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Department of Energy
National Nuclear Security Administration
Washington, DC 20585

November 18, 2002

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DNF SAFETY BOARD

The Honorable John T. Conway
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, NW
Suite 700
Washington, D.C. 20004-2901

Dear Mr. Chairman:

Thank you for your cooperation while we worked to resolve the issues raised by your staff regarding the design of safety-related aspects in the Tritium Extraction Facility (TEF) undergoing construction at the Savannah River Site (SRS). The Department appreciates the objective views from the Defense Nuclear Facilities Safety Board (DNFSB) on this subject and, likewise, is very interested in improving/adding design features to enhance the safety of the TEF. The enclosed responses have been discussed with your staff to reach a consensus on the issues. Formal concurrence with the Department's responses to the issues is requested to properly document the project's path forward with regard to this matter.

The enclosed letter from B. D. Smith to C. H. Ramsey provides a compilation of responses to the issues raised to date by the DNFSB staff concerning the TEF project. As indicated in the enclosure, several responses are dependent on future project activities to facilitate closure. These items will be tracked on the TEF Project action item tracking system until such time as closure/incorporation of actions is completed.

Thank you again for your input and support as we continue with the construction and testing phases of the TEF project. Should you have any questions or concerns relative to this matter, please contact me at (202) 586-2179 or Mike Hickman at (803) 952-7195.

Sincerely,

Everet H. Beckner
Deputy Administrator
for Defense Programs

Enclosure

cc w/enclosure:
M. Whitaker, EH-9

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Westinghouse
Savannah River Company
Aiken, SC 29808

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Mr. Clay H. Ramsey
U. S. Department of Energy
Savannah River Operations
P. O. Box A
Aiken, SC 29802

Dear Mr. Ramsey:

DNFSB ISSUES/RESPONSES (U)

The Tritium Extraction Facility project has maintained an ongoing dialogue with the Defense Nuclear Facility Safety Board and Staff since the Conceptual Design stage of the project. As a result many questions and issues have been raised and addressed between the project and Board staff.

Attached is the list of 46 DNFSB staff issues and project responses for TEF raised during the design portion of the project. These responses have been shared with your staff as well as the Board Staff and we have reached consensus on all but Issue 13. Follow-up to Issue 13 is being addressed separately by Tritium Facility Personnel in response to the DNFSB letter from Conway to Beckner dated July 19, 2002. These responses represent the project's position for the resolution of the stated issues and are forwarded to you for your evaluation and transmittal to the DNFSB. Commitments as a result of these responses have been loaded into the TEF Commitment Tracking System (CTS) for tracking and closure.

It is recommended that the DNFSB be asked to concur with these responses so we have formal agreement on the actions required to satisfy their concerns. Please let me know if I can be of any assistance in this matter.

Sincerely,

B. D. Smith
WSRC CLWR Program Manager

BDS/lc
Att

c: R. W. Boyd, 235-H/109
C. A. Flavin, 730-1B
T. A. Foster, 246-H/111
D. E. Grove, 730-1B
M. O. Hickman, 730-1B
M. A. Reffett, 730-1B
B. C. Patel, 730-1B
J. R. Purucker, 730-1B
T. R. Davis, 730-1B
C. F. Smith, 730-1B
J. W. Wright, 730-1B

Detailed Response to DNFSB Staff Issues and Observations

Issues

Issues 1-3 General Response

A review of the administrative controls in place from the Preliminary Design was performed to evaluate the feasibility of replacing or augmenting the administrative controls with engineered controls. As a result of this review, additional engineered controls were added to the project in Detailed Design. Safety Significant engineered controls replaced the administrative controls where feasible and where a control was added but it was not feasible to make the control Safety Significant, a Production Support engineered control was added to supplement the existing administrative control.

The changes discussed in Issues 1, 2, and 3 add two Safety Significant controls and one Production Support control to the facility. Based on these changes, TEF has reduced its dependence on administrative controls and strengthened the facility design by the addition of more engineered controls

Issue 1

Potential operational accidents caused by moving the crane over an operating furnace are prevented by administrative controls. These scenarios could more effectively be avoided by a simple interlock on the crane motor when the furnace is operating.

Issue 1 Response

The control to prevent movement of a crane load over an operating furnace is an administrative control in the PSAR. The facility is required to be able to operate the crane in other areas of the Remote Handling Area during furnace operation, so a relatively simple hardware interlock to disable the crane during furnace operation would not allow required crane availability. The administrative control to not carry crane loads over an operating furnace will remain in place and be incorporated into the crane operating procedures. The crane is designed to include single failure proof features to prevent dropping a load. In addition, a Production Support (PS) software interlock will be put in place to augment the administrative control. It is anticipated that the software interlock will be a Defense-In-Depth control.

This software control will be a more complex interlock that includes the crane X-Y position to know where the hooks are and the crane load cell information to know if the crane is carrying a load. The interlock will also require input on the energy state of the furnaces to prevent the crane from bringing a load into the X-Y coordinates of the furnace that had power on to its heaters. This interlock function would best be performed by software in the crane PLC with ties to the furnace PLC. Other complications to implementation included security issues because the crane PLC is an unclassified system and the furnace PLC is a classified system, however security issues can be overcome by the use of hardwired relays between the PLCs.

The crane PLC will be performing the control function to avoid carrying loads over an operating furnace. Relays from the furnaces will provide a signal to the crane PLC telling it if each furnace is energized or not. In addition, if load cell information indicates that the crane is carrying a load, then the crane PLC will activate an avoidance zone in its position coordinate system that the crane will not be able to enter if the furnaces are energized. The crane PLC has already been purchased as part of the overall Production Support crane procurement. The crane controls are not part of the current SS Worker Protection System and it would be very expensive to make this change with minimal improvement in performance.

To prevent dropped loads, the crane is designed to meet the requirements of an ASME-NOG, Type II crane and is single failure proof in accordance with NUREG-0554. This requires the incorporation of redundant hoisting and braking systems in the design. These are the same requirements invoked by the NRC at commercial nuclear facilities to assure the safe handling of critical loads. These engineered controls are incorporated into the facility design to ensure that the probability of a load drop is extremely remote.

The combination of an administrative control for crane operation backed up by the zone avoidance features and the single failure proof nature of the crane provide a cost effective layered defense to protect against this event.

Issue 2
The design process hazards review identified a potential for exposure of workers to high levels of radiation if the shield doors should be inadvertently opened when cask or truck bay areas are occupied. Identification of radiation monitors and alarms to protect the workers was recommended. The control identified in the PSAR is limited to operator training and does not include implementation of any design features to protect workers.

Issue 2 Response
The Radiological Protection Program is one of the Administrative controls in place to protect workers. This program includes surveys for radioactivity and control of access to high radiation areas. This program was evaluated to determine if it could be replaced or augmented with engineered controls. In the TEF PSAR, room air tritium monitoring is a Safety Significant control (with Safety Significant power supply) and gamma radiation monitors are Production Support. It was determined that the gamma radiation monitors around the Remote Handling Area entrances and adjacent rooms should be upgraded to Safety Significant (with Safety Significant power supply) because they performed a safety function to protect workers much the same as the room air tritium monitors. This provides an engineered control to supplement a necessary administrative control. Locating the gamma monitors inside the Remote Handling Area was considered, however frequent access to the gamma monitors will be needed for testing and calibration to ensure their operability which would not be

possible in the Remote Handling Area. In addition, the extremely high radiation levels (10,000 to 40,000 rads per hour) during operation would be detrimental to the sensitive electronics on a long-term basis.

Additional Information for Issue 2 – See Attachment A

Issue 3

The Preliminary Safety Analysis Report (PSAR) assumes that one furnace operates at a time. The administrative control to support the PSAR assumption could be replaced with a designed interlock to avoid accidental operation of more than one furnace at a time.

Issue 3 Response

The TEF PSAR included an administrative control to prevent simultaneous operation of two furnaces to protect the source term assumption of the crane load drop event. This administrative control was evaluated and the project determined that this administrative control should be replaced by an engineered control to prevent simultaneous operation of two furnaces. This engineered control will be Safety Significant.

Issue 4

Administrative control used to protect design pressure of product tanks.

Issue 4 Response

The basis for establishing a 2.5-atmosphere pressure limit in TEF was to support initial assumptions made in the PSAR. The PSAR was developed using highly conservative, bounding releases of all the material present without any consideration as to the mechanism or possibility. This assured we had conservatively selected our SSCs. More detailed analysis developed in support of the FSAR (still in draft form) indicates there is not enough material at risk during an explosion to exceed off-site criteria. The largest explosion is an Unlikely event releasing 990.5 grams resulting in 0.46 rem at the site Boundary. This is well below the Evaluation Guideline of 5 rem.

Additionally, there is no mechanism for an explosive mix to occur. In order to form an internal explosive mix we would have to first have a leak of air into the process piping. Since all processes in TEF, like in 233-H are in an inerted glovebox (unlike those in 232-H and 234-H where the 3 atm limit was initially established), we would have to also have un-noticed failure of the glovebox and oxygen monitors. While we do not credit this as Safety Class (because as discussed above we do not approach the off-site guidelines) it is still credited as Safety Significant and available for worker protection and as DiD for off-site considerations. We will include this consideration in our DiD report.

From a historical standpoint the use of a 3 atm. pressure limit was developed in facilities without gloveboxes as it was assumed that a stainless steel vessel would catastrophically fail as a result of an internal explosion if the initial pressure in the vessel is greater than 3 atm. The resulting shrapnel from this explosion could then fail other tanks and therefore the MAR released from a single tank explosion would not be bounding. This was based on data the older tritium facilities (232-H and 234-H) extracted from experimental explosion data developed in the 70's (DP-1295, "Porter Report") specifically for the hydrogen-air explosions of process tanks in the tritium facilities. This report concluded that as long as the initial pressure was less than 10 atmospheres, the tanks would not fail. Deformation of the tank was noted during an explosion starting at an initial pressure of 3 atm. An operational limit was established at 3 atm. to assure that if an explosion occurred, it would not deform the tank and therefore cause operational downtime.

