1300-6.2 Shielding Design	Yes	Yes	4	
	1300-6.3 Hand and Forearm Protection	Yes	Yes	4	
	1300-6.4 Internal Radiation Exposure	Yes	Yes	4	
	1300-6.5 Monitoring, Warning, and Alarm Systems				
B,V	1300-6.5.1 General	Yes	Yes	4	
B,V	1300-6.5.2 Air Monitoring and Warning Systems	Yes	Yes	4	
	1300-6.5.3 Pers. Monitoring & Warning Devices	Yes	Yes	4	
	1300-6.5.4 Ionizing Radiation Monitoring System	Yes	Yes	4	
B,V	1300-6.5.5 Warning and Alarm System Features	Yes	Yes	4	
	1300-6.5.6 Nuclear Accident Dosimetry	Yes	Yes	4	
	1300-6.5.7 Cntrl. Rad. Monitoring & Alarm Readout	Yes	Yes	4	
	1300-6.6 Decontamination of Personnel	Yes	Yes	4	
	1300-6.7 Meteorological Equipment	Yes	Yes	1	
	1300-6.8 Change Rooms	Yes	Yes	1	
	1300-6.9 Breathing Air System	Yes	Yes	4	
	1300-7 Confinement Systems				
	1300-7.1 Objectives	Yes	Yes	5	DOE-1 referenced. Siting fixed.
B,V	1300-7.2 General	Yes	Yes	5	B Plant May not be in compliance per SAIC
B,V	1300-7.3 Access Ways	Yes	Yes	5	
B,V	1300-7.4 Transfer Pipes and Encasements	Yes	Yes	5	

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B = B Plant, V = 244-AR Vault

Balance of Plant - Compliance with DOE 6430.1A

In SAIC		Applicable?	Safety or Environs Impact?	Importance?	Remarks
	1300-8 Waste Management				
B,V	1300-8.1 General	Yes	Yes	5	DOE 5820.2 cited (design and operating requirements for radioactive waste)
	1300-8.2 Hazardous Waste Requirements	Yes	Yes	5	DOE 5480.2 cited
	1300-8.3 Mixed Waste	Yes	Yes	5	DOE 5480.2 cited
	1300-8.4 Waste Segregation	Yes	Yes	5	
	1300-8.5 Spill Protection and Control	Yes	Yes	5	
	1300-8.6 Approvals and Permits	Yes	Yes	5	
B,V	1300-9 Effluent Control and Monitoring	Yes	Yes	5	B Plant not in complete compliance per SA
	1300-10 Phy. Prt., Mt'l. Sfg., & Sto. of Spc. Nuc. Mt'l.				
	1300-10.1 General	Yes	No		
	1300-10.2 Physical Protection				
	1300-10.2.1 General	Yes	No		
	1300-10.2.2 Baseline Protection Requirements	Yes	No		Where are Categorys I, II, III, & IV defined?
	1300-10.2.3 Access Control Requirements	Yes	No		
	1300-10.2.4 Security Equipment	Yes	No		
	1300-10.3 Material Safeguards				
	1300-10.4 SNM Storage Facilities				
	1300-11 Decontamination and Decommissioning				
	1300-11.1 Decontamination	Yes	No		
	1300-11.2 Decommissioning	Yes	No		
	1300-12 Human Factors Engineering				
	1300-12.1 Coverage	Yes	No		
	1300-12.2 Objectives	Yes	No		
	1300-12.3 System Development				
	1300-12.3.1 General	Yes	No		
	1300-12.3.2 Plng the Hmn Fct Eng Rle in Sys Dev	Yes	No		
	1300-12.3.3 Requirements Analyses	Yes	No		
	1300-12.3.4 System Design	Yes	No		
	1300-12.3.5 Test and Evaluation	Yes	No		
	1300-12.4 System Design Considerations				
	1300-12.4.1 General	Yes	No		
	1300-12.4.2 Human Dimension Considerations	Yes	No		
	1300-12.4.3 Environmental Considerations	Yes	No		
	1300-12.4.4 Component Arrangement	Yes	No		
	1300-12.4.5 Protective Equipment	Yes	No		
B,V	1300-12.4.6 Display Devices	Yes	No		
	1300-12.4.7 System Controls	Yes	No		
B,V	1300-12.4.8 Warning and Annunciator Systems	Yes	No		
	1300-12.4.9 Communication Systems	Yes	No		
	1300-12.4.10 Maintainability	Yes	No		
	1300-12.4.11 Labels	Yes	No		
	1300-13 Access and Usab. by Phys Handicapped	No			
	1304 Plutonium Processing and Handling Facilities				
	1304-1 Coverage	?	Yes	5	
	1304-2 Objectives	?	Yes	5	
	1304-3 Nuclear Criticality Safety	?	Yes	4	
	1304-4 Radiation Protection	?	Yes	4	
B,V	1304-5 Special Design Features	?	Yes	5	
	1304-6 Confinement Systems				

