Department of Energy
Brookhaven Group
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Upton, New York 11973

AUG 24 2000

Mr. Michael Schlender
Brookhaven Science Associates, LLC
Brookhaven National Laboratory
Upton, New York 11973

Dear Mr. Schlender:

SUBJECT: APPROVAL OF UNREVIEWED SAFETY ISSUE DETERMINATION/ SAFETY EVALUATION (USID/SE) FOR THE SEALING OF PILE OPENINGS FOR THE BROOKHAVEN RESEARCH REACTOR DECOMMISSIONING PROJECT (BGRR-SE-00-02)

The Brookhaven Group (BHG) has reviewed your request to begin the welding portion of the Pile Sealing. BHG has determined that the actions referenced in USID/SE BGRR-SE-00-02 (Rev.0) comply with the requirements of DOE Order 5480.21, Unreviewed Safety Questions and DOE-EM-STD-5503-94, EM Health and Safety Plan Guidelines. Therefore, welding activities associated with the Pile Sealing are authorized.

If you have any questions regarding this matter, please contact Gail Penny of my staff at extension 3429.

Sincerely,

Frank J. Crescenzo, Acting
Brookhaven Group Manager

cc: M. Holland, BHG
S. Mallette, BHG
G. Penny, BHG
M. Dikeakos, BHG

Safety Evaluation Number: **BGRR – SE – 00 – 02** **Revision Number:** 0

Prepared by: S. H. Moss S H Moss 8/14/00 **Date:** 08/07/00

Description of proposed activity: WBS 2.02, Seal Pile Openings at Bio-Wall

The pile and its associated Bio-Shield walls are considered to be Building 702. There is a negative-pressure filtered air system associated with the Pile. All openings in the Bio-Shield walls will be sealed to isolate the Pile from Building 701; this will include the removing of the experimental equipment that was left attached to the Bio-Shield walls. This isolation work enhances appropriateness of the facility classification as 'Radiological'. This isolation at the Bio-Shield walls will be sufficient to additionally satisfy requirements, with Building 701, as weather-tight protection for the Pile.

*The activities proposed here include:

1) Remove abandoned experimental equipment from the Bio-Shield's walls.
2) Characterize the equipment for disposal as 'rad' or 'non-rad' materials.
3) Undertake mechanical isolation work related to blanking, sealing, or verifying that all experimental and operational Pile penetrations, and removable block mating surfaces are isolated or sealed; provide a mechanical barrier for all potential air-flow paths between Building 701 and the interior spaces of the Pile's Biological Shielding. This includes the Pile's Top, East, West, North, South faces and part of the floor area that is connected with the bottom of the Pile through the animal- and instrument-tunnels.
4) Carry out electrical isolation work related to cutting thermocouple wires and capping the thermocouple penetrations at the Biological Shielding.
5) Remove the filters from the East intake area, and replace the plywood on the East and West intake areas with aluminum or carbon-steel plates. [To be accomplished later.]
6) Install a passive HEPA filtration system. [To be accomplished later , after the Below Ground Duct remediation work.]
7) Perform 'as-left' surveys, sampling and analysis.
8) Prepare an Activity Closure Report.

- Before these activities, where necessary, are authorized to be performed by DOE approval of this USID/SE; Pile Characterization will be performed, under the authority of, and in conformance with the limitations/requirements of the BGRR-ASA [Ref. 2]. With the exception of the welding activities described in Sections 5.3 and 5.4 of the Technical Work Document for Sealing of the Reactor Pile (estimated to be a total of 13 linear feet of weld) [Ref.16]; all the work activities associated with the isolation and sealing of the Pile are covered by the BGRR-ASA [Ref.2] and thereby already approved by DOE.

Purpose:

The purpose of WBS 2.02 for the BGRR Decommissioning Project is to Seal Pile Openings at the Bio-Shield Walls. It specifically consists of sealing and verifying sealed all openings in the Bio-Shield walls to keep graphite dust from becoming a hazard in Building 701 and provide assurance that removal activities in Building 701 will not have an impact on the Graphite Pile.

References:

(1) Procedure No. ERD-OPM-4.4, "Safety Evaluations for Unreviewed Safety Issue Determinations", Rev.0 dated 1/18/00.
(2) BGRR-002, "Hazard Classification and Auditable Safety Analysis for Brookhaven Graphite Research Reactor (BGRR) Decommissioning Project", Rev. 2 dated September 8, 1999, as approved by DOE 11/18/99.
(3) BGRR-001, "Brookhaven Graphite Research Reactor (BGRR) Project Management Plan", Rev. 1 dated March 2, 2000.
(4) BNL ES&H Manual Standard 1.3.3, "Safety Analysis Reports / Safety Assessment Documents", Rev.1 dated 7/28/92. [URL= https:sbms.bnl.gov/ld/ld08/ld08d081.htm]
(5) DOE-STD-1027-92, "Hazard Categorization and Accident Analysis Techniques for Compliance with DOE order 5480.23, Nuclear Safety Analysis Reports" Change Notice No. 1 dated September 1997.
(6) LA-12846-MS, "Specific Activities and DOE-STD-1027-92 Hazard Category 2 Thresholds", LANL Fact Sheet issued November 1994.
(7) LA-12981-MS, "Table of DOE-STD-1027-92 Hazard Category 3 Threshold Quantities for the ICRP-30 List of 757 Radionuclides", LANL Fact Sheet issued August 1995.
(8) NEPA Categorical Exclusion (CX) BNL-361, dated 9/16/99, covering BGRR Stabilization.
(9) NUREG/CR-4981, "A Safety Assessment of the Use of Graphite in Nuclear Reactors Licensed by the NRC", 1987.
(10) BGRR-030, Job Safety Analysis for Sealing of the Reactor Pile, July 13, 2000.
(11) National Fire Protection Association, "Fire Protection Handbook", 18th ed., 1997.

(12) Bureau of Mines Report RI-6597," Explosibility of Carbonaceous Dusts", 1965.
(13) BGRR-SE-00-01, Instrument House (708) Components Removal and Isolation, dated 02/03/00.
(14) BGRR-SE-99-03, Removal of Residual Pile Fans for BGRR-DP, as approved by DOE 12/08/99.
(15) Cutting and Welding Permit, covering the welding to the Bio-Shield Face (Copy included as Attachment No. 2).
(16) ERD-BGRR-TP-00-011, Technical Work Document Sealing of the Reactor Pile (702), (Copy included as Attachment No. 3).
(17) BNL Committee Report on HVAC Testing at the BGRR Complex – December 1998.
(18) BHI-01179, "Auditable Safety Analysis and Final Hazard Classification for the 105-N Reactor Zone and 109-N Steam Generator Zone Facility","Rev.0, July 1998, Bechtel Hanford Inc.
(19) Brookhaven Graphite Research Reactor Decommissioning Project Health and Safety Plan (HASP)-BGRR-0006, dated September, 1999.
(20) BNL FFA under CERCLA Section 120, February 28, 1999 [IAG between U.S. EPA – Region II, U.S. DOE and NYSDEC].

SCREENING CRITERIA

Safety Function(s) of Systems Affected

1. Will the proposed activity affect the safety function(s) or failure mode(s) of the equipment/facility? Y (N) N/A

Because of its defunct status and defueled state, the BGRR has no current requirements for redundant systems and/or safety class or safety significant SSCs (Systems, Structures and Components). Therefore, no safety functions exist that are directly associated with current components or equipment considered part of the scope of the BGRR Decommissioning Project. Where no safety functions exist, there can be NO effect on the safety function by the proposed activity.

The Pile was shutdown as part of the general BGRR shutdown in 1969. It was subsequently defueled and annealed, with all fuel disposed or shipped off-site. Even if all control rods were fully removed, no self-sustaining nuclear chain reaction could or would begin. Therefore, the Pile may be considered as already having failed.

The proposed activity will not affect the safety function(s) of the facility [as there are none]; it will not affect the failure mode(s) of the equipment/facility, as the equipment was previously and permanently shutdown. The answer to Question 1 of Safety Function(s) of System Affected is '**NO**'.

2. Will any new failure modes be introduced by the proposed activity? Y (N) N/A

BGRR-002, "Hazard Classification and Auditable Safety Analysis for the BGRR Decommissioning Project", Rev. 2 dated September 8, 1999 [Ref. 2], was approved by DOE on 11/18/99. It specifically includes in its review and consideration the impact of "undertaking routine facility maintenance and upkeep (including stabilization tasks, e.g., enhancing the isolation of Building 702, as necessary)." As such, failure rates associated with these activities have already been considered by the BGRR-ASA. The only caveat to the 'NO' answer represented by the above statement lay in two Administrative Controls specifically called out in the BGRR-ASA.

"Administrative Control #1: Welding / Torch-cutting on or within 18 inches of the biological shield is prohibited without an approved safety evaluation to demonstrate that the work is safe (margin of safety to prevent igniting graphite or graphite dust).

Administrative Control #2: Electrical penetrations through the biological shield will be isolated from power sources before any other work begins on or near Building 702 Reactor Pile, along with other enhanced means of stabilization to minimize all leakage of air into the bioshield."

It should be noted that Administrative Control #1 does not forbid or preclude all welding or torch-cutting, only "on or within 18 inches of the biological shield ...without an approved safety evaluation". There will be no torch cutting or flame associated with the tasks to accomplish for sealing of the pile. Standard electrical arc welding will be performed on the exterior surface of the Bioshield on the North face (around the removable core sections and estimated at a total of 13 linear feet of weld), in accordance with the Cutting and Welding Permit [Ref.15] (copy included as Attachment No. 2). This USID/SE, when approved, constitutes the safety evaluation referred to in Administrative Control #1. Implementation of Administrative Control #2 is the whole purpose of this particular WBS.

The BGRR-ASA Risk Assessment already considers the following failure modes: Risk Assessment No. 003 covering Graphite Dust Detonation; Risk Assessment No. 004 covering Loss of Pile-Negative-Pressure Ventilation; Risk Assessment

No. 005 covering Loss of Pile-Negative-Pressure Filtration; Risk Assessment No. 007 covering Fire; and Risk Assessment No. 008 covering Facility Workers' Exposure to Toxic/Hazardous Materials.

While the proposed activity (specifically, welding on the bioshield) may change some of the mitigation associated with the Accident Analyses contained within the BGRR-ASA, it does not introduce any new failure modes not previously considered. The answer to Question 2 of the Safety Function(s) of System Affected is '**NO**'.

Effects on Safety

1. Could the proposed activity increase the probability of occurrence of an accident previously evaluated in the ABD? Y (N) N/A

For the Brookhaven Graphite Research Reactor Decommissioning Project, the authorization basis documents include; the BGRR-ASA (which was approved by DOE 11/18/99), the DOE Safety Evaluation Report as approved 10/27/99, the BGRR-DP Quality Assurance Program Plan, BGRR-DP Health and Safety Plan, and DOE-approved USID/SEs. Of those documents, only the BGRR-ASA contains original accident analysis data (the DOE-SER reiterates and amplifies on the contents of the ASA, but includes no new accident scenarios nor changes to the ones in the BGRR-ASA).

The BGRR-ASA accident analysis includes and is based on the consideration of maintenance and stabilization work-related accidents. BGRR-ASA Section 1.4 – Scope of Work, specifically states, " The following are operations planned at the BGRR Complex that are covered by this document: ... undertaking routine facility maintenance and upkeep (including stabilization tasks, e.g., enhancing the isolation of Building 702, as necessary), ... ". But for the fact that the work itself requires the temporary suspension of Administrative Control #1 (coincident with the institution of compensatory mitigative measures) no USID/SE would be needed at all. However, as the work to be performed does require the temporary suspension of Administrative Control #1; it must be reviewed for the potential impact of the proposed activity on the probability of occurrences for the accident scenarios contained within the BGRR-ASA.

Because of the "Routine Risk" nature of the defueled BGRR (classified as a "Radiological Facility"), a rigorous probabilistic risk assessment was not required as part of the Auditable Safety Analysis. Instead, using a graded approach and the guidance offered in BNL ES&H Standard 1.3.3, {https:sbms.bnl.gov/ld/ld08/ld08d081.htm}[Ref. 4], the Risk Assessment Tables of Section 3.2 of the BGRR-ASA were developed.

Among the events analyzed in BGRR-ASA Section 3.2 – Risk Assessment are; Seismic Event, High Winds, Graphite Dust Detonation, Loss of Pile-Negative-Pressure System Ventilation, Loss of Pile-Negative-Pressure System Filtration, Crane Load Drop, Fire, Facility Workers' Exposure to Toxic/Hazardous Materials.

The proposed activity has no capability to impact the probability of occurrence of Seismic Events or High Winds (which are natural phenomena). Furthermore, its impact on the Crane Load Drop accident was already considered as part of the original anticipated workload for the development of the BGRR-ASA probability and consequence. However, as the proposed activity is Scaling of Pile Openings (which requires the temporary suspension of Administrative Control #1); it may have the potential to impact the probability of certain events occurring within the local buildings i.e., Buildings 701 & 702. Based on the detailed work activities covered by this USID/SE, this includes Graphite Dust Detonation, Loss of Pile-Negative-Pressure System Ventilation, Loss of Pile-Negative-Pressure System Filtration, Fire, and Facility Workers' Exposure to Toxic / Hazardous Materials.

The proposed activity involves BGRR-ASA Administrative Control #1 [Welding/torch-cutting on or within 18 inches of the biological shield is prohibited without an approved safety evaluation to demonstrate that the work is safe (margin of safety to prevent igniting graphite or graphite dust)], to allow for the welding of support flanges to limited portions of the exterior surface of the Bioshield Walls to accommodate the installation of metal plates with which to seal off/cover penetrations through the Bioshield.

There are no significant amounts of combustible materials involved and no oxyacetylene torches will be used for welding or cutting. The accident analysis of the proposed activity in Appendix A includes the five accident scenarios mentioned above, which were originally presented in the BGRR-ASA and which have been revisited to account for the temporary and limited relaxation of Administrative Control #1 (with the implementation of alternative/compensatory mitigative measures).

As is clearly shown by comparing the BGRR-ASA with Appendix A – Abnormal Operations Assessment, the temporary and limited relaxation of Administrative Control #1 combined with the simultaneous implementation of alternative compensatory

mitigative measures does not change the overall probability for any of the accidents scenarios examined; neither prior to mitigation nor following mitigation, for the work activities covered by this USID/SE.

So the answer to Question 1 of 'Effects on Safety' is '**NO**'.

The proposed activity does not increase the probability of any accident evaluated in the Authorization Basis Documentation.

2. Could the proposed activity increase the probability of occurrence of a malfunction of equipment, systems, or components that are Important-to-Safety? Y (N) N/A

As was already discussed in response to Screening Criterion No. 1 under 'Safety Function(s) of Systems Affected'; the BGRR has no current requirements for redundant systems and/or safety class or safety significant SSCs (Systems, Structures and Components) due to its defunct status and defueled state. Therefore, no safety functions exist that are directly associated with the proposed activity covered by this USID/SE. Without equipment, systems or components that are Important-to-Safety, there can be no probability of occurrence of a malfunction of equipment, systems or components that are Important-to-Safety; nor any increase in same.

The proposed activity **COULD NOT** increase the probability of occurrence of a malfunction of equipment, systems or components that are Important-to-Safety.

3. Could the proposed activity create the possibility of an accident of a different type than those previously evaluated in the ABD? Y (N) N/A

As already discussed in the response to Screening Criterion No. 2 under 'Safety Function(s) of Systems Affected', the answer to this question is '**NO**'.

4. Could the proposed activity create the possibility of an equipment, system, or component malfunction of a different type than those previously evaluated in the ABD? Y (N) N/A

As already discussed in the response to Screening Criterion No. 2 under 'Safety Function(s) of Systems Affected', the answer to this question is '**NO**'.

5. Does the proposed activity reduce the Margin-of-Safety as defined in the basis for any ABD? (Y) N N/A

In ERD-OPM-4.4 [Ref. 1], the procedure states "In the context of this procedure a Margin-of-Safety is reduced if the Safety Limit or Limiting Condition of Operation or Administrative Control as defined in the Authorization Basis Document(s) is violated". As this safety evaluation is based upon the guidance provided in the above referenced procedure, that definition of Margin-of-Safety compels the answer '**YES**'.

Despite the institution of alternative and compensatory mitigative measures, by relaxing , even temporarily, Administrative Control #1, one has created a reduction in the defined Margin-of-Safety. However any such reduction is deemed insignificantly small by the imposition of adequate alternative and compensatory mitigative measures. It could even be argued that, by the development and approval of this USID/SE, one is not suspending Administrative Control #1, but rather, implementing the portion requiring an approved safety evaluation.

Authorization Basis Document(s) Changes

1. Is a change to the facility ABD(s) being made? (Y) N N/A

Administrative Control #1 of the BGRR-ASA refers to the development of an approved safety evaluation being required prior to the suspension of the limitations on welding or torch-cutting near the Bioshield. The completed and approved USID/SE developed for the proposed activity should be considered as an addendum and amendment to the BGRR-ASA.

As the USID/SE already requires the approval of the DOE Project Manager for the BGRR Decommissioning Project, prior to implementation. The answer to Question 1 under 'Authorization Basis Document(s) Changes' is '**YES**'.

SAFETY EVALUATION CONCLUSION

Based on the evaluation of the evidence cited above, the issue --

_____ Does NOT constitute an Unreviewed Safety Issue.

__✓__ Does constitute an Unreviewed Safety Issue.

**** IF ANY OF THE ABOVE ARE YES, THEN A USI EXISTS. ****

Clyde T. Newson 8/14/00
BGRR Project Engineer Signature/ Date

Steph V. Mezo 8/14/00
BGRR Project ES&H Manager Signature/ Date

8/14/00
BGRR Project Manager Signature/ Date

8-14-00
BGRR Project QA Representative Signature/ Date

APPENDIX A

ABNORMAL OPERATIONS ASSESSMENT

APPENDIX A - ABNORMAL OPERATIONS ASSESSMENT

Method of Abnormal Operations Assessment

The abnormal operations assessment for the Sealing of Pile Openings was based on a methodical review of each initiating event and the severity, probability, and risk category of the corresponding hazards associated with the activity. Only one accident-initiating event is postulated to occur at one time. Guidance for the selection of appropriate failure modes to consider was taken from BGRR-002, "Hazard Classification and Auditable Safety Analysis for Brookhaven Graphite Research Reactor (BGRR) Decommissioning Project", Rev.2 dated September 8, 1999, as approved by DOE 11/18/99 [Ref.2]. The main failure modes to be considered include; Graphite Dust Detonation, Loss of Pile-Negative-Pressure Ventilation, Loss of Pile-Negative-Pressure Filtration, Fire, and Facility Workers' Exposure to Toxic/Hazardous Material. BGRR-030, Job Safety Analysis for Sealing of Pile Openings [Ref. 10] and ERD-BGRR-TP-00-11, Technical Work Document Sealing of the Reactor Pile (702) [Ref.16], specifically mention the use of standard electrical welding equipment, but excludes the use of any flame torch cutting or welding equipment on or near the Bio-Shield. The risk-assessment tables which follow represent the determination of the extent of the hazards associated with the Sealing of the Pile Openings, based on the impact of its current JSA and Technical Work Document on the previous analysis already approved in the BGRR-ASA [Ref.2].

BNL ES&H Standard 1.3.3, {https:sbms.bnl.gov/ld/ld08/ld08d081.htm}[Ref. 4] provides the methodology for examining the safety of facilities at the BNL. It has guidance for assessing the appropriate level of severity, probability, and risk. Table A.1-1 depicts the form used in this Safety Evaluation for Unreviewed Safety Issue Determination to perform the risk assessment. Tables A.1-2 through A.1-4 summarize the Risk Assessment Matrix found in Standard 1.3.3 and used here.

Table A.1-1

RISK ASSESSMENT FORMAT						
Severity	I ( ) Catastrophic	II ( ) Critical	III ( ) Marginal	IV ( ) Negligible		
Probability	A ( ) Frequent	B ( ) Probable	C ( ) Occasional	D ( ) Remote	E ( ) Extr Remote	F ( ) Impossible
Risk Category	1 ( ) High	2 ( ) Moderate	3 ( ) Low	4 ( ) Routine		

Table A.1-2 summarizes the potential consequences of hazards falling into the four severity classifications established by BNL's ES&H Standard 1.3.3. Standard 1.3.3 considers the consequences for the following:

- Non-radiation release/exposure, on-site/off-site
- Radiation release/exposure, on-site/off-site
- Equipment loss
- Program downtime

- Program compromise
- Public-impact perception

Table A.1-2

HAZARD SEVERITY		
Category	**Descriptive Word**	**Potential Consequences**
I	Catastrophic	May cause death or system loss. > 100 rem Committed Effective Dose Equivalent (CEDE) on-site or > EPA Protective Action Guidelines off-site.{Eqpt. Loss>$1,000,000; Downtime >4 months}
II	Critical	May cause severe injury, severe occupational illness, or major system damage. >25 rem CEDE on-site or 10 mrem off-site.{Eqpt. Loss>$250,000; Downtime >3 weeks and <4 months}
III	Marginal	May cause minor injury, minor occupational illness, or minor system damage.> 5 rem annual limit on-site.{Eqpt. Loss>$50,000; Downtime >4 days and <3 weeks}
IV	Negligible	Will not result in injury, occupational illness, or system damage. > 3 rem admin annual limit or 1 rem admin quarterly limit.{Eqpt. Loss <$50,000; Downtime <4 days}

Table A.1-3 summarizes the probability categories established by BNL's ES&H Standard 1.3.3. They are based on the likelihood of the potential consequences occurring for a given hazard.

Table A.1-3

HAZARD PROBABILITY		
Category	**Descriptive Word**	**Potential Consequences**
A	Frequent	Likely to occur repeatedly during life cycle of system.
B	Probable	Likely to occur several times in life cycle of system.
C	Occasional	Likely to occur sometime in life cycle of system.
D	Remote	Not likely to occur in life cycle of system, but possible.
E	Extremely Remote	Probability of occurrence cannot be distinguished from zero.
F	Impossible	Physically impossible to occur.

Table A.1-4 summarizes the risk categories established by BNL's ES&H Standard 1.3.3. Choosing a severity and a probability for a given hazard determines its risk category. Standard

1.3.3 establishes the documentation and minimum approval required for each risk category.

Table A.1-4

RISK CATEGORY						
Hazard Severity	**A Frequent**	**B Probable**	**C Occasional**	**D Remote**	**E Extremely Remote**	**F Impossible**
I Catastrophic	1. High	1. High	1. High	2. Moderate	3. Low	4. Routine
II Critical	1. High	1. High	2. Moderate	3. Low	3. Low	4. Routine
III Marginal	2. Moderate	2. Moderate	3. Low	3. Low	4. Routine	4. Routine
IV Negligible	4. Routine	4. Routine	4. Routine	4. Routine	4. Routine	4. Routine

Hazard mitigation takes the form of engineered features, administrative controls, operator training, or a combination of these. **Generally, the hazard's severity is not changed by mitigation, but its probability is reduced.**

Risk Assessment for the facility is given on the following pages where operator's error, equipment/system failure, an accident or natural phenomenon is the initiating event. Each event is analyzed on four tables: Hazard, Risk Assessment Before Mitigation, Hazard Mitigation, and Risk Assessment After Mitigation.

The Hazard table first identifies the initiating event and lists its possible consequences and its specific hazards. A list of potential initiators is also given.

The Hazard-Mitigation table lists the administrative controls, training, and engineered features that will mitigate the effects of the event. The Risk-Assessment tables contrast the risk involved due to an initiating event with and without mitigation.

Risk Assessment No. A001 covering Graphite Dust Detonation

ACTIVITY: Sealing of Pile Openings **NUMBER:** A001
HAZARD: To On-site Personnel, Equipment, Environment

Event:	Graphite Dust Detonation
Possible Consequences & Hazards:	Damage to facility structures and/or equipment due to fire or blast wave Release of radioactive materials / radiation to the environment Exposure to radioactive materials through ingestion, inhalation, or dermal exposure Equipment, facility or personnel contamination Project delays / interruptions
Potential Initiators:	Direct electric short to ground (or weld rod arc), coming into contact with a specific airborne concentration of particular sized particles of graphite dust inside the Bio-Shield.

Risk Assessment Prior to Mitigation						
Severity:	I ( ) Catastrophic	II ( ) Critical	III (X) Marginal	IV ( ) Negligible		
Probability:	A ( ) Frequent	B ( ) Probable	C ( ) Occasional	D ( ) Remote	E (X) Extr Remote	F ( ) Impossible
Risk Category:	1 ( ) High	2 ( ) Moderate	3 ( ) Low	4 (X) Routine		

Hazard Mitigation:	Limited radiological inventory at risk and available for release from Sealing of Pile Openings (<<Nuclear Hazard Category 3 Threshold), based on the survey and sampling analysis data collected to date. Additional limitation on fraction of inventory available for release due to graphite dust detonation as a result of the strength of the Bio-Shield and the physical forms and distribution of inventory materials. Use of approved Work Control Permit, Radiological Work Permit, Task-specific Technical Work Documents, Task-specific Job Safety Analysis. (Including prohibition on any potentially dust raising activities within Bio-Shield while welding on Bio-Shield face is underway). Performance of work by trained and qualified personnel, familiar with the requirements of BNL ES&H Manual Stds; 1.3.6 - Work Planning and Control for Operations, 4.3.0 - Cutting and Welding. Use of Pre-job briefings and Pre-Start Checklists.

Risk Assessment Following Mitigation						
Severity:	I ( ) Catastrophic	II ( ) Critical	III (X) Marginal	IV ( ) Negligible		
Probability:	A ( ) Frequent	B ( ) Probable	C ( ) Occasional	D ( ) Remote	E ( ) ExtrRemote	F (X) Impossible
Risk Category:	1 ( ) High	2 ( ) Moderate	3 ( ) Low	4 (X) Routine		

Description - Graphite Dust Detonation

Hazard Probability (as defined in Table A.1-3)

A graphite-dust explosion was considered to be an incredible event for the Hanford N Reactor [Ref.18]. The National Fire Protection Association (NFPA) (Fire Protection Handbook, 18th Edition, Chapter 3, Fire Prevention, Table 3-27B, "Explosion Characteristics of Various Dusts," National Fire Protection Association [Ref.11]) has a handbook that discusses dusts and their potential for explosion. A table lists graphite as "not ignitable." However, Factory Mutual Engineering Association conducted sixteen tests on graphite powder and found that median-sized particle, 128-microns or smaller, can be ignitable (Proprietary Information, personal communication). Larger particles have a lower potential for ignition.

Graphite is considerably more difficult to ignite and burn than coal, coke, or charcoal. Graphite has a much higher thermal conductivity, therefore it dissipates the heat produced by burning; and consequently, it is more difficult to keep hot. Coals, cokes, and charcoals develop a porous white ash on their burning surfaces which greatly reduces radiative-heat losses while simultaneously allowing air to reach the carbon surfaces and maintain burning. Also, they are heavily loaded with impurities which catalyze oxidation. Nuclear-grade graphite is one of the purest substances produced in massive quantities. For these reasons graphite dust sometimes is used as a fire-suppressant.

Of the sixteen samples tested by Factory Mutual, none were ignited with small sources, such as a 100-joule electric match or a glowing Nichrome wire. Hence, ordinary electrical equipment would not be an ignition source, nor would static sparks and "grinding wheel" sparks. The dust needs to be exposed to an open flame, welding torch, or full 120-volt circuit- short to start burning.

Graphite dust can only explode if the airborne concentration is very high and particle size very small (<128 microns). A loading of 55 g/m^3 is the minimum explosive concentration for carbonaceous dust [Ref.11], though graphite, because of its purity (lack of volatile contaminants) would need a much higher value to be detonatable. While high airborne loadings conceivably could be created for short periods by mechanically stirring up dust which may be present, such loading cannot be sustained because the dust settles out. There is evidence that the air in the biological shield has a low, if not zero, graphite-dust loading. The "micro visualization" miniature video camera inserted through the Bio-Shield wall penetrations into the Graphite Pile during characterization showed no such 'snow' of graphite, which would clearly have been visibly present well below dust loadings of 55 g/m^3. While slight increases in graphite dust has been detected on expended air monitoring filters as a direct result of pile characterization activities, there is clearly no significant airborne loading of activated graphite dust routinely present within the Bioshield.