The tank used in the Porter Report test was rated for approximately 45 psig and it experienced multiple internal explosions at increasing initial pressure before finally catastrophically failing at an initial pressure of 10 atm. The tank experienced significant strain hardening with each subsequent explosion past 3 atm. Just for reference, the majority of the TEF tanks are designed for 200 psig (over 4 times that of the tank used in the Porter Report).

Calculations were performed for TEF to demonstrate that it will take much higher initial pressures for an internal explosion to cause a catastrophic failure of a 200-psig tank. NFPA 69 provides conservative calculations that can be used to design a tank to survive an explosion. These calculations are supported by the test data generated in the Porter Report. In fact, because of limitations imposed by engineering safety features such as our rupture disks, we can not get to the pressures needed to fail a tank. Conservatively, it would take an initial pressure of 46 psig to cause failure of the tank during a deflagration using the most conservative calculation factors and methods in NFPA 69.

The above discussion focuses on catastrophic failures. For conservatism, we still assume deformations during the explosion separate flanges and release tritium. In fact we assume it releases the entire contents of the tank. However, this is much less tritium than was assumed to be released in the PSAR. Considering this more realistic release quantity, we are well below the off-site guidelines for an internal process explosion without any controls.

Issue 5

Independence of Control Equipment from Safety Shutdown Equipment

Issue 5 Response

The TEF Integrated Control System (ICS) is divided into three main packages:

1. Process Control System (PCS)
2. Programmable Logic Controller (PLC) Network
3. Worker Protection System (WPS)

The PCS controls and monitors the operation of the tritium process. The PLC Network integrates the PLCs that control individual support functions, such as

HVAC, chiller operation, cranes, trolley, etc. All Safety Significant functions are performed on the WPS, which is independent from the other two systems and makes use of Triple Modular Redundant (TMR) PLC features.

Issue 6
Flow-down of Design and Procurement requirements not clear at this time

Issue 6 Response
Presentations were made to Board Staff by WSRC detailing the flow-down of design and procurement requirements from DOE and industry standards, through WSRC site manuals and practices into the project's design and procurement process.

Issue 7
Confinement: The Board's staff noted that the ventilation system was identified in the Preliminary Safety Analysis report (PSAR) as necessary for worker protection, however, the system was classified as production support rather than safety-significant, which is the classification usually required for worker protection.

Issue 7 Response
The TEF utilizes a confinement concept which was described in Sections 1326-6 and 1326-7 of DOE Order 6430.1A, *General Design Criteria*, and involves: (1) building the tritium process systems to stringent standards, realizing some leakage is inevitable; (2) enclosing the process system (i.e., piping, valves and vessels) in an inert strippable atmosphere; (3) providing adequate room ventilation; and (4) providing adequate surveillance. At TEF, the process system enclosure is designated as safety significant, along with the Oxygen monitor inside the enclosure and the Tritium monitor outside the enclosure. The room ventilation (Heating, Ventilation and Air Conditioning, or simply, HVAC) is designated as production support. The HVAC is treated as a defense in depth feature by strengthening the outside building walls and providing a stand-by diesel generator. Finally, the differential pressures in the facility cascade towards the process system enclosures. In the judgement of the TEF Project, all these features form an acceptable confinement for the hazards present.

Issue 8
PC-2 Confinement Systems (Non-Seismic) being used for TEF

Issue 8 Response
The confinement system identified in the PSAR for the TEF project consists of the gloveboxes, modules, and double walled piping system. However these systems are designed to Performance Category 2 requirements, and therefore do not provide confinement during a design basis seismic event. The PSAR shows the consequences of a seismic event to be small enough that this design approach may not result in a significant risk to the public and workers. A realistic dose calculation of the consequences to the public and workers shows these values to be on the order of a few REM. TEF project personnel believe such small consequences do not merit the

significant additional cost of upgrading the confinement system to Performance Category 3 to meet the seismic requirements. This was discussed in a Staff Issue Report included in Board letter, Conway to Gioconda, dated 12/7/99.

Issue 9
Use of passive design modification to improve reliability of Confinement Systems

Issue 9 Response
The detailing of the glovebox anchorage to the structure provides for a ductile connection. Strip embeds have been located in the building floors at the glovebox locations. These embeds consist of steel plates anchored into the concrete with welded studs. The design of the anchorage follows the requirements of ACI 349, Appendix B for ductile design. The legs of the gloveboxes are welded to the strip embeds to complete the attachment.

Issue 10
Potential surface contamination of TPBARs by reactor coolant

Issue 10 Response
PNNL document TTQP-1-2048, Rev 1, "Surface Contamination of Watts Bar and Sequoyah Production TPBARs" includes an estimate of the radioactive isotopes that will be present on TPBARs during processing at the TEF. This document includes data from the lead test assembly (LTA) TPBARs that were irradiated in the Watts Bar reactor, which showed that the oxide layers could be expected to be thin and resistant to removal. This gives confidence that most CRUD material will remain affixed to the TPBAR. Given worst case conditions, the activity levels on a batch of 300 TPBARs may be 0.04 Ci from CRUD and 0.36 mCi from waterlogged TPBARs. This amount of activity is very small in comparison with the amount of cobalt-60 contained in the stainless steel of the TPBAR or the tritium contained within the TPBAR. However, the impurities from CRUD as well as impurities that may be present on the TPBARs from the primary coolant will be included in the source term for the accident analysis of events in the TEF FSAR Addendum.

Issue 11.
Habitability of TEF Control Area during off-normal events. (O)

Issue 11 Response
The Habitability of TEF Control Area during off-normal events from inside the facility as well as from those of other adjacent facilities will be discussed in the TEF FSAR Addendum.

The Tritium Facilities adheres to WSRC site emergency response procedures and is notified of area or site emergencies by either the Area Emergency Coordinator or the site Emergency Operations Center (EOC) respectively. Facility Emergency Plan Implementation Procedures are approved for use in emergency situations.

The Tritium Facilities SAR identifies the Tritium emergency facilities and equipment. For Control Rooms in particular it states " The Tritium Facilities has four separate control rooms that are located in Buildings 232-H, 233-H, and 234-H. Each control room has the necessary instrumentation, controls, and procedures to operate, monitor, and assess problems during normal operation and emergencies. During an emergency, the control room in the affected facility is activated. If the emergency affects more than one facility, then the Building 233-H control room will be designated (unless it is uninhabitable) as the central location for command and control of mitigating actions. If the Building 233-H control room is uninhabitable, then the 233-H FEC will designate the control room to be used. (The 234-H control room is the alternate for the Building 233-H control room.)"

The WSRC Generic SAR describes shutdown of operations. The FEC of each facility, with the assistance of the Technical Support Room (if activated), directs the shutdown of Tritium process facilities.

Per DOE-STD-3009, the interface with TSRs from other facilities will be addressed in the TEF Project FSAR. Chapter 5, Section 5.7, "Interface with TSRs From Other Facilities", will contain a discussion that summarizes TSRs from other facilities that affect this facility's safety basis and briefly summarize the provisions of those TSRs.

Issue 12
Inadvertent mixing of fuel rods with TPBARs

Issue 12 Response
This topic will be discussed in the TEF FSAR Addendum to justify the assumption that TEF being sent a fuel rod is an incredible event. Information related to controls in place at the reactor facility to prevent TVA from shipping TEF a fuel rod or burnable poison assemblies are discussed below.

There are several fuel insert components that could be of concern, such as fuel rods, source rods, wet annular burnable absorber (WABA) rods, and burnable poison rod assemblies (BPRAs). None of these can be mixed in with TPBARS and sent to TEF for the following reasons:

1. Fuel rods have a top end plug design different than TPBARs making them visually discernable from a TPBAR. Source rods are of a different length than TPBARs and are attached to a uniquely identified hold down plate. WABAs are visually discernable from a TPBAR since they are hollow and have a flow hole near the upper end of the rod. BPRAs are similar in visual appearance to TPBARs, but can not be mixed with TPBARs during assembly at the fuel vendor's facility as stated in items 2 and 3 below.

2. Fuel rods are assembled into an array and are not attached to a hold down plate. In a separate assembly activity, TPBARs are attached to a hold down plate after verifying and recording the unique TPBAR identification number, which is

permanently marked on the top end plug, as to location (i.e. which hold down plate). The hold down plate with attached TPBARs is then inserted into the host fuel assemble and identification numbers recorded, correlating which TPBARs are in a specific host fuel assembly. (e.g. TPBAR 99004 is attached to hold down plate XYZW which is inserted in fuel assemble LM001)"

3. TVA's fuel vendors do not mix different types of burnable absorber/poison rods within an assembly. In addition, to support TPBAR removal for consolidating shipments a different style nut is being evaluated than is currently used on other baseplate type inserts. The new nut design would be easier to remove during TPBAR consolidation efforts. Use of a new nut design would require removal tooling different from tooling that would be used for other type rod nut removals, providing additional justification as to why other rods cannot be inadvertently mixed with TPBARs for shipment to the TEF.

4. After irradiation, the host fuel assembly is removed from the reactor core and moved to the spent fuel pool. The location of each fuel assembly and fuel related component is verified after completion of fuel movements for each refueling outage. The hold down plate with TPBARs is then removed from the baseplate and placed into a storage device. When ready for shipment, TPBARs are prepared for shipment using the hold down plate identification number as a means of ensuring the correct component is being shipped.

In addition, TVA does not reconstitute fuel assemblies and has no loose fuel rods in either spent fuel pool. Fuel rods and source rods are tracked as Special Nuclear Material and are required to be inventoried annually.

In summary, the differences in component design along with the established process controls provide assurance that only TPBARs will be shipped to TEF.