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B = B Plant, V = 244-AR Vault

Balance of Plant - Compliance with DOE 6430.1A

In SAIC		Appli-cable?	Safety or Environs Impact?	Impor-tance?	Remarks
	1304-6.1 General	?	Yes	5	
	1304-6.2 Primary Confinement System	?	Yes	4	
	1304-6.3 Secondary Confinement System	?	Yes	4	
	1304-6.4 Tertiary Confinement System	?	Yes	5	
	1304-7 Effluent Control and Monitoring				
	1304-7.1 Radioactive Solid Waste	?	Yes	4	
	1304-7.2 Radioactive Liquid Waste	?	Yes	5	
	1304-7.3 Effluents				
	1304-7.3.1 Airborne Effluents	?	Yes	5	
	1304-8 Decontamination and Decommissioning	?	Yes	4	
	1305 Plutonium Storage Facilities	No			
	1306 Unirradiated Enriched Uranium Facilities	No			
	1307 Explosives Facilities	No			
	1318 Uranium Enrichment Facilities	No			
	1319 Uranium Processing and Handling Facilities	No			
	1320 Irradiated Fissile Material Storage Facilities	No			
	1321 Reprocessing Facilities	No			
	1322 Uranium Conversion and Recovery Facilities	No			
	1323 Radioactive Liquid Waste Facilities				
	1323-1 Coverage	Yes	Yes	5	
	1323-2 Objectives	Yes	Yes	4	
B,V	1323-3 Nuclear Criticality Safety	Yes	Yes	4	
	1323-4 Special Design Features				
B,V	1323-4.1 General	Yes	Yes	5	
B,V	1323-4.2 Collection Systems	Yes	Yes	4	
B,V	1323-4.3 Storage and Transfer Systems	Yes	Yes	4	
B,V	1323-4.4 Treatment Systems	Yes	Yes	5	B Plant not in complete compliance per S
	1323-5 Confinement Systems				
B,V	1323-5.1 General	Yes	Yes	5	
B,V	1323-5.2 High-Level Waste Disposal Facility Confinement	Yes	Yes	5	B Plant and 244-AR Vault may not be in complete compliance per SAIC.
	1323-5.3 Low-level Waste Disposal Facility Confinement	Yes	Yes	5	
	1323-5.4 Transuranic-Contaminated Liquid Waste Confinement	Yes	Yes	5	
	1323-6 Effluent Control and Monitoring				
	1323-6.1 Contaminated Solid Waste	Yes	Yes	4	
	1323-6.2 Contaminated Liquid Waste				
B,V	1323-6.2.1 Process Wastes	Yes	Yes	5	
	1323-6.3 Effluents				
B,V	1323-6.3.1 Airborne Effluents	Yes	Yes	5	244-AR Vault compliance to be determined per SAIC.

B = B Plant, V = 244-AR Vault

Balance of Plant - Compliance with DOE 6430.1A

In SAIC		Applicable?	Safety or Environs Impact?	Importance?	Remarks
	1324 Radioactive Solid Waste Facilities	No			
	1325 Laboratory Facilities (Incl. Hot Laboratories)	No			
	1326 Tritium Facilities	No			
	1328 Fusion Facilities	No			
	Division 14 - Conveying Systems				
	1401 General	Yes	Yes	4	
	1420 Elevators	Yes	Yes	4	
	1440 Lifts				
	1440-2 Wheelchair Lifts	No			
B,V	1460 Cranes	Yes	Yes	4	
	Division 15 - Mechanical				
	1525 Mechanical Insulation				
	1525-1 Applicability	Yes	Yes	4	Asbestos addressed
	1525-2 Min. of Energy Loss	Yes	No		
	1525-3 Condensation Preven.	Yes	No		
	1525-4 Safe Surface Temps.	Yes	Yes	4	
	1530 Fire Protection				
B,V	1530-1 General	Yes	Yes	4	DOE 5480.7 cited.
	1530-2 Improved Risk Concept for Fire Prot. Systems				
B,V	1530-2.1 General	Yes	Yes	4	"improved risk" noted
	1530-2.2 Vital Programs	?	Yes	4	
	1530-2.3 Maximum Possible Fire Loss				
	1530-2.3 1 General	No			
	1530-2.3.2 Criterion I	No			
	1530-2.3.3 Criterion II	No			
	1530-2.3 4 Criterion III	No			
	1530-2.3.5 Criterion IV	Yes		4	
	1530-2.3.6 Criterion V	No			
	1530-3 Water Flow & Pressure Rqmts. for Fire Prot.				
B,V	1530-3.1 General	Yes	Yes	2	
B,V	1530-3.2 Occupancy Hazard Classification	Yes	Yes	2	
	1530-3.3 Water Demands for Sprinklered Facilities				
B,V	1530-3.3.1 Schedule-Designed Sprinkler Systems	Yes	Yes	2	
B,V	1530-3.3.2 Hydraulically Designed Sprinkler Systems	Yes	Yes	2	
B,V	1530-3.3.3 Fire Hydrant Demand	Yes	Yes	2	
	1530-4 Automatic Sprinkler Protection				
B,V	1530-4.1 General	Yes	Yes	2	NFPA 13 cited.