For these reasons, the unmitigated probability conservatively assigned to Graphite Dust Detonation was **EXTREMELY REMOTE** (probability of occurrence cannot be distinguished from zero).

Taking into account the mitigation factors listed on Risk Assessment No. A001, the limited time required to perform the work (60 days), and the extremely limited scope of work (approximately 13 linear feet of welding total and only on the North face around the removable core location), post-mitigation probability is reduced to **IMPOSSIBLE** (physically impossible to occur).

Hazard Severity (as defined by Table A.1-2)

The Factory Mutual tests of the graphite dust indicated that such explosions generated only a moderate power. As the Pile's negative-pressure systems maintain the air pressure within the Bioshield slightly below that outside, any moderate pressure has ample relief capabilities, without damaging either the Pile or the Bioshield. In particular, the design airflow rate for the primary air cooling system was over 300,000 cfm. It currently flows at about 3,000 cfm (a reduction from design flow rate of a factor of 100). Any postulated graphite dust detonation of moderate power would be absorbed as a localized resistance-less air expansion through the rest of the system, without any damage to the Pile or the Bio-shield.

Since the BGRR was defueled and shut down approximately 30 years ago, there are no programmatic delays or repair costs associated with minor damage caused by detonation of graphite dust. Based on the location of the Decommissioning offices within Bldg 701, relative to the location of the work being performed, the potential for occupational illness or injury is small. However, in this particular case, the potential initiator implies the presence nearby of decommissioning worker(s), so minor injury is a possibility. The Job Safety Analysis [Ref.10] provides guidance for appropriate mitigation of risk to workers on the job.

In the absence of detectable airborne levels of activated graphite on the replaceable HEPA exhaust-filters, the minimum adequate explosive concentration of activated dust will be the maximum inventory assumed present and available for dispersion.

Based on Table 4.15A, Explosion Characteristics of Various Dusts, of NFPA Handbook [Ref.11], and, in the absence of any other reasonable values specifically for Graphite Dust, the Minimum Explosive Concentration for Carbonaceous Dusts (55-140 g/m^3) shall be used for these estimates. (While much higher values of graphite dust concentration are believed to be required for an explosion, the clear absence of such concentrations negates the value of such estimates being used for this determination.) The free volume inside the Bioshield is estimated at 558 m^3, less the volume of the Pile and not including any portion of the plenum. This represents a dispersible graphite inventory of 30,690 to 78,120 gm.

Based on the analysis located in Appendix B - Source Term Development, which uses a maximal dispersible graphite dust load of 78,120 gm, the following radiological inventory was developed for Sealing of the Pile Openings

Nuclide	Inventory [Ci]	Cat 3 Threshold [Ci]	Cat 3 Threshold Fraction
Co-60	1.36E-03	2.80E+02	4.86E-06
Sr-90	8.89E-05	1.60E+01	5.56E-06
Y-90	8.89E-05	1.42E+03	6.26E-08
Cs-137	7.72E-05	6.00E+01	1.29E-06
Eu-152	9.68E-04	2.00E+02	4.84E-06
Eu-154	1.28E-03	2.00E+02	6.40E-06
Am-241	4.45E-06	5.20E- 01	8.56E-06
		Sum =	3.16E-05

Based on the guidance of DOE-STD-1027-92, Attachment 1 [Ref.5], this sum represents a maximal potential dose of less than 0.5 mRem effective whole body where dose is calculated at 30 meters for one day of inhalation and direct exposure, while the ingestion pathway is determined over a longer period.

The potential consequences discussed here most closely correspond to the definition of Hazard Severity III - **MARGINAL** (per Table A.1-2, Hazard Severity), primarily due to the potential for minor personnel injury.

Risk Category (as defined by Table A.1-4)

Both the pre-mitigation combination of Severity = **MARGINAL** with Probability = **EXTREMELY REMOTE**, and the post-mitigation combination of Severity = **MARGINAL** with Probability = **IMPOSSIBLE**, define the risk category as **ROUTINE** for the activities covered under this USID/SE.

Risk Assessment No. A002 covering Loss of Pile-Negative-Pressure Ventilation

ACTIVITY: Sealing of Pile Openings **NUMBER:** A002
HAZARD: To On-site Personnel, Equipment, Environment

Event:	Loss of Pile-Negative-Pressure Ventilation
Possible Consequences & Hazards:	Radiation exposure to on-site personnel. Release of radioactive materials / radiation to the building and/or environment. Exposure to radioactive materials through ingestion, inhalation, and/or dermal exposure. Contamination of building, equipment and/or environment Project delays
Potential Initiators:	Failure of fan or loss of power.

Risk Assessment Prior to Mitigation

Severity	I ( ) Catastrophic	II ( ) Critical	III ( ) Marginal	IV (X) Negligible		
Probability	A ( ) Frequent	B (X) Probable	C ( ) Occasional	D ( ) Remote	E ( ) Extr Remote	F ( ) Impossible
Risk Category	1 ( ) High	2 ( ) Moderate	3 ( ) Low	4 (X) Routine		

Hazard Mitigation:	Limited radiological inventory at risk and available for release from Sealing of Pile Openings (<<Nuclear Hazard Category 3 Threshold), based on the survey and sampling analysis data collected to date. Additional limitation on fraction of inventory available for release due to Loss of Pile-Negative-Pressure Ventilation as a result of the physical forms and distribution of inventory materials. Limitations on use of combustible materials for the Sealing of Pile Openings and restrictions on storing combustible material near the job-site. Use of approved Work Control Permit, Radiological Work Permit, Task-specific Technical Work Documents, Task-specific Job Safety Analysis Performance of work by trained and qualified personnel, familiar with the requirements of BNL ES&H Manual Stds; 1 3.6 - Work Planning and Control for Operations, 4.3.0 - Cutting and Welding. Use of Pre-job briefings and Pre-Start Checklists. Fan alarm indicating loss of negative pressure. Results from BNL's Committee Report on HVAC Testing at the BGRR Complex [Ref.17].

Risk Assessment Following Mitigation

Severity:	I ( ) Catastrophic	II ( ) Critical	III ( ) Marginal	IV (X) Negligible		
Probability:	A ( ) Frequent	B ( ) Probable	C (X) Occasional	D ( ) Remote	E ( ) Extr Remote	F ( ) Impossible
Risk Category:	1 ( ) High	2 ( ) Moderate	3 ( ) Low	4 (X) Routine		

Description - Loss of Pile-Negative-Pressure Ventilation

Hazard Probability (as defined in Table A.1-3)
After the BGRR was taken out of operation in 1969, the HVAC system was modified to keep the reactor at a negative pressure relative to Building 701, to ensure there was no potential for airborne transport of the residual radioactivity in Building 702 (Bioshield and Graphite Pile) into Building 701. This was done because Building 701 was being converted into the BNL Science Museum, which was to be open to the public, including primary-school children.

Exhaust ducts were isolated from the stack by closing the valves at the discharge of the primary- and secondary-air fans to prevent reverse flow through them. Plywood covers were installed over the west- and east-air inlet ducts, separating the ducts from the intake bays and louvers. A small auxiliary fan and HEPA filter was installed in the east-intake bay, which drew suction from the Pile via a hole in the plywood cover separating the east-inlet duct from the east air-intake bay; it exhausted into the isolated east-intake bay. This reversed the flow through the east air-inlet duct (adapted from "BNL Committee Report on HVAC Testing at the BGRR Complex," December 1998 [Ref.17]).

During the approximately 20 years that the Science Museum was housed in Building 701, the Pile Negative-Pressure System shut down a number of times, including shutdowns for maintenance and accidental ones caused by power outages or equipment failures.

For these reasons, the unmitigated probability conservatively assigned to Loss of Pile Negative-Pressure Ventilation was **PROBABLE** (likely to occur several times in life cycle of the system).

Considering the mitigation factors listed under Risk Assessment No. A002, the limited time required to perform the work (60 days), and the extremely limited scope of work (approximately 13 linear feet of welding total and only on the North face around the removable core location), post-mitigation probability is reduced to **OCCASIONAL** (likely to occur sometime in life-cycle of the system).

Hazard Severity (as defined by Table A.1-2)
The event addressed under this Risk Assessment occurred several times during the history of the facility without any detected spread of airborne radioactivity or contamination from Building 702 to 701.

Since the BGRR was defueled and shut down approximately 30 years ago (and the Science Museum relocated about 2 years ago to another building not part of the BGRR Complex), there are no programmatic delays or repair costs associated with minor damage caused by Loss of Pile-Negative-Pressure Ventilation. Based upon the location of the Decommissioning Offices within Bldg 701 and the non-impact of prior losses of Pile-Negative-Pressure Ventilation, the potential is small for occupational illness or injury resulting from exposure to radiation or radiological material as a consequence of a Loss of Pile-Negative-Pressure Ventilation.

The limited activated/contaminated dust inventory available for airborne transfer from Building

702 to 701 (as defined in Risk Assessment No. A001 - Graphite Dust Detonation) was conservatively determined to be 3.16E-05 times the equivalent Hazard Category 3 Threshold. This represents a maximal potential dose of less than 0.5 mRem effective whole body where dose is calculated per DOE-STD-1027-92, Attachment 1[Ref.5].

The potential consequences discussed here most closely correspond to the definition of Hazard Severity IV - **NEGLIGIBLE** (per Table A.1-2, Hazard Severity). This determination is reinforced by the actual experience of ventilation failure in the past without any attendant migration of contamination or generation of airborne.

Risk Category (as defined by Table A.1-4)
Both the pre-mitigation combination of Severity = **NEGLIGIBLE** with Probability = **PROBABLE**, and the post-mitigation combination of Severity = **NEGLIGIBLE** with Probability = **OCCASIONAL**, define the risk category as **ROUTINE** for the activities covered under this USID/SE.

Risk Assessment No. A003 covering Loss of Pile-Negative-Pressure Filtration

ACTIVITY: Sealing of Pile Openings **NUMBER:** A003
HAZARD: To On-site Personnel, Equipment, Environment

Event:	Loss of Pile-Negative-Pressure Filtration
Possible Consequences & Hazards:	Radiation exposure to on-site personnel. Contamination of area, equipment and/or environment Release of radioactive materials / radiation to the environment. Exposure to radioactive materials through ingestion, inhalation, and dermal exposure. Project delays / work plan interruptions
Potential Initiators:	Failure of, or fire in, the filter

Risk Assessment Prior to Mitigation

Severity:	I ( ) Catastrophic	II ( ) Critical	III ( ) Marginal	IV (X) Negligible		
Probability:	A ( ) Frequent	B (X) Probable	C ( ) Occasional	D ( ) Remote	E ( ) Extr Remote	F ( ) Impossible
Risk Category:	1 ( ) High	2 ( ) Moderate	3 ( ) Low	4 (X) Routine		

Hazard Mitigation:	Limited radiological inventory at risk and available for release from Sealing of Pile Openings (<<Nuclear Hazard Category 3 Threshold), based on the survey and sampling analysis data collected to date. Additional limitation on fraction of inventory available as a result of the physical forms and distribution of inventory materials. Limitations on use of combustible materials for the Sealing of Pile Openings and restrictions on the storage of combustible material near the job-site. Use of approved Work Control Permit, Radiological Work Permit, Task-specific Technical Work Documents, Task-specific Job Safety Analysis. Performance of work by trained and qualified personnel, familiar with the requirements of BNL ES&H Manual Stds; 1.3.6 - Work Planning and Control for Operations, 4.3.0 - Cutting and Welding. Use of Pre-job briefings and Pre-Start Checklists. Constant use of Continuous Air Monitoring (CAMs) during work activities.

Risk Assessment Following Mitigation

Severity:	I ( ) Catastrophic	II ( ) Critical	III ( ) Marginal	IV (X) Negligible		
Probability:	A ( ) Frequent	B ( ) Probable	C (X) Occasional	D ( ) Remote	E ( ) Extr Remote	F ( ) Impossible
Risk Category:	1 ( ) High	2 ( ) Moderate	3 ( ) Low	4 (X) Routine		

Description - Loss of Pile-Negative-Pressure Filtration

Hazard Probability (as defined in Table A.1-3)

After taking the BGRR out of operation in 1969, the HVAC system was modified to keep the reactor at a negative pressure relative to Building 701, to ensure that no residual radioactivity in Building 702 (Bioshield and Graphite Pile) could be transported by air into Building 701 or to the environment. This was done because Building 701 was being converted into the BNL Science Museum, open to the public, including primary school children.

Exhaust ducts were isolated from the stack by closing the valves at the discharge of the primary- and secondary-air fans to prevent reverse flow through them. Plywood covers were installed over the west and east air-inlet ducts, separating them from the intake bays and louvers. A small auxiliary fan and HEPA filter was installed in the east-intake bay, which drew suction from the Pile via a hole in the plywood cover separating the east-inlet duct from the east air-intake bay and exhausted into the isolated east intake bay. This reversed flow through the east air inlet duct (adapted from "BNL Committee Report on HVAC Testing at the BGRR Complex," December 1998 [Ref.17]).

During the approximately 20 years that the Science Museum was housed in Building 701, the Pile Negative-Pressure System shut down several times, including shutdowns for maintenance and accidental ones caused by power outages or equipment failures, though never due to failures of the HEPA filter.

For these reasons, the unmitigated probability conservatively assigned to Loss of Pile Negative-Pressure Filtration was **PROBABLE** (likely to occur several times in life-cycle of the system).

Accounting for the mitigation factors listed under Risk Assessment No. A003, and the limited time required to perform the work activities (60 days), and the extremely limited scope of work (approximately 13 linear feet of welding total and only on the North face around the removable core location), post-mitigation probability is reduced to **OCCASIONAL** (likely to occur sometime in life cycle of system).

Hazard Severity (as defined by Table A.1-2)

While the Pile-Negative-Pressure Ventilation system failed several times during the history of the facility without any detected spread of airborne radioactivity or contamination from Building 702 to 701, the HEPA filters have never failed. When they are routinely replaced for preventive maintenance, no radioactive graphite-dust loading is detected.

Since the BGRR was defueled and shut down approximately 30 years ago (and the Science Museum relocated 3 years ago to another building not part of the BGRR Complex), there are no programmatic delays or repair costs associated with minor damage caused by Loss of Pile-Negative-Pressure Filtration. Based upon the location of the Decommissioning Offices within Bldg 701 and the non-impact of prior losses of Pile-Negative-Pressure Ventilation, the potential is small for occupational illness or injury resulting from exposure to radiation or radiological material as a consequence of a Loss of Pile-Negative-Pressure Ventilation. No personnel are assigned to the BGRR Complex, other than the few temporary decommissioning staff occupying

office space in Building 701, so there is a small potential for occupational illness or injury resulting from Loss of Pile Negative-Pressure Filtration.

The limited activated/contaminated dust inventory available for airborne transfer from Building 702 to 701 or to the environment (as defined in Risk Assessment No. A001 - Graphite Dust Detonation) was conservatively determined to be 3.16E-05 times the equivalent Hazard Category 3 Threshold. This represents a maximal potential dose of less than 0.5 mRem effective-whole-body-dose where dose is calculated per DOE-STD-1027-92, Attachment 1 [Ref.5].

The potential consequences discussed here most closely correspond to the definition of Hazard Severity IV - **NEGLIGIBLE** (per Table A.1-2, Hazard Severity).

Risk Category (as defined by Table A.1-4)

Both the pre-mitigation combination of Severity = **NEGLIGIBLE** with Probability = **PROBABLE**, and the post-mitigation combination of Severity = **NEGLIGIBLE** with Probability = **OCCASIONAL**, define the risk category as **ROUTINE** for the work activities covered under this USID/SE.

Risk Assessment No. A004 covering Fire

ACTIVITY: Sealing of Pile Openings **NUMBER:** A004
HAZARD: To On-site Personnel, Equipment, Environment

Event:	Fire
Possible Consequences & Hazards:	Injury to workers Contamination of area, equipment and/or environment Radiation exposure to on-site personnel Release of radioactive materials / radiation to the environment. Exposure to radioactive materials through ingestion, inhalation, and dermal exposure. Project delays / work plan interruptions
Potential Initiators:	Equipment failure, operator error, natural phenomenon

Risk Assessment Prior to Mitigation

Severity:	I ( ) Catastrophic	II ( ) Critical	III ( ) Marginal	IV (X) Negligible		
Probability:	A ( ) Frequent	B ( ) Probable	C (X) Occasional	D ( ) Remote	E ( ) Extr Remote	F ( ) Impossible
Risk Category:	1 ( ) High	2 ( ) Moderate	3 ( ) Low	4 (X) Routine		

Hazard Mitigation:	Limited radiological inventory at risk and available for release from Sealing of Pile Openings (<<Nuclear Hazard Category 3 Threshold), based on the survey and sampling analysis data collected to date. Additional limitation on fraction of inventory availablefor release as a result of the physical forms and distribution of inventory materials. Prohibition on use of oxyacetylene for the Sealing of Pile Openings and restrictions on the storage of oxyacetylene near the job-site. Use of approved Work Control Permit, Cutting and Welding Permit, Radiological Work Permit, Task-specific Technical Work Documents, Task-specific Job Safety Analysis. Performance of work by trained and qualified personnel, familiar with the requirements of BNL ES&H Manual Stds; 1 3.6 - Work Planning and Control for Operations, 4.3.0 - Cutting and Welding . Use of Pre-job briefings and Pre-Start Checklists. Building protected from lightning strike by proximity of 100 m. Reactor stack.

Risk Assessment Following Mitigation

Severity:	I ( ) Catastrophic	II ( ) Critical	III ( ) Marginal	IV (X) Negligible		
Probability:	A ( ) Frequent	B ( ) Probable	C ( ) Occasional	D (X) Remote	E ( ) Extr Remote	F ( ) Impossible
Risk Category:	1 ( ) High	2 ( ) Moderate	3 ( ) Low	4 (X) Routine		

Description - Fire

Hazard Probability (as defined in Table A.1-3)
Risk Assessment No. A001 covering Graphite Dust Detonation already provides information on the difficulties associated with trying to ignite graphite, even in the form of dust. Further, according to "A Safety Assessment of the Use of Graphite in Nuclear Reactors Licensed by the NRC," NUREG/CR-4981 [Ref.9], the following are the bounding conditions needed to initiate burning of graphite:

- Graphite must be heated to at least 650°C.
- This temperature must be maintained either by the heat of combustion or some outside energy source.
- There must be an adequate supply of oxidant (air or oxygen).
- The gaseous source of oxidant must flow at a rate that can remove gaseous reaction products without excessively cooling the graphite surface.

Although there is little exposed combustible-loading within Building 701 of the BGRR Complex (especially since the museum debris was removed), and automated fire-detection and alarm systems (although not automated fire-suppression) are present in the facility, the unmitigated probability conservatively assigned to Fire was **OCCASIONAL** (likely to occur sometime in life-cycle of system).

Considering the mitigation factors listed on Risk Assessment No. A004, and the limited time required to complete the work (60 days), and the extremely limited scope of work (approximately 13 linear feet of welding total and only on the North face around the removable core location), post-mitigation probability is reduced to **REMOTE** (not likely to occur in life cycle of system, but possible).

Hazard Severity (as defined by Table A.1-2)
Since the BGRR was shut down and defueled approximately 30 years ago, there are no programmatic delays or repair costs associated with any anticipated fire damage. Based on the location of Decommissioning offices within Bldg 701, relative to the location of the work being done on Bldg 702, the potential for occupational illness or injury is small. The JSA [Ref.10] provides guidance on appropriate mitigative measures for workers to escape injury or illness while working on the job.

Despite the lack of credible ignition scenarios for the graphite pile, and the great difficulty in keeping a fire burning even if one were ignited, in the absence of any other local radiological source term being vulnerable during the work activities associated with this USID/SE; the radiological impact of the fire will be assessed using the graphite dust radiological inventory. (This is necessary since the exterior of the Bio-shield itself was surveyed and decontaminated where necessary during the characterization).

Based on the analysis located in Appendix B - Source Term Development, which uses a maximal dispersible graphite dust load of 78,120 gm, the radiological inventory conservatively developed for Sealing of the Pile Openings was determined to be 3.16E-05 times the equivalent Hazard

Category 3 Threshold.

Based on the guidance of DOE-STD-1027-92, Attachment 1 [Ref.5], this sum represents a maximal potential dose of less than 0.5 mRem effective whole body where dose is calculated at 30 meters for one day of inhalation and direct exposure, while the ingestion pathway is determined over a longer period.

The potential consequences discussed above most closely correspond to the definition of Hazard Severity IV, **NEGLIGIBLE** (per Table A.1-2, Hazard Severity).

Risk Category (as defined by Table A.1-4)

Both the pre-mitigation combination of Severity = **NEGLIGIBLE** with Probability = **OCCASIONAL**, and the post-mitigation combination of Severity = **NEGLIGIBLE** with Probability = **REMOTE**, define the risk category as **ROUTINE** for the work activities covered under this USID/SE.

Risk Assessment No. A005 covering Facility Workers' Exposure to Toxic/Hazardous Material

ACTIVITY: Sealing of Pile Openings **NUMBER:** A005
HAZARD: To On-site Personnel, Equipment, Environment

Event:	Facility Workers' Exposure to Toxic/Hazardous Material
Possible Consequences & Hazards:	Toxic exposure injury to on-site personnel Release of toxic/hazardous materials to the building and/or environment. Exposure to toxic/hazardous materials through ingestion, inhalation, and/or dermal exposure. Contamination of work area or equipment Project delays, work plan interruptions
Potential Initiators:	Equipment failure, operator's error, or manufacturer defect

Risk Assessment Prior to Mitigation						
Severity:	I ( ) Catastrophic	II ( ) Critical	III ( ) Marginal	IV (X) Negligible		
Probability:	A ( ) Frequent	B ( ) Probable	C (X) Occasional	D ( ) Remote	E ( ) Extr Remote	F ( ) Impossible
Risk Category:	1 ( ) High	2 ( ) Moderate	3 ( ) Low	4 (X) Routine		

Hazard Mitigation:	Limited toxic/hazardous inventory available for release from Sealing of Pile Openings based on the survey and sampling analysis data collected to date. (There was no significant inventories of non-radiological hazardous material identified during Preliminary Hazard Assessment [PHA]). Limitations on inventory of combustible material within facility and restrictions on introducing new combustible material. Use of approved Work Control Permit, Radiological Work Permit, Task-specific Technical Work Documents, Task-specific Job Safety Analysis, including PPE where needed. Use of Pre-job briefings and Pre-start checklists. Performance of work by trained and qualified personnel, familiar with the requirements of BNL ES&H Manual Stds; 1.3.6 - Work Planning and Control for Operations, 4.3.0 - Cutting and Welding. Limitations on introducing new toxic/hazardous material to the facility during the remaining life of the project.

Risk Assessment Following Mitigation						
Severity:	I ( ) Catastrophic	II ( ) Critical	III ( ) Marginal	IV (X) Negligible		
Probability:	A ( ) Frequent	B ( ) Probable	C ( ) Occasional	D (X) Remote	E ( ) Extr Remote	F ( ) Impossible
Risk Category:	1 ( ) High	2 ( ) Moderate	3 ( ) Low	4 (X) Routine		

Description - Facility Workers' Exposure to Toxic/Hazardous Materials

Hazard Probability (as defined in Table A.1-3)
Because there are no significant inventories of non-radiological hazardous materials within the BGRR Complex, this accident scenario was not developed as part of the original draft of BGRR Hazards Summary and Recommendations Document, nor in the draft BGRR-DBIO (which evolved into this ASA document). However, during the ASA draft reviews and comments, it was suggested that this accident scenario should be added because it was present in the Safety Authorization Bases of other old reactor-decommissioning projects.

Among the non-radiological hazardous materials to be found within the BGRR Complex are the following:

- asbestos and/or asbestos-containing material (ACM)
- mercury
- lead shielding and/or lead-based paint
- PCBs
- cadmium

Despite the absence of significant quantities of non-radiological hazardous materials and the existence of a well-developed Industrial Hygiene and Work Planning/Control Program, the unmitigated probability conservatively assigned to Facility Workers' Exposure to Toxic/Hazardous Materials was **OCCASIONAL** (likely to occur sometime in life-cycle of system).

Taking into account the mitigation factors listed on Risk Assessment No. A005, and the limited time required to perform the work activities (60 days), and the extremely limited scope of work (approximately 13 linear feet of welding total and only on the North face around the removable core location), post-mitigation probability is reduced to **REMOTE** (not likely to occur in life cycle of system, but possible)

Hazard Severity (as defined by Table A.1-2)
Since the BGRR was shut down and defueled approximately 30 years ago, there are no programmatic delays or repair costs associated with any anticipated damage caused by Facility Workers' Exposure to Toxic/Hazardous Materials.

By definition, this event has no radiological impact.

Based on the extremely limited inventories of non-radiological hazardous materials known to exist within the BGRR Complex and the extensive Industrial Hygiene/Work Controls Program in effect for facility workers on the BGRR Decommissioning Project, any potential accidental exposure should not result in any lost time, injury, or occupational illness.

The potential consequences discussed here most closely correspond to the definition of Hazard Severity IV, **NEGLIGIBLE** (per Table A.1-2, Hazard Severity).

Risk Category (as defined by Table A.1-4)

Both the pre-mitigation combination of Severity = **NEGLIGIBLE** with Probability = **OCCASIONAL**, and the post-mitigation combination of Severity = **NEGLIGIBLE** with Probability = **REMOTE**, define the risk category as **ROUTINE** for the work activities covered under this USID/SE.

Risk Assessment Summary

This section and Tables A.1-5 and A.1-6 summarize the Risk Assessment for the Sealing of Pile Openings given above. Five types of events are addressed under the Risk Assessment for the Sealing of Pile Openings in this Safety Evaluation for Unreviewed Safety Issue Determination for the covered work activities:

- A001 Graphite Dust Detonation
- A002 Loss of Pile-Negative-Pressure Ventilation
- A003 Loss of Pile-Negative-Pressure Filtration
- A004 Fire
- A005 Facility Workers' Exposure to Toxic/Hazardous Material

These are discussed in detail as part of the Abnormal Operations Assessment above. These failure modes represent the known or anticipated types possible for the Sealing of Pile Openings. The specific examples represent the most severe combination of consequences and frequency deemed credible. Thus, each separate Risk Assessment Table represents an individual envelope encompassing a variety of similar or related events whose severity and probability fall within the bounds of the specific event. Each such event includes all lesser similar ones with lower overall risk (a product of the functions of severity or consequence, and probability or frequency). This combination of assorted types of events caused by any of a variety of potential initiators defines a bounding spectrum of accidents. The spectrum can cover or subtend numerous specific but unnamed incidents under their overlapping umbrellas, so long as the specific event does not exceed the envelope for the type it represents.

As summarized in the tables below, with the administrative controls and mitigating factors considered, only **ROUTINE** risks are associated with the Sealing of Pile Openings scope described in this USID/SE.

Table A.1-5

PRE-MITIGATION RISK CATEGORIES				
No.	**Event**	**Hazard Severity (1)**	**Hazard Frequency (1)**	**Risk (2)**
A001	Graphite Dust Detonation	Marginal	Extremely Remote	Routine
A002	Loss of Pile-Negative-Pressure Ventilation	Negligible	Probable	Routine
A003	Loss of Pile-Negative-Pressure Filtration	Negligible	Probable	Routine
A004	Fire	Negligible	Occasional	Routine
A005	Facility Workers' Exposure to Toxic/Hazardous Material	Negligible	Occasional	Routine

1. Severity and frequency are discussed in Section A.1-2.
2. Risk (based on severity and frequency) is defined in Table A.1-4.

Table A.1-6

POST-MITIGATION RISK CATEGORIES				
No.	**Event**	**Hazard Severity (1)**	**Hazard Frequency (1)**	**Risk (2)**
A001	Graphite Dust Detonation	Marginal	Impossible	Routine
A002	Loss of Pile-Negative-Pressure Ventilation	Negligible	Occasional	Routine
A003	Loss of Pile-Negative-Pressure Filtration	Negligible	Occasional	Routine
A004	Fire	Negligible	Remote	Routine
A005	Facility Workers' Exposure to Toxic/Hazardous Material	Negligible	Remote	Routine

1. Severity and frequency are discussed in Section A.1-2.
2. Risk (based on severity and frequency) is defined in Table A.1-4.