Issue 13
Seismic monitors to provide early warning of earthquakes to workers

Issue 13 Response
TEF will install a Defense-in-Depth seismic monitor. However this alarm will first be installed in 233-H (RTF) for evaluation. The alarm will be evaluated in terms of function (spurious alarms, sensitivity settings, etc.), maintenance requirements (calibration, battery changes, etc.), and human factors (recognition of alarms, delay time, etc.). Additionally, the facility will develop meaningful, thought out responses and perform drills to evaluate the responses.

While there is debate as to the requirement for this monitor at the site level, it is recognized that a seismic detection monitor can provide Defense-in-Depth protection for facility workers in the Tritium Facilities in a seismic event. Providing this monitor in the near term and in an existing facility provides worker protection sooner and protects more personnel than if it was to be installed only in TEF.

Issue 14
Redesign existing fire barriers to be more seismically robust.

Issue 14 Response
TEF Project indicated fire barriers are designed to seismic PC-2 requirements.

Issue 15
Potential impact of water from fire sprinklers on electrical and electronic components

Issue 15 Response
TEF has specified NEMA 12 enclosures for water resistance and requested waiver from DOE to not sprinkle the Remote Handling Area

Issue 16
Room air tritium monitors and alarms are classified as safety-significant systems. Loss of the monitoring system requires operator evacuation. It was not clear to the staff that loss of the blowers would be immediately noticed through an alarm or other means and that operators would take appropriate action.

Issue 16 Response
The room air tritium monitors used in TEF will be of a different design than the Kanne chambers used in the existing Tritium Facilities. These monitors are made by NRC and have an integral blower with each unit. The monitor and the blower are powered by the same power source. These Safety Significant monitoring systems are powered by a Safety Significant uninterruptible power supply built to PC-2 performance criteria that is backed up by the TEF Standby diesel generator. In addition, the monitors have a low flow alarm to indicate failure of the blower, clogging of the filter or other problem causing loss of sample flow.

Issue 17
It appears that several power, control, and instrumentation cables will be routed through high-radiation areas. The TEF project needs to consider implementation of a cable condition monitoring program, similar to that of the Defense Waste Processing Facility, to monitor the cable degradation using Electrical Characteristics and Diagnostics or an equivalent system.

Issue 17 Response
The path-forward for maintaining safe plant operations for forty years is to:

1. Minimize routing cables and installing system components in high radiation areas
2. Provide shielding where practicable
3. Procure cables qualified to IEEE-323-1996 which are qualified to $2X10^8$ RADS
4. Obtain test samples of the proposed cables for SRTC testing
5. Utilize a monitoring system to test and analyze installed cables within the high radiation areas

6. Baseline all high radiation area exposed cable systems with a procured monitoring system
7. Provide a means, remotely, to replace cables in the high radiation areas.

An Electronic Characterization and Diagnostic (ECAD) System with Time Domain Reflectometry will be utilized to baseline, monitor and periodically test electrical and instrumentation systems in the RHB. (See Attachment B)

Issue 18
Acceptability of seismic design spectra given in SRS Engineering Standard 01060, Rev 4 for TEF

Issue 18 Response
Seismic design spectrum and actions to increase seismic safety identified in SRS Engineering Standard 01060, Rev 4 were determined to be adequate for TEF per Board Letter, Conway to Gioconda, dated 12/23/99.

Issue 19
Log strata in RHB excavation trench

Issue 19 Response
Complete. Excavation faces of interest logged prior to application of material to prevent erosion. Faces observed by Board Staff.

Issue 20.
Consider additional high range gamma monitors in RHB.

Issue 20 Response
Permanently installed, Safety Significant, area gamma radiation monitors are provided in the Remote Handling Building (RHB) at entrances into the Remote Handling Area (RHA). Permanent gamma radiation monitors are not provided in the RHA, due to the limited personnel access requirements and personnel exposures necessary to maintain and calibrate the detectors.

The preliminary design had gamma monitors located on the crane. The detector could be attached to a crane hook and lowered to various points in the RHA to assess gamma dose rates prior to personnel entry. During detailed design it was determined that these crane mounted detectors would be difficult to operate due to the detector cabling with the crane hook and crane cable festooning.

The project looked at alternative RHA gamma detection monitors to back up the Safety Significant gamma monitors. The key attributes were that the system be mobile (capable of accessing doses around modules, filters etc.), employ ALARA concepts for maintenance / calibration, minimize cabling with its attendant cable reeling and radiation exposure problems.

This RF system will employ six repeater antennas and one base station antenna. These antennas will be located on existing camera and lighting remotable Hanfords. The radiation detector would be a battery operated device that could be lowered by a crane hook to monitor dose rates throughout the RHA. The detector could be set down at a fixed location should continuous monitoring of a specific area be required. Multiple detectors could be used at one time. These detectors would be used when the TPBAR baskets are in the shielded storage area, to monitor for high background radiation levels in the RHA.

The project will be preparing a specification to procure this RF gamma detection system. Siemens and SAIC are two potential bidders.

Issue 21.
Consider elimination of inerting and desiccant for storage of TPBARs.

Issue 21 Response
A desiccant and furnace basket inerting study (M-ESR-H-00143, rev. 0, 11/00) was performed. This study selected the desiccant basket lid as the preferred method of storing TPBARs. Basket inerting and "do nothing" alternatives were also considered but in the evaluation scoring, they were evaluated lower than the desiccant basket lid design.

The criteria used for design of the desiccant lid is contained in PNNL document TTQP-00-114, "Storage of TPBARs Using Molecular Sieve to Control Moisture", 5/15/00.

Issue 22
Consider analysis of cask drop in truck bay

Issue 22 Response
The Cask Handling Crane is designed to meet the requirements of an ASME-NOG, Type II crane and is single failure proof in accordance with NUREG-0554. This requires the incorporation of redundant hoisting and braking systems in the design. These are the same requirements invoked by the NRC at commercial nuclear facilities to assure the safe handling of critical loads. These engineered controls are incorporated into the facility design to ensure that the probability of a cask drop is extremely remote. In addition, crane operators and maintenance personnel will be specifically trained and qualified in the operation and maintenance of this equipment as well. The combination of engineered controls and operator training should make a cask drop incredible.

Should a cask be dropped however, it would not release a significant quantity of radioactive material, nor would it compromise the shielding function of the building as discussed below.

Casks are to be used in the transportation of Tritium Producing Burnable Absorber Rods (TPBARs) from the TVA reactors to the Savannah River Site Tritium Facilities and from the Tritium Facilities to the Savannah River E-Area waste repositories. These Casks are to be designed to meet the requirements of 10CFR 71 as a Type B Package. The cask weighing up to 125 tons will be unloaded from a truck in the Truck Bay of the RHB using a Cask Handling Crane. The cask will be lifted from the truck bed and transported to a hatch where it will be lowered onto a cask trolley in the Cask Decon Room below. The trolley will move the cask into and out of the Remote Handling Area of the facility. The cask will not be lifted in the Remote Handling Area.

The lifts involved in moving the casks are within the Truck Bay and from the Truck Bay down through the Truck Bay hatch to the Cask Decon Room. Should a cask be dropped, the highest distance it can fall for lifts within the Truck Bay is less than 30 feet. The distance from the point of highest lift in the Truck Bay down to the Cask Decon Room is greater than 30 feet. The cask design will be tested in accordance with 10 CFR 71 which includes a 30 feet free fall drop test to demonstrate the design of the cask will not release radioactive material. The qualifications of the 10 CFR 71 test could be only exceeded if the cask experienced a free fall while lowering it from the Truck Bay to the Cask Decon Room below. If this occurred, the cask could collide with the cask trolley, the cask trolley rail system or the Cask Decon Room floor, walls or ceiling.

Damage as a result of a cask drop includes potential damage to the cask trolley and trolley rails. Failure of the concrete in the Cask Decon Room floor is possible causing localized structural failure. Damage to the shield door (between the Cask Receiving and the Cask Decon Room) is possible, potentially knocking the shield door off of its track and preventing the door from opening but not affecting the shielding function of the door.

The Safety Significant function of the building and structure is to protect the other Safety Significant (SS) SSCs contained within and to provide a shielding function. The primary structural damage to the building caused by this event would be to the Cask Decon Room floor, which may affect the building's ability to resist future events, but should not affect the structural capacity or shielding function of the other portions of the structure. There are no other SS SSCs in the Cask Decon Room that would be at risk from this event. Recovery from the event would require an extensive analysis of the damage and repair of the structure.

The damaged cask could result in exposure to anyone in the Cask Decon Room and Truck Bay to gamma sources within the cask. The cask may be damaged such that it is not longer leak-tight. Small amounts of particulate released from a failed cask would be drawn into the RHA through the ventilation system where the exhaust is HEPA filtered. A failed cask could possibly emit gamma radiation to the Cask Decon Room. The primary isotopes of concern are tritium, which is held to the zircalloy as a metal hydride within the TPBAR and cobalt-60, which is contained in the stainless steel of the TPBAR outer shell. Some small amount of activation products may be present on the surfaces of the TPBARs. No significant release of tritium or other airborne radioactive isotopes to the environment is anticipated.

Issue 23.
Perform an evaluation of 6-inch differential settlement for RHB foundation (Post-Seismic Differential Settlement)

Issue 23 Response
The total predicted differential settlement, soft zone subsidence and dynamic settlement, in the RHB is between 1.25 to 2.25 inches following a PC-3 earthquake. In the RHB structural design this differential settlement was conservatively idealized as 1.2 inches of soft zone subsidence combined with 3.0 inches of dynamic settlement. Subsequent parametric analyses have shown that the basemat has considerable reserve capacity and meets the ACI code with a post-seismic differential settlements consisting of 2.6 inches of soft zone subsidence combined with 6.6 inches of dynamic settlement. Thus, the basemat can tolerate settlements more than 2.2 times the design settlements or 4 times (2.6+6.6/2.25) the maximum predicted settlement. [References: K-ESR-H-00010, Rev 2 and T-CLC-H-00466]

Issue 24
Consider contacting the Navy Crane Center

Issue 24 Response
DOE-SR and Westinghouse have initiated contact with the Navy Crane Center for site level interactions. The Navy Crane Center has offered to perform an assessment of SRS's hoisting and rigging program. The Site is currently considering having this assessment performed. Primary site level contacts at SRS are Larry Snyder (DOE-SR) and Charles Campbell & Michael Berry (WSRC).