BSL WHOOSOO (A03)
June 13, 1989 10:51 AM

B = B Plant, V = 244-AR Vault

Balance of Plant - Compliance with DOE 6430.1A

In SAIC		Applicable?	Safety or Environs Impact?	Importance?	Remarks
	1530-4.2 Types of Sprinkler Systems				
B,V	1530-4.2.1 Wet Pipe	Yes	Yes	2	
B,V	1530-4.2.2 Dry Pipe	Yes	Yes	2	
B,V	1530-4.2.3 Preaction	Yes	Yes	2	
	1530-4.2.4 Deluge	Yes	Yes	2	
B,V	1530-4.2.5 Self-Restoring	Yes	Yes	2	
B,V	1530-4.2.6 Quick Response	Yes	Yes	2	
	1530-5 Special Protection Systems				
B,V	1530-5.1 General	Yes	Yes	2	NFPA 13 cited.
	1530-5.2 Types of Special Suppression Systems				
B,V	1530-5.2.1 Water Spray	Yes	Yes	2	
B,V	1530-5.2.2 Carbon Dioxide	Yes	Yes	2	
B,V	1530-5.2.3 Dry Chemical	Yes	Yes	2	
B,V	1530-5.2.4 Foam	Yes	Yes	2	
B,V	1530-5.2.5 Halon	Yes	Yes	2	
B,V	1530-6 Standpipes and Hose Systems	Yes	Yes	2	NFPA 14 cited
B,V	1530-7 Portable Fire Extinguishers	Yes	Yes	2	NFPA 10 cited
	1530-8 Fire Detection and Alarm Systems				
B,V	1530-8.1 General	Yes	Yes	2	
	1530-8.2 Alarm Systems				
B,V	1530-8.2.1 General	Yes	Yes	2	
B,V	1530-8.2.2 Alarm Actuating Devices	Yes	Yes	2	
	1530-8.3 Automatic Fire Detection Systems				
B,V	1530-8.3.1 General	Yes	Yes	2	
B,V	1530-8.3.2 Heat-Actuated Detectors	Yes	Yes	2	
B,V	1530-8.3.3 Flame-Actuated Detectors	Yes	Yes	2	
B,V	1530-8.3.4 Smoke Detectors	Yes	Yes	2	
B,V	1530-9 Water Storage and Distribution	Yes	Yes	2	
	1530-99 Special Facilities				
B,V	1530-99.0 Nonreactor Nuclear Facilities - General	Yes	Yes	5	Seismic and water supply requirements. B Plant and 244-AR Vault not in complete compliance per SAIC (some compliance to b determined)
	1530-99.2 Emergency Preparedness Facilities	No			
	1530-99.4 Explosives Facilities	No			
	1530-99.8 Telcom., Alm., & ADP Ctr. & Rad. Rep. Sta.	No			
	1530-99.12 Uranium Enrichment Facilities	No			
	1530-99.12.1 Gaseous Diffusion & Centrifuge Fac.	No			
	1530-99.12.2 Atomic Vapor Laser Isotopes Sep. Fac.	No			
	1530-99.16 Uranium Conversion & Recovery Fac.	No			
	1530-99.19 Tritium Facilities	No			
	1540 Plumbing/Service Piping				
	1540-1 Plumbing				
B,V	1540-1.1 General	Yes	No		
	1540-1.2 Fixtures	Yes	No		
	1540-1.3 Piping				
	1540-1.3.1 Supply	Yes	No		
	1540-1.3.2 Drain, Waste and Vent	Yes	No		
	1540-1.4 Service Water Heating Equipment	Yes	No		
B,V	1540-1.5 Safety Devices	Yes	Yes	4	
	1540-1.6 Appurtenances				

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B = B Plant, V = 244-AR Vault

