EXPERIENCE-BASED SEISMIC QUALIFICATION OF ADVANCED TEST REACTOR SEISMIC CATEGORY I EQUIPMENT

prepared for

BATTELLE ENERGY ALLIANCE

Subcontract No. 00056063
Report No. 060230101-002
Revision 0

September 2008

prepared by

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EXECUTIVE SUMMARY

The Advanced Test Reactor is located at the Idaho National Laboratory. It is operated for the U.S. Department of Energy by Battelle Energy Alliance. The Advanced Test Reactor began operation in 1967. The original design of the Advanced Test Reactor for earthquake effects was based upon 1961 Uniform Building Code provisions for Seismic Zone 2.

Seismic criteria for nuclear facilities have evolved since the original design of the Advanced Test Reactor. Current U.S. Department of Energy seismic criteria are established in DOE-STD-1020-2002, *Natural Phenomena Hazard Design and Evaluation Criteria for DOE Facilities*. DOE/EH-0545, *Seismic Evaluation Procedure for Equipment in U.S. Department of Energy Facilities* provides procedures for experience-based seismic evaluation of certain generic categories of equipment consistent with the requirements of DOE-STD-1020-2002.

ARES Corporation was contracted by Battelle Energy Alliance to perform the seismic qualification of Seismic Category I equipment at the Advanced Test Reactor for Performance Category-4 seismic criteria specified by DOE-STD-1020-2002. The scope of work for this project covered all Advanced Test Reactor safety-related equipment except for non-buried piping, equipment which is obviously not amenable to experience-based seismic qualification, and equipment with current seismic qualification documentation.

Seismic Category I equipment included in the scope of work were screened following DOE/EH-0545 procedures. Screening was performed through field walkdowns, quantitative analytical evaluations, and engineering judgment. Elements of the experience-based equipment seismic qualification included comparison of seismic capacity and seismic demand, equipment caveat screening, anchorage verification, and interaction screening. Most of the Seismic Category I equipment included in the scope of work were determined to be seismically qualified for Performance Category-4 seismic criteria.

Equipment components not satisfying the DOE/EH-0545 screening procedures were designated as outliers. Many of the outliers were seismically qualified for Performance Category-4 seismic criteria by implementing other methods besides experience-based procedures, including further review of earthquake experience data beyond that implicit in DOE/EH-0545, additional seismic analysis, and engineering judgment.

Outliers that remain unresolved were identified. Recommendations for further actions that may be taken to resolve these remaining outliers are provided in Table 7-1 of this report. Once these (or similar) actions are implemented, the outliers will be seismically qualified.

Table of Contents

1.0 INTRODUCTION 1
1.1 Background 1
1.2 Scope of Work 1
1.3 Report Organization 2
2.0 SEISMIC QUALIFICATION CRITERIA AND PROCEDURES 2
2.1 Overall Seismic Criteria 2
2.2 Design Basis Earthquake Ground Motion 3
2.3 Seismic Demand Spectrum 5
3.0 EQUIPMENT LIST AND DATABASE 6
4.0 FIELD WALKDOWNS 7
4.1.1 Seismic Review Team Composition 7
4.1.2 Pre-Walkdown Preparation 8
4.1.3 Walkdown Activities 8
4.1.4 Walkdown Documentation 8
5.0 EXPERIENCE-BASED EQUIPMENT SEISMIC QUALIFICATION 9
5.1 Comparison of Seismic Capacity and Seismic Demand 9
5.1.1 Experience-Based Seismic Capacity 9
5.1.2 Seismic Demand 13
5.1.3 Seismic Capacity-Versus-Demand Comparison 19
5.2 Equipment Caveat Screening 34
5.3 Anchorage Verification 34
5.4 Interaction Screening 38
5.4.1 Field Walkdown Observations 38
5.4.2 Quantitative Evaluation of Seismic Interaction Sources 47
5.5 Cable Tray Limited Analytical Review 58
5.6 Other Analytical Evaluations 65
5.7 Equipment Seismic Qualification Results 67
6.0 SEISMIC QUALIFICATION BY OTHER METHODS 80
6.1 Underground Firewater System 81
6.1.1 Condition Assessment 82
6.1.2 Evaluation of Seismic Wave Passage Effects 82
6.1.3 Evaluation of Thrust Restraint 87
6.1.4 Evaluation of Seismic Displacements at Piping Penetrations 87
6.1.5 Review of Earthquake Experience Data on Fire Hydrants and Valves 87
6.2 Deep Well Pumps 89
6.2.1 Review of Earthquake Experience Data 94
6.2.2 Geotechnical Evaluation 95
6.2.3 Review of Applicable Caveats for Vertical Pumps 95
6.2.4 Anchorage Evaluation 96
6.2.5 Pump Casing Evaluation 96
6.3 Small Valves and Mechanical Components 97