Several years ago, the SRS performed a comparison of the SRS hoisting and rigging program with that of the Navy. It was determined that the SRS program incorporated most of the essential features of the Navy's program.

In addition, the TEF project has consulted directly with the Navy Crane Center for information related to crane mounted torque wrenches to be used in the TEF Remote Handling Area. Unfortunately, the Navy Crane Center had little experience to offer in that application.

Issue 25.
Consider additional provisions to handle drainage around below-grade portions of building (RHB foundation French drain)

Issue 25 Response
The design water table has been conservatively specified based on water table measurements taken in the field. The elevation of the foundation / wall joint has been established five feet above this design water table elevation. Additionally, to provide seepage protection from moisture in the soil, a waterproof membrane has been specified from the bottom of the foundation mat to grade. A surface drainage system is being designed to carry surface water away from the buildings, limiting the amount of water infiltration at or near the RHB. Based on the provisions made in the design, the potential marginal benefit of reduced risk of leakage derived from a French drain system at the foundation elevation of the RHB does not justify the initial plus continuing operational cost.

Issue 26.
Consider reinforcing steel configurations that form a plastic hinge of selected areas of structure. (Ductile Detailing)

Issue 26 Response
The design capacities of the RHB elements exceed the elastic analysis demand. To insure defense in depth a number of provisions have been included in the RHB design to ensure ductile behavior should the elastically determined loads be exceeded. These include:

- The requirements of ACI-349 Chapter 21 "Special Provisions for Seismic Design" have been met.
- A706 reinforcing, which is 70% more ductile than A615 reinforcing (12% elongation/7% elongation), is used.
- Both faces of reinforcement at the face of each joint are fully developed.
- Conservative lap splice lengths are used.
- Providing U-bars along the exposed concrete face, providing vertical U-bars as wall dowels, and providing confinement reinforcement perpendicular to the U-bars at each joint face enhances wall-basemat joint confinement.
- Vertical and horizontal U-bars are used to confine major wall and slab openings.
- A reinforced concrete box system, which limits the rotational demand on joints, is used to resist lateral loads.

Issue 27
Thermal effects on structural members supporting piping

Issue 27 Response
The specific concern was subsequently clarify by the consultant to relate to whether the effects of thermal loads from piping were considered for the structure's wall design.

The maximum temperature of any piping passing through the concrete is less than 120° F, which is within the limits specified in the concrete codes for embedded pipe. Considering the pipe sizes and operating temperatures we do not believe that thermal effects will pose a significant load to the massive RHB shielding walls. The pipe will be analyzed for the appropriate temperatures and the supports designed accordingly including confirmation of the adequacy of the wall when the loads are significant. (See Issue 29)

Issue 28.
Improvements in design calculation documentation

Issue 28 Response
To facilitate understanding of the series of calculations prepared to analyze and design the Remote Handling Building structure, the RHB structural calculations have been revised to include a two page summary that identifies the relationship of the various RHB analysis and design calculations.

Issue 29
Evaluate wall support commodities including pipe thermal loads.

Issue 29 Response
The maximum temperature of any piping passing through the concrete is less than 120°F, which is within the limits specified in the concrete codes for embedded pipe. The pipe will be analyzed for the appropriate temperatures and supports designed accordingly including confirmation of the adequacy of the wall when the loads are significant. (See Issue 27)

Issue 30.
Torsional effects on floor spectra

Issue 30 Response
Torsion response of the building can be induced by pure horizontal seismic excitation due to the difference in location of the center of mass and the center of stiffness. To account for this affect a 3D-stick model of the building was used to calculate the in-structure response. An envelope of the acceleration response spectra at the corners and center of the building was used to develop in-structure response spectra. This enveloping response spectra therefore includes torsional effects due to structural irregularities. (Reference: T-CLC-H-00471)

Issue 31.
Use of real versus artificial time histories

Issue 31 Response
The RHB design is based on elastic analyses utilizing artificial time histories that envelop the PC-3 design spectra. The elastically calculated demand loads are based on F_{μ}=1.0 and are less than the capacities for corresponding elements. Since the analysis performed is elastic, the spectra at the building frequencies are the critical component of the input motion, not the specific timing of the individual peaks. Provided that both the real and artificial time histories meet the design spectra and the

response is based on an elastic analysis, then the response to both real and artificial time histories should be relatively the same. Therefore, the use of artificial time histories for the RHB seismic analysis is acceptable and appropriate. (Reference: T-CLC-G-00119, T-CLC-H-00464 and T-CLC-H-00468)

Issue 32.
Mass concrete placement issues

Issue 32 Response
Shrinkage and cracking of mass concrete are controlled by the specification which:

- defines mass concrete as any element with a thickness greater than 36 inches;
- limits the maximum amount of shrinkage in the concrete mix design to 0.036% to minimize shrinkage cracks;
- requires 25 to 50% of the cement to be replaced with pozzolans to reduce the heat of hydration and minimize thermal cracking;
- limits the maximum placement size to reduce thermal stresses; and
- requires conformance with ACI-301, which has special provisions for mass concrete in Section 8.

Additionally, the building was designed with a minimum of 0.18% reinforcement in each face and each direction of every wall and slab. This reinforcement is fully developed and will provide adequate crack control.

Issue 33.
Construction management: fixed price impact on Q/A

Issue 33 Response
The construction specification requires a Quality Program in accordance with NQA-1. SRS will perform periodic surveillance and the design organization will have representatives assigned to the construction site whose responsibilities will include construction observation.

As of 8/15/02, SRS will self perform the Remainder of Plant construction. This approach was presented to Board Staff members at the 8/15/02 review.

Issue 34
Wave passage effects

Issue 34 Response
The following write-up was present to the staff and consultants in April without objection.

Wave passage effects
Wave passage effects were evaluated for the Remote Handling Building. The approach proposed by Dr. Hall was used to develop averaged translational and rotational time histories for the RHB geometry. The average translational response spectra is about 20% lower than the free field response at 20 hz while the torsional

motion is a maximum at the same frequency. Combining the translational and torsional results in forces that are enveloped by the 5% accidental torsion that was considered in the RHB design. Therefore the remote handling building has sufficient margin to resist wave passage effects. (Reference: T-CLC-H-00471)

Issue 35

Location of Safety Significant Oxygen Monitors in Gloveboxes/Flow distribution of nitrogen in gloveboxes

Issue 35 Response

Issues related to glovebox oxygen monitor location center around:

- Having good mixing within the glovebox to quickly dilute localized inleakage of oxygen
- Locating the oxygen monitor to sample the glovebox environment oxygen concentration
- Setting alarm points appropriately to provide early warning of leaks prior to a hazardous condition developing

Oxygen monitors are located in the TEF gloveboxes for the purposes of monitoring the bulk oxygen concentration of the glovebox environment. The nitrogen environment in each glovebox is recirculated through a heat exchanger to remove heat generated by the equipment within the glovebox. The glovebox cooling system is recirculating between 1250 and 4451 CFM for the process system gloveboxes (flow rate varies depending on heat load). The process system glovebox volumes range from 2016 cubic feet to 3486 cubic feet. This provides 31.5 to 98.7 "air" changes per hour. The Mass Spec glovebox is smaller (977 cubic feet) and has a lower heat removal requirement, but has 25.7 volume changes. The glovebox coolers are located underneath the gloveboxes. Nitrogen is drawn into the cooler at one end of the glovebox and returned to the glovebox at the opposite end of the box. This large recirculation flow provides rapid mixing of any inleakage of oxygen with the glovebox environment.

Oxygen inleakage will primarily occur through the gloves or gloveport seals. Other possible leak points are electrical penetrations and glass window seals. Flaws in welds of the secondary confinement structure could also allow oxygen to enter the glovebox, however these will be found as part of fabrication and startup testing and eliminated prior to operation. Because the leak points could occur almost anywhere in the glovebox, there is not one location to put the monitor that will allow it to detect oxygen prior to the oxygen being diluted in the bulk gas. Therefore, the oxygen monitor is placed to monitor the bulk gas for oxygen. Additionally oxygen is neutrally buoyant in nitrogen. The mixing action of the cooling system recirculation to also aids in preventing pockets of oxygen from forming

Glovebox oxygen monitors are located in areas of the glovebox that will be in the recirculation path within the glovebox and where they are accessible for maintenance. This assures that the nominal average glovebox gas oxygen concentrations measured as a result of the mixing from glovebox cooler flow. This allows reasonable measurement of oxygen levels and accounts for possible differences between local and bulk concentrations. Recirculation flow at the oxygen monitor locations for each glovebox will be confirmed during startup by verifying by means of a visual flow indicator that there is detectable gas recirculation flow at each sampling location for each glovebox. This will ensure that there is good mixing within the gloveboxes to quickly dilute localized inleakage of oxygen.

Glovebox oxygen concentrations are expected to be maintained around 0.1% O2 based on 233-H experience with systems of similar design. The TEF oxygen monitors will be set to alarm at 1.0% and anticipate having an LCO Limit of 3% O2. This will allow for trending of oxygen levels 30 times lower than the expected LCO level and alarm at levels a factor of three below the expected LCO level. This will allow for the detection of small leaks and require action prior to oxygen levels reaching too high a level. These principles of oxygen monitoring have performed well in the 233-H gloveboxes and similar performance is expected in TEF.