Balance of Plant - Compliance with DOE 6430.1A

In SAIC		Applicable?	Safety or Environs Impact?	Importance?	Remarks
	1540-1.6.1 Pressure Modifications	Yes	No		
	1540-1.6.2 Water Treatment	Yes	No		
	1540-1.6.3 Trap Seal Protection	Yes	No		
	1540-1.6.4 Hs. Bibbs, Wall Hs. Otlts., & Yard Hs. Otlts.	Yes	No		
	1540-1.6.5 Insulation	Yes	No		
	1540-1.6.6 Sterilization	Yes	No		
	1540-1.6.7 Miscellaneous	Yes	No		
	1540-99 Special Facilities				
	1540-99.0 Nonreactor Nuclear Facilities - General				
B,V	1540-99.0.1 General Cooling System Criteria	Yes	Yes	5	Hydrostatic testing permitted.
B,V	1540-99.0.2 Water Collection System	Yes	Yes	5	
B,V	1540-99.0.3 Other Collection Systems	Yes	Yes	5	
B,V	1540-99.0.4 Equipment Operability Qualification	Yes	Yes	5	Testing preferred method.
	1540-99.0.5 Water Supplies & Other Utility Svcs	Yes	Yes	5	
B,V	1540-99.0.6 System Installation	Yes	Yes	5	B Plant not in complete compliance per SA
	1540-99.4 Explosives Facilities				
	1540-99.4.1 Drains and Sumps	No			
	1540-99.12 Uranium Enrichment Facilities	No			
	1540-99.14 Irradiated Fissile Mat'l. Stor. Facilities	No			
	1540-99.15 Reprocessing Facilities	No			
	1540-99.18 Radioactive Solid Waste Facilities	No			
	1550 Heating, Ventilating, and Air-Conditioning Sys				
	1550-1 General Sizing & Design Criteria				
B,V	1550-1.1 General Sel. Proc. for HVAC Systems	Yes	Yes	5	
	1550-1.2 Heat Gain & Heat Loss Calculations				
B,V	1550-1.2.1 Build. Env. Thermal Trans. ("U") Values	Yes	No		
B,V	1550-1.2.2 Inside Des. Temp. & Rel. Humidities	Yes	No		
B,V	1550-1.2.3 Outside Design Temperatures	Yes	No		
B,V	1550-1.2.4 Infiltration Calculations	Yes	No		
B,V	1550-1.2.5 Weather Data	Yes	No		
B,V	1550-1.3 Heating & Air-Cond. Equip. Sizing & Perf.	Yes	No		
B,V	1550-1.4 Use of Evaporative/Adiabatic Cooling	Yes	No		
	1550-1.5 Vent.-Exhaust Sys. Design Requirements				
B,V	1550-1.5.1 General	Yes	Yes	4	
B,V	1550-1.5.2 Outdoor Air Quality	Yes	Yes	4	
B,V	1550-1.5.3 Personnel Ventilation Air Requirements	Yes	Yes	4	
B,V	1550-1.5.4 Recirculation	Yes	Yes	4	
B,V	1550-1.5.5 Ind. Ventilation Requirements	Yes	Yes	4	
B,V	1550-1.5.6 Local Exhaust Systems	Yes	Yes	4	
B,V	1550-1.5.7 Equipment Room Ventilation	Yes	No		
V	1550-1.6 Energy Conser.-Wste. Heat Recov. Systems	Yes	No		
	1550-2 Heating Vent. and Air-Cond. Sys. Selection				
	1550-2.1 Central Sta. Cooling Equip. & Systems				
V	1550-2.1.1 General	Yes	No		
V	1550-2.1.2 Water Chillers	Yes	No		
V	1550-2.1.3 Condensers/Condensing Units	Yes	No		
V	1550-2.1.4 Cooling Towers	Yes	No		

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B = B Plant, V = 244-AR Vault