6.4 Control Room Switches 97
6.5 Other Resolved Outliers 97
7.0 RECOMMENDATIONS FOR FURTHER ACTIONS 99
8.0 CONCLUSIONS AND RECOMMENDATIONS 116
9.0 REFERENCES 116

APPENDICES

Appendix A
Seismic Category I Equipment Included in the Scope of Work

Appendix B
ATR Equipment Database (1 CD)

Appendix C
Listing of Calculations

Appendix D
Calculation No. 0602301.01-S-001, *Comparison of Seismic Demand to Seismic Experience Capacity*

Appendix E
Calculation No. 0602301.01-S-002, *Seismic Evaluation of the Seismic Category I Underground Firewater System*

Appendix F
Calculation No. 0602301.01-S-003, *Seismic Evaluation of Deep Well Pump Nos. 3 and 4*

Appendix G
Calculation No. 0602301.01-S-004, *Support Evaluation for Panel 670-E-67*

Appendix H
Calculation No. 0602301.01-S-005, *Seismic Evaluation of the TRA-770 Ventilation Stack*

Appendix I
Calculation No. 0602301.01-S-006, *Limited Analytical Review of Cable Tray Supports*

Appendix J
Calculation No. 0602301.01-S-007, *Seismic Evaluation of the Concrete Block and Shielding Walls in TRA-670*

Appendix K
Calculation No. 0602301.01-S-008, *Seismic Evaluation of Seismic Category I Relays*

Appendix L
Calculation No. 0602301.01-S-009, *Anchorage Evaluation for Group O-3*

Appendix M
Calculation No. 0602301.01-S-101, *Anchorage Evaluation For Group F-4*

Appendix N
Calculation No. 0602301.01-S-102, *Anchorage Evaluation For Group F-3*

Appendix O
Calculation No. 0602301.01-S-103, *Anchorage Evaluation For Groups W-4 and W-5*

Appendix P
Calculation No. 0602301.01-S-104, *Anchorage Evaluation For Group W-1*

Appendix Q
Calculation No. 0602301.01-S-105, *Anchorage Evaluation For Group F-10*

Appendix R
Calculation No. 0602301.01-S-106, *Anchorage Evaluation For Group F-15*

Appendix S
Calculation No. 0602301.01-S-107, *Anchorage Evaluation For Group F-6*

Appendix T
Calculation No. 0602301.01-S-108, *Anchorage Evaluation For Group F-1*

Appendix U
Calculation No. 0602301.01-S-109, *Anchorage Evaluation For Group F-19*

Appendix V
Calculation No. 0602301.01-S-110, *Anchorage Evaluation For Group F-2*

Appendix W
Calculation No. 0602301.01-S-111, *Anchorage Evaluation For Group F-7*

Appendix X
Calculation No. 0602301.01-S-112, *Anchorage Evaluation For Group F-5*

Appendix Y
Calculation No. 0602301.01-S-113, *Anchorage Evaluation For Group F-12*

Appendix Z
Calculation No. 0602301.01-S-114, *Anchorage Evaluation For Group F-23*

Appendix AA
Calculation No. 0602301.01-S-115, *Anchorage Evaluation For Group F-20*

Appendix BB
Calculation No. 0602301.01-S-116, *Anchorage Evaluation For Group F-9*

Appendix CC
Calculation No. 0602301.01-S-117, *Anchorage Evaluation For Group F-14*

Appendix DD
Calculation No. 0602301.01-S-118, *Anchorage Evaluation For Group F-16*

Appendix EE
Calculation No. 0602301.01-S-119, *Anchorage Evaluation For Group F-26*

Appendix FF
Calculation No. 0602301.01-S-120, *Anchorage Evaluation For Group F-27*

Appendix GG
Calculation No. 0602301.01-S-121, *Anchorage Evaluation For Group F-22*

Appendix HH
Calculation No. 0602301.01-S-122, *Anchorage Evaluation For Group F-24*