Issue 36
PC-2 Crane in Remote Handling Building/PC-3 Crane in cask unloading. Why Difference/Why Not PC-3 in RHA.

Issue 36 Response
The performance requirement for the TEF Cask Handling Crane and the Remote Handling Area (RHA) Crane based on safety analysis is PC-1. The cranes are categorized as PC-2 for II/I requirements. The design of the cranes to meet UBC seismic criteria actually exceeds the criteria for PC-3, which provides added robustness to the facility.

The crane rails and anchor bolts for the 30 Ton Remote Handling Crane were designed to PC-3 criteria since these components are considered part of the PC-3 Remote Handling Building. The crane rails and anchor bolts for the 125 Ton Cask Handling crane were also designed to PC-3 criteria along with the Truck Bay support steel, although categorized as PC-2, to avoid II/I issues and for added robustness. (See Attachment C)

Issue 37
Should Seismic Anchor Motion (SAM) be considered for PC-2 piping design?

Issue 37 Response
DOE Order 420.1 and DOE-STD-1021-93 provide guidelines for Natural Phenomena Hazard Performance Categorization. These documents provide a relationship between Functional Classification as developed in facility SAR's and Performance Categories. Essentially, designating a Structure, System, or Component (SSC) as Safety Class (SC) means it must be categorized as PC-3 or higher and designating a SSC as Safety Significant (SS) means it must be categorized as PC-2 or higher.

DOE guide to DOE Order 420.1 (DOE-G-420.1-2) states that the designation of PC-2 should assure the operability of essential facilities or prevent physical injury to in-facility workers. Additionally it states "When safety analysis determine that local and limited confinement of low-hazard materials is required for worker safety, PC-2 designation should be used for the SSCs involved". Therefore, the most recent DOE guidance recognizes the SAR along with worker protection from life hazards associated with NPH events should be used to establish performance categorization.

For the TEF, there are no SC SSCs. Additionally, other than the Facility Structure and Stack, no SS SSC are required by safety analysis to protect facility workers from NPH events. Therefore, PC-2 is adequate for the Facility Structure and Stack and PC-1 is adequate for all other SSC to meet minimum DOE-G-420.1-2 guidance. Recognizing that it is prudent to provide additional worker protection for NPH events as required by the model building codes, the design of SSCs will meet the requirement of the Uniform Building Code (UBC). Essentially for the TEF project this requires nonstructural components and equipment attachments weighing more than 400 lbs. be seismically designed so they will not become a life safety hazard during a seismic event. Evaluations will also be performed to consider the relative motion of equipment attachments or seismic anchor motion (SAM) for PC-2 confinement systems to minimize hazardous material release.

Selected Safety Significant (SS) SSCs will be designed to PC-3 or PC-2 criteria (above the requirements) when cost effective to provide worker protection during and after NPH events and minimize facility replacement cost/downtime. However, II/I system interaction evaluations will not be performed in all cases as justified below.

Provided below is a discussion of the recommended performance categorization, II/I considerations and SAM recommendations for each SSC in TEF and the basis for its selection. Also included are selected PS SSCs because of the impact these have on Defense-in Depth (DiD). Note that for TEF systems and components located inside the Tritium Processing Building (TPB) and Remote Handling Building (RHB) the only NPH event considered is a seismic event. Because of the robust design and facility construction of the TPB and RHB, high winds and tornadoes are not considered a threat.

Fire Suppression System (SS) – There are no SAR requirements for function of the system following a seismic event as personnel are trained to evacuate the facility upon a seismic event. However, design to PC-2 will be performed to minimize capital facility loss and potential for release in a seismic event. Design to PC-3 is not warranted since there is not currently a seismically (PC-2 or PC-3) qualified fire water supply for the Tritium Facilities. II/I interaction evaluations are not required, as this system is typically located above most heavy equipment in the facility. No SAM analysis is required, as this is not a confinement system.

Room Tritium Monitoring System and Gamma Monitors (SS) – There are no SAR requirements for function of the system following a seismic event since personnel are trained to evacuate the facility following a seismic event. Piping, electronics, and supports are to be designed to PC-2 to assure additional resistance to seismic events and the possibility of some function during and after the event. Because of the redundant nature and large number of these monitors in the facility it is not probable that a large number of the monitors will fail due to II/I interactions. Therefore, no II/I interaction evaluation is required. No SAM analysis is required, as this is not a confinement system.

Glovebox Oxygen Monitors (SS) – There are no SAR requirements for function of the system following a seismic event since personnel are trained to evacuate the facility following a seismic event. Piping, electronics, and supports are to be designed to PC-2 to assure additional resistance to seismic events and the possibility of some function during and after the event. Because of protection provided by the glovebox, no II/I interaction evaluation is required. No SAM analysis is required, as this is not a confinement system.

Secondary Confinement including Gloveboxes, Modules, Pipe Jackets, and Stripper Headers (SS) – There are no SAR requirements for function of the system following a seismic event since personnel are trained to evacuate the facility following a seismic event. Secondary Confinement systems are to be designed to PC-2 to assure they do not cause interaction with other systems or the building structure, and that they provide adequate support of the PC-2 piping and vessels within them. Additionally, they are PC-2 to assure they do not become a life safety hazard (i.e. falling on employees), and because they are very costly to replace and would cause extensive facility downtime if extensively damaged. II/I evaluations of interaction by overhead systems/components (ventilation duct, cable trays, etc) will not be performed as the potential for significant damage (defined as beyond the ability of personnel to repair in-place) due to such interaction is low. SAM analysis between the glovebox/module and the internal process piping and vessels (PC-2) will be performed to assure damage to the primary confinement system is minimized. No SAM analysis is required on the Stripper Headers (supply or return) or Jackets between gloveboxes as the gas contained in them is glovebox atmosphere (nitrogen or argon with trace quantities of elemental tritium). SAM analysis will be performed on Stripper piping between the Stripper Heater and the Z-Beds and from the Z-Beds to the Z-Bed Recovery system since these portions of the system may contain tritium oxide.

Building Structures and Stack (SS) – The SAR does credit this system for providing protection of all other SSCs during a seismic event. Since this system is SS, the minimum required Performance Criteria is PC-2. However, to assure it does not become a life hazard, minimize damage to other SSCs during severe seismic events, and because it would be very costly to replace, it will be designated as PC-3. No II/I evaluations are required as no potential for external damage exists. No SAM analysis is required, as this is not a confinement system.

Transfer Line Covers and Jacket (SS) – There are currently no SAR requirements for function of this system during or after a seismic event. However, concerns about exposure of facility personnel remaining in the tritium yard area following a seismic event make it prudent to designate this system PC-3. No II/I evaluations are required as no potential for external damage exists. SAM analysis is to be performed on this system. This will be reflected in the revised SAR.

Ventilation Exhaust (PS) - There are no SAR requirements for function of this system during or after a seismic event. The system should be designed to PC-2 to assure it does not become a life hazard (i.e. falling on employees) and because it is potentially a long lead time item. II/I evaluations of interaction by overhead systems/components (fire suppression, cable trays, etc) will not be performed as the potential for significant damage to the duct (defined as beyond the ability of personnel to repair in-place) due to such interaction is low. No SAM analysis is required, as this is not a confinement system.

Process Piping (PS) - There are no SAR requirements for function of this system during or after a seismic event. However, this system provides employee protection by preventing a hazardous material release and is therefore considered as one of the PS SSCs available for DiD. The piping systems within the glovebox will be designed to PC-2 to assure maximum practical survivability during seismic events. No II/I interactions of other equipment with the piping systems will be evaluated however, since the glovebox itself provides protection of this system from external hazards. SAM analysis will not be performed for the process piping (except those sections between a non-rigidly mounted tank or vessel and its first anchor point) as it is constructed from small diameter ductile stainless steel and will result in a release of minimal amounts of hazardous material if failed. Large process equipment such as tanks and vessels will be evaluated for SAM and II/I interactions with the glovebox and process piping, as they contain a significant quantity of hazardous material, and could cause damage to the PC-2 piping systems or glovebox during a seismic event.

Worker Protection System (SS) - There are no SAR requirements for function of the system following a seismic event since personnel are trained to evacuate the facility following a seismic event. Electronics and supports are to be designed to PC-2 to assure additional resistance to seismic events and the possibility of some function during and after the event. Because of the redundant nature of this system it is not probable the entire system will fail due to II/I interactions. Additionally, the design of the system is "fail safe" such that loss of signal or power to the sensing device (O2 analyzer, Tritium Monitor, or Gamma Monitor) will cause a local and control room alarm unless main and standby building power is lost. Personnel are trained to evacuate the facility upon loss of power scenarios for their protection. Therefore, no II/I interaction evaluation is required. No SAM analysis is required, as this is not a confinement system.

Electrical Power to SS SSCs (SS) - There are no SAR requirements for function of the system following a seismic event since personnel are trained to evacuate the facility following a seismic event. Electronics and supports are to be designed to PC-2 to assure additional resistance to seismic events and the possibility of some function during and after the event. It is not probable the primary and standby electrical systems will fail due to II/I interactions without facility personnel noticing, especially since normal building lighting would be affected as well. Facility personnel are trained to evacuate the facility during loss of power. Therefore, no II/I interaction evaluation is required. No SAM analysis is required, as this is not a confinement system.

Issue 38

Questioned why input spectra for the TPB obtained from "free field" node in the RHB analysis did not show amplification in the high frequency range.

Issue 38 Response

The RHB zero period acceleration (ZPA) at grade elevation is 0.16g on the west end wall, 0.9g at the center of the building and 0.15g on the east end wall. The first row of free field nodes for the TPB was located 12' north of the RHB and had corresponding ZPA acceleration of 0.15g, 0.18g and 0.15g. The ZPA on the remaining two rows of TPB free field nodes, located 60' and 125' from the north RHB wall, is 0.16g. Since the TPB has a mat foundation, which will move as a unit, the ZPA accelerations over the mat are averaged, which results in a 0.16 ZPA for the TPB.