The Risk Assessment concludes that all events with or without mitigation present only a Routine Risk. This analysis did not postulate any accidents or natural phenomena that could result in a credible release mechanism for any radiological inventories other than those discussed above and in Appendix B - Source Term Development. Therefore, it is the conclusion of this analysis that the Sealing of the Pile Openings does not represent a significant risk to the public, the environment or the workers on the BGRR Decommissioning Project.

APPENDIX B

SOURCE TERM DEVELOPMENT

BGRR-SE-00-02 Source Term Inventory

as of 08/07/00

	(1)		(2)	(3)	(4)	(1)	(5)
RADIO-NUCLIDE	HALF LIFE [Yr]	ACTIVITY CONC. [ ]	TOTAL ACTIVITY [Ci]	HAZ.CAT. 3 THRESHOLD [Ci]	HAZ.CAT. 3 FRACTION	HAZ.CAT. 2 THRESHOLD [Ci]	HAZ.CAT. 2 FRACTION
003H	1.23E+01			1.60E+04	0.00E+00	2.90E+05	0.00E+00
014C	5.73E+03			4.20E+02	0.00E+00	1.38E+06	0.00E+00
055Fe	2.70E+00			5.40E+03	0.00E+00	1.11E+07	0.00E+00
060Co	5.27E+00		1.36E-03	2.80E+02	4.86E-06	1.92E+05	7.07E-09
063Ni	1.00E+02			5.40E+03	0.00E+00	4.54E+06	0.00E+00
085Kr	1.07E+01			2.00E+04	0.00E+00	2.83E+07	0.00E+00
090Sr	2.88E+01		8.89E-05	1.60E+01	5.56E-06	2.21E+04	4.03E-09
090Y			8.89E-05	1.42E+03	6.26E-08		0.00E+00
093Zr	1.50E+06			6.20E+01	0.00E+00	9.23E+04	0.00E+00
093Nbm				2.00E+03	0.00E+00		0.00E+00
099Tc	2.14E+05			1.70E+03	0.00E+00	3.88E+06	0.00E+00
113Cdm	9.00E+15			1.18E+01	0.00E+00	1.86E+04	0.00E+00
125Sb				1.20E+03	0.00E+00		0.00E+00
137Cs	3.02E+01		7.72E-05	6.00E+01	1.29E-06	8.65E+04	8.92E-10
137Bam				N/A	0.00E+00	N/A	0.00E+00
147Pm	2.62E+00			1.00E+03	0.00E+00	8.40E+05	0.00E+00
151Sm	9.00E+01			1.00E+03	0.00E+00	9.74E+05	0.00E+00
152Eu	1.30E+01		9.68E-04	2.00E+02	4.84E-06	1.36E+05	7.13E-09
154Eu	8.50E+00		1.28E-03	2.00E+02	6.40E-06	1.15E+05	1.12E-08
155Eu	4.90E+00			9.40E+02	0.00E+00	7.53E+05	0.00E+00
226Ra				1.20E+01	0.00E+00		0.00E+00
231Th				1.20E+04	0.00E+00		0.00E+00
232Th	1.41E+10			1.00E-01	0.00E+00	1.75E+01	0.00E+00
234Th				2.80E+03	0.00E+00		0.00E+00
233Pa				4.60E+03	0.00E+00		0.00E+00
234Pam				1.52E+03	0.00E+00		0.00E+00
233U	1.59E+05		*	4.20E+00	0.00E+00	2.22E+02	0.00E+00
234U	2.45E+05		*	4.20E+00	0.00E+00	2.22E+02	0.00E+00
235U	7.04E+08		*	4.20E+00	0.00E+00	2.38E+02	0.00E+00
236U				4.20E+00	0.00E+00		0.00E+00
238U	4.47E+09		*	4.20E+00	0.00E+00	2.39E+02	0.00E+00
237Np	2.14E+06			4.20E-01	0.00E+00	5.85E+01	0.00E+00
238Pu	8.77E+01		*	6.20E-01	0.00E+00	6.17E+01	0.00E+00
239Pu	2.44E+04		*	5.20E-01	0.00E+00	5.52E+01	0.00E+00
240Pu	6.57E+03		*	5.20E-01	0.00E+00	5.60E+01	0.00E+00
241Pu	1.44E+01			3.20E+01	0.00E+00	2.89E+03	0.00E+00
241Am	4.33E+02		4.45E-06	5.20E-01	8.56E-06	5.48E+01	8.11E-08
242Am				8.20E+03	0.00E+00		0.00E+00
242Amm	1.52E+02			5.20E-01	0.00E+00	5.64E+01	0.00E+00
242Cm	4.46E-01			3.20E+01	0.00E+00	1.69E+03	0.00E+00
252Cf	2.64E+00			3.20E+00	0.00E+00	2.20E+02	0.00E+00
SUM					3.16E-05		1.11E-07
				==========>	3.16E-01 mRem for total release		

1) Values taken from LA-12846-MS, "Specific Activities and DOE-STD-1027-92 Hazard Category 2 Thresholds"
2) Values as calculated on the following pages.
3) Values taken from LA-12981-MS, "Table of DOE-STD-1027-92 Hazard Category 3 Threshold Quantities for the ICRP-30 list of 757 Radionuclides" (except for Tritium whose value was taken from Change 1 to DOE-STD-1027-92).
4) Values developed by dividing the actual isotopic inventory by the respective Haz Cat 3 Threshold.
5) Values developed by dividing the actual isotopic inventory by the respective Haz Cat 2 Threshold.

* Observation 1, under Step 3 of Sealing of Pile Openings USID/SE Source Terms states, "As the average ratio of Alpha activity to Am-241 is <1, all Alpha activity will be attributed to Am-241."

Risk Assessment Nos. A001, A002, A003 and A004

Sealing of Pile Openings USID/SE Source Terms

1) Weight average concentration of gamma emitters in graphite samples analyzed by ISOCS=

Sample Number	Weight [gms]	Co-60 [uCi/gm]	Cs-137 [uCi/gm]	Eu-152 [uCi/gm]	Eu-154 [uCi/gm]	Am-241 [uCi/gm]
IG01186	9672	4.20E-02	1.50E-03	ND	4.75E-04	<MDA
IG01188	7662	1.60E-03	7.00E-04	1.40E-02	2.67E-02	ND
IG01191	147	5.90E-03	1.80E-03	3.30E-03	3.13E-02	<MDA
IG01192	142	2.50E-03	9.20E-04	6.80E-03	3.06E-02	<MDA
IG01196	6188	2.05E-04	ND	3.00E-02	2.82E-02	ND
IG01201	150.8	7.80E-03	3.00E-04	3.30E-02	3.27E-02	ND
IG01246	316.5	1.37E-03	9.00E-03	2.70E-04	ND	ND
Tot. Wt.	24278.3	**Co-60**	**Cs-137**	**Eu-152**	**Eu-154**	
	Avg. Conc.	**1.74E-02**	**9.88E-04**	**1.24E-02**	**1.64E-02**	

2) Average ratio of excess beta to Cs-137 as detected on smears analyzed by ASL=

Sample Number	Beta [dpm]	Equiv [uCi]	Cs-137 [uCi]	Excess B [uCi]	Equiv [%]
071207-01	13433.8	6.05E-03	9.75E-04	5.07E-03	520.02%
071207-02	37261.0	1.68E-02	5.95E-03	1.08E-02	181.81%
071207-03	81458.9	3.67E-02	1.17E-02	2.50E-02	213.30%
071207-04	5523.4	2.49E-03	3.64E-04	2.12E-03	582.84%
071207-05	51901.5	2.34E-02	3.87E-03	1.95E-02	503.51%
071207-06	30404.7	1.37E-02	1.00E-03	1.27E-02	1268.21%
071208-01	715000.8	3.22E-01	1.71E-01	1.51E-01	88.16%
071208-02	310842.4	1.40E-01	4.86E-02	9.13E-02	187.82%
071208-03	1708002.0	7.69E-01	2.59E-01	5.10E-01	196.76%
071208-04	6860.7	3.09E-03	8.65E-04	2.22E-03	256.92%
071208-05	537429.4	2.42E-01	1.93E-01	4.88E-02	25.31%
071208-06	57971.5	2.61E-02	1.78E-02	8.29E-03	46.56%
071209-01	22934.2	1.03E-02	6.18E-03	4.14E-03	67.00%
071209-02	443719.3	2.00E-01	2.30E-01	NONE	0.00%
071209-03	94805.6	4.27E-02	5.69E-02	NONE	0.00%
071209-04	236795.2	1.07E-01	3.08E-02	7.58E-02	245.97%
071209-05	29461.6	1.33E-02	3.86E-03	9.40E-03	243.46%
071209-06	54419.2	2.45E-02	8.26E-03	1.62E-02	196.47%
071210-01	10360.7	4.66E-03	3.15E-03	1.51E-03	48.01%
071210-02	236660.2	1.06E-01	8.28E-02	2.37E-02	28.62%
071210-03	24866.1	1.12E-02	6.49E-03	4.70E-03	72.42%
071210-04	232317.3	1.05E-01	5.29E-02	5.16E-02	97.62%
				Avg. Ratio	230.49%

Average excess beta = 230.49% of the Cs-137 and will be split as

Sr-90 = 115.245% of the Cs-137@ 9.88E-04 uCi/gm = **1.14E-03 uCi/gm**

Y-90 = 115.245% of the Cs-137@ 9.88E-04 uCi/gm = **1.14E-03 uCi/gm**

3) Average ratio of alpha to Am-241 & Cs-137 as detected on smears analyzed by ASL=

Sample Number	Alpha [dpm]	Equiv [uCi]	Am-241 [uCi]	Ratio [%]	Cs-137 [uCi]	Ratio [%]
071207-01	90.8	4.09E-05	ND	Undefined	9.75E-04	4.19%
071207-02	295.0	1.33E-04	2.70E-04	49.17%	5.95E-03	2.23%
071207-03	593.2	2.67E-04	4.96E-04	53.82%	1.17E-02	2.28%
071207-04	25.9	1.17E-05	ND	Undefined	3.64E-04	3.20%
071207-05	722.9	3.25E-04	8.49E-04	38.32%	3.87E-03	8.41%
071207-06	343.6	1.55E-04	1.57E-04	98.48%	1.00E-03	15.46%
071208-01	9640.3	4.34E-03	5.51E-03	78.73%	1.71E-01	2.54%
071208-02	20638.8	9.29E-03	9.60E-03	96.74%	4.86E-02	19.11%
071208-03	42648.9	1.92E-02	2.23E-02	86.06%	2.59E-01	7.41%
071208-04	25.9	1.17E-05	4.32E-05	26.98%	8.65E-04	1.35%
071208-05	3212.4	1.45E-03	6.89E-04	209.81%	1.93E-01	0.75%
071208-06	677.5	3.05E-04	ND	Undefined	1.78E-02	1.71%
071209-01	320.9	1.44E-04	2.46E-04	58.70%	6.18E-03	2.34%
071209-02	3812.0	1.72E-03	3.92E-03	43.76%	2.30E-01	0.75%
071209-03	1257.7	5.66E-04	1.28E-03	44.22%	5.69E-02	0.99%
071209-04	2032.4	9.15E-04	6.41E-04	142.68%	3.08E-02	2.97%
071209-05	878.5	3.95E-04	5.86E-04	67.46%	3.86E-03	10.24%
071209-06	680.7	3.06E-04	2.46E-04	124.52%	8.26E-03	3.71%
071210-01	839.6	3.78E-04	6.79E-04	55.64%	3.15E-03	11.99%
071210-02	11617.7	5.23E-03	1.24E-02	42.16%	8.28E-02	6.31%
071210-03	1137.8	5.12E-04	1.14E-03	44.91%	6.49E-03	7.89%
071210-04	12804.1	5.76E-03	1.33E-02	43.32%	5.29E-02	10.89%
			Avg. Ratio	73.97%	Avg. Ratio	5.76%

Observation 1: As the average ratio of Alpha activity to Am-241 activity is <1, all Alpha activity will be attributed to Am-241.

Observation 2: As the average ratio of Alpha activity to Cs-137 activity is 5.76 %, Am-241 activity will be 5.76% of 9.88E-04 uCi/gm {per Step 1 above}.

Am-241 activity = 5.69E-05 uCi/gm

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4) Based on the Abnormal Operations Assessment for Risk Assessment No. A001, covering Graphite Dust Detonation, (See Appendix A), a maximum dispersible graphite inventory of 78,120 gms was estimated. Using this value yields the following radiological inventory:

Nuclide	Co-60	Sr-90	Y-90	Cs-137	Eu-152	Eu-154	Am-241
Activity [Ci]	**1.36E-03**	**8.89E-05**	**8.89E-05**	**7.72E-05**	**9.68E-04**	**1.28E-03**	**4.45E-06**
Cat 3 Limit	280	16	1420	60	200	200	0.52
Cat 3 Frac	4.86E-06	5.56E-06	6.26E-08	1.29E-06	4.84E-06	6.40E-06	8.55E-06

Sum of all Cat 3 Fractions = **3.16E-05**

Total Release Dose Impact = **3.16E-01 mRem**

Sealing of Pile Openings Sampling & Analysis

ASL #	DATE	TIME	MAT'L	ALPHA [dpm]	BETA [dpm]	Sr-90 [dpm]	MDL - dpm Alpha	MDL - dpm Beta	MDL - dpm Sr-90	GAMMA Nuclide	ACTIVITY [uCi/gm]	MDA [uCi/gm]
ASTD-IG01186	06/21/00		Graphite							Co-60	4.20E-02	1.19E-04
EXPW-31			9672 gms							Cs-137	1.50E-03	3.50E-04
ISOCS										Eu-152	ND	1.46E-04
										Eu-154	4.75E-04	1.59E-04
										Am-241	<MDA	2.56E-04
ASTD-IG01188	06/21/00		Graphite							Co-60	1.60E-03	5.20E-05
EXPW-36			7662 gms							Cs-137	7.00E-04	1.14E-04
ISOCS										Eu-152	1.40E-02	2.20E-04
										Eu-154	2.67E-02	1.43E-04
										Am-241	ND	2.14E-04
ASTD-IG01191	06/21/00		Graphite							Co-60	5.90E-03	6.30E-05
EXPW-42			147 gms							Cs-137	1.80E-03	1.01E-04
ISOCS										Eu-152	3.30E-03	2.03E-04
										Eu-154	3.13E-02	2.22E-04
										Am-241	<MDA	1.67E-04
ASTD-IG01192	06/21/00		Graphite							Co-60	2.50E-03	6.00E-05
EXPW-42			142 gms							Cs-137	9.20E-04	1.78E-04
ISOCS										Eu-152	6.80E-03	1.98E-04
										Eu-154	3.06E-02	2.11E-04
										Am-241	<MDA	1.69E-04
ASTD-IG01196	06/21/00		Graphite							Co-60	2.05E-04	3.80E-05
EXPW-12			6188 gms							Cs-137	ND	1.34E-04
ISOCS										Eu-152	3.00E-02	3.11E-04
										Eu-154	2.82E-02	3.47E-04
										Am-241	ND	3.00E-04

ASL #	DATE	TIME	MAT'L	ALPHA [dpm]	BETA [dpm]	Sr-90 [dpm]	MDL - dpm Alpha	MDL - dpm Beta	MDL - dpm Sr-90	GAMMA Nuclide	ACTIVITY [uCi/gm]	MDA [uCi/gm]
ASTD-IG01201	06/21/00		Graphite							Co-60	7.80E-03	1.85E-04
EXPW-30			150.8 gms							Cs-137	3.00E-04	2.90E-04
ISOCS										Eu-152	3.30E-02	5.30E-04
										Eu-154	3.27E-02	3.54E-04
										Am-241	ND	4.81E-04
ASTD-IG01246	7/12/00		Graphite							Co-60	1.37E-03	1.15E-04
P-4			316.5 gms							Cs-137	9.00E-03	1.23E-04
ISOCS										Eu-152	2.70E-04	1.70E-04
										Eu-154	ND	1.32E-04
										Am-241	ND	1.84E-04
20071207-01	07/11/00	1730 hrs	smear	90.8	13433.8		8.8	20.3		Co-60	9.08E-04	uCi/smear
										Ag-108m	5.53E-05	uCi/smear
										Ba-133	4.76E-05	uCi/smear
										Cs-137	9.75E-04	uCi/smear
										Eu-152	7.20E-04	uCi/smear
										Eu-154	4.92E-04	uCi/smear
										Eu-155	5.59E-05	uCi/smear
20071207-02	07/11/00	1730 hrs	smear	295.0	37261.0		8.8	20.3		Co-60	2.71E-03	uCi/smear
										Ag-108m	8.01E-04	uCi/smear
										Ba-133	1.34E-04	uCi/smear
										Cs-137	5.95E-03	uCi/smear
										Eu-152	1.58E-03	uCi/smear
										Eu-154	8.07E-04	uCi/smear
										Eu-155	1.01E-04	uCi/smear
										Am-241	2.70E-04	uCi/smear
20071207-03	07/11/00	1730 hrs	smear	593.2	81458.9		8.8	20.3		Co-60	6.14E-03	uCi/smear
										Ag-108m	1.79E-03	uCi/smear
										Ba-133	2.96E-04	uCi/smear
										Cs-137	1.17E-02	uCi/smear
										Eu-152	2.52E-03	uCi/smear
										Eu-154	2.03E-03	uCi/smear
										Eu-155	3.62E-04	uCi/smear
										Am-241	4.96E-04	uCi/smear

ASL #	DATE	TIME	MAT'L	ALPHA [dpm]	BETA [dpm]	Sr-90 [dpm]	MDL - dpm Alpha	MDL - dpm Beta	MDL - dpm Sr-90	GAMMA Nuclide	ACTIVITY [uCi/gm]	MDA [uCi/gm]
20071207-04	07/11/00	1730 hrs	smear	25.9	5523.4		8.8	20.3		Co-60	2.73E-04	uCi/smear
										Ag-108m	1.17E-05	uCi/smear
										Ba-133	3.14E-05	uCi/smear
										Cs-137	3.64E-04	uCi/smear
										Eu-154	3.24E-04	uCi/smear
										Eu-155	7.62E-05	uCi/smear
20071207-05	07/11/00	1730 hrs	smear	722.9	51901.5		8.8	20.3		Co-60	1.22E-02	uCi/smear
										Ag-108m	5.90E-04	uCi/smear
										Ba-133	6.82E-04	uCi/smear
										Cs-137	3.87E-03	uCi/smear
										Eu-152	1.73E-03	uCi/smear
										Eu-154	2.59E-03	uCi/smear
										Eu-155	5.19E-04	uCi/smear
										Am-241	8.49E-04	uCi/smear
20071207-06	07/11/00	1730 hrs	smear	343.6	30404.7		8.8	20.3		Co-60	8.61E-03	uCi/smear
										Ag-108m	3.02E-04	uCi/smear
										Ba-133	3.43E-04	uCi/smear
										Cs-137	1.00E-03	uCi/smear
										Eu-154	1.89E-03	uCi/smear
										Eu-155	3.06E-04	uCi/smear
										Am-241	1.57E-04	uCi/smear
20071208-01	07/11/00	1730 hrs.	smear	9640.3	715000.8		8.8	20.3		Co-60	8.45E-04	uCi/smear
										Cs-137	1.71E-01	uCi/smear
										Eu-152	4.66E-04	uCi/smear
										Eu-154	3.38E-04	uCi/smear
										Am-241	5.51E-03	uCi/smear
20071208-02	07/11/00	1730 hrs.	smear	20638.8	310842.4		8.8	20.3		Co-60	1.03E-03	uCi/smear
										Cs-137	4.86E-02	uCi/smear
										Eu-152	6.91E-04	uCi/smear
										Eu-154	1.79E-04	uCi/smear
										Am-241	9.60E-03	uCi/smear

ASL #	DATE	TIME	MAT'L	ALPHA [dpm]	BETA [dpm]	Sr-90 [dpm]	MDL - dpm Alpha	MDL - dpm Beta	MDL - dpm Sr-90	GAMMA Nuclide	ACTIVITY [uCi/gm]	MDA [uCi/gm]
20071208-03	07/11/00	1730 hrs.	smear	42648.9	1708002		8.8	20.3		Co-60	2.03E-03	uCi/smear
										Cs-137	2.59E-01	uCi/smear
										Eu-152	1.09E-03	uCi/smear
										Eu-154	8.55E-04	uCi/smear
										Am-241	2.23E-02	uCi/smear
20071208-04	07/11/00	1730 hrs.	smear	25.9	6860.7		8.8	20.3		Co-60	8.11E-04	uCi/smear
										Cs-137	8.65E-04	uCi/smear
										Eu-152	1.12E-03	uCi/smear
										Am-241	4.32E-05	uCi/smear
20071208-05	07/11/00	1730 hrs.	smear	3212.4	537429.4		8.8	20.3		Co-60	3.53E-04	uCi/smear
										Cs-137	1.93E-01	uCi/smear
										Am-241	6.89E-04	uCi/smear
20071208-06	07/11/00	1730 hrs.	smear	677.5	57971.5		8.8	20.3		Co-60	4.22E-05	uCi/smear
										Cs-137	1.78E-02	uCi/smear
20071209-01	07/11/00		smear	320.9	22934.2		8.8	20.3		Co-60	2.13E-03	uCi/smear
										Cs-137	6.18E-03	uCi/smear
										Eu-152	1.12E-03	uCi/smear
										Eu-154	1.87E-04	uCi/smear
										Am-241	2.46E-04	uCi/smear
20071209-02	07/11/00		smear	3812.0	443719.3		8.8	20.3		Co-60	9.13E-03	uCi/smear
										Cs-137	2.30E-01	uCi/smear
										Eu-152	2.89E-03	uCi/smear
										Eu-154	1.05E-03	uCi/smear
										Am-241	3.92E-03	uCi/smear
20071209-03	07/11/00		smear	1257.7	94805.6		8.8	20.3		Co-60	3.78E-03	uCi/smear
										Ag-108m	2.68E-05	uCi/smear
										Cs-137	5.69E-02	uCi/smear
										Eu-152	9.96E-04	uCi/smear
										Eu-154	6.76E-04	uCi/smear
										Am-241	1.28E-03	uCi/smear
20071209-04	07/11/00		smear	2032.4	236795.2		8.8	20.3		Co-60	5.75E-03	uCi/smear
										Cs-137	3.08E-02	uCi/smear
										Eu-152	2.21E-03	uCi/smear
										Am-241	6.41E-04	uCi/smear

ASL #	DATE	TIME	MAT'L	ALPHA [dpm]	BETA [dpm]	Sr-90 [dpm]	MDL - dpm Alpha	MDL - dpm Beta	MDL - dpm Sr-90	GAMMA Nuclide	ACTIVITY [uCi/gm]	MDA [uCi/gm]
20071209-05	07/11/00		smear	878.5	29461.6		8.8	20.3		Co-60	6.77E-04	uCi/smear
										Ag-108m	5.82E-05	uCi/smear
										Cs-137	3.86E-03	uCi/smear
										Eu-152	3.04E-04	uCi/smear
										Am-241	5.86E-04	uCi/smear
20071209-06	07/11/00		smear	680.7	54419.2		8.8	20.3		Co-60	1.49E-03	uCi/smear
										Cs-137	8.26E-03	uCi/smear
										Eu-152	8.71E-04	uCi/smear
										Eu-154	1.57E-04	uCi/smear
										Am-241	2.46E-04	uCi/smear
20071210-01	07/11/00	1730 hrs	smear	839.6	10360.7		8.8	20.3		Co-60	1.39E-04	uCi/smear
										Cs-137	3.15E-03	uCi/smear
										Eu-152	7.80E-05	uCi/smear
										Am-241	6.79E-04	uCi/smear
20071210-02	07/11/00	1730 hrs	smear	11617.7	236660.2		8.8	20.3		Co-60	1.85E-03	uCi/smear
										Ag-108m	9.52E-05	uCi/smear
										Cs-137	8.28E-02	uCi/smear
										Eu-152	2.24E-04	uCi/smear
										Eu-154	3.28E-04	uCi/smear
										Am-241	1.24E-02	uCi/smear
20071210-03	07/11/00	1730 hrs	smear	1137.8	24866.1		8.8	20.3		Co-60	1.06E-03	uCi/smear
										Cs-137	6.49E-03	uCi/smear
										Eu-152	3.06E-04	uCi/smear
										Eu-154	1.38E-04	uCi/smear
										Am-241	1.14E-03	uCi/smear
20071210-04	07/11/00	1730 hrs	smear	12804.1	232317.3		8.8	20.3		Co-60	2.80E-03	uCi/smear
										Ag-108m	1.14E-04	uCi/smear
										Cs-137	5.29E-02	uCi/smear
										Eu-154	1.10E-03	uCi/smear
										Eu-155	1.93E-04	uCi/smear
										Am-241	1.33E-02	uCi/smear

ATTACHMENT 1

ERD-BGRR Task-Specific Job Safety Analysis

for

Sealing of the Reactor Pile

ERD-BGRR TASK-SPECIFIC JOB SAFETY ANALYSIS

Project Task: **SEALING OF THE REACTOR PILE (702)**

Discussion Participants:
R. Litzke
C. Newson
R. Halsey

Date: August 3, 2000

Reference Documentation:

1. Technical Work Document, ERD-BGRR-TP-00-11
2. Work Permit No. _____

Attachments: A. Emergency Call-out List

Available documents:
MSDS for GE RTV157
MSDS for GE RTV159
MSDS for Liquid Nails® Liquid Seal™ Clear Sealant
MSDS for Liquid Nails® Adhesive for Steel & Metal Framing™
MSDS for Quick-Off
MSDS for Touch It Up® De-Contaminant
MSDS for FS 635 Trowelable Firestop Compound
MSDS for FS 601 Elastometric Firestop Compound

NOT INCLUDED IN THIS COPY

Reviewed by:
P. Abrams
H. Bachner
T. Jernigan
K. Corbett
M. Lilimpakis
S. Moss
S. Musolino

Prepared by:

_____ _____
Roger Halsey Date

ERD-BGRR TASK-SPECIFIC JOB SAFETY ANALYSIS **SEALING OF THE REACTOR PILE (702)**				
Task	**Steps/Activity**	**Hazards**	**Mitigation/Reduction**	**Comments**
1. General	Maintain clean work areas	Trips and slips	Remove unnecessary equipment and materials.	
	Control entry to work area	Injuries, potential exposures to hazardous substances	Put up warning signs, placards, and barricades.	
	Installation and removal of Controlled Area materials	Hand injuries from use of sharps Radiological hazards Generation of radioactive waste	Wear proper gloves. Cut-resistant gloves are required when using open cutting blades. Follow RWP for exposure and contamination control. Dispose/decon contaminated materials per RWP instructions of RCT/WMR.	
	Working in congested areas and on uneven surfaces	Falls, trips, and slips	Use proper footwear. Remove non-essential materials. If necessary, install stable surface for sturdy footing.	
	Use of powder-actuated nail gun	Eye injury from concrete chips Personnel injury from accidentally discharged gun Noise Injury from misplaced charges.	Workers will wear goggles when using the nail gun directly into concrete. Workers will not aim the gun at anyone, loaded or unloaded. The nail gun will not be loaded prior to use and unloaded immediately after. The area will be posted when the nail gun is in use. A noise survey will be performed at the start of the activity. The ES&H Coordinator shall issue charges. Spent and unspent charges shall be returned for inventory control.	Only trained individuals will operate the nail gun. If the noise survey indicates impact noise levels in excess of 140 dB (the OSHA impact noise limit for construction) hearing protection will be required.

ERD-BGRR TASK-SPECIFIC JOB SAFETY ANALYSIS **SEALING OF THE REACTOR PILE (702)**				
Task	**Steps/Activity**	**Hazards**	**Mitigation/Reduction**	**Comments**
1. General (continued)	Use of electrical tools, lights and working with any other electrical equipment	Electrical shock	Treat all electrical equipment as energized until PE has performed a zero energy check and marked as such.	Unenergized circuits may be marked with spray paint.
		Injury from failed equipment	Inspect all equipment and associated power cords before its operation. Use GFCI with all extension cords. Use only Underwriter's Laboratories listed or equivalent equipment. If there is a need for temporary power upgrade, it must comply with ES&H BNL Standard 1.5.0, Electrical Safety.	
	Use of GE RTV157/RTV159	Inhalation hazard	Monitoring will be performed to assure acetic acid levels do not exceed TLV of 10 PPM during curing. Mechanical ventilation will be used during curing.	Use FID or PID with a bulb > 10.66 eV and assume all organics detected are Acetic Acid. If monitoring shows air concentrations exceed 10 PPM, full-face respirator with organic cartridges will be required.
		Skin irritant, Eye irritant	PPE will be worn to prevent skin and eye contact.	