Appendix II
Independent Peer Review Report by Dr. Robert P. Kennedy

List of Figures

Figure 2-1. PC-4 DBE Horizontal and Vertical Ground Response Spectra, 5% Damping, Top of Rock....4
Figure 2-2. PC-4 DBE Horizontal and Vertical Ground Response Spectra, 5% Damping, Top of Soil....5
Figure 5-1. Reference Spectrum....10
Figure 5-2. Extended Reference Spectrum....11
Figure 5-3. Batteries on Racks GERS....11
Figure 5-4. Battery Charger GERS....12
Figure 5-5. Distribution Panels GERS....12
Figure 5-6. Fluid-Operated Valve GERS....13
Figure 5-7. Node Locations for Substructure ISRS, Second Basement....14
Figure 5-8. Node Locations for Substructure ISRS, First Basement....15
Figure 5-9. Node Locations for Substructure ISRS from CJC-INL-C-003, First Floor....16
Figure 5-10. Node Locations for Substructure ISRS from CJC-INL-C-004, First Floor....17
Figure 5-11. Node Locations for Superstructure ISRS....18
Figure 5-12. Comparison of the Extended Reference Spectrum to SDS for Node 273....20
Figure 5-13. Comparison of the Extended Reference Spectrum to SDS for Node 1375....21
Figure 5-14. Comparison of the Extended Reference Spectrum to SDS for Node 626....22
Figure 5-15. Comparison of the Extended Reference Spectrum to SDS for Node 1666....23
Figure 5-16. Comparison of the Extended Reference Spectrum to SDS for Node 4219....24
Figure 5-17. Comparison of PC-4 DBE Ground Response Spectra at the Top of Soil to the Extended Reference Spectrum....25
Figure 5-18. Comparison of Battery GERS with SDS at Node 1234....28
Figure 5-19. Comparison of Fluid-Operated Valve GERS with SDS at Node 1234....29
Figure 5-20. Comparison of Battery Charger GERS with SDS at Node 1234....30
Figure 5-21. Constant Air Monitor Chained to the Floor....39
Figure 5-22. 670-E-23, 670-E-28, and Adjacent Non-Seismic Category I Components....40
Figure 5-23. Control Room Ceiling....41
Figure 5-24. Beam Clamps for Rod-Supported Utilities Near the Control Panels....42
Figure 5-25. Cables for Battery 670-E-59....43
Figure 5-26. Chained Gas Bottles....44
Figure 5-27. Air Accumulator at TRA-770....45
Figure 5-28. Unanchored Storage Locker Near Battery 11C....46
Figure 5-29. Unanchored Storage Locker in TRA-672....47
Figure 5-30. Mortar Joint at the Top of the Station Battery Room Enclosure Wall....49
Figure 5-31. Wall 1B-F5-1 Looking East....50

Figure 5-32. Door Frame Anchorage to Canal Wall....51
Figure 5-33. TRA-770 Ventilation Stack....53
Figure 5-34. RMSS Components at the Base of TRA-770....54
Figure 5-35. Vibration Isolators for Diesel Generators 670-M-42 and 670-M-43....56
Figure 5-36. Flexible Hose Connection for Diesel Generator Fuel Oil Lines....57
Figure 5-37. Coupling Connection for Diesel Generator Lube Oil Lines....58
Figure 5-38. Bounding Case Cable Tray Support 2B-C-1....59
Figure 5-39. Bounding Case Cable Tray Support 2B-C-2....60
Figure 5-40. Bounding Case Cable Tray Support 2B-C-3....61
Figure 5-41. Bounding Case Cable Tray Support 2B-C-4....62
Figure 5-42. Unistrut P3200 Concrete Inserts....63
Figure 5-43. Panel 670-E-67....66
Figure 5-44. Skid for Deep Well Pump No. 3 in TRA-650....67
Figure 6-1. Seismic Category I Underground Firewater System....81
Figure 6-2. Typical Fire Hydrant and Road Valve....88
Figure 6-3. Typical Post-Indicator Valve....89
Figure 6-4. Deep Well Pump No. 3....90
Figure 6-5. Discharge Piping for Deep Well Pump No. 3....91
Figure 6-6. Deep Well Pump No. 4....92
Figure 6-7. Discharge Piping for Deep Well Pump No. 4....93

List of Tables

Table 2-1. Experience Data Factors. 5
Table 5-1. Comparison of Seismic Capacity Using GERS and Seismic Demand 27
Table 5-2. Relay Capacities. 31
Table 5-3. Relay Seismic Evaluation Results. (3 sheets) 32
Table 5-4. Quantitative Anchorage Evaluation Results 37
Table 5-5. Concrete Block and Shielding Wall Groups. 48
Table 5-6. Concrete Block and Shielding Wall Demand-to-Capacity Ratios. 52
Table 5-7. Outliers for PC-4 Seismic Criteria. (12 sheets) 68
Table 6-1. Resolved Underground Firewater System Outliers. (3 sheets) 83
Table 6-2. Sources of Earthquake Damage 94
Table 6-3. Resolved Small Valve and Mechanical Component Outliers. 98
Table 6-4. Resolved Control Room Switch Outliers. 99
Table 6-5. Other Resolved Outliers. 99
Table 7-1. Recommendations for Further Actions to Resolve Remaining Outliers. (15 sheets) 100
Table 7-2. Seismic Category I Equipment in TRA-650 and TRA-672. 115
Table 7-3. Equipment Requiring Anchor Bolt Inspection. 115
Table C-1. Listing of Calculations that Do Not Evaluate Equipment Anchorage. C-3
Table C-2. Listing of Calculations Evaluate Equipment Anchorage. C-3