To increase our confidence in the TPB design, the building assessed with a 0.18g ZPA which resulted in a slight increase in base shear which was well within the existing design margins.

Issue 39

Missile impact load should be considered concurrent with tornado wind pressure loads on the building.

Issue 39 Response

The rolling and tumbling automobile tornado missile was combined with tornado wind pressure in the TPB design. This missile was applied to 12" thick walls and bounds the 3" pipe and 2x4 timber missiles acting on 12" thick walls.
The calculation was revised to combine tornado missile and wind loads on the 8" thick tornado missile shield. (Reference: T-CLC-H-00498)

Issue 40

Need to justify 75' concrete placement is acceptable to guard against cracking.

Issue 40 Response

ACI 224.3R-95, "Joints in Concrete Construction" states that the "construction joints are needed to accommodate the construction sequence for placing concrete. The amount of concrete that can be place at one time is governed by batching and mixing capacity, crew size and the amount of time available." Expansion joints are typically used to control cracking. Both ACI 224.3R-95 and the National Academy of Science Technical Report #65, "Expansion Joints in Buildings" state that even nonrectangular concrete buildings can be constructed with expansion joints 200 feet on center which is over 2.5 times the 75 feet limit on concrete placement specified in the construction specification.

The TEF CSA specification has specified additional restrictions on the allowable drying shrinkage of 0.036 percent using a modified ASTM C-157 that is more conservative than the ASTM itself, which also reduces the potential for cracking. As a further safeguard the placement plans, including construction joint location and sequence of placement, were required to be submitted by the contractor for approval. Considering all of the restrictions incorporated in the construction specification, we believe more than adequate protection from cracking has been provided.

Issue 41
Recommended that prying action be addressed in embedded plate calculation.

Issue 41 Response
A parametric calculation was performed to quantify the prying action on embedded plates. These calculations shown that if the face of the attached item is four inches or less from the center of the stud then the effect of prying action on the stud length is negligible. Prying action will be addressed on a case-by-case basis if the face of the attached item is more than four inches from the center of the stud. (Reference T-CLC-H-00498, Rev 4)

Issue 42
Recommended that the TPB grade beams be checked for torsion for the case of lost of support under the foundation slab.

Issue 42 Response
Calculation T-CLC-H-00498 was revised to include a check for torsion in the perimeter grade beams. The 4'x6' perimeter grade beams have a torsion demand to capacity ratio of 0.85.

Issue 43
Clarify the Performance Category of the TPB catwalks. If they are designed to PC-3 loads, why aren't they PC-3?

Issue 43 Response
From a practical viewpoint the catwalk's lateral load resisting system could be considered a PC-3 structure because it was designed to PC-3 loads in order to preclude adverse interactions with the PC-3 building columns. However, the failure of other portions of the catwalk – such as the floor stringers spanning between frames – would not have an adverse impact on the PC-3 columns and need not be designed for PC-3 loads. Thus, the PC-2 performance category was retained for the catwalk and portions of the catwalk, which could have an adverse reaction with PC-3 structures, were designed to PC-3 loads.

Issue 44
Why use ACI 318 augmented by ACI 349 and not the other way around?

Issue 44 Response
DOE G 420.1-1 identifies that ACI 318 as is the relevant code for Safety Significant structures. The TPB is a Safety Significant structure and the use of ACI 318 is therefore appropriate. ACI 349 is identified in DOE G 420.1-1 as the relevant code for Safety Class structures.

Issue 45
Consider adding structural grade beams in the TPB design.

Issue 45 Response
Structural grade beams were incorporated into the TPB design. Reference Issue 30 for additional discussion.

Issue 46
Recommend performing a detailed evaluation of the interaction between buildings during a seismic event.

Issue 46 Response
Interaction between the RHB and TPB was considered and factored into the TEF design.

Attachment A

SHIELD DOORS / AREA GAMMA RADIATION MONITORS SUMMARY DESCRIPTION

PURPOSE-

The purpose of this document is to provide a summary description of the radiation shield doors and their planned operation; locations of Safety Significant (SS) Area Gamma Radiation Monitors and requirements based on shield door supplier.

RADIATION SHIELD DOORS-

General-
Shield doors are used where limited access to areas of potentially high radiation is required for personnel or equipment. There are six radiation shield doors provided in the Remote Handling Building. These doors are steel, motor operated, and horizontal sliding. Each door's steel thickness is determined based on locations of potential radiation sources and required radiation attenuation. Reference 1 provides the required radiation shield thickness for the shield doors and walls. Reference 2 provides the radiation levels for various operations and shield door configurations.

Door Descriptions-

Door 21- Cask Decontamination Area to Cask Receiving Area, This door is single leaf, 16" thick, 14.33 feet wide and 28.34 feet high. This door is used to provide access into the Remote Handling Area (RHA) for the trolley carrying transportation cask, waste cask, empty baskets, empty overpacks, RHA equipment requiring maintenance or waste. During trolley operation a portable rail section will block the door pathway. The door motor is located on the cask decontamination side.

Door 25- Airlock to Cask Decontamination Area, This door is a single leaf, 8.5" thick, 11.2 feet wide and 8.9' high. This door is used for personnel access into the cask decontamination area for cask operations and maintenance activities. The door motor is located on the cask decontamination side.

Door 24- Hot Maintenance Area to Remote Handling Area, This door is a single leaf 14.5" thick, 8.33 feet wide and 9.2 feet high. This door will be used for personnel access into the RHA, which is expected to be a very infrequent occurrence, and subject to radiation source configuration detailed in Reference 2g. The door motor is located on the hot maintenance area side.

Door 23- Air Lock to Hot Maintenance Area, This door is a single leaf, 8" thick, 9.2 feet wide and 8.6 feet high. This door is used for access to the hot maintenance area for small equipment repair and for transfer of equipment into the RHA via a hatch. The door motor is located on the airlock side.

Door 27- Crane Maintenance Area to Remote Handling Area, This door is double leaf, 13" thick, and. 16.4 feet high. One leaf is 21.6 feet wide and the other 20.2 feet wide. The 30-ton remotely operated crane uses this door for access between the crane maintenance area and RHA. This door must be open whenever the crane is in the RHA. The crane is designed to bridge the gap in the rails created for the shield door. This means there is not a moveable crane rail associated with this door. The door motors are located in the shield door "pocket" at the North side of the crane maintenance area.

Door 26- Air Lock to Crane Maintenance Area, This door is single leaf, 7" thick, 8.3 feet wide and 8.9 feet high. This door is used for personnel access into the crane maintenance area. The door motor is located on the airlock side.

Door Design Features-

Figures 1 and 2 illustrate the shield door locations. The control scheme for the shield doors will include key operated switches and password protected bypassing capabilities to prevent inadvertent opening of any shield door. The following is a list of controls applicable to all doors:

a. The shield doors will be operated from the crane control room. To operate any shield door the Shift Manager and Radiological Control Operations (RCO) personnel must provide a permissive. This permissive is in the form of a key operated switch and / or password protected input to the PLC. The crane operator, shift manager or RCO personnel can remove the permissive at any time disabling the shield door operation.
b. Each shield door will have emergency stop switch(es) to stop door movement (within one inch). These emergency stops are located in the crane control room and at locations local to the doors. The crane operator, shift manager, or RCO personnel must activate a key operated switch to reset the control switch after any emergency stop or open switch activation.
c. Redundant limit switches to indicate door fully open will be provided.
d. Redundant limit switches to indicate door fully closed will be provided.
e. At the low radiation side of each shield door, a yellow light rotating beacon with horn will indicate shield door in motion.
f. At the low radiation side of each shield door a red rotating beacon with horn will indicate shield door not fully closed.
g. A "load-hang-up" sensing device will be provided. This device will disable the electrical power source to the drive motor at a 115% of static load opening force.
h. RCO personnel will perform walkdowns and radiation surveys to confirm doors have been properly closed. Doors will be posted and barricaded consistent with RCO requirements.

Doors 21 and 25 (Cask Decontamination Area)-

Door 21 (between cask decontamination area and cask receiving) will be for equipment, via trolley, access. Personnel would not normally use this door. Prior to opening shield door 21, personnel leave the cask decontamination area into the airlock and close shield door 25. RCO will verify personnel have left this area. A television camera will provide remote viewing of this area from the crane control room. An emergency stop switch for door 21 and emergency open switch for door 25 along with the door movement / door not closed flashing lights and horn are provided in the cask decontamination area. Located on the east wall of the cask decontamination area will be an SS gamma radiation detector (RE2, Reference 3). Upon radiation levels exceeding the detector setpoint, a local red light will flash and horn will sound. In addition, alarms (audible and visual) will occur at the entrance to the cask decontamination area and in the control room.

Doors 21 and 25 will be interlocked such that door 25 can be opened only if door 21 is closed. This will be a software interlock configured so it can be bypassed only by the shift manager or RCO personnel via a password-protected PLC input.

Door 21 is interlocked such that it cannot be closed unless the trolley bridge rail is in the up position.

Doors 21 and 25 each have a local control station, which will be used for maintenance testing. The shift manager and RCO personnel must provide a permissive, key operated or password protected input to enable the shield door control switches at the local control station.

Doors 24 and 23 (Hot Maintenance Area)

Door 24 (between hot maintenance area and RHA) will be used by personnel for infrequent access into the RHA. Prior to opening shield door 24, personnel leave the hot maintenance area into the air lock and close shield door 23. RCO will verify personnel have left this area. A television camera will provide remote viewing of this area from the crane control room. An emergency stop switch for door 24 and emergency open switch for door 23 along with the door movement / door not closed flashing lights and horn are provided in the hot maintenance area. Located on the north wall of the hot maintenance area will be a SS gamma radiation detector (RE4, Reference 3). Upon radiation levels exceeding the detector setpoint, a local red light will flash and horn will sound. In addition, alarms (audible and visual) will occur at the entrance to the cask decontamination area and in the control room.