ERD-BGRR TASK-SPECIFIC JOB SAFETY ANALYSIS **SEALING OF THE REACTOR PILE (702)**				
Task	**Steps/Activity**	**Hazards**	**Mitigation/Reduction**	**Comments**
1. General (continued)	Use of Liquid Nails® Liquid Seal™ Clear Sealant (CS-145)	Inhalation hazard	Monitoring with a PID will be performed to assure air concentrations of organic vapors do not exceed 100 PPM. The work area will be well ventilated.	All organics detected will be assumed to be the most limiting material, ethyl benzene. Monitoring may be reduced if measurements show air concentrations stay well below 100 PPM.
		Skin irritant, eye irritant	Workers will be wearing impervious protective clothing, impervious gloves, and eye protection.	
		Flammable	Should any tools be needed in the immediate area of large amounts of exposed material, only non-sparking and intrinsically safe equipment shall be used.	The flash point, 54°F is below ambient. No grinding or welding will occur near exposed product.
	Use of Liquid Nails® Adhesive for Steel and Metal Framing™ (LN-925)	Inhalation hazard	Monitoring with a PID will be performed to assure air concentrations of organic vapors do not exceed 500 PPM. The work area will be well ventilated.	All organics detected will be assumed to be the most limiting materials, 2-methylpentante, dimethylbutane, and 3-methyl pentane. Monitoring may be reduced if measurements show air concentrations stay well below 500 PPM.
		Skin irritant, eye irritant	Workers will be wearing impervious protective clothing, impervious gloves, and eye protection.	
		Flammable	Should any tools be needed in the immediate area of large amounts of exposed product, only non-sparking and intrinsically safe equipment shall be used.	The flash point, 1°F is well below ambient. No grinding or welding will occur near exposed product.

ERD-BGRR TASK-SPECIFIC JOB SAFETY ANALYSIS **SEALING OF THE REACTOR PILE (702)**				
Task	**Steps/Activity**	**Hazards**	**Mitigation/Reduction**	**Comments**
1. General (continued)	Use of Touch It Up® De-Contaminant	Minor eye irritant	Workers will be wearing eye protection; product is a foam.	Product is not an EPA hazardous waste.
	Use of Quick-Off alkaline detergent	Eye irritant, Skin irritant	PPE will be worn to prevent skin and eye contact.	Product is not an EPA hazardous waste.
	Use of FS 635 Trowelable Firestop Compound	Eye irritant, Skin irritant Inhalation irritant, as dust	PPE will be worn to prevent skin and eye contact. Care will be taken to keep the product from drying out and producing dust during use.	
	Use of FS 601 Elastometric Firestop Compound	Eye irritant, Skin irritant	PPE will be worn to prevent skin and eye contact.	
	Use of hand tools	Hand injury	Tools will be inspected for damage prior to use. Work gloves will be used where hands must come in contact with unfinished surfaces or edges while using tools.	

ERD-BGRR TASK-SPECIFIC JOB SAFETY ANALYSIS **SEALING OF THE REACTOR PILE (702)**				
Task	**Steps/Activity**	**Hazards**	**Mitigation/Reduction**	**Comments**
1. General (continued)	Materials handling	Hand injuries	Use assistance when handling long or bulky items. Work gloves will be used when handling materials with unfinished edges.	All hoisting and rigging will be handled by PE riggers following ESH 1.6.0 "Materials Handling: Equipment & Procedures."
		Dropped objects	All workers will be wearing hard hats. Workers will not stand beneath materials being hoisted.	

ERD-BGRR TASK-SPECIFIC JOB SAFETY ANALYSIS
SEALING OF THE REACTOR PILE (702)

Task	Steps/Activity	Hazards	Mitigation/Reduction	Comments
1. General (continued)	Working at Heights, scaffolding	Falls from collapse of scaffolding	Only PE trained personnel will assemble or disassemble scaffolding. Workers will be trained before working on scaffolding.	
		Electrocution	All 110v electrical tools will use GFCI protection when used on	
		Falls	Scaffolding work elevations at or above six feet will have guardrails on all sides. Scaffolding elevations above two feet will have ladder, stair, or other methods of access. Climbing of external scaffolding will be prohibited.	
		Dropped materials	All workers will be wearing hardhats. Scaffolding work elevations at or above ten feet will have toeboards to prevent dropped tools or materials. Areas of operation will be roped off to control access.	

ERD-BGRR TASK-SPECIFIC JOB SAFETY ANALYSIS
SEALING OF THE REACTOR PILE (702)

Task	Steps/Activity	Hazards	Mitigation/Reduction	Comments
1. General (continued)	Working at Heights, working from ladders	Falls	Ladders will be tied off. Workers will maintain three points of contact with the ladder while working (both feet and one hand at all times). Work above 20 feet will require fall protection.	All standard ladder rules apply: folding stepladders can't be used as a leaning ladder, can't stand on top two rungs, extension ladders must overlap a minimum of 3', ladders must be at a 4:1 pitch.
		Electrocution	All 110v electrical tools will use GFCI protection when used on metal ladders.	
		Dropped materials	Workers will not carry materials up ladders. Any necessary materials or tools will be passed up or pulled up.	
	Working at Heights, Fall Protection	Falls	Workers will be trained, will wear approved fall protection harnesses and use appropriate tie-off and attachment schemes.	All OSHA and BNL fall protection requirements apply.
		Dropped materials	All workers will be wearing hardhats.	
1. General (continued)	Working at Heights, Manlifts	Falls	Manlifts will be inspected prior to use daily. Only trained personnel shall operate or work from manlifts.	Manlifts will be operated by trained personnel.
		Electrocution	All 110V electrical tools will use GFCI protection when used on manlifts.	
		Dropped materials	All workers will be wearing hardhats. Areas of operation will be roped off to control access.	

ERD-BGRR TASK-SPECIFIC JOB SAFETY ANALYSIS **SEALING OF THE REACTOR PILE (702)**				
Task	**Steps/Activity**	**Hazards**	**Mitigation/Reduction**	**Comments**
	Post-work activities	Fall, trips, and slips	Clear the work areas of any obstruction.	
	Disposal of contaminated materials	Uncontrolled release of contaminated materials	Consult the RCT and WMR regarding deconning, storing (if any), and disposal of contaminated materials and waste.	
Step 5.1 - East Vertical Face Isolation	5.1.1 Seal the penetrations in the vertical bioshield wall			
	A. Verify radiological and hazardous characterization completed	None		
	B. Identify Sealing Detail	None		
	C. Remove existing cap/plug and discard existing gasket	Working at heights		
		Exposure to Asbestos	Workers will not break or crumble, as gasket is potential ACM.	Gaskets, if found, may be ACM and need assessment before disposal.
	D. Prepare surface by thoroughly cleaning	Use of Quick-Off or Touch It Up®		
	E. Apply sealant primer	Primer will not be used.		
	F. Apply silicone sealant GE RTV157 or GE RTV159	Use of GE RTV157, Use of GE RTV159		
	G. Reinstall the cap/plug	None		

ERD-BGRR TASK-SPECIFIC JOB SAFETY ANALYSIS **SEALING OF THE REACTOR PILE (702)**				
Task	**Steps/Activity**	**Hazards**	**Mitigation/Reduction**	**Comments**
Step 5.2 - West Vertical Face Isolation	5.2.1 Seal the penetrations in the vertical bioshield wall A. Verify radiological and hazardous characterization completed B. Identify Sealing Detail C. Remove existing cap/plug and discard existing gasket D. Prepare surface by thoroughly cleaning E. Apply sealant primer F. Apply silicone sealant GE RTV157 or GE RTV159 G. Reinstall the cap/plug	Same as 5.1		
Step 5.3 - South Vertical Face Isolation	5.3.1 Prepare South Face A. Remove or verify removed intereferences from the south face B. Verify and remove paint from weld attachment point	Working at heights Use of hand tools Materials handling Paint will be removed prior to this operation.		The removal of any paint will occur prior to the operations covered in the Technical Work Document for Sealing the Rector Pile and will be covered under a BGRR-WP-0107.

ERD-BGRR TASK-SPECIFIC JOB SAFETY ANALYSIS **SEALING OF THE REACTOR PILE (702)**				
Task	**Steps/Activity**	**Hazards**	**Mitigation/Reduction**	**Comments**
Step 5.3 - South Vertical Face Isolation (continued)	5.3.2 Installation of face seal plate flange			
	A. Approval of Unreviewed Safety Issue Determination/Safety Evaluation	None		
	B. Verify preparation	Working at heights		
	C. Install Face Plate Seal Flange			
	Remove east end and west end piping manifolds and install caps (pp 4,5 of Att. 8.3)	Materials handling Use of hand tools		
	Remove pneumatic tubes at wall, install mechanical pipe caps (pp 6,7 of Att. 8.3)	Materials handling		
	Cut electrical cables, push in grout plug, prepare surface and seal (p. 8 of Att. 8.3)	Use of FS 635 Trowelable Firestop Compound Use of Quick-Off or Touch It Up®	Eye, Skin and Inhalation irritant	

ERD-BGRR TASK-SPECIFIC JOB SAFETY ANALYSIS **SEALING OF THE REACTOR PILE (702)**				
Task	**Steps/Activity**	**Hazards**	**Mitigation/Reduction**	**Comments**
Step 5.3 - South Vertical Face Isolation (continued)	Remove Electrical Enclosure, cut cables at wall, push in grout plug, and seal (p 9 of Att. 8.3)	Electrocution	BNL Lock Out/Tag Out procedures will be followed.	This may reduce to simply assuring cables do not physically connect to any source.
		Use of FS 635 Trowelable Firestop Compound		
	verify details	None		
	Weld perimeter flange to bioshield wall, intermediate flanges welded to bioshield wall	Hot work, welding	Operate under BNL Cutting Welding Permit.	Only PE personnel will perform welding.
		Exposure to metal fumes	The area will be well ventillated.	
		Exposure to UV	Welder will wear UV goggles. Welding site will be blocked from all other workers' view.	An alternative to welding is the use of the powder-actuated nail gun. Precautions for the nail gun are listed in the General Section.
		Fire	A fire watch will be established and maintained during all welding operations. If PPE is necessary, only fire protective PPE will be used. Fireproof barriers will be used to assure no sparks or slag may come in contact with any penetrations.	The fire watch will remain in place for 30 minutes after welding has finished, as per OSHA regulations
	Joints sealed with 2" aluminum strap, sealed with GE RTV157	Working at heights		
		Use of GE RTV157		

ERD-BGRR TASK-SPECIFIC JOB SAFETY ANALYSIS **SEALING OF THE REACTOR PILE (702)**				
Task	**Steps/Activity**	**Hazards**	**Mitigation/Reduction**	**Comments**
Step 5.3 - South Vertical Face Isolation (continued)	D. Verify Face Seal Plate Flange installation	Working at heights		
	E. Verify weld bead	Working at heights		
	F. Prepare sealing surface by cleaning	Use of Quick-Off or Touch It Up®		

ERD-BGRR TASK-SPECIFIC JOB SAFETY ANALYSIS **SEALING OF THE REACTOR PILE (702)**				
Task	**Steps/Activity**	**Hazards**	**Mitigation/Reduction**	**Comments**
Step 5.3 - South Vertical Face Isolation (continued)	5.3.3. Installation of the Face Seal Plates			
	A. Verify radiological and hazardous characterization	None		
	B. Verify mating surfaces are clean	Working at heights		
	C. Apply GE RTV157	Use of GE RTV157		
	D. Install temporary spacers	None		
	E. Hang seal plate on upper locating pins	Working at heights Materials handling Dropped materials	ESH 1.6.0 "Material Handling: Equipment & Procedures" will be followed.	
		Hand injury	Workers will use work gloves.	
	F. Install long fasteners and hand tighten	Hand injury	Workers will use work gloves.	
	G. Install remaining fasteners, hand tighten, remove spacers	Hand injury	Workers will use work gloves.	
	H. Tighten fasteners	Use of hand tools		
	I. Visually inspect	Working at heights		

ERD-BGRR TASK-SPECIFIC JOB SAFETY ANALYSIS **SEALING OF THE REACTOR PILE (702)**				
Task	**Steps/Activity**	**Hazards**	**Mitigation/Reduction**	**Comments**
Step 5.4 North Vertical Face Isolation	5.4.1 Prepare North Face	Same as Step 5.3.1		
Step 5.4 – North Vertical Face Isolation (continued)	5.4.2 Installation of the Face Seal Plate Flange	Same as Step 5.3.2		
	5.4.3 Installation of the Face Seal Plate	Same as Step 5.3.3		
	5.4.4 Sealing the Fuel Channel Penetrations			The removal of any paint will occur prior to the operations covered in the Technical Work Document for Sealing the Rector Pile and will be covered under a BGRR-WP-0107.
	1. Remove Rubber Plug	Radioactive contamination	All handling of contaminated materials will under an RWP.	
	2. Move high-density grout	None		
	3. Clean penetration of all dirt, paint, and oil	Use of Quick-Off or Touch It Up®		
	4. Inject Hiliti FS-1 into penetration. Use finishing knife to dress sealant flush with the sleeve open end	Use of FS 601 Elastometric Firestop Compound		The finishing knife is a flat, unsharpened blade.
	5. Inspect with flashlight for voids or gaps	None		

ERD-BGRR TASK-SPECIFIC JOB SAFETY ANALYSIS **SEALING OF THE REACTOR PILE (702)**				
Task	**Steps/Activity**	**Hazards**	**Mitigation/Reduction**	**Comments**
Step 5.5 - Floor Hole Isolation	5.5.1 Floor Hole Isolation	Slips and trips		The removal of any paint will occur prior to the operations covered in the Technical Work Document for Sealing the Rector Pile and will be covered under a BGRR-WP-0107. An alternative to the use of Liquid Nails® Adhesive is the use of the powder-actuated nail gun. Precautions for the nail gun are listed in the General Section.
	A. Verify all of ACM floor tile has been removed	None		
	B. Prepare floor by removing all paint, dirt, oils, grease, and adhesive	Use of Quick-Off or Touch It Up®		
	C. Layout frame	Materials handling		
	D. Install floor anchors	Use of electric tools		
	E. Install frame and tighten fasteners	Use of hand tools		
	F. Verify floor frame is properly installed	None		
	G. Remove Frame	Materials handling		
	H. Verify floor is properly prepared	None		
	I. Apply epoxy adhesive	Use of Liquid Nails® Adhesive		
	J. Tighten fasteners	Use of hand tools		
	K. Verify installation	None		

ERD-BGRR TASK-SPECIFIC JOB SAFETY ANALYSIS **SEALING OF THE REACTOR PILE (702)**				
Task	**Steps/Activity**	**Hazards**	**Mitigation/Reduction**	**Comments**
Step 5.5 - Floor Hole Isolation (continued)	5.5.2 Installation of Seal Plate			
	A. Verify radiological and hazardous characterization is complete.	None		
	B. Layout seal plates	Materials handling		
	C. Drill and tap Seal Plate Frame	Use of hand tools		
	D. Remove plates and drill out fastener holes to 7/16"	Use of hand tools		
	E. Clean and prepare mating surfaces	Use of Quick-Off or Touch It Up®		
	F. Install temporary spacers	None		
	G. Apply GE RTV157	Use of GE RTV157		
	H. Install spacer washers	None		
	I. Install fasteners and hand tighten	Hand injuries		
	J. Tighten fasteners	Use of hand tools		
	K. Visually inspect perimeter	None		

ERD-BGRR TASK-SPECIFIC JOB SAFETY ANALYSIS **SEALING OF THE REACTOR PILE (702)**				
Task	**Steps/Activity**	**Hazards**	**Mitigation/Reduction**	**Comments**
Step 5.6 - Pile Roof Isolation	5.6.1 Installation of the Seal Plate Frames Over Shot Well Openings A. Prepare roof floor by removing paint, dirt, oils, grease, and tile adhesive B. Layout frame C. Install floor anchors D. Verify floor is prepared and free of paint, oils, grease and dirt E. Apply epoxy adhesive F. Tighten fasteners G. Verify floor frame is properly installed	All steps contained in above.		The removal of any paint will occur prior to the operations covered in the Technical Work Document for Sealing the Rector Pile and will be covered under a BGRR-WP-0107.

ERD-BGRR TASK-SPECIFIC JOB SAFETY ANALYSIS **SEALING OF THE REACTOR PILE (702)**				
Task	**Steps/Activity**	**Hazards**	**Mitigation/Reduction**	**Comments**
Step 5.6 - Pile Roof Isolation (continued)	5.6.2 Installation of Shot Well Seal Plates A. Clean and prepare mating surfaces B. Apply GE RTV157 C. Install spacing washers and fasteners and hand tighten D. Tighten fasteners	All steps contained in above.		
	5.6.3 Installation of Sealing Flange on the Scanner Slot Openings A. Thoroughly clean surface of reinforcing steel edging B. Drill and tap edging C. Verify mating surfaces are clean D. Apply epoxy, install sealing flange with flathead cap screws	All steps contained in above.		

ERD-BGRR TASK-SPECIFIC JOB SAFETY ANALYSIS **SEALING OF THE REACTOR PILE (702)**				
Task	**Steps/Activity**	**Hazards**	**Mitigation/Reduction**	**Comments**
Step 5.6 - Pile Roof Isolation (continued)	5.6.4 Installation of Scanner Slot Seal Plates A. Verify radiological and hazardous characterization B. Layout Seal Plates on Seal Plate Frame C. Drill and tap Seal Plate Frame D. Remove plates and drill out fastener holes E. Clean and prepare mating surfaces F. Install temporary fasteners G. Apply GERTV157 H. Install spacer washers I. Install fasteners and hand tighten and remove spacers J. Tighten fasteners K. Visually inspect full perimeter	All steps contained in above.		

ERD-BGRR TASK-SPECIFIC JOB SAFETY ANALYSIS **SEALING OF THE REACTOR PILE (702)**				
Task	**Steps/Activity**	**Hazards**	**Mitigation/Reduction**	**Comments**
Step 5.6 - Pile Roof Isolation (continued)	5.6.5 Installation of the perimeter Sealing Flange on the Removable Plug Openings A. Clean surface of reinforcing steel B. Drill and tap reinforcing edging C. Verify mating surfaces are clean D. Apply epoxy	All steps contained in above.		

ERD-BGRR TASK-SPECIFIC JOB SAFETY ANALYSIS
SEALING OF THE REACTOR PILE (702)

Task	Steps/Activity	Hazards	Mitigation/Reduction	Comments
Step 5.6 - Pile Roof Isolation (continued)	5.6.6 Installation of the Removable Plug Opening Seal Plates A. Verify radiological and hazardous characterization is complete. B. Layout seal plates C. Drill and tap Seal Plate Frame D. Remove plates and drill out fastener holes to 7/16" E. Clean and prepare mating surfaces F. Install temporary spacers G. Apply GE RTV157 H. Install spacer washers I. Install fasteners and hand tighten J. Tighten fasteners K. Visually inspect perimeter	All steps contained in above.		

ERD-BGRR TASK-SPECIFIC JOB SAFETY ANALYSIS **SEALING OF THE REACTOR PILE (702)**				
Task	**Steps/Activity**	**Hazards**	**Mitigation/Reduction**	**Comments**
Step 5.6 - Pile Roof Isolation	5.6.7 Sealing the Periscope Openings			
	A. Install deep wedge anchors in concrete floors	Eye injury from concrete chips	Workers shall wear goggles.	Normal safety glasses with side shields do not provide adequate protection against flying particles.
	B. Prepare floor	Use of Quick-Off or Touch It Up®		
	C. Verify surfaces are clean	None		
	D. Apply epoxy	Use of Liquid Nails® Adhesive		
	E. Install and tighten seal cap fasteners	Use of hand tools		

ERD-BGRR TASK-SPECIFIC JOB SAFETY ANALYSIS **SEALING OF THE REACTOR PILE (702)**				
Task	**Steps/Activity**	**Hazards**	**Mitigation/Reduction**	**Comments**
5.7 CRD Openings	5.7.1 West CRD Openings			
	A. Verify radiological and hazardous characterization	None		
	B. Remove lead shield blocks	Materials handling Lead exposure	Workers are lead trained and have had baseline blood-lead and will have blood-lead as part of exit physicals. Air monitoring will be performed to quantify worker exposure.	All workers will receive Lead Awareness training. Should any monitoring indicate the potential to exceed the action level of 30μg/m3, workers will receive Lead Worker training as described in 29 CFR 1926.62(l)(2).
	C. Verify seal cap will fit	None		
	D. Prepare surface by thorough cleaning	Use of Quick-Off or Touch It Up®		
	E. Apply sealant primer	Primer will not be used.		
	F. Apply silicone sealant	Use of GE RTV157		
	G. Install sealing cap	None		
	H. Inspect	None		
	5.7.2 East CRD Openings	Same as 5.7.1		

Attachment A

Emergency Response

First Aid/Medical Assistance..... 2222 or 911 or 344-2222 cellular
Spill Reporting..... 2222

	Voice	Pager
Project Manager (Stephen Pulsford)	344-2394	554-7028
Project ES&H/Q Manager (Stephen Musolino)	344-4211	441-8136
Construction/Facility Manager (Hank Bachner)	344-8246	554-4062
ES&H Coordinator (Reggie Suga)	344-8248	554-4313
Local Emergency Coordinator (Kevin Corbett)	344-2431	554-3923
DOE BGRR Project Manager (Gail Penny)	344-3429	none
DOE Facility Representative for BGRR (Maria Dikeakos)	344-3950	888-512-2423

Preliminary MEDICAL CARE is provided through Fire/Rescue and Occupational Medicine Clinic.

ATTACHMENT 2

Cutting and Welding Permit

for

Sealing of Pile Openings

HOT WORK PERMIT

BEFORE INITIATING HOT WORK, CAN THIS JOB BE AVOIDED? IS THERE A SAFER WAY?

This Hot Work Permit is required for any temporary operation involving open flames or producing heat and/or sparks, as stated in ES&H Standard 4.3.0.

PART I

INSTRUCTIONS

1. **Firesafety Officer:**
   - **A. Complete & Retain Part I**
   - **B. Issue Part 2 to person doing job.**
2. **Supervisor:**
   - **A. Verify Precautions at right or do not proceed with work.**
   - **B. Return Part 2 when done.**

HOT WORK BEING DONE BY:

☒ EMPLOYEE B.N. ELL LIFE NO. ØØ

☐ CONTRACTOR _____ CO. _____

DATE	JOB NO.
8-8-2000	

LOCATION/BUILDING & FLOOR
701/702 NORTH FACE, EL. 110'-0"

NATURE OF JOB
WELD ANGLE TO 702 NORH FACE

NAME OF PERSON DOING FIRE WATCH
I. M. SAFE

I verify the above location has been examined, and permission is authorized for this work.

SIGNED: (FIRE/SAFETY OFFICER)
SAMPLE DATE: 0-0-00

PERMIT EXPIRES	DATE	TIME
	SAMPLE	AM / PM

I verify that the List of Precautions is Understood and work will proceed only if precautions are followed:
Signed: (Supervisor) XYZ

NOTE EMERGENCY NOTIFICATION ON BACK OF FORM. USE AS APPROPRIATE FOR YOUR FACILITY.

Required Precautions Checklist
(Stop Work if Precautions Are Not Present)
Welder Initial EACH box complied with.

- ☑ Available sprinklers, hose streams and extinguishers are in service/operable.
- ☑ Hot Work equipment in good repair.

Requirements within 35 ft (10m) of work

- ☑ Flammable liquids, dust, lint and oil deposits removed.
- ☑ Explosive atmosphere in area eliminated.
- ☑ Floors swept clean.
- ☑ Combustible floors wet down, covered with damp sand or fire-resistive sheets.
- ☑ Remove other combustibles where possible. Otherwise protect with fire-resistive tarpaulins or metal shields.
- ☑ All wall and floor openings covered.
- ☑ Fire-resistive tarpaulins suspended beneath work.

Work on walls or ceilings

- ☑ Construction is noncombustible and without combustible covering or insulation.
- ☑ Combustibles on other side of walls moved away.

Work on enclosed equipment

- ☐ Enclosed equipment cleaned of all combustibles.
- ☐ Containers purged of flammable liquids/vapors and monitored for vapor buildup.

Fire watch/Hot Work area monitoring

- ☑ Fire watch conractor/department will supply during and for 60 minutes after work, including any coffee or lunch breaks.
- ☑ Fire watch is supplied with suitable extinguishers, charged small hose.
- ☑ Fire watch is trained in use of this equipment and in sounding alarm (telephone, alarm box, radio).
- ☐ Fire watch may be required for adjoining areas, above, and below (see other precautions).
- ☑ Monitor Hot Work area for 4 hours after job is completed.

Other Precautions Taken

- ☑ False alarm with detection systems considered.
- ☑ ALL OPENINGS INTO PILE ARE SEALED/CLOSED PER ERD-BARR-TP-00-11 SECT. 5.4.2

BNL F 3015A

No. 1840

ATTACHMENT 3

ERD-BGRR-TP-00-11

Technical Work Document

for

Sealing of the Reactor Pile (702)

ERD Operations Procedures Manual

TECHNICAL WORK DOCUMENT
SEALING OF THE REACTOR PILE (702)

Text Pages 1 through 32
Attachment(s) 8.1 through 8.9 (inclusive)

Temporary Procedure

Approved: _____ Date: 8/15/00
Stephen K. Pulsford, Manager
BGRR Decommissioning Project

Preparer: **T. Jernigan**

Expiration Date: **December 31, 2000**

ERD OPM No.: **ERD-BGRR-TP-00-11, Rev. 1**

ERD Operations Procedures Manual

TECHNICAL WORK DOCUMENT
SEALING OF THE REACTOR PILE (702)

Text Pages 1 through 32
Attachment(s) 8.1 through 8.9 (inclusive)

Temporary Procedure

Approved: _____ Date: _____
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Preparer: **T. Jernigan**

Expiration Date: **December 31, 2000**

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1.0 PURPOSE AND SCOPE

1.1 The purpose of this procedure is to provide the detailed work instructions for the isolation and sealing of the BGRR Reactor Pile (702) from the Reactor Building (701) to prevent graphite dust and pile contaminants from becoming a hazard in (701), and to prevent any decommissioning activities being conducted in (701) and science activities in (703) to impact the pile.

1.2 The scope of the work activities prescribed herein include the following:

- Removal of the abandoned reactor experimental equipment and associated piping from the bio-shield walls.
- Mechanically isolating the openings in the bio-shield wall by installation of blanks, seals, plugs, or other positive mechanically sealing devices, including 701 floor areas that provide access to the instrument and animal tunnels.
- Removal abandoned electrical apparatus and isolation of electrical penetrations in the bio-shield.

1.3 Table 5-1 lists the openings in the bio-shield and the faces of the pile that they penetrate. The work instructions in Section 5.0 are divided into a separate sub-section for each face of the bio-shield.

1.4 The isolation of the pile from the Canal and the Below Grade Duct is not in the scope of this Technical Work Document and will be accomplished under a separate Work Package.

1.5 Because of continuing intrusive work in the Above and Below Grade Ducting, the following work activities which isolate the pile from the outside environment will be accomplished upon completion of all intrusive work in the ducting:

- Replacement of the plywood covers on the Primary Air System inlet filter openings with permanent metal sealing plates.
- Removal of the inlet filter elements.
- Installation of a passive HEPA filter on the pile.
- Shutdown and removal of the Pile Negative Pressure Fan

1.6 With the exception of welding activities prescribed in Sections 5.3 and 5.4, the work activities prescribed herein to isolate and seal the pile are covered under the BGRR-ASA.

2.0 RESPONSIBILITIES

2.1 The BGRR-DP Construction Manager or designee is responsible for the proper execution of this Work Document.

2.2 The BGRR-DP Field Engineer (FE) is responsible for direction of all field work activities prescribed in this Work Document.