Acronyms

ARES	ARES Corporation
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ATR	Advanced Test Reactor
BEA	Battelle Energy Alliance
D/C	Demand-to-capacity
DBE	Design Basis Earthquake
DC	Direct current
DF	Design Factor
DOE	U.S. Department of Energy
EPRI	Electric Power Research Institute
GERS	Generic Equipment Ruggedness Spectrum
GIP	Generic Implementation Procedure
INL	Idaho National Laboratory
ISRS	in-structure response spectrum
LAR	Limited Analytical Review
MCC	motor control center
NC	Normally closed
NEP	Non-exceedance probabilities
NO	Normally open
NPH	Natural phenomena hazards
PC	Performance Category
PPS	Plant Protection System
QA	quality assurance
RCCC	Rod Clutch Coil Controller
RMSS	Radiation Monitoring and Seal System
RTC	Reactor Technology Complex
SCE	Seismic Capability Engineers
SDS	Seismic Demand Spectrum
SER	Sequence of Events Recorder
SEWS	Screening Evaluation Work Sheet
SF	Scale Factor
SQUG	Seismic Qualification Utility Group
SRSS	square-root-of-the-sum-of-the-squares
SRT	Seismic Review Team
SSCs	structures, systems, and components
TRA	Test Reactor Area
TRS	Test Response Spectrum
UBC	Uniform Building Code
ZPA	Zero Period Acceleration

1.0 INTRODUCTION

1.1 Background

The Advanced Test Reactor (ATR) is located at the Idaho National Laboratory (INL). It is operated for the U.S. Department of Energy (DOE) by Battelle Energy Alliance (BEA). The ATR began operation in 1967. The original design of the ATR for earthquake effects was based upon 1961 Uniform Building Code (UBC) provisions for Seismic Zone 2.

Seismic criteria for nuclear facilities have evolved since the original design of ATR. Current DOE seismic criteria are established in DOE-STD-1020-2002, *Natural Phenomena Hazard Design and Evaluation Criteria for DOE Facilities*. DOE/EH-0545, *Seismic Evaluation Procedure for Equipment in U.S. Department of Energy Facilities* provides procedures for experience-based seismic evaluation of certain generic categories of equipment consistent with the requirements of DOE-STD-1020-2002.

1.2 Scope of Work

ARES Corporation (ARES) was contracted by BEA to perform the seismic qualification of Seismic Category I equipment at the ATR. The scope of work for this project was established in SOW-4084, *Statement of Work for Experience-Based Seismic Qualification of ATR Equipment*. Attachment 2 of SOW-4084 provides a listing of equipment items to be addressed by this project. This list was intended to cover all ATR safety-related equipment except for non-buried piping, equipment which is obviously not amenable to experience-based seismic qualification, and equipment with current seismic qualification documentation.

The project scope of work is summarized as follows:

- A project plan establishing the overall project technical criteria, scope, organization, quality assurance requirements, and schedule was developed.
- A kickoff meeting attended by key members of the project team was held at ATR to review project objectives, activities, and issues.
- A database of equipment included in the scope of work was developed.
- Existing documentation on the equipment was collected.
- Field walkdowns were performed to implement the experience-based seismic qualification procedures and record data for further evaluations.
- Seismic qualification of the equipment based on comparison of seismic capacity and seismic demand, equipment caveat screening, anchorage verification, and interaction screening was performed.
- Seismic qualification of equipment by methods other than the application of experience data, including resolution of outliers, was performed.

- This report documenting the project was prepared.

1.3 Report Organization

This report documents the experience-based seismic qualification of ATR Seismic Category I equipment. The overall seismic qualification criteria and procedures are summarized in Section 2.0. An overview of the equipment included in the scope of work and the ATR equipment database is presented in Section 3.0. The field walkdowns are summarized in Section 4.0. The methodology and results for the experience-based seismic qualification are presented in Section 5.0. Implementation of other methods for seismic qualification is summarized in Section 6.0. Recommendations for future actions to address unresolved issues are identified in Section 7.0. Conclusions and recommendations obtained by this study are presented in Section 8.0. References cited in this report are listed in Section 9.0.

Appendix A contains a list of Seismic Category I equipment addressed by this project. A CD containing the ATR equipment database in Microsoft®[1] Access™[1] data base format and associated photos is included in Appendix B. Appendix C contains a list of calculations prepared in support of this report. These calculations are contained in Appendices D to HH. The report documenting the independent peer review of this project by Dr. Robert P. Kennedy is contained in Appendix II.

2.0 SEISMIC QUALIFICATION CRITERIA AND PROCEDURES

2.1 Overall Seismic Criteria

DOE-STD-1020-2002 provides design and evaluation criteria for DOE facilities against the effects of natural phenomena hazards (NPH), including earthquakes, tornados and extreme winds, and floods. DOE-STD-1020-2002 implements a graded approach. Structures, systems, and components (SSCs) are placed into one of five performance categories, each having a specified performance goal. Performance Category (PC)-0 has no special considerations. The NPH criteria vary with increasing rigor from PC-1 to PC-4.

Seismic qualification of the Seismic Category I equipment in the scope of work was performed for PC-4 seismic criteria. DOE-STD-1020-2002 permits some relief in the evaluation of existing SSCs which are close to meeting the target performance goals by using the NPH exceedance probability of twice the value specified for new design. This relief was not implemented in this project, but it remains as an alternative for resolution of outliers that do not quite satisfy PC-4 seismic criteria for new design (Section 7.0).