Doors 24 and 23 will be interlocked such that door 23 can be opened only if door 24 is closed. This will be a software interlock configured so it can be bypassed only by the shift manager or RCO personnel via a password-protected PLC input.

Door 23 has a local control station, which will be used for maintenance testing. The shift manager and RCO personnel must provide a permissive, key operated or password protected input to enable the shield door control switches at the local control station.

Doors 27 and 26 (Crane Maintenance Area (CMA))

Door 27 (between CMA and RHA) will be used for the 30-ton remotely operated crane. This door is open whenever the crane is operation. Personnel would not normally use this door. Prior to opening shield door 27, personnel leave the CMA into the air lock and close shield door 26. RCO will verify personnel have left this area. Television cameras on the crane will provide remote viewing of this area from the crane control room. An emergency stop switch for door 27 and emergency open switch for door 26 along with the door movement / door not closed flashing lights and horn are provided in the crane maintenance area. Located on the west wall of the CMA will be an SS gamma radiation detector (RE7, Reference 3). Upon radiation levels exceeding the detector setpoint, a local red light will flash and horn will sound. In addition, alarms (audible and visual) will occur at the entrance to the crane maintenance area and in the control room.

Doors 27 and 26 will be interlocked such that door 27 can be opened only if door 26 is closed. This will be a software interlock configured so it can be bypassed only the shift manager or RCO personnel via a password-protected PLC input.

Door 27 cannot be closed unless the crane is in the CMA.

Door 26 has a local control station, which will be used for maintenance testing. The shift manager and RCO personnel must provide a permissive, key operated or password protected input to enable the shield door control switches at the local control station.

RADIATION SHIELD DOOR DESIGN STATUS

The steel sections for shield doors 21, 23, 24 and 25 have been received at the site for installation. The shield door supplier is working with site engineering to develop detailed door electrical and PLC drawings. These drawings are expected for review in October.

SAFETY SIGNIFICANT AREA GAMMA RADIATION MONITORS

In addition to the SS area gamma radiation monitors discussed above in conjunction with the shield doors, there are four other SS monitors in TEF. These monitors all have local visual and audio alarms in addition to alarms at entrances to the gamma monitor area.

1. RE-3, Located on the north side of the dressout area. Refer to Figure 1 and reference 3.

2. RE-5 Located on the outside of the north side of the penetration air hood room wall. Refer to Figure 1 and reference 3.

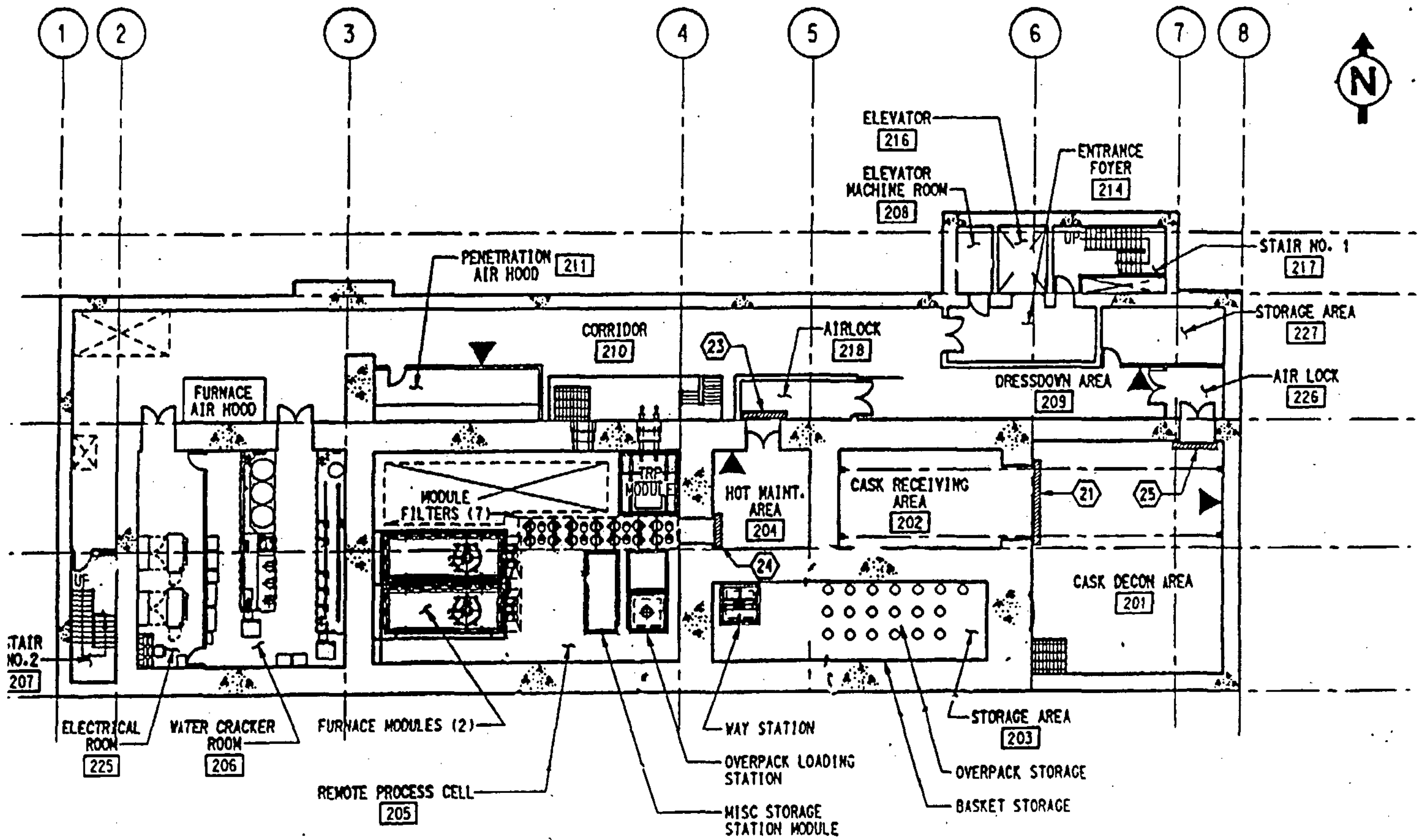
3. RE-1 Located on the east side of the truck bay. Refer to Figure 3 and reference 3.

4. RE-6 Located on the outside of the north HEPA filter room wall. Refer to Figure 3 and reference 3.

REFERENCES-

1. A-AD-H-7199, CLWR-TEF Tritium Extraction Facility, Remote Handling Building, Radiation Shield Thickness
2. CLWR-TEF Tritium Extraction Facility, Remote Handling Building, Radiation Zone Drawings:
    a. A-AD-H-7200, Normal Operation
    b. A-AD-H-7201, Hot Maintenance Area Hatch Open
    c. A-AD-H-7202, Cask in Truck Bay
    d. A-AD-H-7203, Cask in Cask Decontamination Area
    e. A-AD-H-7204, Cask Decon to Cask Receiving Area Door Open
    f. A-AD-H-7205, Crane in Maintenance Area
    g. A-AD-H-7206, Remote Handling Area Personnel Access
3. J-J8-H-7761, Remote Handling Building Area Radiation Monitoring System, Misc. Instrumentation and Control Diagram
4. C-SPP-H-00074, Shield Door Procurement Specification
5. ACC11405A, Trentec Shield Door Procurement Specification
6. C-SYD-H-00002, Building and Cell Structures System Design Description
7. Q-SYD-H-00002, Radiation and Contamination Sampling / Monitoring Systems System Design Description

FIGURES

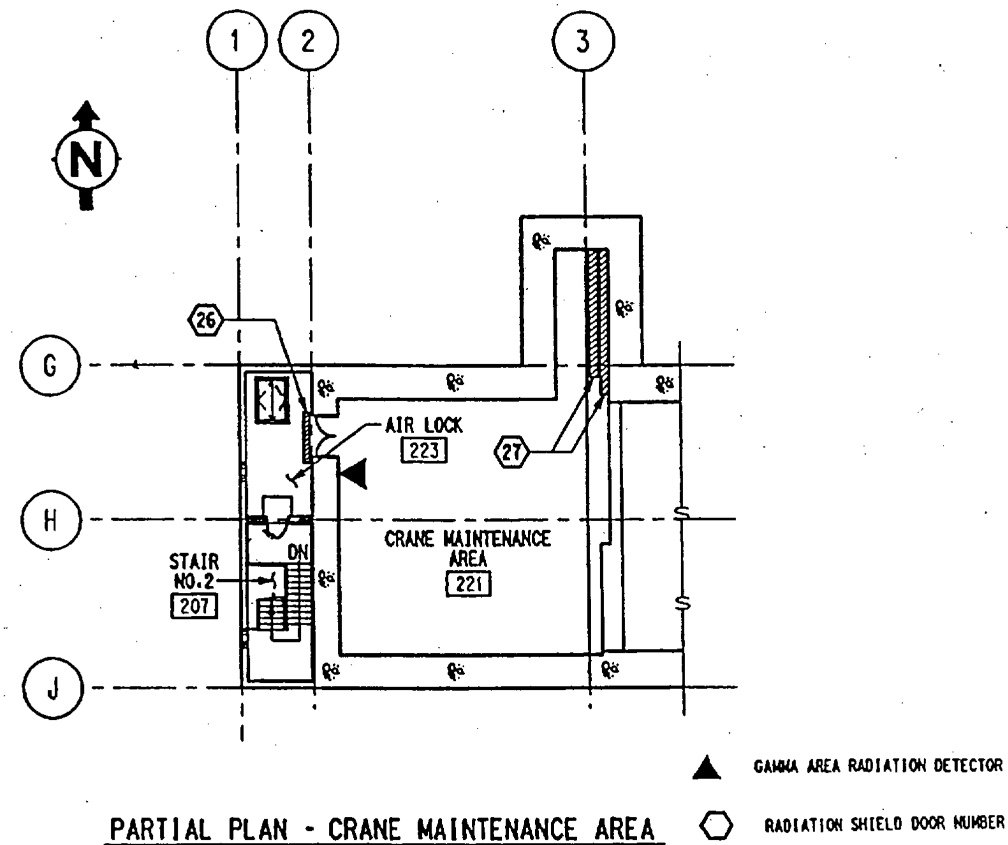


FLOOR PLAN EL 265'-1" (UNO)