2.3 The BGRR-DP Project Engineer or designee is responsible for the technical content of this Work Document.

2.4 The BGRR-DP ESH&Q Manager (ESH) or designee is responsible for the assessment of environment, safety and health issues associated with the work activities delineated herein.

2.5 The BGRR-DP Quality Representative is responsible for review of the Task Quality Plan for the work activities prescribed herein.

3.0 PREREQUISITES

3.1 A Task-specific Job Safety Analysis (JSA) for this work activity has been approved and reviewed by all personnel involved with these work activities.

FE Initial: _____ Date: _____

3.2 An Unreviewed Safety Issue Determination/Safety Evaluation (USID/SE) for this task has been approved. This is required for the welding prescribed in Sections 5.3 and 5.4 only; verification of this Prerequisite is contained in these sections.

3.3 A Radiological Work Permit (RWP) has been issued and reviewed by all personnel involved with these work activities.

RWP No:_____ FE Initial:_____ Date: _____

3.4 A Hazardous Materials Assessment has been completed in accordance with Ref. 7.3 for all of the work areas covered in this procedure, and all identified hazardous materials have been removed or stabilized to ensure a safe working environment.

ESH Initial: _____ Date: _____

3.5 Waste disposal container(s) available for radiological and hazardous items removed during these work activities.

FE Initial: _____ Date: _____

3.6 All personnel involved in the installation of Hilti "DX" fasteners (Powder Actuated Fasteners) shall have been trained in the operation of the tools and have in their possession certification of such training from Hilti Corporation.

FE Initial: _____ Date: _____

4.0 PRECAUTIONS AND LIMITATIONS

4.1 This document is a TEMPORARY procedure valid only for the specific work activities delineated in **Section 5.0**, and may only be implemented in conjunction with an approved Work Permit, and other approved appropriate documents and permits (e.g. Radiation Work Permit)

4.2 The internal and external surfaces of the pile bio-shield wall are known to be contaminated with radionuclides such as Co-60, Cs-137, Am-241, Pu-239 and others. Observe the requirements of the RWP when breaching system boundaries. System breaches are noted prior to the work step in Section 5.0.

4.5 Both the JSA and USID/SE BGRR-00-02 are based on NO FLAME CUTTING. If it is later determined that flame cutting is required, both of these documents shall be revised.

4.6 The instructions for sealing openings shall be strictly adhered to. Failure to comply with instructions herein may result in poor sealing of the penetrations.

4.7 GE RTV™ Sealant bead depth shall not exceed 1/4" after installation and tightening of the sealing plates. Sealant bead depths greater than 1/4" will not cure properly and will result in a poor seal.

4.8 Improper sealing may occur if the sealing covers are not immediately installed after application of the silicone sealant to the sealing surface. If "skin" has formed on the sealant before the cover is installed, the sealant shall be removed, the sealing surfaces shall be re-prepped, and new sealant applied.

4.9 Final sealing of the opening should not be done until the radiological and hazardous characterization of that opening has been completed.

4.10 Sealing of the individual openings may be performed in any sequence, however the steps contained in Section 5.0 prescribing the sealing method shall be performed in sequence as delineated.

4.11 Hilti "DX" (Powder Actuated Fasteners) system studs may be substituted for drilled, drilled and tapped, or expandable concrete anchors for any fasteners specified herein. However, the Hilti fastener shall be of equivalent size and bolt spacing as specified in the affected procedural step or drawing.

4.12 All fastening of seal plates shall use split-ring lock washers. Fasteners shall be tightened only until the lockwasher is fully compressed.

4.13 The Field Engineer shall determine the methods to be used for preparation of the sealing surfaces; the ES&H Coordinator shall approve cleaning solvents and solutions used. Material Safety Data Sheets (MSDS) shall be included in the Work Package associated with this Technical Work Document.

4.14 Welding and/or hot work in the vicinity of the bio-logical shield is not permitted while any intrusive activities into the pile are underway, or any of the Pile Biological Shield Wall opening covers are removed on the Pile roof, east, north or west faces.

5.0 PROCEDURE

The Reactor Pile (702) will be isolated and sealed from the Reactor Building (701) using non-destructive methods which will provide a positive seal, and at the same time, allow for complete access to the pile for future activities. These future activities could include further radiological and hazardous characterization, visual inspections, and preventive maintenance of the bio-shield wall seals.

On the east and west wall penetrations, the original designed and installed penetration sealing plates will be utilized to accomplish the sealing of the penetration.

The south face of the bio-shield will be sealed using metal plates installed (tapped and bolted) on a flanged mating surface. This flanged surface will be welded to the steel face of the bio-shield.

The individual fuel channel openings in the north face of the bio-shield wall shall be sealed using "Fire Stop One (FS-1)" manufactured by Hilti. The openings for the pneumatic tubes and other miscellaneous pipe openings will be sealed using standard construction code-approved hardware. The access for the removable core with a welded flange and bolted seal plate similar to that installed on the south wall.

The top (roof) of the pile bio-shield, and the floor openings (elevation 110'-0") for the animal and instrument tunnels shall be sealed using aluminum plates installed over a steel frame that is bolted and bonded to the floor.

In lieu of a gasket, high-strength silicone sealant will be used both to seal the plates on the north and south wall, the roof, and the floor openings for the animal and instrument tunnels. This sealant will also be used in lieu of the gaskets that were originally used on the experimental openings (east and west walls). Once cured, this sealant will require limited periodic monitoring, and provide a long-lasting seal.

As determined by the Field Engineer, Hilti "DX" studs may be substituted for nuts and bolts, drilled and tapped capscrews, or expandable concrete anchors specified in the following steps. The size and fastener spacing shall be equivalent to that specified herein where such substitutions are made.

Table 5-1 lists the openings in the biological shield wall that communicate with the pile.

Table 5-1
Openings in Reactor Pile Bio-shield

Bio-shield Face	Description	Number of Openings
Roof	Scanner Slots	3#
	Periscopes	3
	Thermocouple Conduit Trench	2
	Thermocouples	9
	Shot Wells	4
	Removable Roof Sections	1#
North	Ion Chambers	2
	Fuel Channels	1368
	Pneumatic Tubes	4
	Removable Central Core	1
South	Fuel Channels	1368
East	Plenum Access	5
	Ion Chambers	4
	Control Rods	8
	Experimental Holes	30
	Target Conveyors	2
West	Plenum Access	5
	Ion Chambers	4
	Control Rods	8
	Experimental Holes	30
	Target Conveyors	2
Floor	Instrument Tunnels	2
	Animal Tunnels	2

Multiple Interlocking Plugs for each opening

5.1 East Vertical Face Isolation

Note 1: *Refer to the appropriate Sealing Detail in Attachment 8.2 that corresponds with the penetration.*

Note 2: *Work activities prescribed in this section are covered under the BGRR-ASA and require no USID/SE.*

Note 3: *As determined by the Field Engineer, Hilti "DX" studs may be substituted for nuts and bolts, drilled and tapped capscrews, or expandable concrete anchors specified in the following steps. The size and fastener spacing shall be equivalent to that specified herein where such substitutions are made.*

CAUTION

The work activities prescribed in the following steps involve removal of the metal shield plates that are installed over the Pile Experimental Holes. The requirements of the RWP and the JSA shall be strictly followed to control radiological exposure, spreading of contamination or exposure to hazardous substances.

5.1.1 SEAL the penetrations in the vertical bio-shield wall as follows:

A. VERIFY radiological and hazardous characterization completed per Reference 7.5 for the openings to be sealed in this section.

FE Initial: _____ Date: _____

B. IDENTIFY the appropriate Sealing Detail in Attachment 8.2.

C. REMOVE the existing cap/plug and discard the original gasket if installed.

Note: *The following steps apply to all openings in the east/west face. Refer to Attachment 8.1 and verify the sealing of each opening by initialing and dating the appropriate sign-off block.*

D. PREPARE the sealing surface by thoroughly cleaning, using approved decontamination cleaning solutions and mechanical/abrasive means, e.g. scraping.

E. APPLY sealant primer to the sealing surfaces per the manufacturer's instructions.

F. APPLY silicone sealant to the sealing surface.

G. REINSTALL the cap/plug removed in step C. above in accordance with the instructions provided in Attachment 8.2.

H. REPEAT steps B through G above for all openings.

5.2 West Vertical Face Isolation

Note 1: *Refer to the appropriate Sealing Detail in Attachment 8.2 that corresponds with the penetration.*

Note 2: *Work activities prescribed in this section are covered under the BGRR-ASA and require no USID/SE.*

Note 3: *As determined by the Field Engineer, Hilti "DX" studs may be substituted for nuts and bolts, drilled and tapped capscrews, or expandable concrete anchors specified in the following steps. The size and fastener spacing shall be equivalent to that specified herein where such substitutions are made.*

CAUTION

The work activities prescribed in the following steps involve removal of the metal shield plates that are installed over the Pile Experimental Holes. The requirements of the RWP and the JSA shall be strictly followed to prevent radiological exposure, spreading of contamination or exposure to hazardous substances.

5.2.1 SEAL the penetrations in the vertical bio-shield wall as follows:

A. VERIFY radiological and hazardous characterization completed per Reference 7.5 for the openings to be sealed in this section.

FE Initial: _____ Date: _____

B. IDENTIFY the appropriate Sealing Detail in Attachment 8.3.

C. REMOVE the existing cap/plug and discard the original gasket if installed.

Note: *The following steps apply to all openings in the east/west face. Refer to Attachment 8.1 and verify the sealing of each opening by initialing and dating the appropriate sign-off block.*

D. PREPARE the sealing surface by thoroughly cleaning.

E. APPLY sealant primer to the sealing surfaces per the manufacturer's instructions.

F. APPLY silicone sealant to the sealing surface.

G. REINSTALL the cap/plug removed in step C. above in accordance with the instructions provided in Attachment 8.2.

H. REPEAT steps B through G above for all openings.

5.3 South Vertical Face Isolation

Note 1: *Refer to Attachment 8.3 for the detailed drawings/pictures.*

Note 2: *As determined by the Field Engineer, Hilti "DX" studs may be substituted for nuts and bolts, drilled and tapped capscrews, or expandable concrete anchors specified in the following steps. The size and fastener spacing shall be equivalent to that specified herein where such substitutions are made.*

5.3.1 Install Seal Plate Retaining Studs as Follows:

Note: *Total number of Seal Plates shall be determined at the time of the installation of the retaining studs. This is due to the welds in the face of the shield wall. Plates shall be sized to avoid the perimeter sealing edge passing over the construction welds on the shield face.*

A. Referring to Attachment 8.3, LAYOUT the perimeter locations of each individual Face Seal Plate on the face of the bio-shield wall. Plate sizes shall be a large as possible, but not larger than 5'-0" x 10'-0". Plate sealing edge shall not pass over any weld or offset in the pile face that is greater than 1/4".

B. INSTALL 3/8-16UNC x 1-1/2" Hilti "DX" studs on the Face Seal Plate perimeter lines; studs shall be located no more than 12" apart, and no more than 1" from each Seal Plate corner.

C. Thoroughly CLEAN the face area along the Face Seal Plate perimeter lines; VERIFY face cleaned.

FE Initial: _____ Date: _____

5.3.2 Install the Seal Plates as Follows:

Note: *Seal Plates shall be installed one at a time. The existing fuel channel opening covers shall remain in place until the Face Seal Plate is ready to be installed.*

A. REMOVE all of the fuel channel opening cover plates within the perimeter of the plate to be installed.

B. APPLY two (2) beads of GE RTV157™ or equivalent to the full perimeter of the Face Seal Plate. One bead shall be applied outside of the bolt pattern and the other bead inside of the bolt pattern.

C. ATTACH the Face Seal Plate to the as shown on Attachment 8.3, with one (1) 1/8" (nom.) thick flat washer between the seal plate and the bio-shield face and one (1) split lockwasher under the fastening nut.

D. TIGHTEN the fastening nut until the split lockwasher is fully compressed. DO NOT OVERTIGHTEN.

E. INSPECT the full perimeter of the installed plate to verify all fasteners are tight and a full, continuous bead of sealant is visible.

(Plate No. ___) FE Initial: _____ Date: _____

F. REPEAT Steps A through E for the remaining Face Seal Plates.

(Plate No. ___) FE Initial: _____ Date: _____
(Plate No. ___) FE Initial: _____ Date: _____
(Plate No. ___) FE Initial: _____ Date: _____
(Plate No. ___) FE Initial: _____ Date: _____
(Plate No. ___) FE Initial: _____ Date: _____
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(Plate No. ___) FE Initial: _____ Date: _____
(Plate No. ___) FE Initial: _____ Date: _____
(Plate No. ___) FE Initial: _____ Date: _____

5.4 North Vertical Face Isolation

Note 1: *Refer to Attachment 8.3 for the detailed drawings/pictures.*

Note 2: *As determined by the Field Engineer, Hilti "DX" studs may be substituted for nuts and bolts, drilled and tapped capscrews, or expandable concrete anchors specified in the following steps. The size and fastener spacing shall be equivalent to that specified herein where such substitutions are made.*

The openings on the north face of the bio-shield wall will be sealed using a bolted sealing plate installed over the removable core, mechanical pipe caps (plugs) for the pneumatic tubes, and injected sealant in the remainder of the openings.

Note: *The following steps 5.4.1 through 5.4.3 install the seal plate to seal the Pile Removable Core Access and the (16) fuel channel penetrations surrounding the access*

5.4.1 Prepare the North Face for installation of the Face Seal Plate Flange as follows:

A. REMOVE or VERIFY removed interferences from the north face.

B. VERIFY the north face has been prepared for installation (welding) of the Face Seal Plate Flange. This requires removal of all paint from the weld attachment point down to bare metal. See Attachment 8.3 for location of flange.

FE Initial: _____ Date: _____

5.4.2 Installation of the Face Seal Plate Flange

A. An Unreviewed Safety Issue Determination/Safety Evaluation (USID/SE) for this task has been approved. (Required for parts of Sections 5.3 and 5.4 only).

FE Initial: _____ Date: _____ USID/SE No: _____

B. VERIFY preparation for performing hot work completed in accordance with the JSA and the Cutting/Welding Permit

FE Initial: _____ Date: _____

C. VERIFY that no other work activities on the Pile are in progress that may involve ANY of the following:

- Removal of any covers or ports on the Roof, North, East or West Pile Biological Shield Walls that breach the integrity of the shield. (NOTE: Removal of the cover plates on the South Wall is permitted).
- Any intrusive activity into the Pile or Biological Shield (such as sample retrieval) that may disturb the graphite core.

FE Initial: _____ Date: _____

CAUTION: In the following steps, the frame will be welded to the face of the bio-shield wall. Strictly observe the precautions and instructions in the JSA and the Cutting/Welding Permit to prevent any flames or sparks from coming in contact with the wall penetrations.

C. INSTALL the Face Seal Plate Flange as shown on Attachment 8.3.

D. VERIFY the Face Seal Plate Flange installed per details on Attachment 8.3 assuring that the flange sealing surfaces are parallel to the wall face and that all sealing surfaces are in the same plane.

FE Initial: _____ Date: _____

E. VERIFY the attachment weld bead for the Face Seal Plate Flange is continuous, and free of holes, voids, or slag.

FE Initial: _____ Date: _____

F. PREPARE the sealing surface of the Face Seal Plate Flange by cleaning as required to removal all dirt, oil, and other substances that may impair the bonding of the sealant, using approved decontamination cleaning solutions and mechanical/abrasive means, e.g. scraping.

FE Initial: _____ Date: _____

5.4.3 Installation of the Face Seal Plate

A. VERIFY radiological and hazardous characterization completed per Reference 7.5 for the openings to be sealed in this section.

FE Initial: _____ Date: _____

B. VERIFY the mating surfaces of the Face Seal Plate Flange and the Face Seal Plate are clean.

FE Initial: _____ Date: _____

C. APPLY two (2) beads of GE RTV157™ or equivalent to the full perimeter of the Face Seal Plate Flange. One bead shall be applied outside of the flange bolt pattern and the other bead inside of the flange bolt pattern.

D. INSTALL four (minimum) temporary spaces on the flange perimeter to prevent inadvertent plate contact with the sealant.

E. PLACE the seal plate on the flange by hanging it on the upper locating pins on the flange.

F. INSTALL the eight (minimum) long fasteners HAND TIGHT, bringing the plate in contact with the spacers installed in Step C. above.

G. INSTALL the remaining fasteners HAND TIGHT, then REMOVE the spacers installed in Step C. above.

H. TIGHTEN Face Seal Plate fasteners using and alternating criss-cross tightening sequence until the Face Seal Plate is fully tightened to the flange mating surface the Face Seal Plates as shown on Attachment 8.3.

I. VISUALLY inspect the full perimeter of the flange -to-plate mating surface to confirm a full bead of sealant.

FE Initial: _____ Date: _____

J. REPEAT Steps A. through I. for the remaining plates.

K. PERFORM final inspection of completed face sealing (all plates).

FE Initial: _____ Date: _____

5.4.4 Sealing the Fuel Channel Penetrations

Note 1: *Sixteen (16) north fuel channel penetrations will be sealed by installation of the welded-flange/seal plate method prescribed in Section 5.4.3 above. If the penetrations have already been sealed by this method, insert "N/A" in the appropriate check-off block on Attachment 8.8, and annotate and initial in the margin.*

Note 2: *Work activities prescribed in this section are covered under the BGRR-ASA and require no USID/SE.*

A. Referring to Attachment 8.8, seal each individual fuel channel penetration as follows. The Field Engineer shall (√) the appropriate box for each penetration as the preparation and sealing is completed. Once the entire row has been sealed the Field Engineer shall initial and date to verify sealing has been completed.

CAUTION

The work activities prescribed in the following steps involve removal of the rubber plugs that are installed in the fuel channel openings. The requirements of the RWP and the JSA shall be strictly followed to control radiological exposure, spreading of contamination or exposure to hazardous substances.

1. REMOVE the expandable rubber plug. If there is no rubber plug, REMOVE whatever interference is present to reveal the high-density grout plug installed in the penetration.

2. If necessary, move the high-density grout plug in or out of the penetration to achieve a depth of approximately 3/4" for the sealant.

3. CLEAN the penetration of all loose dirt, paint, oil or other foreign matter using approved decontamination cleaning solutions and mechanical/abrasive means, e.g. scraping. Paint that is well adhered need not be removed.

4. INJECT the sealant Hilti "FS-1" (or equivalent) into the penetration, filling the penetration sleeve fully. Using a finishing knife or equivalent tool, DRESS the sealant flush with the sleeve open end.

5. INSPECT the penetration for proper sealing with a high-intensity flashlight or equivalent source, verifying no voids or gaps in the seal. If necessary REPEAT step 4 above.

6. REPEAT steps 1 - 5 above for all penetrations.

5.5 Floor Hole Isolation

Note 1: *Refer to the Sealing Detail in Attachment 8.4.*

Note 2: *Work activities prescribed in this section are covered under the BGRR-ASA and require no USID/SE.*

Note 3: *As determined by the Field Engineer, Hilti "DX" studs may be substituted for nuts and bolts, drilled and tapped capscrews, or expandable concrete anchors specified in the following steps. The size and fastener spacing shall be equivalent to that specified herein where such substitutions are made.*

The animal and instrument tunnel openings in (701) floor that communicate with the Pile will be sealed by the installation of 1/2"(min.) thick aluminum sealing plates bolted to a flanged frame that is installed directly to the floor using mechanical fasteners and epoxy adhesive. These face-to-face sealing of these plates to the floor structure will be accomplished using GE Sealant RTV157™ or equal.

5.5.1 Installation of the Seal Plate Frame (East & West Tunnels)

A. PREPARE the floor for installation of the Seal Plate Frame by removing all paint, dirt, oil, grease, and tile adhesive.

B. LAYOUT the frame on the floor as shown on Attachment 8.4.

C. INSTALL floor anchors using the frame as a template.

D. INSTALL the floor frame without any adhesive, TIGHTEN fasteners.

E. VERIFY floor frame is installed properly, assuring that the frame-to-seal plate mating surface is in the same plane and the corners are square.

(East Verified) FE Initial: _____ Date: _____
(West Verified) FE Initial: _____ Date: _____

F. REMOVE the frame.

G. PREPARE the floor for installation of the frame by verifying that all paint, dirt, oil, and other foreign matter has been removed, using approved decontamination cleaning solutions and mechanical/abrasive means, e.g. scraping.

(East Prepared) FE Initial: _____ Date: _____
(West Prepared) FE Initial: _____ Date: _____

H. APPLY the epoxy adhesive to the floor/frame mating area per the manufacturer's instructions, then IMMEDIATELY install the floor frame.

I. TIGHTEN the fasteners using an alternating tightening sequence to prevent racking or twisting of the frame.

J. VERIFY again that the floor frame is installed properly, assuring that the frame-to-seal plate mating surface is in the same plane and the corners are square.

(East Verified) FE Initial: _____ Date: _____
(West Verified) FE Initial: _____ Date: _____

5.5.2 Installation of the Seal Plate (East & West Tunnels)

A. VERIFY radiological and hazardous characterization completed per Reference 7.5 for the openings to be sealed in this section.

(East Verified) FE Initial: _____ Date: _____
(West Verified) FE Initial: _____ Date: _____

B. LAYOUT the Seal Plates on the Seal Plate Frame assuring that plates align with the frame.

C. Using the plates as a template, DRILL and TAP the Seal Plate Frame for 3/8"-16UNC at 12" (max.) field spacing and no more than 2" from the ends on the frame per Attachment 8.4.

D. REMOVE the plates and drill out the fastener holes to 7/16" to accommodate the 3/8" fasteners.

NOTE: *The following steps (E through K) apply to one Seal Plate. Install only one plate at a time, and repeat the steps as necessary.*

E. CLEAN and PREPARE the mating surfaces of the plates and frame for application of the sealant/primer, using approved decontamination cleaning solutions and mechanical/ abrasive means, e.g. scraping.

(East Prepared) FE Initial: _____ Date: _____
(West Prepared) FE Initial: _____ Date: _____

F. INSTALL four (minimum) temporary 1/2" thick spacers on the frame perimeter to prevent inadvertent plate contact with the sealant.

G. APPLY two (2) beads of GE RTV157™ or equivalent to the full perimeter of the Seal Plate Frame. One bead shall be applied outside of the frame bolt pattern and the other bead inside of the bolt pattern.

H. INSTALL the 1/8" thick spacer washers.

I. INSTALL the fasteners HAND TIGHT then REMOVE the spacers installed in Step F. above.

(East Spacers Removed) FE Initial: _____ Date: _____
(West Spacers Removed) FE Initial: _____ Date: _____

J. TIGHTEN Seal Plate fasteners using an alternating criss-cross tightening sequence until the Seal Plate is fully tightened to the frame mating surface the as shown on Attachment 8.4.

K. Visually INSPECT the full perimeter of the frame-to-plate mating surface to confirm a full bead of sealant.

(East Preparation Verified) FE Initial: _____ Date: _____
(West Preparation Verified) FE Initial: _____ Date: _____

L. REPEAT Steps A through I as necessary for the remaining plates.

5.6 Pile Roof Isolation

Note 1: *Refer to the Sealing Detail in Attachment 8.5.*

Note 2: *Work activities prescribed in this section are covered under the BGRR-ASA and require no USID/SE.*

Note 3: *As determined by the Field Engineer, Hilti "DX" studs may be substituted for nuts and bolts, drilled and tapped capscrews, or expandable concrete anchors specified in the following steps. The size and fastener spacing shall be equivalent to that specified herein where such substitutions are made.*

5.6.1 Installation of the Seal Plate Frames Over Shot Well Openings

Note: *The (2) Shot Well openings in the bio-shield roof that communicate with the pile shall be sealed by the installation of 1/4"(min.) thick aluminum sealing plates bolted to a flanged frame that is installed directly to the roof floor using mechanical fasteners and epoxy adhesive. The face-to-face sealing of these plates to the Seal Plate Frame will be accomplished using GE Sealant RTV157™ or equal.*

A. PREPARE the roof floor for installation of the Seal Plate Frame by removing all paint, dirt, oil, grease, and tile adhesive.

B. LAYOUT the frame on the floor as shown on Attachment 8.5.

C. INSTALL floor anchors using the frame as a template.

D. PREPARE the floor for installation of the frame by verifying that all paint, dirt, oil, and other foreign matter has been removed, using approved decontamination cleaning solutions and mechanical/abrasive means, e.g. scraping.

(Preparation Verified - East) FE Initial: _____ Date: _____
(Preparation Verified - West) FE Initial: _____ Date: _____

E. APPLY the epoxy adhesive to the floor/frame mating area per the manufacturer's instructions, then IMMEDIATELY install the floor frame.

F. TIGHTEN the fasteners using an alternating tightening sequence to prevent racking or twisting of the frame.

G. VERIFY again that the floor frame is installed properly, assuring that the frame-to-seal plate mating surface is in the same plane and the corners are square.

(Installation Verified - East) FE Initial: _____ Date: _____
(Installation Verified - West) FE Initial: _____ Date: _____

5.6.2 Installation of the Shot Well Seal Plates

A. CLEAN and PREPARE the mating surfaces of the plates and frame for application of the sealant/primer, using approved decontamination cleaning solutions and mechanical/abrasive means, e.g. scraping.

(Preparation Verified - East) FE Initial: _____ Date: _____
(Preparation Verified - West) FE Initial: _____ Date: _____

B. APPLY two (2) beads of GE RTV157™ or equivalent to the full perimeter of the Seal Plate Frame. One bead shall be applied outside of the frame bolt pattern and the other bead inside of the bolt pattern.

C. INSTALL the 1/8" thick spacing washers and tighten fasteners HAND TIGHT.

D. TIGHTEN Seal Plate fasteners using an alternating criss-cross tightening sequence until the Seal Plate is fully tightened to the frame mating surface the as shown on Attachment 8.5.

(Installation Verified - East) FE Initial: _____ Date: _____
(Installation Verified - West) FE Initial: _____ Date: _____

Note: *The openings for the (3) Scanner Slots and the Removable Plug Openings shall be sealed using 1/4" (min.) thick aluminum plate bolted to a 1/2" steel sealing flange. This sealing flange is screwed and bonded to the existing embedded steel angle that reinforces the openings. The face-to-face sealing of the Seal Plates to the Sealing Flange will be accomplished using GE Sealant RTV157™ or equal.*

5.6.3 Installation of Sealing Flange on the Scanner Slot Openings

A. Thoroughly CLEAN the surface of the reinforcing steel edging in the perimeter opening for the Scanner Slots.

B. DRILL and TAP the reinforcing edging for 1/4"-20 using the sealing flange as a template. Holes shall be spaced no more than 16" apart in the field and no more than 1" from either end.

C. VERIFY that the mating surfaces of the steel edging and the sealing flange are clean, using approved decontamination cleaning solutions and mechanical/abrasive means, e.g. scraping.

(Preparation Verified - South) FE Initial: _____ Date: _____
(Preparation Verified - Center) FE Initial: _____ Date: _____
(Preparation Verified - North) FE Initial: _____ Date: _____

Note: *The ends of the individual sealing flange pieces have a 45° bevel. Make sure the bevel is facing up on the end to accept the bevel on the next piece to be installed.*

D. APPLY a full continuous bead of epoxy adhesive to the steel edging, then immediately install the sealing flange using 1/4"-20UNC flathead cap screws. DO NOT OVERTIGHTEN.

E. REPEAT Steps A. through D. above. APPLY the epoxy adhesive to the mating edge of the beveled end to seal to the previously installed piece.

F. REPEAT all above steps until the Scanner Slot Sealing Flange is installed.

(Installation Verified - South) FE Initial: _____ Date: _____
(Installation Verified - Center) FE Initial: _____ Date: _____
(Installation Verified - North) FE Initial: _____ Date: _____

5.6.4 Installation of the Scanner Slot Seal Plates

A. VERIFY radiological and hazardous characterization completed per Reference 7.5 for the scanner slots.

FE Initial: _____ Date: _____

B. LAYOUT the Seal Plates on the Seal Plate Frame assuring that plates align with the frame.

C. Using the plates as a template, DRILL and TAP the Seal Plate Frame for 3/8"-16UNC at 12" (max.) field spacing and no more than 2" from the ends on the frame per Attachment 8.4.