Balance of Plant - Compliance with DOE 6430.1A

In SAIC		Applicable?	Safety or Environs Impact?	Importance?	Remarks
	1550-2.2 Central Station Heating Equipment & Sys.				
B,V	1550-2.2.1 General	Yes	No		
B,V	1550-2.2.2 Interf. w/ Cen. Plnt. Heat Gen./Distrb. Sys.	Yes	No		
B,V	1550-2.2.3 Build. Heat Gen. Equip./Distrib. Sys.	Yes	No		
	1550-2.3 Water Distribution Systems				
B,V	1550-2.3.1 General	Yes	No		
	1550-2.3.2 Pumps & Pumping Systems	Yes	No		
	1550-2.3.3 Piping, Fitting and Accessories	Yes	No		
B,V	1550-2.4 Steam Distribution Systems	Yes	No		
	1550-2.5 Air Handling & Air Distrib. Systems				
B,V	1550-2.5.1 General	Yes	No		
B,V	1550-2.5.2 Air Handling Units	Yes	No		
B,V	1550-2.5.3 Fans/Motors	Yes	No		
B,V	1550-2.5.4 Coils	Yes	No		
B,V	1550-2.5.5 Air Cleaning Devices	Yes	Yes	5	Implace testing of HEPA filters required Not addressed by SAIC. 244-AR Vault not complete compliance per SAIC.
B,V	1550-2.5.6 Ductwork Systems	Yes	No		
	1550-3 Testing, Adjusting and Balancing				
B,V	1550-3 1 System Performance Tests	Yes	No		
B,V	1550-3.2 Testing and Balancing Devices	Yes	No		
B,V	0550-3.3 General Guidelines	Yes	No		
	1550-99 Special Facilities				
	1550-99 0 Nonreactor Nuclear Facilities - General				
B,V	1550-99 0.1 General Vent. and Off-Gas Criteria	Yes	Yes	5	Extremely important requirements. B Plant and 244-AR Vault not in complete compliance per SAIC.
	1550-99 0.2 Confinement Ventilation Systems	Yes	Yes	5	Redundant filter banks required. Not addressed by SAIC.
	1550-99 0.3 Off-Gas Systems	Yes	Yes	5	
	1550-99 4 Explosive Facilities				
	1550-99 4.1 Ventilation Requirements	No			
	1550-99 4.2 Collection of Explosives Wastes	No			
	1550-99 4.3 Air Mon Rqmts for Expl /Plut Bays	No			
	1550-99 8 Telcm., Alrm., & ADP Ctr & Rad Rep Stat				
	1550-99 8 1 General	No			
	1550-99 8 2 Air-Cond and Ventilating Systems	No			
	1550-99 10 Secure Conference Rooms	No			
	1555 Central Plant Heat Generation/Distribution				
	1555-1 Planning				
	1555-1.1 General	Yes	No		
	1555.1.2 Facility Sizing	Yes	No		
	1555-1.3 Generating Facility Location	Yes	No		
	1555-1.4 Central Facilities Versus Satellite Facilities	Yes	No		
	1555-1.5 Selection of Fuels	Yes	No		
	1555-1.6 Cogeneration	Yes	No		
	1555-2 Steam & High-Temp. Water Generation				
	1555-2.1 General	Yes	No		
	1555-2.2 Pckg.-Type Versus Field-Erected Boilers	Yes	No		
	1555-2.3 Comp. Steam & High-Temp. Water Sys	Yes	No		
	1555-2.4 Steam Generation Units	Yes	No		

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B = B Plant, V = 244-AR Vault

Balance of Plant - Compliance with DOE 6430.1A

In SAIC		Appli-cable?	Safety or Environs Impact?	Impor-tance?	Remarks
	1555-2.5 High-Temp. Water Generation Units				
	1555-2.5.1 Definition	Yes	No		
	1555-2.5.2 General	Yes	No		
	1555-2.5.3 System Pressurization	Yes	No		
	1555-2.5.4 Circulating Pumps	Yes	No		
	1555-2.6 Assoc. Sys. for Stm. & Hgh.-Tmp. Wtr. Gen.				
	1555-2.6.1 Fuel Stor. and Handling Systems	Yes	No		
	1555-2.6.2 Fuel Burning Systems	Yes	No		
	1555-2.6.3 Ash Handling Systems	Yes	No		
	1555-2.6.4 Combustion Auxiliaries	Yes	No		
	1555-2.6.5 Boiler Water Treatment	Yes	No		
	1555-2.6.6 Boiler Water Makeup	Yes	No		
	1555-2.6.7 Boiler Rm. Controls & Instrumentation	Yes	No		
	1555-2.6.8 Plant Insulation	Yes	No		
	1555-3 Steam & High-Temp. Water Distribution				
	1555-3.1 General	Yes	No		
B,V	1555-3.2 Steam Distribution Systems	Yes	No		
	1555-3.3 HTW Distribution Systems	Yes	No		
	1555-3.4 Piping Insulation	Yes	No		
	1574 Cryogenic Systems				
	1574-1 Coverage	Yes	No		
	1574-2 System Design				
	1574-2.1 General	Yes	No		
	1574.2.2 Compressors				
	1574-2 2.1 Screen or Lobe Compressors	Yes	No		
	1574-2.2.2 Reciprocating Compressors	Yes	No		
	1574-2 2.3 Centrifugal Compressors	Yes	No		
	1574-2.2.4 High-Pressure Centrifugal Compressors	Yes	No		
	1574-2.2.5 Axial Compressors	Yes	No		
	1574-2.2.6 Diaphragm Compressors	Yes	No		
	1574-2.2.7 Multistage Compressors	Yes	No		
	1574-2.2.8 Compressor Support and Isolation	Yes	No		
	1574-2.3 Pumps				
	1574-2.3.1 Axial-Piston Pumps	Yes	No		
	1574-2.3.2 Centrifugal Pumps	Yes	No		
	1574-2.3.3 Pressure Vessel Pumping	Yes	No		
	1574-2.4 Vaporizers				
	1574-2.4.1 Ambient Air Vaporizers	Yes	No		
	1574-2.4.2 Forced-Flow Ambient Air Vaporizers	Yes	No		
	1574-2.4.3 Electric Vaporizers	Yes	No		
	1574-2.4.4 Steam Vaporizers	Yes	No		
	1574-2.5 Storage Vessels				
	1574-2.5.1 General	Yes	No		
	1574-2.5.2 Inner Vessel Design	Yes	No		
	1574-2.5.3 Outer Vessel Design	Yes	No		
	1574-2.6 Instrumentation and Control	Yes	No		
	1574-2.7 Piping and Fittings	Yes	No		
	1574-2.8 Joining Methods				
	1574-2.8.1 Welded Joints	Yes	No		
	1574-2.8.2 Reweldable Joints	Yes	No		
	1574-2.8.3 Bayonet Joints	Yes	No		