▲ GAMMA AREA RADIATION DETECTOR

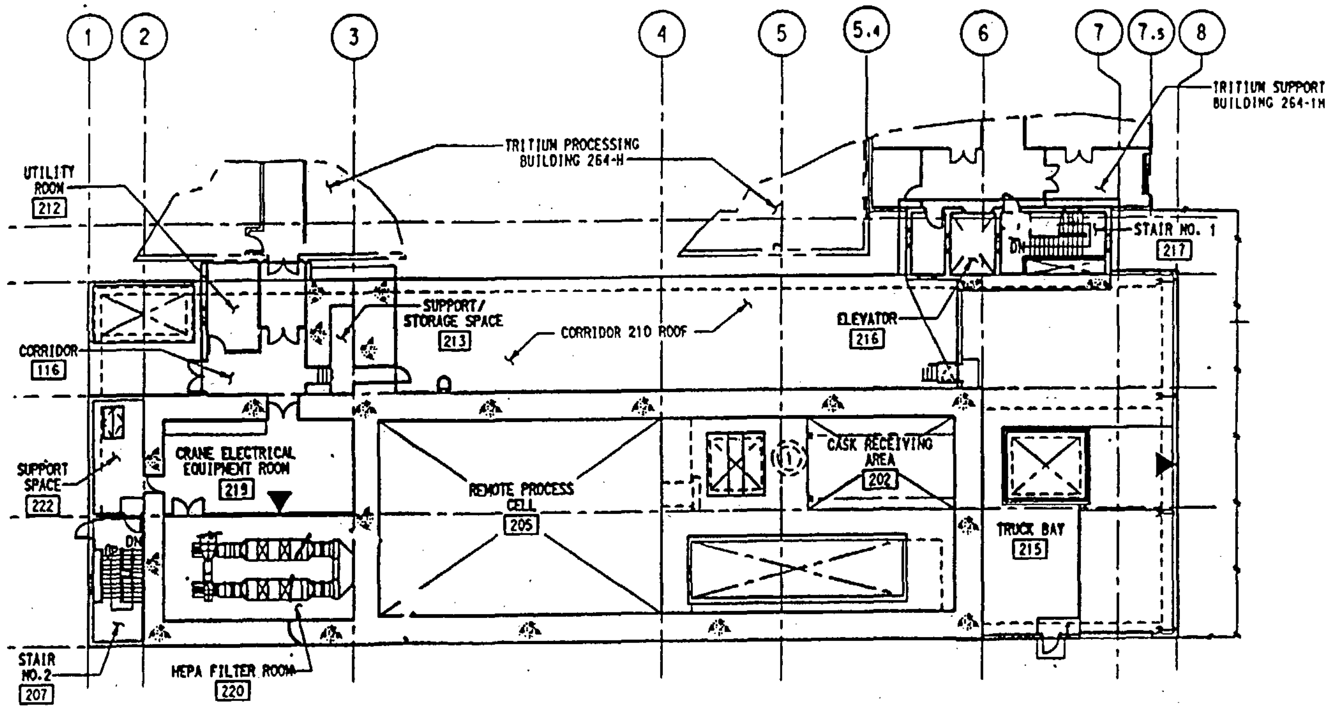
⬡ RADIATION SHIELD DOOR NUMBER

FIGURE 1



PARTIAL PLAN - CRANE MAINTENANCE AREA

FIGURE 2



FLOOR PLAN @ GRADE ▲ GAMMA AREA RADIATION DETECTOR

FIGURE 3

Attachment B

CABLE CONDITION MONITORING PROGRAM

This following provides an overview of the plan for monitoring, testing, troubleshooting and maintaining cables exposed to high doses of gamma radiation within the Remote Handling Building (RHB) of the Tritium Extraction Facility (TEF). Since some electrical power, control and instrumentation cables and their associated components will be exposed to high radiation, these cables and systems will be baselined, periodically monitored and tested to verify and maintain system operability.

The TEF is designed for a forty (40) year life. Electrical cables exposed to High Radiation levels will not survive forty years. It has been determined that portions of the RHB will see a dose rate in excess of 50,000 R/hr. Where possible, radiation shielding will be provided to reduce the effect of radiation on cables and system components. Radiation reduces the life of cables by destroying their insulating ability and causing them to become brittle, conductive and to disintegrate.

The path-forward for maintaining safe plant operations for forty years is to:

- Minimize routing cables and installing system components in high radiation areas
- Provide shielding where practicable
- Procure cables qualified to IEEE-323-1996 which are qualified to $2X10^8$ RADS
- Obtain test samples of the proposed cables for SRTC testing
- Utilize a monitoring system to test and analyze installed cables within the high radiation areas
- Baseline all high radiation area exposed cable systems with a procured monitoring system
- Provide a means, remotely, to replace cables in the high radiation areas.

Efforts have been made to identify a suitable system capable of performing the necessary monitoring and testing of high radiation exposed cables. Based on site experience, an Electronic Characterization and Diagnostic (ECAD) System with Time Domain Reflectometry will be utilized to baseline, monitor and periodically test electrical and instrumentation systems in the RHB. This System is currently in operation in the Defense Waste Processing Facility with a well-satisfied performance.

The ECAD is a computerized, automated state-of-the-art electronic system which gathers and stores data in a computerized database for analysis, trending and troubleshooting. This data will be used in predictive maintenance manner and, assist in maintaining a safe operating facility for its design life. The ECAD approach is based on viewing the plant circuits as a radio frequency (r-f) line with a load, and analyzing the lumped distributed circuit elements. Typical transmission lines include parallel wires, wire over a ground plane and coaxial cable. Direct current and radio frequency testing techniques can be applied to determine and monitor those electrical characteristics necessary for circuit functionality and assessment. The direct current or low frequency measurements provide the lumped values of circuit loop resistance, insulation resistance, inductance, and capacitance. These measurements provide the best indication of circuit degradation, but cannot determine where the degradation is occurring. Using the radio frequency technique of analyzing reflected electromagnetic pulses in the time domain; the circuit is analyzed as an r-f transmission line, consisting of a series of resistors, inductors and capacitors. This technique, known as Time-Domain Reflectometry (TDR), identifies the distributed resistance, inductance, and capacitance of the circuit, and can accurately detect the location of circuit degradation.

The ECAD is a completely automated data acquisition system. The computer provides complete control of the test instrumentation through the IEEE-488 interface bus utilizing specially designed software. All measurements are conducted remotely using a 2-wire connection to the circuit under test. This system can measure circuits with loads as far as 3000 feet away.

This system can perform the desired diagnostic tasks needed to: maintain safe system operation, predict system degradation and minimize personnel exposure to radiation. The types of degradation and problems that can be detected by the ECAD are: changes to dielectric materials, deterioration of circuit insulation, high resistance connections, short circuits, open circuits, circuit continuity, moisture intrusion, circuit noise, improper ground and /or shield connections, and development of shunt conducting paths. The ECAD can accurately and quickly locate these problem areas in a short period of time.

Attachment C

DETAILS OF TEF CASK HANDLING CRANE AND THE REMOTE HANDLING AREA (RHA) CRANE SEISMIC DESIGN

The TEF Cask Handling Crane and the Remote Handling Area (RHA) Crane initially had different performance categories. The Cask Handling Crane was specified to meet PC-3 and the RHA Crane was specified to meet PC-2 requirements.

The cask unloading crane classification was revised to PC-2 in a DCF issued in March 2001. The seismic loads for the PC-2 Cask Unloading and Remote Handling cranes is generated using UBC-97. The UBC lateral force, calculated using Section 1632.2 Equation 32-1 with Ca=0.22 and Ip=1.5 is Fp=1.32Wp, while the lateral force calculated using Equation 32-2 with ap=2.5 and R=3 is Fp=0.81Wp. For comparison the peak PC-3 roof accelerations are 0.58g in the north-south direction, 0.21g in the east-west direction and 0.21g vertically.

Although UBC allows the design to the lower of Equations 32-1 and 32-2, the crane vendor chose to design the 30 Ton Remote Handling Crane to Equation 32-1 which results in an effective lateral acceleration of 1.32g. This crane is rigid in the north-south direction and the 1.32g PC-2 effective acceleration envelopes the peak PC-3 acceleration of 0.59g. In the east-west direction the peak PC-3 spectral acceleration is 0.62g which is enveloped by the PC-2 effective acceleration of 1.32g. Vertically, the 0.21g vertical acceleration is enveloped by the gravity load factors. Thus, the PC-2 UBC seismic design envelopes the actual PC-3 seismic forces acting on the Remote Handling crane.

A vendor calculation for the 125 Ton Cask Handling crane based on the original PC-3 spectra was received and demonstrates that this crane is acceptable for the PC-3 loading. Since the crane design is govern by gravity loads, the specification change from PC-3 to PC-2 criteria will not result in material changes to the crane and the Cask Handling crane would survive a PC-3 seismic event.

The crane rails and anchor bolts for the 30 Ton Remote Handling Crane were designed to PC-3 criteria since these components are considered part of the PC-3 Remote Handling Building. The crane rails and anchor bolts for the 125 Ton Cask Handling crane were also designed to PC-3 criteria along with the Truck Bay support steel, although categorized as PC-2, to avoid 2 over 1 issues and for added robustness.