D. REMOVE the plates and drill out the fastener holes to 7/16" to accommodate the 3/8" fasteners.

NOTE: *The following steps (E through K) apply to one Seal Plate. Install only one plate at a time, and repeat the steps as necessary.*

E. CLEAN and PREPARE the mating surfaces of the plates and frame for application of the sealant/primer, using approved decontamination cleaning solutions and mechanical/abrasive means, e.g. scraping.

(Preparation Verified - South) FE Initial: _____ Date: _____
(Preparation Verified - Center) FE Initial: _____ Date: _____
(Preparation Verified - North) FE Initial: _____ Date: _____

F. INSTALL four (minimum) temporary 1/2" thick spacers on the frame perimeter to prevent inadvertent plate contact with the sealant.

G. APPLY two (2) beads of GE RTV157™ or equivalent to the full perimeter of the Seal Plate Frame. One bead shall be applied outside of the frame bolt pattern and the other bead inside of the bolt pattern.

H. INSTALL the 1/8" thick spacer washers.

I. INSTALL the fasteners HAND TIGHT then REMOVE the spacers installed in Step F. above.

(Spacers Removed - South) FE Initial: _____ Date: _____
(Spacers Removed - Center) FE Initial: _____ Date: _____
(Spacers Removed - North) FE Initial: _____ Date: _____

J. TIGHTEN Seal Plate fasteners using an alternating criss-cross tightening sequence until the Seal Plate is fully tightened to the frame mating surface the as shown on Attachment 8.5.

K. Visually INSPECT the full perimeter of the frame-to-plate mating surface to confirm a full bead of sealant.

(Preparation Verified - South #1) FE Initial: _____ Date: _____
(Preparation Verified - South #2) FE Initial: _____ Date: _____
(Preparation Verified - South #3) FE Initial: _____ Date: _____

(Preparation Verified - Center #1) FE Initial: _____ Date: _____
(Preparation Verified - Center #2) FE Initial: _____ Date: _____
(Preparation Verified - Center #3) FE Initial: _____ Date: _____

(Preparation Verified - North #1) FE Initial: _____ Date: _____
(Preparation Verified - North #2) FE Initial: _____ Date: _____
(Preparation Verified - North #3) FE Initial: _____ Date: _____

L. REPEAT Steps B through K as necessary for the remaining plates.

M. INSTALL the 2" wide joint sealing strap with GE RTV157™ and self-tapping sheet metal screws.

N. Visually INSPECT the completed installation (all plates installed).

(Installation Verified - South) FE Initial: _____ Date: _____
(Installation Verified - Center) FE Initial: _____ Date: _____
(Installation Verified - North) FE Initial: _____ Date: _____

5.6.5 Installation of the Perimeter Sealing Flange on the Removable Plug Openings

A. Thoroughly CLEAN the surface of the reinforcing steel edging in the perimeter opening for the removable plugs.

B. DRILL and TAP the reinforcing edging for 1/4"-20 using the sealing flange as a template. Holes shall be spaced no more than 16" apart in the field and no more than 1" from either end.

C. VERIFY that the mating surfaces of the steel edging and the sealing flange are clean.

(Preparation Verified - South) FE Initial: _____ Date: _____
(Preparation Verified - West) FE Initial: _____ Date: _____
(Preparation Verified - North) FE Initial: _____ Date: _____
(Preparation Verified - East) FE Initial: _____ Date: _____

Note: *The ends of the individual sealing flange pieces have a 45° bevel. Make sure the bevel is facing up on the end to accept the bevel on the next piece to be installed.*

D. APPLY a full continuous bead of epoxy adhesive to the steel edging, then immediately install the sealing flange using 1/4"-20UNC flathead cap screws. DO NOT OVERTIGHTEN.

E. REPEAT Steps A. and D. above. APPLY the epoxy adhesive to the mating edge of the beveled end to seal to the previously installed piece.

F. REPEAT all above steps until the full Perimeter Sealing Flange is installed.

(Installation Verified - South) FE Initial: _____ Date: _____
(Installation Verified - West) FE Initial: _____ Date: _____
(Installation Verified - North) FE Initial: _____ Date: _____
(Installation Verified - East) FE Initial: _____ Date: _____

G. INSTALL the intermediate Sealing Flanges (inside the Perimeter Sealing Flange). Do not fasten the flanges to the floor as they will have to be adjusted to align with the Seal Plates.

5.6.6 Installation of the Removable Plug Opening Seal Plates

A. VERIFY radiological and hazardous characterization completed per Reference 7.5 for the openings to be sealed in this section.

FE Initial: _____ Date: _____

B. LAYOUT the Seal Plates on the Seal Plate Frame assuring that plates align with the frame. ADJUST the Intermediate Sealing Flanges as necessary to align with the plates.

C. Using the plates as a template, DRILL and TAP the Seal Plate Frame for 3/8"-16UNC at 12" (max.) field spacing and no more than 2" from the ends on the frame per Attachment 8.4.

D. REMOVE the plates and drill out the fastener holes to 7/16" to accommodate the 3/8" fasteners.

NOTE: *The following steps (E through J) apply to one Seal Plate. Install only one plate at a time, and repeat the steps as necessary.*

E. CLEAN and PREPARE the mating surfaces of the plates and frame for application of the sealant/primer, using approved decontamination cleaning solutions and mechanical/abrasive means, e.g. scraping.

(Preparation Verified #1) FE Initial: _____ Date: _____
(Preparation Verified #2) FE Initial: _____ Date: _____
(Preparation Verified #3) FE Initial: _____ Date: _____
(Preparation Verified #4) FE Initial: _____ Date: _____
(Preparation Verified #5) FE Initial: _____ Date: _____
(Preparation Verified #6) FE Initial: _____ Date: _____
(Preparation Verified #7) FE Initial: _____ Date: _____
(Preparation Verified #8) FE Initial: _____ Date: _____
(Preparation Verified #9) FE Initial: _____ Date: _____
(Preparation Verified #10) FE Initial: _____ Date: _____
(Preparation Verified #11) FE Initial: _____ Date: _____
(Preparation Verified #12) FE Initial: _____ Date: _____
(Preparation Verified #13) FE Initial: _____ Date: _____

F. INSTALL four (minimum) temporary 1/2" thick spacers on the frame perimeter to prevent inadvertent plate contact with the sealant.

G. APPLY two (2) beads of GE RTV157™ or equivalent to the full perimeter of the Seal Plate Frame. One bead shall be applied outside of the frame bolt pattern and the other bead inside of the bolt pattern.

H. INSTALL the 1/8" thick spacer washers.

I. INSTALL the fasteners HAND TIGHT then REMOVE the spacers installed in Step F. above.

(Spacers Removed #1) FE Initial: _____ Date: _____
(Spacers Removed #2) FE Initial: _____ Date: _____
(Spacers Removed #3) FE Initial: _____ Date: _____
(Spacers Removed #4) FE Initial: _____ Date: _____
(Spacers Removed #5) FE Initial: _____ Date: _____
(Spacers Removed #6) FE Initial: _____ Date: _____
(Spacers Removed #7) FE Initial: _____ Date: _____
(Spacers Removed #8) FE Initial: _____ Date: _____
(Spacers Removed #9) FE Initial: _____ Date: _____
(Spacers Removed #10) FE Initial: _____ Date: _____
(Spacers Removed #11) FE Initial: _____ Date: _____
(Spacers Removed #12) FE Initial: _____ Date: _____
(Spacers Removed #13) FE Initial: _____ Date: _____

J. TIGHTEN Seal Plate fasteners using an alternating criss-cross tightening sequence until the Seal Plate is fully tightened to the frame mating surface the as shown on Attachment 8.5.

K. VISUALLY inspect the full perimeter of the frame-to-plate mating surface to confirm a full bead of sealant.

(Inspected #1) FE Initial: _____ Date: _____
(Inspected #2) FE Initial: _____ Date: _____
(Inspected #3) FE Initial: _____ Date: _____
(Inspected #4) FE Initial: _____ Date: _____
(Inspected #5) FE Initial: _____ Date: _____
(Inspected #6) FE Initial: _____ Date: _____
(Inspected #7) FE Initial: _____ Date: _____
(Inspected #8) FE Initial: _____ Date: _____
(Inspected #9) FE Initial: _____ Date: _____
(Inspected #10) FE Initial: _____ Date: _____
(Inspected #11) FE Initial: _____ Date: _____
(Inspected #12) FE Initial: _____ Date: _____
(Inspected #13) FE Initial: _____ Date: _____

L. REPEAT Steps B through K as necessary for the remaining plates.

M. VISUALLY inspect the completed installation (all plates installed).

(Inspected) FE Initial: _____ Date: _____

5.6.7 Sealing the Periscope Openings

A. Using the flanged seal caps as a template, INSTALL (4) 3/8" x 2" deep wedge anchors (Phillips "Redhead" or eq.) in the concrete floor.

B. PREPARE the floor for installation of the opening flanged seal caps by verifying that all paint, dirt, oil, and other foreign matter has been removed, using approved decontamination cleaning solutions and mechanical/abrasive means, e.g. scraping.

(East Prepared) FE Initial: _____ Date: _____
(Center Prepared) FE Initial: _____ Date: _____
(West Prepared) FE Initial: _____ Date: _____

C. VERIFY the mating sealing surfaces of the floor and the flanged seal caps are clean and free of all paint, dirt, oil, and other foreign matter.

(East Verified) FE Initial: _____ Date: _____
(Center Verified) FE Initial: _____ Date: _____
(West Verified) FE Initial: _____ Date: _____

D. APPLY two (2) beads of epoxy adhesive or equivalent to the full perimeter of the flanged seal cap. One bead shall be applied outside of the frame bolt pattern and the other bead inside of the bolt pattern.

E. INSTALL the seal cap fasteners. TIGHTEN fasteners using an alternating criss-cross tightening sequence until the cap is fully tightened to the floor mating surface the as shown on Attachment 8.5.

F. VERIFY installation of the caps.

(East Verified) FE Initial: _____ Date: _____
(Center Verified) FE Initial: _____ Date: _____
(West Verified) FE Initial: _____ Date: _____

5.7 Control Rod Drive (CRD) Openings

Note 1: *Refer to the Sealing Detail in Attachment 8.6.*

Note 2: *Work activities prescribed in this section are covered under the BGRR-ASA and require no USID/SE.*

5.7.1 West CRD Openings

CAUTION

The work activities prescribed in the following steps involve removal of the metal shield plates that are installed over the CRD openings. The requirements of the RWP and the JSA shall be strictly followed to control radiological exposure, the spread of contamination or exposure to hazardous substances.

A. VERIFY radiological and hazardous characterization completed per Reference 7.5 for the openings to be sealed in this section.

FE Initial: _____ Date: _____

Note: *The following steps apply to all CRD openings in the west face. Refer to Attachment 8.6 and verify the sealing of each opening by initialing and dating the appropriate sign-off block.*

B. REMOVE lead shield blocks to access the CRD opening in the bio-wall.

C. VERIFY that the new seal cap will fit over the CRD opening.

D. PREPARE the sealing surface by thoroughly cleaning.

E. APPLY sealant primer to the sealing surfaces per the manufacturer's instructions.

F. APPLY GE RTV157™ or equivalent he sealing surface.

G. INSTALL the sealing cap as shown on Attachment 8.6.

H. INSPECT for proper installation.

(Inspected #1) FE Initial: _____ Date: _____

(Inspected #2) FE Initial: _____ Date: _____

(Inspected #3) FE Initial: _____ Date: _____

(Inspected #4) FE Initial: _____ Date: _____

(Inspected #5) FE Initial: _____ Date: _____

(Inspected #6) FE Initial: _____ Date: _____

(Inspected #7) FE Initial: _____ Date: _____

(Inspected #8) FE Initial: _____ Date: _____

I. REPEAT steps B. through H. above for all CRD openings.

5.7.2 East CRD Openings

CAUTION

The work activities prescribed in the following steps involve removal of the metal shield plates that are installed over the CRD openings. The requirements of the RWP and the JSA shall be strictly followed to control radiological exposure, the spread of contamination or exposure to hazardous substances.

A. VERIFY radiological and hazardous characterization completed per Reference .5 for the openings to be sealed in this section.

FE Initial: _____ Date: _____

Note: *The following steps apply to all CRD openings in the east face. Refer to Attachment 8.6 and verify the sealing of each opening by initialing and dating the appropriate sign-off block.*

B. REMOVE lead shield blocks to access the CRD opening in the bio-wall.

C. VERIFY that the new seal cap will fit over the CRD opening.

D. PREPARE the sealing surface by thoroughly cleaning, using approved decontamination cleaning solutions and mechanical/abrasive means, e.g. scraping.

E. APPLY sealant primer to the sealing surfaces per the manufacturer's instructions.

F. APPLY silicone sealant to the sealing surface.

G. INSTALL the sealing cap as shown on Attachment 8.6.

H. INSPECT for proper installation.

(Inspected #9) FE Initial: _____ Date: _____

(Inspected #10) FE Initial: _____ Date: _____

(Inspected #11) FE Initial: _____ Date: _____

(Inspected #12) FE Initial: _____ Date: _____

(Inspected #13) FE Initial: _____ Date: _____

(Inspected #14) FE Initial: _____ Date: _____

(Inspected #15) FE Initial: _____ Date: _____

(Inspected #16) FE Initial: _____ Date: _____

I. REPEAT steps B. through H. above for all CRD openings.

6.0 RECORDS

File the Work Package and all supporting data and documentation in accordance with Reference 7.2.

7.0 REFERENCES

7.1 ERD-OPM-1.0, Procedure Development Requirements

7.2 ERD-OPM-4.5, Implementation, Control, and Configuration Management for BGRR Decommissioning Project Work Activities

7.3 ERD-OPM-4.6, Hazardous Materials Analysis for BGRR Decommissioning Activities

7.4 BNL Radiological Control Manual

7.5 ERD-BGRR-TP-00-07, Characterization Sampling Analysis Plan for the Pile, Associated Equipment and Area

7.6 ESH Std 4.3.0, Cutting and Welding

7.7 BGRR-DP Project Management Plan (PMP)

7.8 Hazard Classification and Auditable Safety Analysis (ASA) for the Brookhaven Graphite Research Reactor (BGRR) Decommissioning Project

7.9 USID/SE BGRR-SE-00-02, Seal Pile Openings at Bio-Wall

Drawings

M-701-16A, Access Hole for Pile Locking Device
M-702-181A, Sections of Shot Well
M-702-48C, Shot Well Charging Tube Details
M-702-183A, Location of Holes in Shield
M-702-16A, Door for Removable Core
M-702-18A, Small Chamber General Ass'y
M-702-27A, Large Chamber General Ass'y
M-702-36A, Pushing Machine General Ass'y
M-702-40A, Liquid Shutdown System
M-702-42A, Lead Shielding for Control Rod
M-702-43A, Pile Locking Device
M-702-45A, Pneumatic System Inst'l & Piping
M-702-46A, General Arrg't of Pneumatic Tubes
M-702-48A, Arrg't Plan & Elev.-Pneumatic Tube System

M-702-49A, Bottling Machine General Arrg't
M-702-50A, Bottling Machine Mechanism Arrg't
M-702-52A, Removable Plug Details
M-702-53A, Outer Hole Plug Ass'y & Details
M-702-54A, Removable Plug Details
M-702-55A, Removable Plug Details
M-702-59A, Gen. Arrg't of Shot Well
M-702-60A, Sections of Shot Well
M-702-68A, General Arrg't-Plugs for North and South
M-702-155A, Identification of Lattice Holes on WP Plates
M-702-162A, Plugs for Charging, Ion, Periscope & Pushing Holes
M-702-164A, Inner Graphite Plugs for Plenum Chamber Roof Slots
M-702-171A, Bottling Machine Details
M-702-172A, Bottling Machine Details
M-702-181A, Sections of Shot Well
M-702-10B, Periscope Hole Plug (North)
M-702-13B, Short Pushing Hole Plug Ass'y (North Wall)
M-702-15B, Ion Plug Ass'y & Experimental Plug Ass'y
M-702-16B, Experimental Plug Ass'y No. E-16
M-702-18B, Removable Core Plug Ass'y
M-702-19B, Detail of Pneumatic Tube Connection
M-702-21B, Arrg't of Animal & Ion Chamber
M-702-39B, Shot Well Assembly
M-702-41B, Experimental Plug Ass'y No.'s E-9, E-14, E-17, E-21 & E-23
M-702-42B, Pneumatic Tube System Isometric
M-702-44B, Pneumatic Tube System Removal Plug
M-702-45B, Periscope Plug Ass'y & Details
M-702-48B, Periscope Plug for Shot Well (at Gap)
M-702-50B, Removable Plug Ass'y for Holes I-1, I-2, I-3, I-4 & I-6
M-702-51B, Removable Plug Ass'y for Holes E-26, E-3
M-702-43C, Outer Plug for Experimental Holes
M-702-45C, Removable Shotwell (Gap) Plug (Ass'y)
M-702-14D, Drilling for Flanges on E & W Elev. For E & I Holes

8.0 ATTACHMENTS

8.1 Checklist for Sealing Pile Experimental Openings
8.2 Details for Sealing Pile
8.3 Pile Sealing Details - North & South Vertical Faces
8.4 Pile Sealing Details - Animal & Instrument Tunnel Openings
8.5 Pile Sealing Details - Roof Openings
8.6 Installation of Control Rod Drive (CRD) Opening Seal Plates
8.7 Special Equipment and Materials
8.8 Details for Sealing Pile West & East Faces
8.9 Salient Characteristics- GE RTV157™ & GE RTV159™ Sealants

9.0 DEFINITIONS/ACRONYMS

ACM	Asbestos Containing Material
ASA	Hazard Classification and Auditable Safety Analysis
BGRR-DP	Brookhaven Graphite Research Reactor Decommissioning Project
ESH&Q	Environment, Safety, Health and Quality
HEPA	High Efficiency Particulate Absolute

Attachment 8.1
Checklist for Sealing Pile Experimental Openings
Page 1 of 6

East Wall, Sheet 1 of 3

PENETRATION ID/DESCRIPTION	SEALING METHOD	FIELD ENGINEER VERIFY BELOW BY INITIAL/DATE			
		SEALING SURFACES PREPARED	SEALANT APPLIED	SEALING COMPLETE	FINAL INSPECTION
I-1	A				
I-2	A				
I-3	A				
I-4	A				
E-11	A				
E-12	A				
E-13	A				
E-14	A				
E-15	A				
E-16	A				
E-21	A				

Attachment 8.1
Checklist for Sealing Pile Experimental Openings
Page 2 of 6

East Wall, Sheet 2 of 3

PENETRATION ID/DESCRIPTION	SEALING METHOD	FIELD ENGINEER VERIFY BELOW BY INITIAL/DATE			
		SEALING SURFACES PREPARED	SEALANT APPLIED	SEALING COMPLETE	FINAL INSPECTION
E-22	A				
E-23	A				
E-24	A				
E-25	A				
E-26	A				
E-31	A				
E-32	A				
E-33	A				
E-34	A				
E-35	A				
E-36	A				
E-41	A				
E-42 Target Conv.	A Combined Cover				
E-42A Target Conv.					
E-43	A				
E-44	A				
E-45	A				
E-46	A				
E-51	A				
E-52	A				

Attachment 8.1
Checklist for Sealing Pile Experimental Openings
Page 3 of 6

East Wall, Sheet 3 of 3

PENETRATION ID/DESCRIPTION	SEALING METHOD	FIELD ENGINEER VERIFY BELOW BY INITIAL/DATE			
		SEALING SURFACES PREPARED	SEALANT APPLIED	SEALING COMPLETE	FINAL INSPECTION
E-53	A				
E-54	A				
E-55	A				
E-56	A				

Attachment 8.1
Checklist for Sealing Pile Experimental Openings
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West Wall, Sheet 1 of 3

PENETRATION ID/DESCRIPTION	SEALING METHOD	FIELD ENGINEER VERIFY BELOW BY INITIAL/DATE			
		SEALING SURFACES PREPARED	SEALANT APPLIED	SEALING COMPLETE	FINAL INSPECTION
I-5	A				
I-6	A				
I-7	A				
I-8	A				
W-11	A				
W-12	A				
W-13	A				
W-14	A				
W-15	A				
W-16	A				
W-21	A				

Attachment 8.1
Checklist for Sealing Pile Experimental Openings
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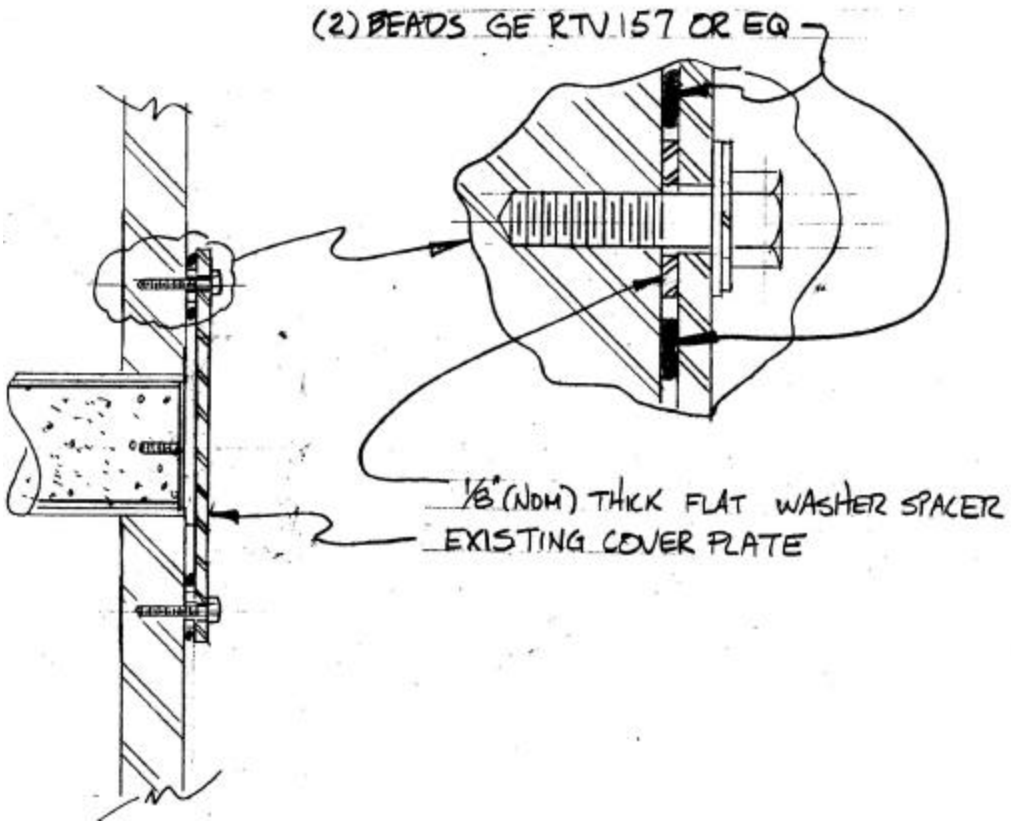
West Wall, Sheet 2 of 3

PENETRATION ID/DESCRIPTION	SEALING METHOD	FIELD ENGINEER VERIFY BELOW BY INITIAL/DATE			
		SEALING SURFACES PREPARED	SEALANT APPLIED	SEALING COMPLETE	FINAL INSPECTION
W-22	A				
W-23	A				
W-24	A				
W-25	A				
W-26	A				
W-31	A				
W-32	A				
W-33	A				
W-34	A				
W-35	A				
W-36	A				
W-41	A				
W-42	A				
W-42A	Combined Cover				
W-43	A				
W-44	A				
W-45	A				
W-46	A				
W-51	A				
W-52	A				

Attachment 8.1
Checklist for Sealing Pile Experimental Openings
Page 6 of 6

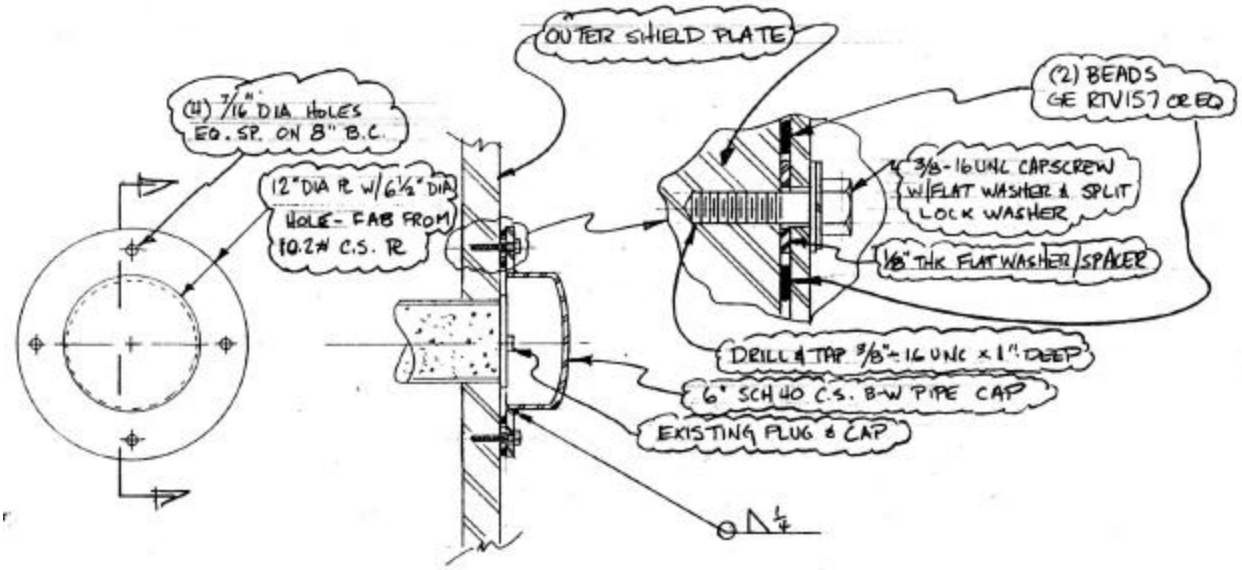
West Wall, Sheet 3 of 3

PENETRATION ID/DESCRIPTION	SEALING METHOD	FIELD ENGINEER VERIFY BELOW BY INITIAL/DATE			
		SEALING SURFACES PREPARED	SEALANT APPLIED	SEALING COMPLETE	FINAL INSPECTION
W-53	A				
W-54	A				
W-55	A				
W-56	A				
SW PLENUM ACCESS (UPPER)	B				
SW PLENUM ACCESS (LOWER)	B				
NW PLENUM ACCESS (LOWER ONLY)	B				



METHOD "A"

SEALING DETAILS - EAST & WEST EXPERIMENTAL HOLES



METHOD "B"

SEALING DETAILS - PLENUM ACCESS HOLES

NOTE:

FLANGED SEALING CAP WILL ALSO BE USED TO SEAL THE (3) PERISCOPE OPENINGS IN LOCATED IN THE BIO-WALL ROOF. (STEP 5.6.7)