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B = B Plant, V = 244-AR Vault

Balance of Plant - Compliance with DOE 6430.1A

In SAIC	Applicable?	Safety or Environs Impact?	Importance?	Remarks
1574-2.8.4 Flanged Joints	Yes	No		
1574-2.8.5 Compression Joints	Yes	No		
1574-2.8.6 Copper Shear Seals	Yes	No		
1574-2.8.7 Vacuum Seals	Yes	No		
1574-2.8.8 Transition Couplings	Yes	No		
1574-9 Valves and Pressure Relief Devices	Yes	No		
1574-2.10 Miscellaneous Materials	Yes	No		
1574-2.11 Insulation	Yes	No		
1574-3 Facility Siting and Equipment Installation				
1574-3.1 General	Yes	No		
1574-3.2 Siting	Yes	No		
1574-3.3 Noise	Yes	No		
1574-3.4 Spills	Yes	No		
1574-4 Quality Assurance				
1574-4.1 General	Yes	No		
1574-4.2 Cleaning	Yes	No		
1574-4.3 Testing	Yes	No		
1574-5 Safety Review	Yes	Yes	4	
1589 Air Pollution Control				
1589-1 General	Yes	Yes	5	Not a radioactive problem but important
1589-2 Improved Risk Concept	Yes	Yes	5	Not a radioactive problem but important
1589-3 Planning for Air Pollution Control	Yes	Yes	5	Not a radioactive problem but important
1589-4 Combustion Process Installations				
1589-4.1 Selection of Fuel	Yes	No		
1589-4.2 Firing Equipment	Yes	No		
1589-4.3 Draft Auxiliaries	Yes	No		
1589-4.4 Emission Detectors	Yes	No		
1589-4.5 Coal and Ash Handling	?	No		
1589-4.6 Facilities for Testing	Yes	No		
1589-5 Refuse Disposal Facilities				
1589-5.1 Incinerators	Yes	No		
1589-5.2 Off-Site Disposal	Yes	No		
1589-5.3 Landfill and Dumping	Yes	No		
1589-6 Gas-Cleaning Equip & Emission Cntrl. Dvcs.				
1589-6.1 Gases	Yes	No		
1589-6.2 Particulates	Yes	No		
1589-7 Storage Facilities for Volatile Liquid	Yes	Yes	2	Not a radioactive problem but important.
1589-99 Special Facilities				
1589-99.0 Non-Reactor Nuclear Facilities - General				
1589-99.0.1 Radioactive Airborne Effluents	Yes	Yes	5	
1589-99.0.2 Nonradioactive Airborne Effluents	Yes	Yes	5	Not a radioactive problem but important.
1595 Controls				
1595-1 General	Yes	Yes	4	
1595-2 Zoning	Yes	No		
1595-3 Control Setback and Shutoff Devices	Yes	No		
1595-4 Humidity Control	Yes	No		
1595-5 Simultaneous Heating and Cooling	Yes	No		
1595-6 Control of Air Handling Systems				
1595-6.1 Mechanical Ventilation Control	Yes	No		

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B = B Plant, V = 244-AR Vault