Seismic qualification of the Seismic Category I equipment in the scope of work implemented the experience-based procedures of DOE/EH-0545. These procedures were developed from the Seismic Qualification Utility Group (SQUG) Generic Implementation Procedure (GIP) with the intention of satisfying DOE-STD-1020-2002 seismic criteria. The DOE/EH-0545 procedures also address SSCs that were not included in the GIP, such as piping, heating, ventilation, and air conditioning ducting, and

[1] Microsoft and Access are trademarks or registered trademarks of Microsoft Corporation in the United States and other countries.

architectural features. In this project, selected outliers were resolved using further evaluation or engineering judgment as permitted by DOE/EH-0545.

When required, seismic analysis was performed following the requirements of ASCE 4-98, *Seismic Analysis of Nuclear Safety Related Structures and Commentary,* and ASCE/SEI 43-05, *Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities*. The requirements of DOE-STD-1020-2002 and DOE/EH-0545 were generally considered to take precedence over those of ASCE 4-98 and ASCE/SEI 43-05.

2.2 Design Basis Earthquake Ground Motion

DOE-STD-1020-2002 specifies that design and evaluation of PC-4 SSCs be based upon earthquake ground motion having an annual exceedance probability of $1x10^{-4}$, which corresponds to a return period of 10,000 years. Horizontal and vertical ground response spectra applicable to ATR are available from the following sources:

- Top of Rock: INEEL/EXT-99-00775, Revision 2, *Development of Probabilistic Design Basis Earthquake (DBE) Parameters for Moderate and High Hazard Facilities at INEEL,* and
- Top of Soil: INEEL/EXT-03-00942, Revision 2, *Development of Soil Design Basis Earthquake (DBE) Parameters for Moderate and High Hazard Facilities at TRA.*

DOE-STD-1020-2002 also requires that seismic demands for PC-3 and PC-4 SSCs be multiplied by a seismic Scale Factor (SF) that provides the appropriate risk reduction consistent with the desired performance goal. It is preferable that the ground motion used for PC-3 and PC-4 seismic analysis include the seismic SF to ensure consistency between the seismic input and certain properties that are partially dependent on response amplitudes (e.g., soil stiffness and damping; structure damping).

ASCE/SEI 43-05 defines Design Factors (DFs), which are used to develop Design Basis Earthquake (DBE) ground motions. The DF for Seismic Design Category -5 of ASCE/SEI 43-05 and seismic SF for PC-4 of DOE-STD-1020-2002 were considered to be equivalent.

Seismic SFs for PC-4 motions at the top of rock and soil were determined in EDF-5994, *Seismic and Stress Analysis of the ATR MICE Table and Support Structure* and INEEL/EXT-03-00942, respectively. The seismic SFs are typically 1.0 at all frequencies, except below 1 Hz for motions at the top of soil where a value of 1.03 is applicable. Seismic SFs for vertical motions were assumed to be the same as the seismic SFs for horizontal motion.

Ground response spectra for the PC-4 DBE were based upon products of the 10,000-year ground response spectra and the seismic SFs. Five percent damped PC-4 DBE ground response spectra at the top of rock and top of soil are shown in Figures 2-1 and 2-2, respectively.