Attachment 8.3
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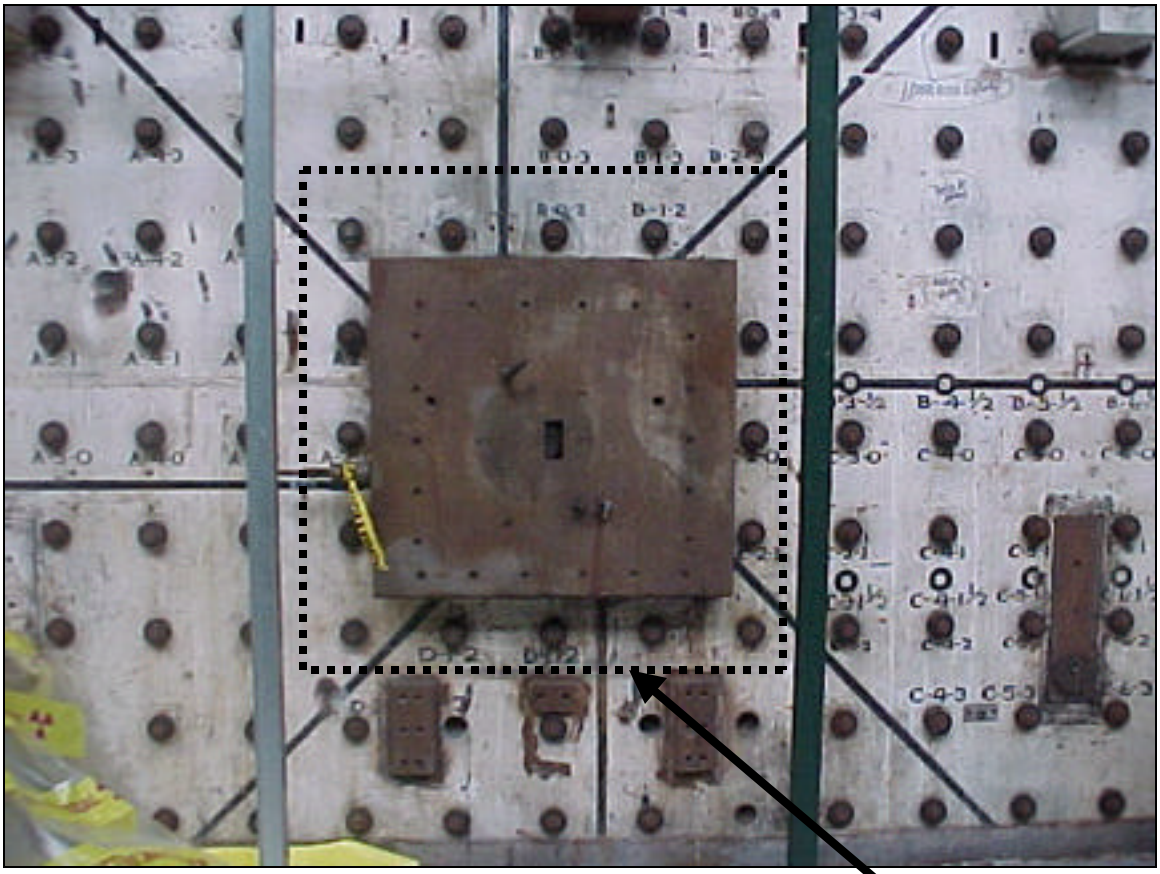
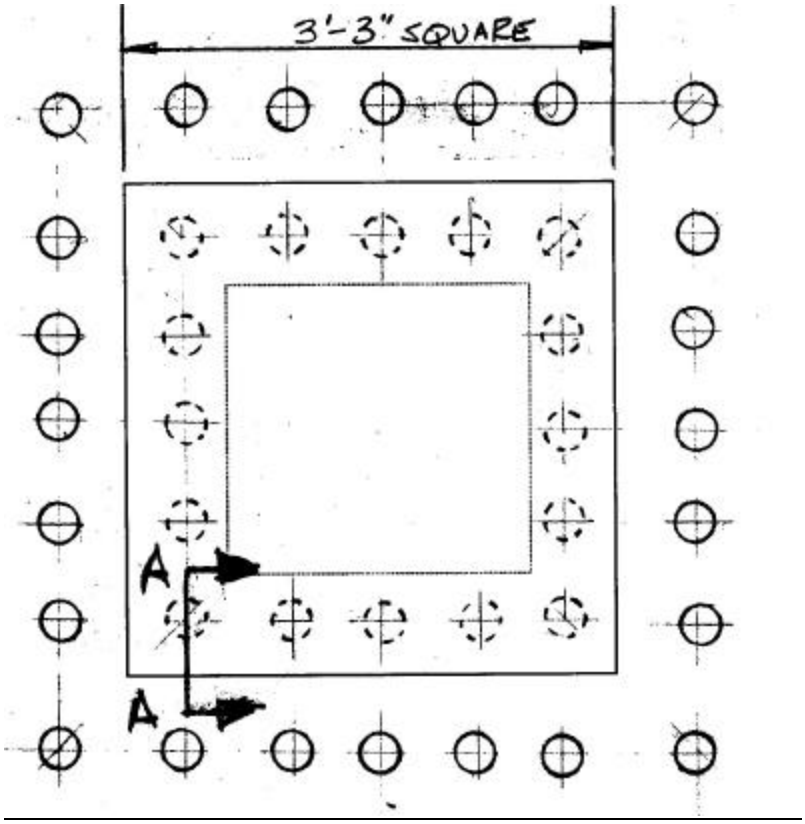
Removable Core Access-North Face

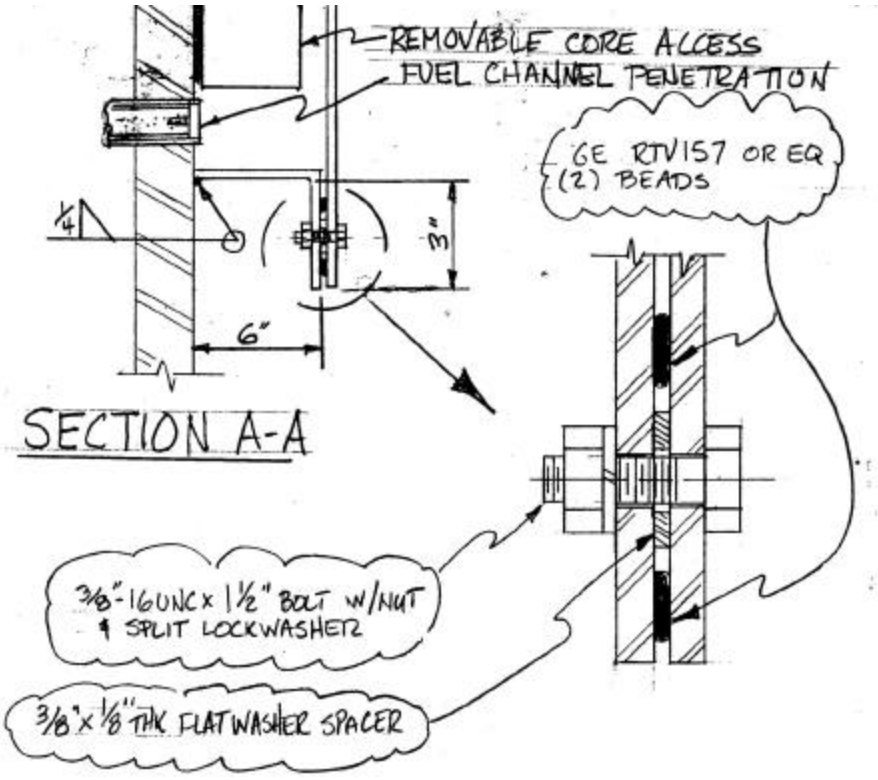


REMOVE PAINT FROM WALL, WELD SEAL FLANGE IN AREA SHOWN AND INSTALL SEAL PLATE



SEAL PLATE DETAIL - REMOVABLE CORE ACCESS COVER

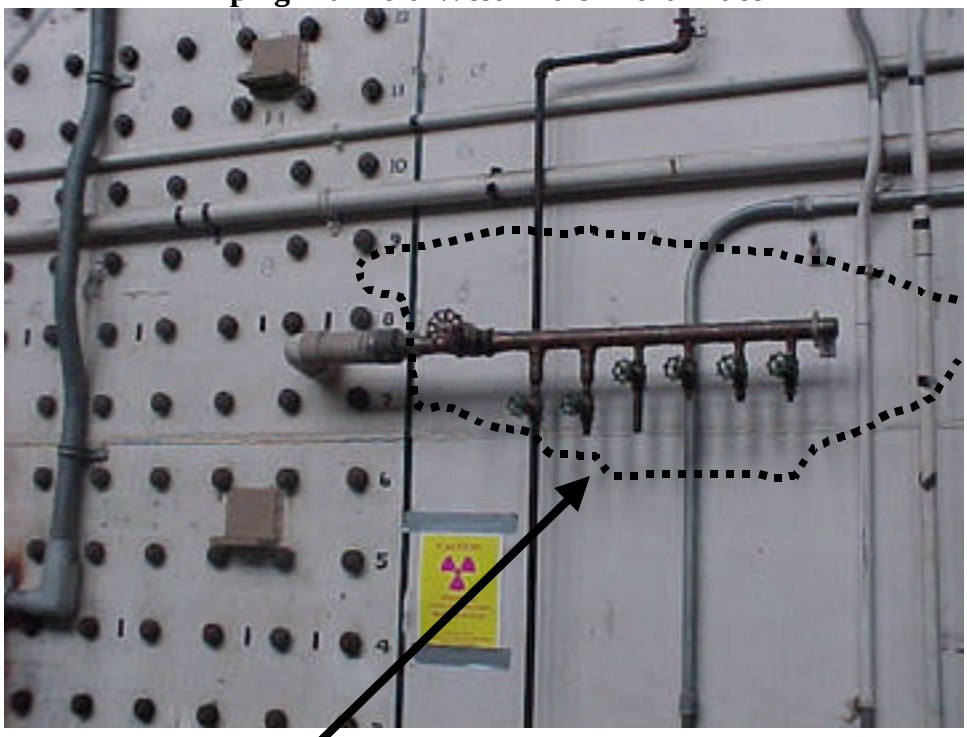
Removable Core Access-North Face
Seal Plate Details



SECTIONS - REMOVABLE CORE ACCESS SEAL PLATE & FRAME

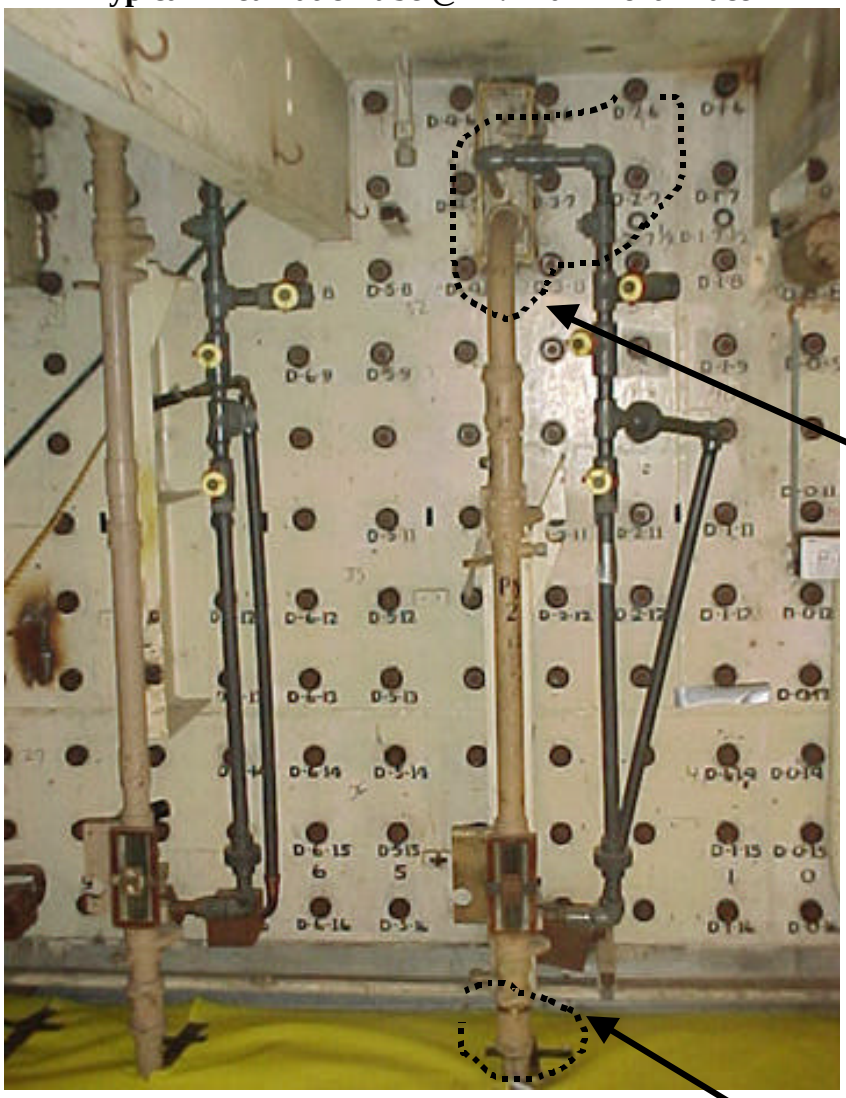
Piping Manifold-East End of North Face

Piping Manifold-West End of North Face

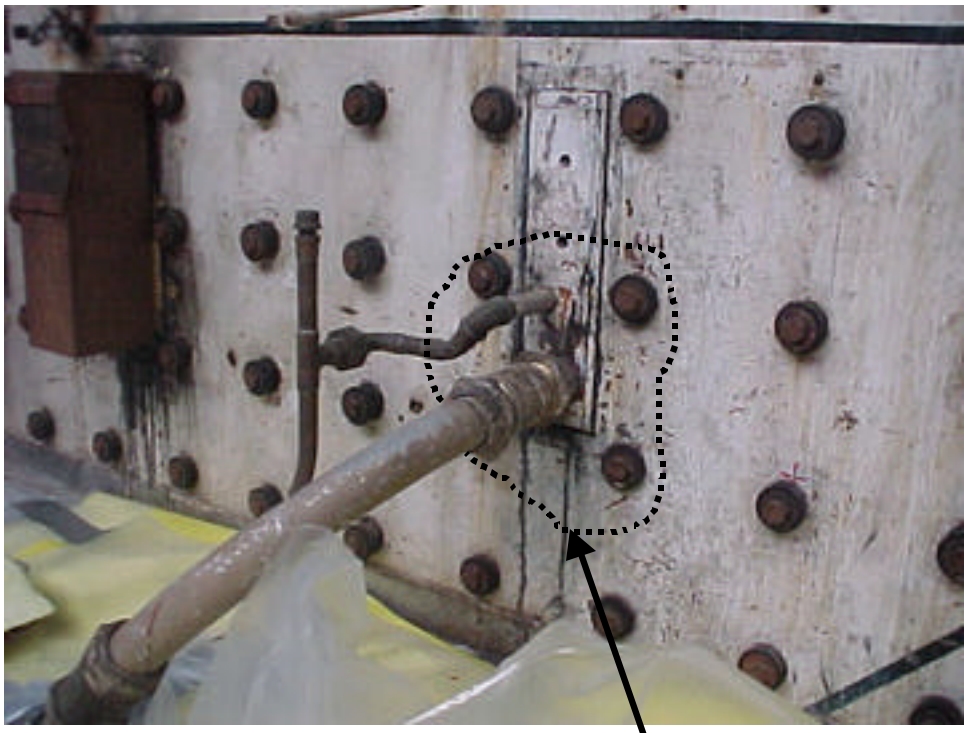


REMOVE ALL PIPING DOWNSTREAM OF THREADED FITTING AND INSTALL CAP

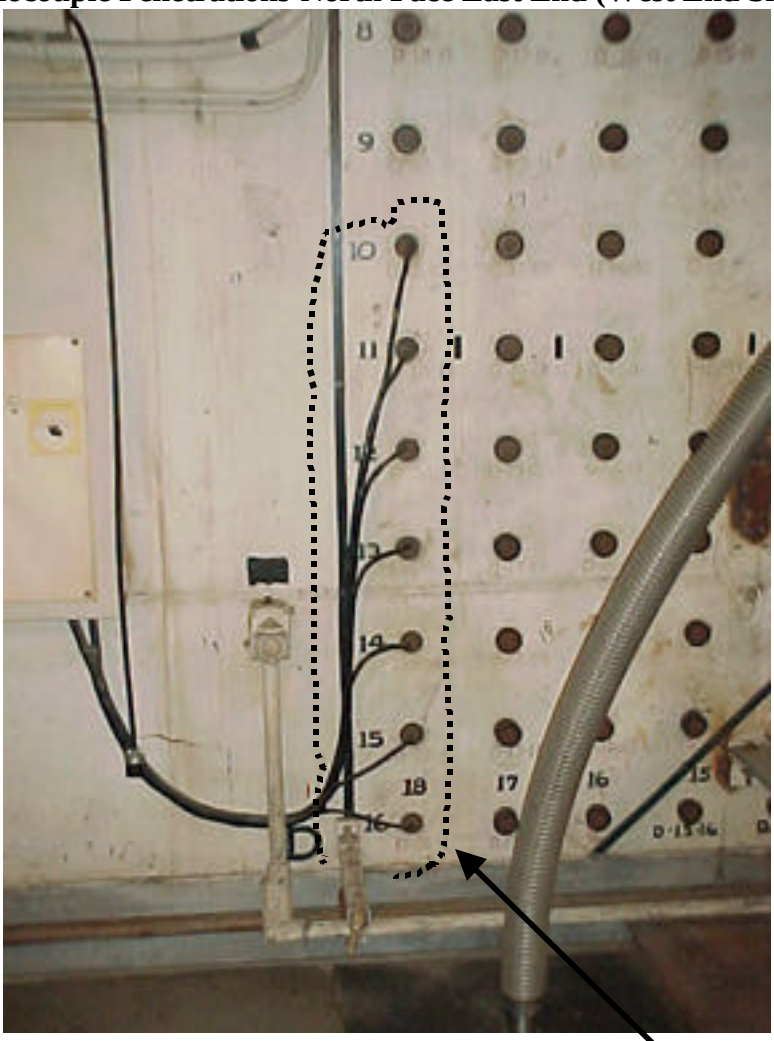
Typical Pneumatic Tube @ El. 110' - North Face



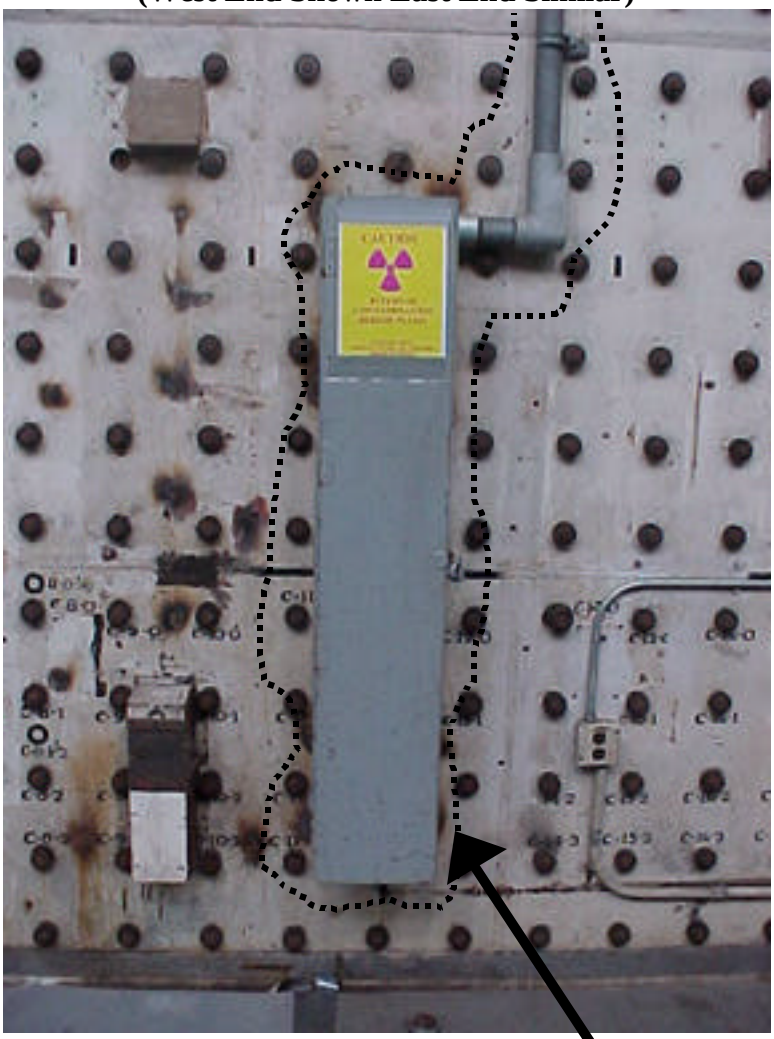
Pneumatic Tube at Mezzanine - North Face



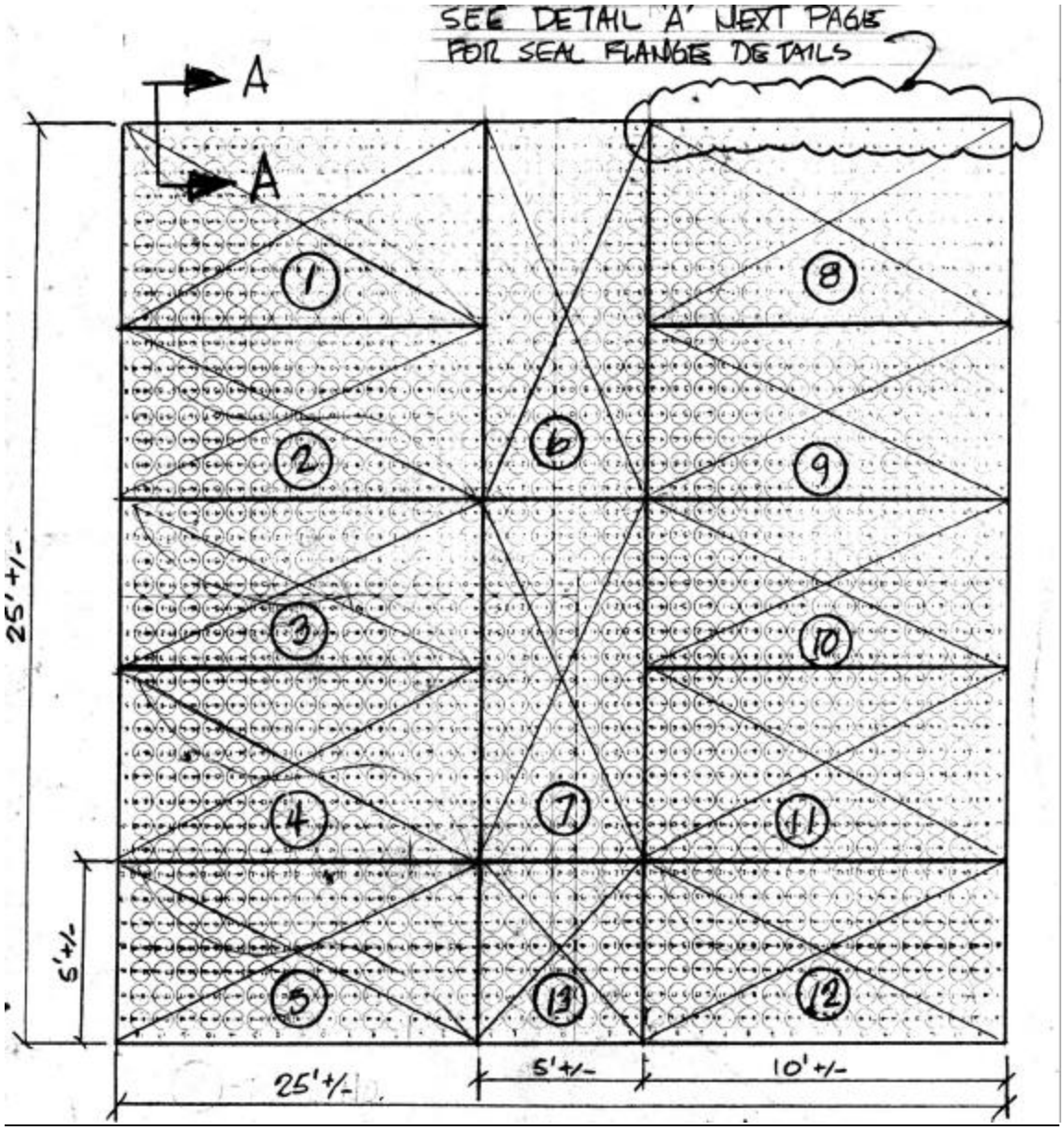
Thermocouple Penetrations-North Face East End (West End Similar)



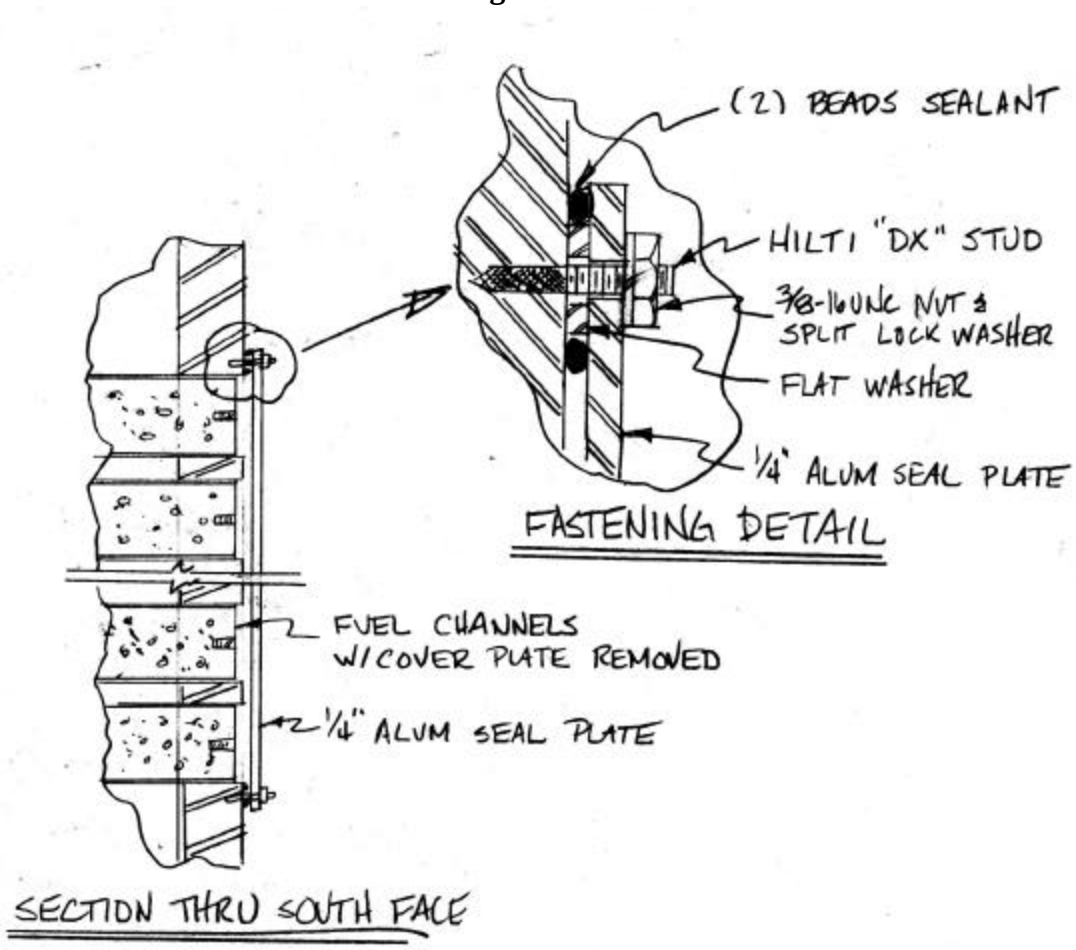
Electrical Enclosure & Penetrations North Face Upper Lever
(West End Shown East End Similar)



REMOVE ELEC. ENCLOSURE, CUT CABLES AT WALL, PUSH GROUT PLUG IN APPROX. 3/4", AND SEAL

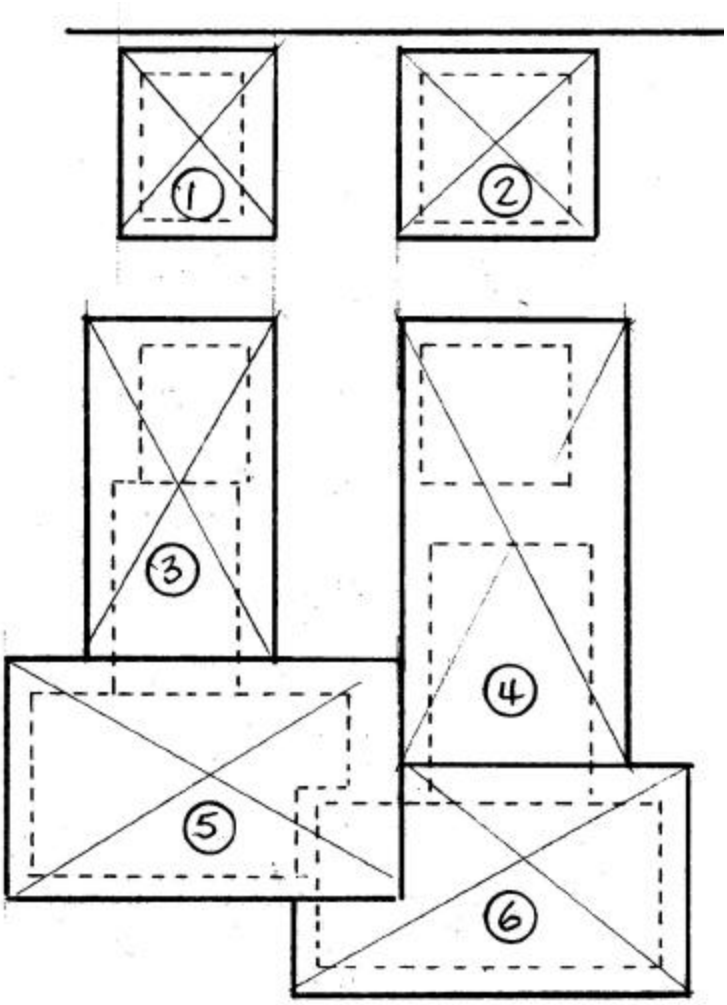


SEAL PLATE LAYOUT - SOUTH FACE
(NOTE: NO. OF PLATES DETERMINED IN FIELD)