Balance of Plant - Compliance with DOE 6430.1A

In SAIC		Appli-cable?	Safety or Environs Impact?	Impor-tance?	Remarks
	1595-6.2 Outdoor Air Cooling Control (Econ. Cycle)	Yes	No		
	1595-6.3 Automatic Control Dampers	Yes	No		
	1595-6.4 Variable-Air Volume System Fan Control	Yes	No		
	1595-6.5 Fire & Smoke Detection & Prot. Controls	Yes	Yes	4	
	1595-6.6 Gas-Fired Air Handling Unit Control	Yes	No		
	1595-7 Cntrl. of Chilled Water & Hot Water Dist. Sys.				
	1595-7.1 Zone Control/Distrib. Sys. Control	Yes	No		
	1595-7.2 Control Valve Selection	Yes	No		
	1595-7.3 Two-Pipe & Three-Pipe Combo. Ht. & Cl Sys.	Yes	No		
	1595-7.4 Load Control for Hot Water Systems	Yes	No		
	1595-7.5 Load Control for Chilled Water Systems	Yes	No		
	1595-8 Cool Tower & Water-Cooled Cond. Sys. Cont.	Yes	No		
	1595-9 Control of Steam Systems				
	1595-9.1 Zone Control	Yes	No		
	1595-9.2 Control Valve Selection	Yes	No		
	1595-9.3 Load Control for Steam Systems	Yes	No		
	1595-10 Energy Monitoring and Control Systems	Yes	No		
	1595-11 Energy Metering	Yes	No		
	Division 16 - Electrical				
	1600 General Requirements	Yes	No		
	1605 Basic Electrical Materials and Methods				
B,V	1605-1 General	Yes	No		
	1605-2 Wiring Systems				
	1605-2.1 Raceways				
B,V	1605-2.1.1 General	Yes	Yes	3	
B,V	1605-2.1.2 Electrical Metallic Tubing	Yes	No		
B,V	1605-2.1.3 Flexible Steel Conduit	Yes	No		New wiring should comply.
B,V	1605-2.1.4 Rig. Steel Conduit & Inter. Metal Conduit	Yes	No		
B,V	1605-2.1.5 Aluminum Conduit	Yes	No		
B,V	1605-2.1.6 Nonmetallic Conduit	Yes	No		
B,V	1605-2.1.7 Surface-Metal or Nonmetallic Systems	Yes	No		
B,V	1605-2.1.8 Cable Trays	Yes	No		
	1605-2.2 Conductors				
B,V	1605-2.2.1 General	Yes	Yes	5	Safety class systems should be rewire B Plant and 244-AR Vault not in compl compliance per SAIC.
B,V	1605-2.2.2 Aluminum Conductor Termination	Yes	No		
B,V	1605-2.2.3 Conductor Identification	Yes	No		
B,V	1605-2.3 Receptacles	Yes	No		
	1620 Power Generators				
B,V	1620-1 General	Yes	No		
	1630 Exterior Electrical Utility Service				
	1630-1 General				
B,V	1630-1.1 Load Requirements	Yes	No		
B,V	1630-1.2 Power Factor	Yes	No		
B,V	1630-1.3 Redundancy	Yes	Yes	5	

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B = B Plant, V = 244-AR Vault

Balance of Plant - Compliance with DOE 6430.1A

In SAIC		Applicable?	Safety or Environs Impact?	Importance?	Remarks
B,V	1630-1.4 Utility Corridor	Yes	No		
	1630-2 Supply Equipment and Facilities				
B,V	1630-2.1 General	Yes	No		
	1630-2.2 Power Supply Lines				
B,V	1630-2.2.1 General	Yes	No		
B,V	1360-2.2.2 Overhead Lines	Yes	No		
B,V	1630-2.2.3 Underground Lines	Yes	No		
	1630-2.3 Substations and Switching Stations				
B,V	1630-2.3.1 General	Yes	No		
B,V	1630-2.3.2 Metering	Yes	No		
B,V	1360-2.3.3 Grounding	Yes	No		
B,V	1630-2.3.4 Surge Protection	Yes	No		
B,V	1630-2.3.5 Oil-Filled Equipment	Yes	Yes	5	
	1630-3 Power Supply for Exterior Lighting				
B,V	1630-3.1 Primary Power	Yes	No		
B,V	1630-3.2 Emergency Power	Yes	No		
B,V	1630-3.3 Switching	Yes	No		
	1630-4 Power Supply for Buildings				
B,V	1630-4.1 General	Yes	No		
B,V	0630-4.2 Voltage Levels	Yes	No		
B,V	1630-5 Lightning Protection	Yes	Yes	3	
	1630-99 Special Facilities				
	1630-99.8 Telcm., Alrm., & ADP Ctr. & Rad Rep. Sys.	No			
	1639 Grounding				
B,V	1639-1 General	Yes	Yes	4	
B,V	1639-2 Substation & Switching Station Grounding	Yes	Yes	4	
B,V	1639-3 Fence Grounding	Yes	Yes	4	
B,V	1639-4 Isolated Ground Systems	Yes	Yes	4	
	1640 Interior Electrical Systems				
	1640-1 General				
B,V	1640-1.1 Demand and Diversity Factors	Yes	No		
B,V	1640-1.2 Power Factor	Yes	No		
B,V	1640-1.3 Interior Distribution Voltage Levels	Yes	No		
B,V	1640-1.4 Power System Reliability	Yes	Yes	5	B Plant may not be in complete compliar per SAIC.
B,V	1640-1.5 Power Quality Requirements	Yes	No		
B,V	1640-1.6 System Protection	Yes	Yes	3	
B,V	1640-1.7 Ground-Fault Protection	Yes	Yes	4	
B,V	1640-1.8 Neutral Conductors	Yes	No		
	1640-2 Service Equipment and Facilities				
B,V	1640-2.1 General	Yes	No		
B,V	1640-2.2 Metering	Yes	No		
B,V	1640-2.3 Transformers	Yes	No		
V	1640-2.4 Motors	Yes	No		
V	1640-2.5 Motor Control	Yes	No		
	1640-3 Power Service for Scrty., Comm., & Alrm Sys.				
V	1640-3.1 General	Yes	Yes	4	
V	1640-3.2 Primary Power Supply	Yes	Yes	4	
V	1640-3.3 Emergency Power Supply	Yes	Yes	4	