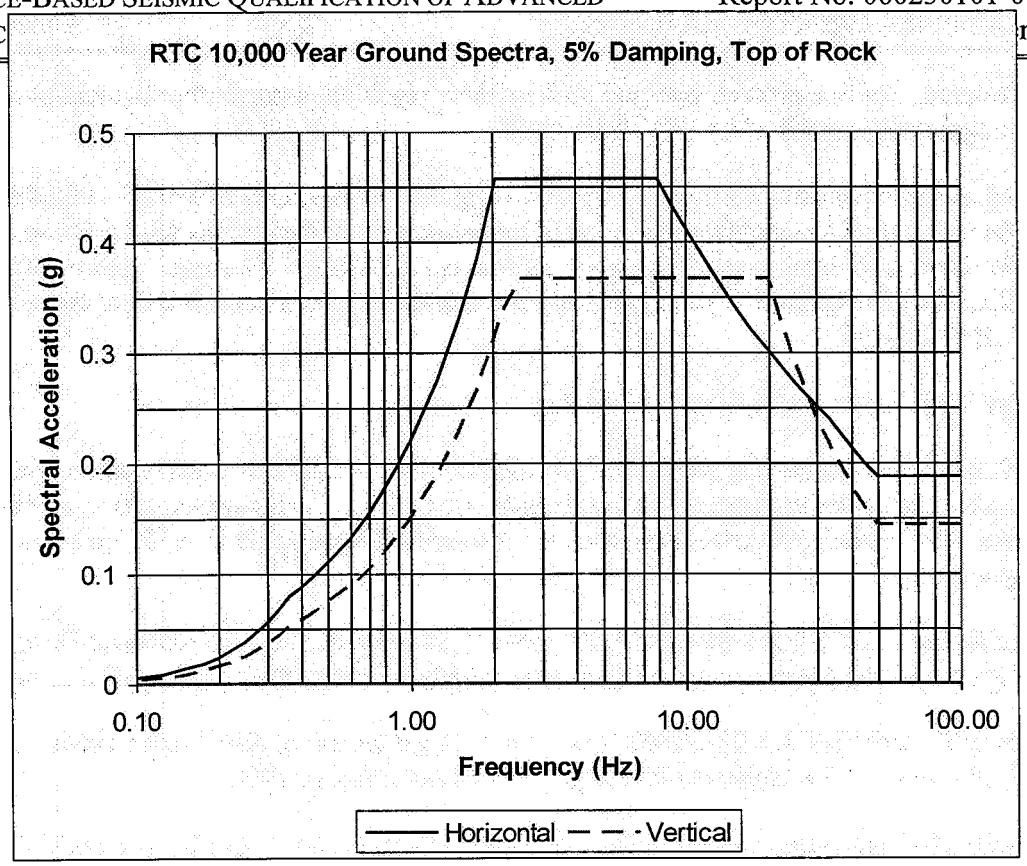

Figure 2-1. PC-4 DBE Horizontal and Vertical Ground Response Spectra, 5% Damping, Top of Rock.

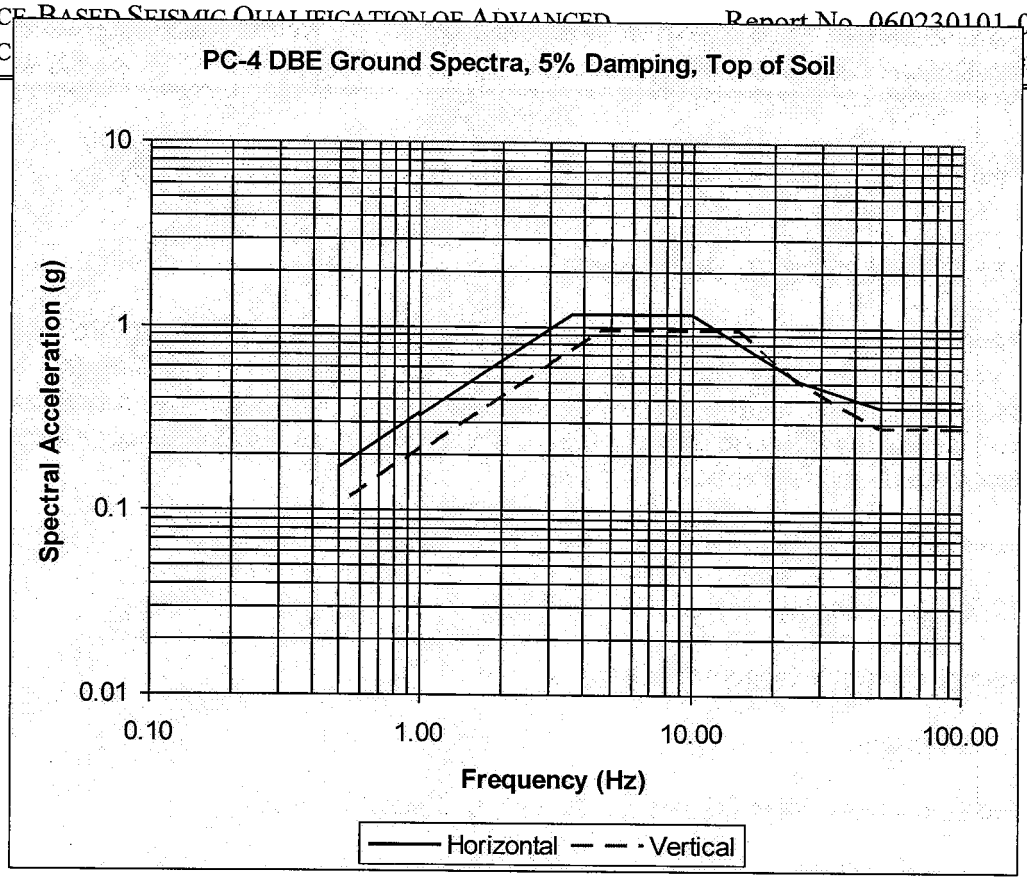

Figure 2-2. PC-4 DBE Horizontal and Vertical Ground Response Spectra, 5% Damping, Top of Soil.

2.3 Seismic Demand Spectrum

DOE/EH-0545 defines the Seismic Demand Spectrum (SDS) as the product of the in-structure response spectrum (ISRS) at the location where the equipment is attached to the supporting structure and an experience data factor.

SDS	=	Seismic Demand Spectrum
	=	F_{ED}*ISRS
ISRS	=	In-structure response spectrum
F_{ED}	=	Experience data factor

The experience data factor varies with the capacity representation for the equipment item. Values for these factors from DOE/EH-0545 are listed in Table 2-1.