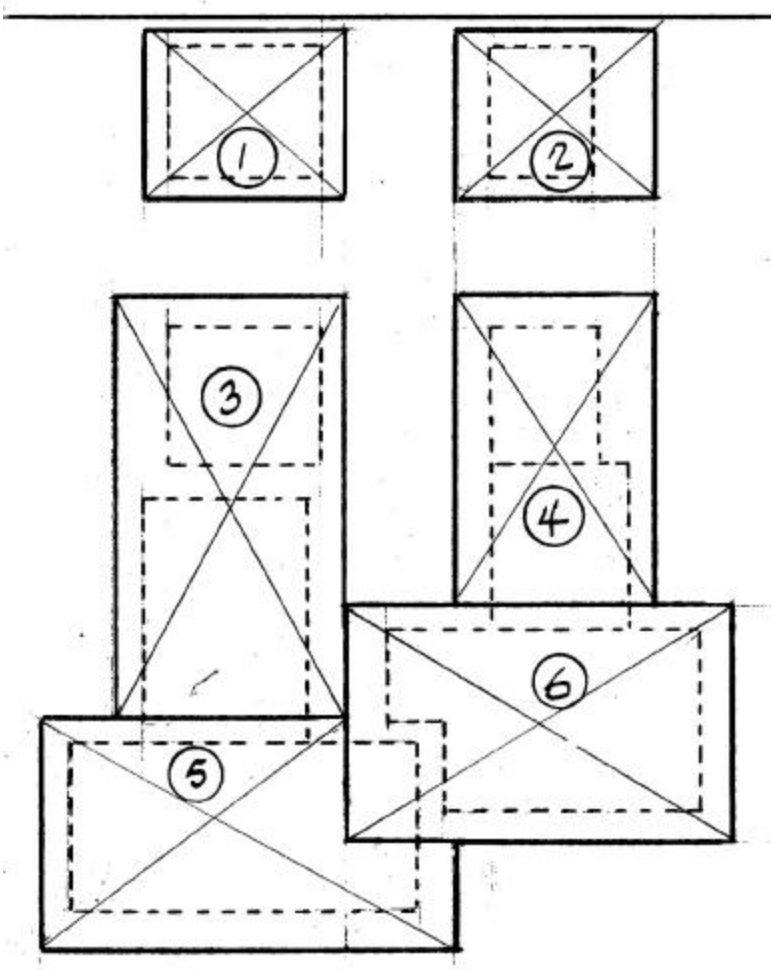
DETAIL " A"
SEAL PLATE ATTACHMENT - SOUTH FACE

Attachment 8.4
Page 1 of 3



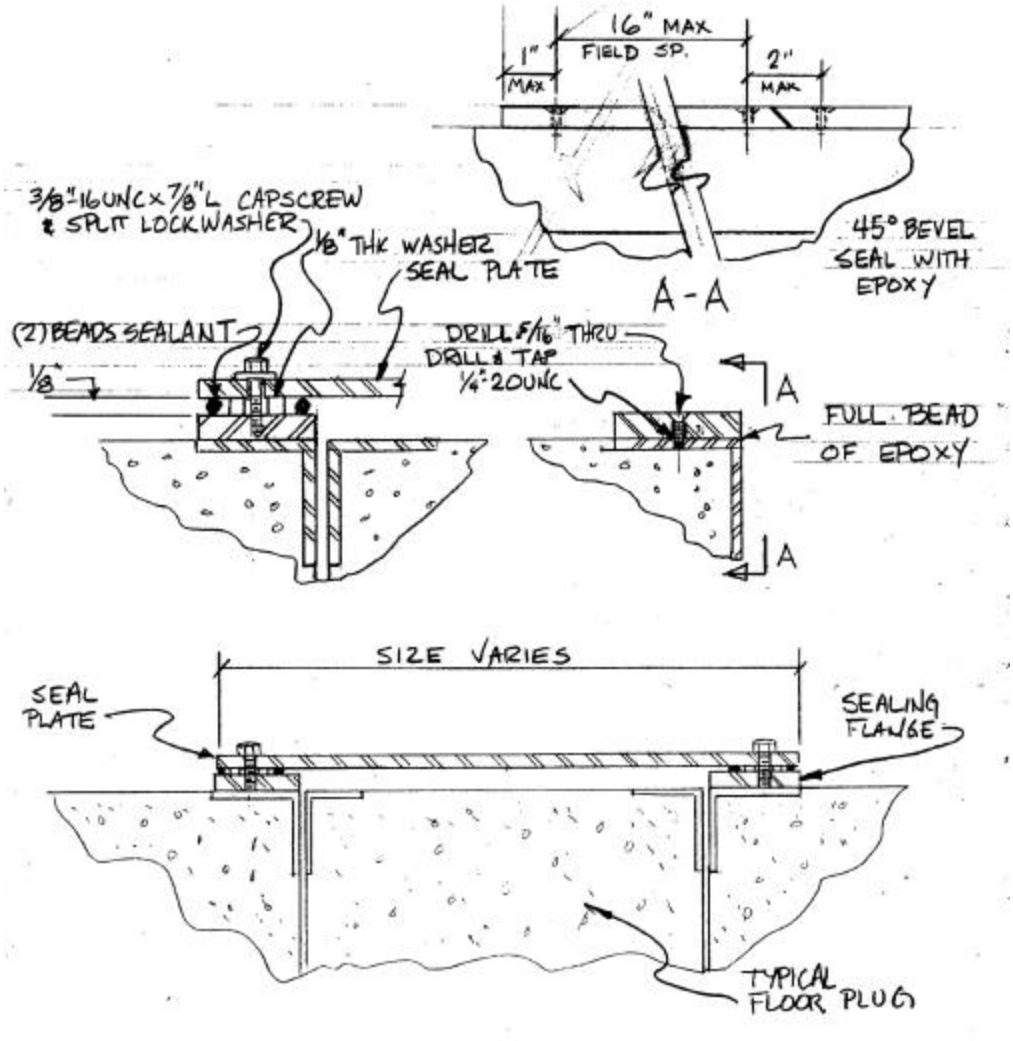
LAYOUT - ANIMAL & INSTRUMENT TUNNELS SEAL PLATES

EAST TUNNELS

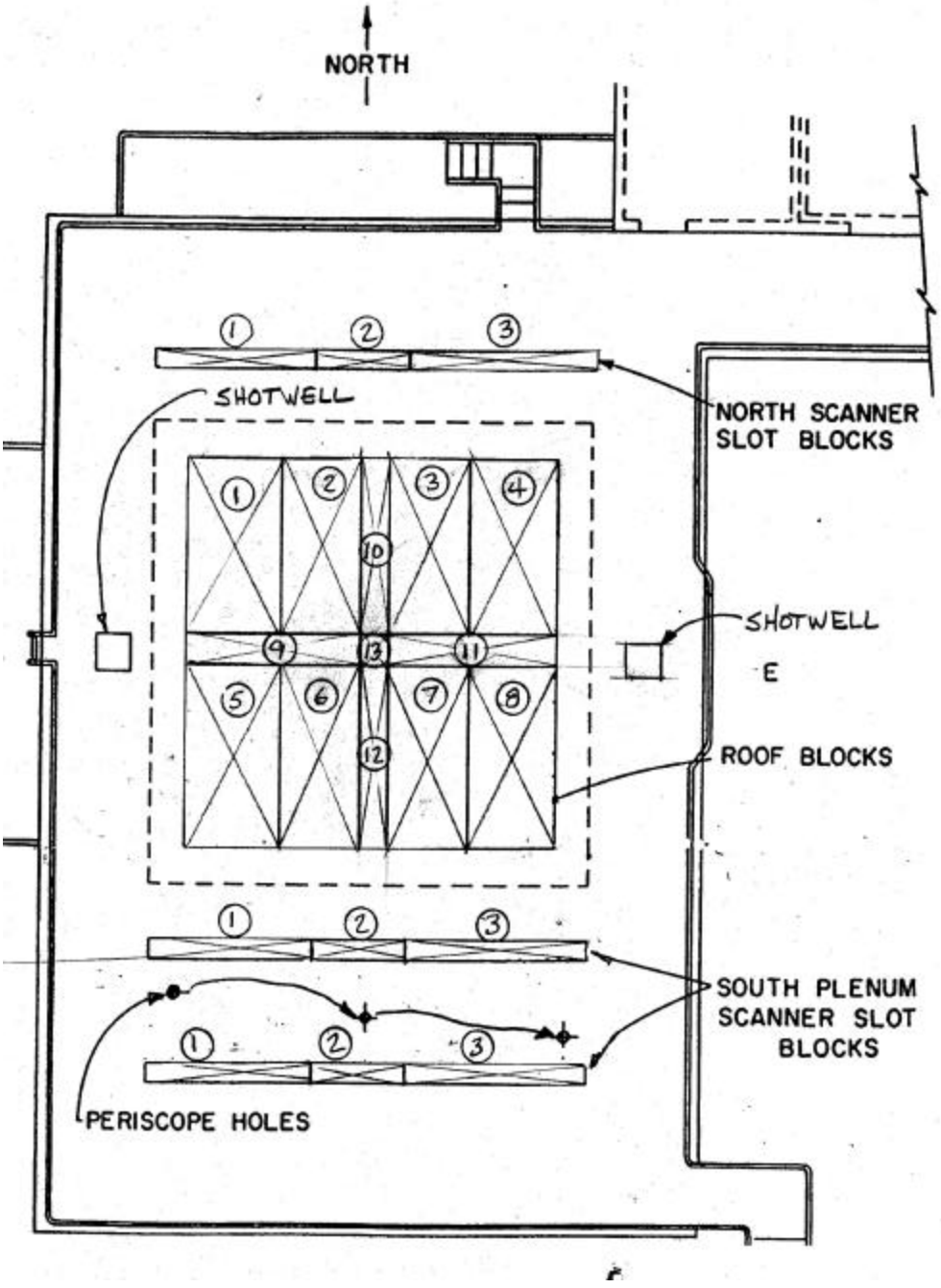


LAYOUT-ANIMAL & INSTRUMENT TUNNELS SEAL PLATES

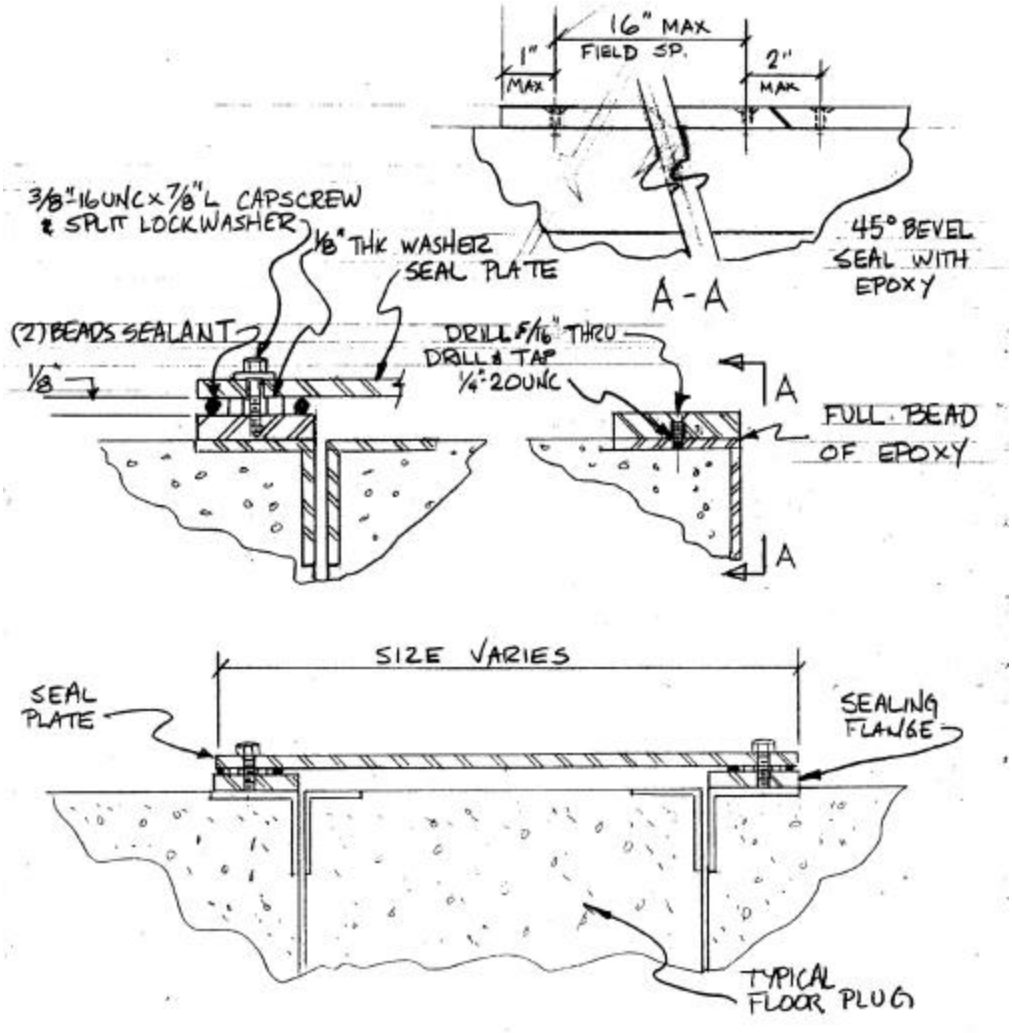
WEST TUNNELS



DETAILS-ANIMAL & INSTRUMENT TUNNELS SEAL PLATES & FRAMES
TYPICAL FOR EAST & WEST TUNNELS

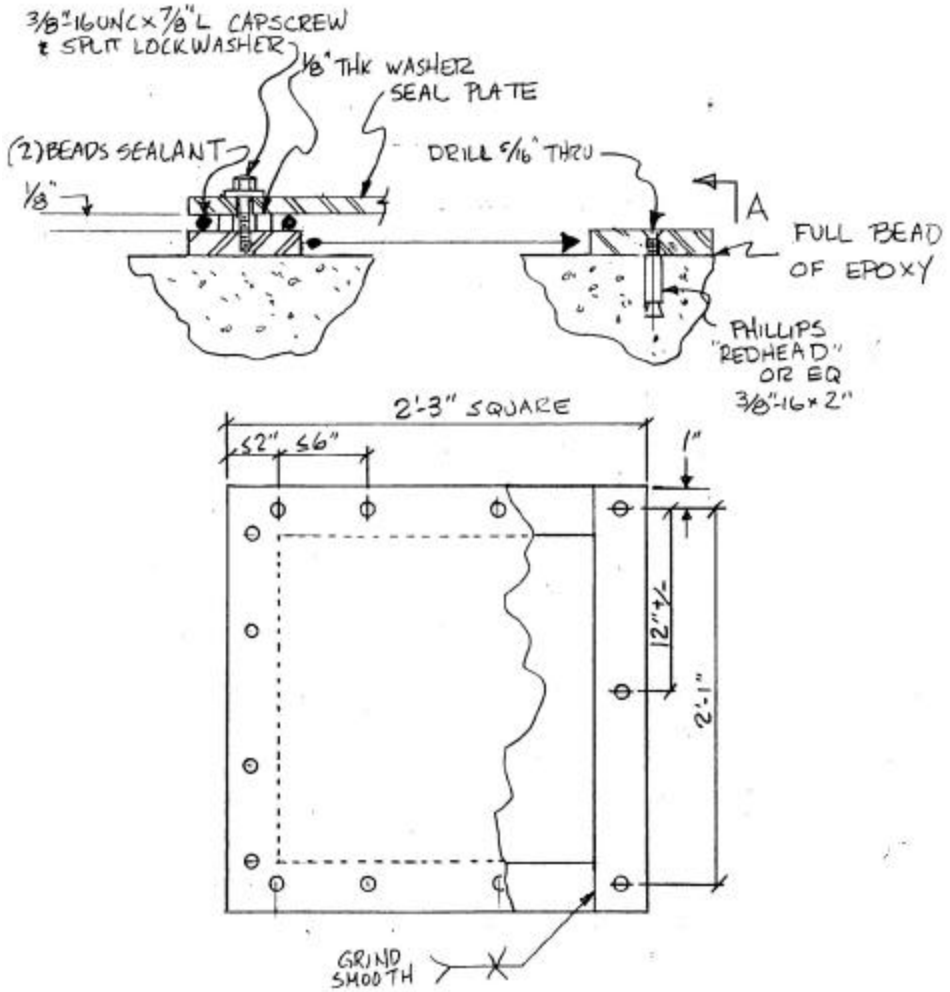


ROOF SEAL PLATE LAYOUT



DETAILS-PILE ROOF SEAL PLATES & FRAMES

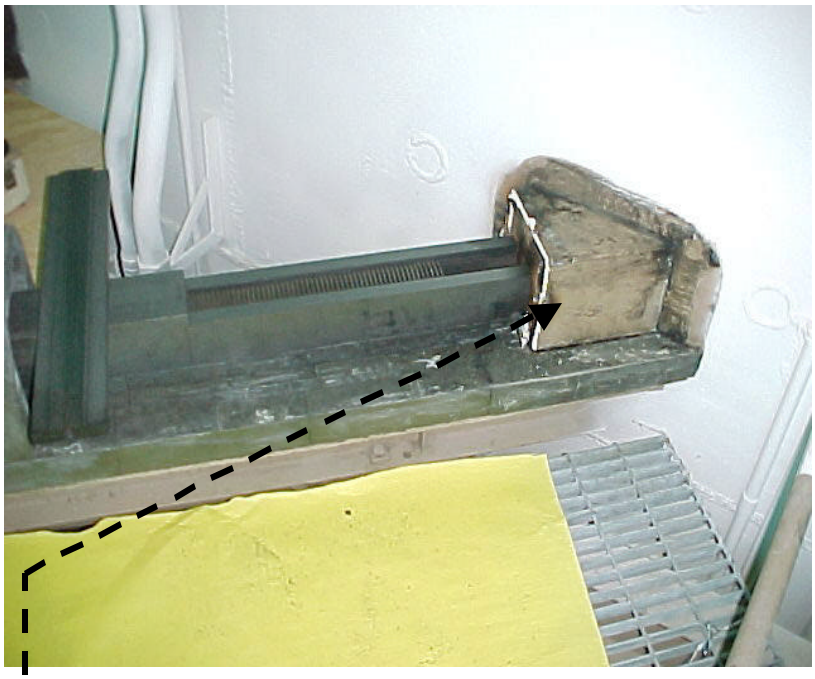
TYPICAL FOR ALL PLATES



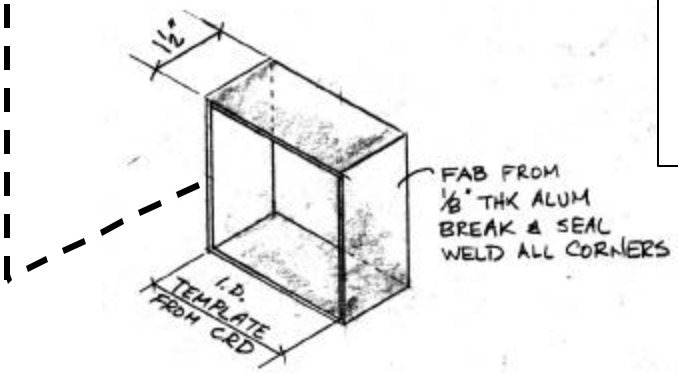
DETAILS - SHOT WELL SEAL PLATE & FRAME
TYPICAL FOR BOTH SHOT WELLS

Attachment 8.6
Page 1 of 2

Installation of Control Rod Drive (CRD) Opening Seal Plates



REMOVE GRAPHITE SHIELDS FROM OPENING AREA, CLEAN CRD OPENING, APPLY FULL LAYER OF GE RTV 157 INSIDE OF CAP, INSTALL SEAL CAP OVER CRD OPENING



CRD OPENING SEALING DETAILS
TYPICAL FOR (16) CRD'S

Installation of Control Rod Drive (CRD) Opening Seal Plates

Checklist for Sealing CRD Openings

PENETRATION ID/DESCRIPTION	LOCATION	FIELD ENGINEER VERIFY BELOW BY INITIAL/DATE			
		SEALING SURFACES PREPARED	SEALANT APPLIED	SEALING COMPLETE	FINAL INSPECTION
CRD-1	W				
CRD-2	W				
CRD-3	W				
CRD-4	W				
CRD-5	W				
CRD-6	W				
CRD-7	W				
CRD-8	W				
CRD-9	E				
CRD-10	E				
CRD-11	E				
CRD-12	E				
CRD-13	E				
CRD-14	E				
CRD-15	E				
CRD-16	E				

Attachment 8.7

Special Tools and Equipment
Page 1 of 1

DESCRIPTION	QTY	STEP
GE RTV157™ Silicone Sealant, or equal.	A/R	All
14" Dia. Sealing Plate for Experimental Holes	15	5.1, 5.2
Sealing Plates,1/4" Alum, from 5' x 10' sheets	35	5.3, 5.4, 5.5, 5.6
Sealant, Hilti Sealant FS-1	A/R	5.4
Epoxy Hi-Build #197, by Anti-Hydro-International, Inc. or equal	A/R	5.5, 5.6 , 5.7
6" SCH 40 Pipe Cap, Carbon Steel	13	5.1, 5.2, 5.6
Flat Bar, Steel, 40.8# x 2-1/2" W	A/R	5.5, 5.6
Angle, Steel, 3" x 3" x 1/4"	↓	5.3, 5.4
Wedge Anchor, 3/8" x 2" , Phillips "redhead" or equal	↓	5.6
Flat Washers for Spacer, 3/8" x 1/8" (nom) thk	↓	ALL
Capscrews, 3/8-16UNC x 7/8" (H-H or Phillips head)	↓	↓
Capscrews, 1/4"-20UNC x 3/4"	↓	↓
Lockwasher, Split, 3/8"	↓	↓
Plate, Steel, 20.2#	15 SF	5.1, 5.2, 5.3
Aluminum Plate, 1/8" thick	A/R	

Attachment 8.8
Checklist for Sealing North Face Fuel Channels
Page 1 of 4

FUEL CHANNEL QUADRANT A	FIELD ENGINEER/DESIGNEE VERIFY BELOW BY INITIAL/DATE																																							
	PREPARATION AND SEALING OF CHANNELS - FIELDENGINEER SHALL (√) EACH CHANNEL COMPLETE																																							FIELD ENGINEER FINAL INSPECTION
	SURFACE PREPARED - FIELD ENGINEER (√)																			SEALING COMPLETE - FIELD ENGINEER (SEALING COMPLETE - FIELD ENGINEER (√)																			
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	INITIAL/DATE
A-0-																																							
A-1-																																							
A-2-																																							
A-3-																																							
A-4-																																							
A-5-																																							
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A-13-																																							
A-15-																																							
A-16-																																							
A-17-																																							
A-18-																																							

Attachment 8.8
Checklist for Sealing North Face Fuel Channels
Page 2 of 4

FUEL CHANNEL QUADRANT B	FIELD ENGINEER/DESIGNEE VERIFY BELOW BY INITIAL/DATE																																										FIELD ENGINEER FINAL INSPECTION
	PREPARATION AND SEALING OF CHANNELS - FIELDENGINEER SHALL (√) EACH CHANNEL COMPLETE																																											
	SURFACE PREPARED - FIELD ENGINEER (√)																			SEALING COMPLETE - FIELD ENGINEER (SEALING COMPLETE - FIELD ENGINEER (√)																								
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	INITIAL/DATE
B-0-																																												
B-1-																																												
B-2-																																												
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B-18-																																												

Attachment 8.8
Checklist for Sealing North Face Fuel Channels

FUEL CHANNEL QUADRANT C	FIELD ENGINEER/DESIGNEE VERIFY BELOW BY INITIAL/DATE																																										FIELD ENGINEER FINAL INSPECTION
	PREPARATION AND SEALING OF CHANNELS - FIELDENGINEER SHALL (√) EACH CHANNEL COMPLETE																																											
	SURFACE PREPARED - FIELD ENGINEER (√)																			SEALING COMPLETE - FIELD ENGINEER (SEALING COMPLETE - FIELD ENGINEER (√)																									
C-0-	0	1	2	3	4	5	6	7	8	9	10	12	12	13	14	15	16	17	18	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	INITIAL/DATE
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
C-1-																																							
C-2-																																							
C-3-																																							
C-4-																																							
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C-13-																																							
C-15-																																							
C-16-																																							
C-17-																																							
C-18-																																							

Attachment 8.8
Checklist for Sealing North Face Fuel Channels
Page 4 of 4

FUEL CHANNEL QUADRANT D	FIELD ENGINEER/DESIGNEE VERIFY BELOW BY INITIAL/DATE																																									FIELD ENGINEER FINAL INSPECTION
	PREPARATION AND SEALING OF CHANNELS - FIELDENGINEER SHALL (√) EACH CHANNEL COMPLETE																																										
	SURFACE PREPARED - FIELD ENGINEER (√)																			SEALING COMPLETE - FIELD ENGINEER (SEALING COMPLETE - FIELD ENGINEER (√)																			
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	INITIAL/DATE
D-0-																																										
D-1-																																									
D-2-																																									
D-3-																																									
D-4-																																									
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D-18-																																									

Salient Characteristics
General Electric RTV157™ & GE RTV159 Sealants

UNCURED PROPERTIES:	**RTV157™**	**RTV159**
Consistency	Paste	Paste
Color	Gray	Red
Application Rate, g/min.	155	175
Specific Gravity	1.09	1.09
Tack-Free Time, minutes	45	45
CURED PROPERTIES:(1)	**RTV157™**	**RTV159**
Mechanical:		
Hardness, Shore A	28	28
Percent Elongation	825	825
Tensile Strength, kg/cm2 (lbs./in.2)	63.3 (975)	72.1 (1025)
Tear Strength, kg/cm, (lbs./in.)	17.0 (90)	15.2 (95)
Peel Strength, kg/cm, (lbs./in.)(2)	7.1 (60)	7.1 (60)
Electrical:		
Dielectric Strength, kv/mm (v/mil)	20.7 (525)	19.7 (500)
Dielectric Constant	2.9	2.6
Dissipation Factor	0.0009	0.0007
Volume Resistivity, ohm-cm	7.5 x 1014	1.1 x 1015
Thermal:(3)		
Brittle Point, °C (°F)	-60 (-75)	-60 (-75)
Maximum Continuous Operating Temperature ,°C (°F)	204 (400)	260 (500)
Maximum Intermittent Operating Temperature, °C (°F)	260 (500)	315 (600)
Additional Information:(3)		
Linear Shrinkage	1.0	1.0
Thermal Conductivity, cal/sec/cm2, °C/cm	.0005	.0005
(btu/hr/ft2, °F/ft)	(.12)	(.12)
Coefficient of Expansion cm/cm, °C	27 x 10-5	27 x 10-5
(in/in, °F)	(15 x 10-5)	(15 x 10-5)

(1) Cured 3 days at 25°C(77°F) and 50% relative humidity.
(2) Cured 7 days at 25°C(77°F) and 50% relative humidity. Substrate was alclad aluminum.
(3) Information is provided for customer convenience only. These properties are not tested on a routine basis.