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B = B Plant, V = 244-AR Vault

Balance of Plant - Compliance with DOE 6430.1A

In SAIC		Appli-cable?	Safety or Environs Impact?	Impor-tance?	Remarks
	1640-99 Special Facilities				
	1640-99.2 Emergency Preparedness Facilities	No			
	1640-99.7 Occupational Health Facilities	No			
	1640-99.8 Telcm., Alrm. & ADP Ctr. & Rad. Rep. Sys.				
	1640-99.8.1 General	No			
	1640-99.8.2 ADP Centers	No			
	1640-99.8.3 Radio Control Centers	No			
	1650 Exterior Lighting				
	1650-1 General	Yes	No		
	1650-2 Lighting Sources	Yes	No		
	1655 Interior Lighting				
	1655-1 General	Yes	No		
	1655-2 Lighting Sources	Yes	No		
	1655-3 Fixtures	Yes	No		
	1655-99 Special Facilities				
	1655-99.8 Telcm., Alrm. & ADP Ctr. & Rad Rep. Sys.	No			
	1660 Special Systems				
B,V	1660-1 General	Yes	Yes	5	Emergency systems discussed including UPS. B Plant and 244-AR Vault not in complete compliance per SAIC.
B,V	1660-2 Emergency Power Systems	Yes	Yes	5	244-AR Vault not in complete compliance per SAIC.
B,V	0660-3 Uninterruptible Power Systems	Yes	Yes	5	UPS required on final stack monitor (LATA)
	1660-99 Special Facilities				
	1660-99.0 Nonreactor Nuclear Facilities - General				
V	1660-99.0.1 Safety Class Electrical Systems	Yes	Yes	5	Safety class electic systems need to be identified (LATA). 244-AR Vault not in complete compliance per SAIC.
B,V	1660-99.0.2 Prot. Sys. & Instrumentation & Controls	Yes	Yes	5	B Plant not in complete compliance per SAI
B,V	1660-99.0.3 Qualification	Yes	Yes	5	B Plant compliance to be determined (SAIC)
B,V	1660-99.0.4 Separation & Physical Protection	Yes	Yes	5	B Plant compliance to be determined (SAIC)
B,V	1660-99.0.5 Test and Calibration	Yes	Yes	5	B Plant compliance to be determined (SAIC)
B,V	1660-99.0.6 Power Sources	Yes	Yes	5	B Plant compliance to be determined (SAIC)
B,V	1660-99.0.7 Control Areas	Yes	Yes	5	B Plant compliance to be determined (SAIC)
	1660-99.4 Explosives Facilities				
	1660-99.4.1 General	No			
	1660-99.4.2 Permanent Equipment & Wiring	No			
	1660-99.4.3 Static Electricity	No			
	1660-99.4.4 Lightning Protection	No			
	1670 Exterior Communication & Alarm Systems				
	1670-1 General	Yes	No		
B,V	1670-2 Fire Alarm & Supervisory Systems	Yes	Yes	3	
	1670-3 Security Alarm & Supervisory Systems	Yes	No		
	1670-4 Secure Communications Systems	Yes	No		
	1670-5 Energy Monitoring & Control Sys. & Devices	Yes	No		
	1670-6 Antenna Towers, Poles, & Masts	Yes	No		

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B = B Plant, V = 244-AR Vault

Balance of Plant - Compliance with DOE 6430.1A

In SAIC		Applicable?	Safety or Environs Impact?	Importance?	Remarks
	1671 Interior Communications and Alarm Systems				
	1671-1 Planning				
	1671-1.1 General	Yes	Yes	4	
	1671-1.2 Joint Use	Yes	No		
	1671-1.3 Hazardous Locations	Yes	Yes	4	
	1671-2 Fire Alarm and Supervisory Systems	Yes	Yes	4	
	1685 Electric Space Heating				
	1694 Energy Conservation				
	1694-1 General	Yes	No		
	1694-2 Energy Monitoring & Control Sys. & Devices	Yes	No		

BSU [illegible] (A03)
June 13, 1989 11:18 AM

B = B Plant, V = 244-AR Vault