Table 2-1. Experience Data Factors.

Capacity Representation	Experience Data Factor
Reference Spectrum	1.0SF
Generic Equipment Ruggedness Spectrum (GERS)	1.4SF
Relay GERS	1.8SF
Qualification Test	1.4SF

SDS used in the ATR equipment seismic qualification are discussed in Section 5.1.2.

3.0 EQUIPMENT LIST AND DATABASE

Seismic Category I equipment included in the project scope of work were defined by Attachment 2 of SOW-4084. The scope defined by this list was intended to cover all ATR Seismic Category I equipment except for non-buried piping, equipment obviously not amenable to experience-based qualification, and equipment with current qualification documentation. Equipment in the scope of work comprised the following plant systems and functions:

- Control Complex.
- Electrical Power Supply.
- Emergency Firewater Injection System.
- Firewater System.
- Loss-of-Coolant-Accident Primary Coolant Pump Shutoff System.
- Pressurizing and Gland Seal Pump Shutoff System.
- Primary Coolant System.
- Primary Coolant System Overpressure Relief System.
- Radiation Monitoring and Seal System (RMSS).
- Reactor Shutdown System.
- Safety Rod System.
- Vessel Vent System.
- Buildings, Miscellaneous Structures and Components.
- Fuel Handling and Storage.

The list of equipment requiring seismic qualification evolved during the course of this project. Additions and deletions resulted from further investigation and review of equipment and system functions by facility systems engineers and safety analysts.

Appendix A contains a listing of Seismic Category I equipment included in the project scope of work and their approximate locations. The listing in Appendix A includes both parent components, and subcomponents mounted within the parent components.

Appendix B contains the electronic file of a Microsoft Access database of data on the Seismic Category I equipment included in the project scope of work. The ATR Equipment Database records data on equipment obtained from field walkdowns and available documentation, and screening assessments following DOE/EH-0545 procedures. Features of the ATR Equipment Database include the following:

- Permit extraction of the Screening Evaluation Work Sheets (SEWSs) following DOE/EH-0545 format.
- Cross-reference to supporting calculations.
- Hyperlink to photos.
- Cross-reference between parent components and their sub-components.
- Sort and filter equipment by user-selected parameters.

4.0 FIELD WALKDOWNS

Several field walkdowns were performed over the course of the project. The objectives of the field walkdowns were as follows:

- Screen those equipment items that have high seismic capacity.
- Identify equipment or structures that are not Seismic Category I, but whose structural failure may impact nearby Seismic Category I items (i.e., seismic interaction concerns).
- Define failure modes (e.g., functionality, structural integrity, or anchorage failure) for the Seismic Category I equipment items that are not screened and identify the type of further evaluation required.
- Address issues of seismic-induced fire, seismic-induced flooding, and actuation of fire suppression systems.

4.1.1 Seismic Review Team Composition

The Seismic Review Team (SRT) performing the field walkdowns typically consisted of the following members:

- Systems engineers having knowledge of functional requirements for the plant safety systems and equipment locations.
- Seismic Capability Engineers (SCEs) responsible for review and screening of the Seismic Category I equipment.

The SRT included two SCEs meeting the training and experience requirements specified by DOE/EH-0545. The SCEs received Radworker Training offered by INL.

4.1.2 Pre-Walkdown Preparation

Prior to the walkdowns, available plant documentation was reviewed by the SCEs to obtain an understanding of the plant configuration and design features. The equipment layout drawings were marked to denote locations of equipment to be reviewed. Support to be provided by plant personnel was identified in advance. Such support included opening panel doors for anchorage inspection, and de-energizing switchgear and transformers during outages for internal inspection.

4.1.3 Walkdown Activities

All equipment included in the scope of work was accessible for walkdown, with the exception of elements of the Safety Rod System housed in the reactor vessel. Field walkdown of this equipment included the following activities:

- Equipment locations listed in Attachment 2 of SOW-4084 were confirmed or corrected.
- The equipment was reviewed for the DOE/EH-0545 screening caveats applicable to the various generic equipment categories.
- Data on equipment configurations, dimensions, weights, and anchorage and support details were recorded for use in quantitative anchorage evaluations. In some cases, equipment anchorage was screened from evaluation based on tug-testing and judgment.
- Equipment were reviewed for potential seismic interaction concerns due to impact with other nearby equipment or structures, collapse of overhead items, seismic-induced flood or spray, seismic-induced fire, etc.
- Photos of the equipment were taken.
- Bounding cases for Limited Analytical Review (LAR) of cable trays were selected.
- Certain equipment was reviewed in the facility with systems engineers to understand equipment functionality requirements.

4.1.4 Walkdown Documentation

For each equipment item, a SEWS was used to document the walkdown findings. The SEWSs were formatted following the example sheets in DOE/EH-0545. The SEWSs indicated specific information required to confirm the screening of the component during the walkdown or to record details sufficient to perform a subsequent seismic capacity evaluation if necessary.

Entries in the SEWS conform to the following convention:

- "Yes" signifies that the specific criterion is satisfied.

- "No" signifies that the specific criterion is not satisfied.
- "U" signifies that it is unknown if the criterion is satisfied and must be resolved.
- "N/A" signifies that the criterion is not applicable to the specific item of equipment.

As noted in Section 3.0, the seismic walkdown findings were documented in the ATR Equipment Database. The SEWS may be extracted from the database in either electronic or hardcopy format. Walkdown photos of the equipment were hyperlinked to the database for permanent record.

5.0 EXPERIENCE-BASED EQUIPMENT SEISMIC QUALIFICATION

Elements of experience-based equipment seismic qualification include comparison of seismic capacity and seismic demand, equipment caveat screening, anchorage verification, and interaction screening. Implementation of DOE/EH-0545 procedures for each of these elements is discussed below.

5.1 Comparison of Seismic Capacity and Seismic Demand

By DOE/EH-0545 procedures, the seismic capacity is defined by the Reference Spectrum or the GERS. The seismic demand is represented by the SDS discussed in Section 2.3. Comparison of seismic capacity and seismic demand for the Seismic Category I equipment in the scope of work was documented in ARES Calculation No. 0602301.01-S-001 (Appendix E). This comparison is summarized below.

5.1.1 Experience-Based Seismic Capacity

5.1.1.1 Reference Spectrum

For equipment qualified using earthquake experience, the seismic capacity is represented by the Reference Spectrum (Figure 5-1). The Reference Spectrum was based upon the 5% damped ground response spectra at four sites in the earthquake experience database. The Reference Spectrum has a peak ground acceleration of 0.5g and a maximum spectral acceleration of 1.2g at frequencies between 2.5 Hz and 7.5 Hz.

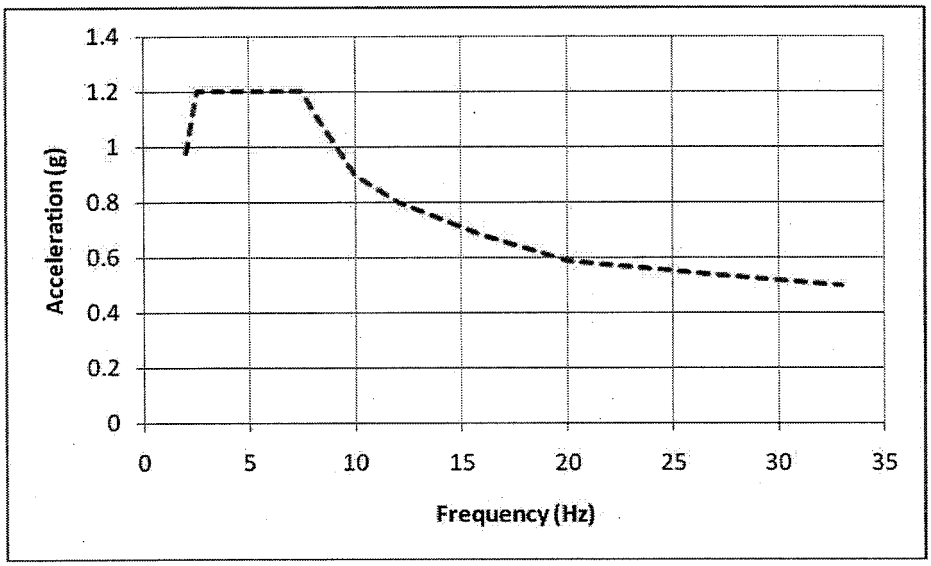

Figure 5-1. Reference Spectrum.

More recent seismic hazard analyses have identified the potential for high-frequency earthquake ground motions at Eastern and Central United States sites. Application of earthquake experience at these sites could be limited since the Reference Spectrum reduces in amplitude at frequencies greater than 7.5 Hz. This issue was addressed in Appendix B of Electric Power Research Institute (EPRI) NP-7498, *Industry Approach to Seismic Severe Accident Policy Implementation*, which states that "...extending the spectral acceleration capacity limits at constant levels for frequencies beyond 7.5 Hz is justified based on an understanding of the potential failure characteristics of structures and equipment at nuclear power plants." Appendix B of EPRI NP-7498 also notes that the limitation is not an indication of equipment capacities, but rather a reflection of the seismic experience database earthquakes which are less rich in high-frequency content.

Following Appendix B of EPRI NP-7498, the Extended Reference Spectrum was defined by extending the 1.2g spectral acceleration to frequencies exceeding 7.5 Hz as shown in Figure 5-2. The seismic capacity of ATR Seismic Category I equipment qualified by earthquake experience in this project was defined to be the Extended Reference Spectrum, conditional upon the equipment meeting the intent of the associated caveats for the specific equipment class.

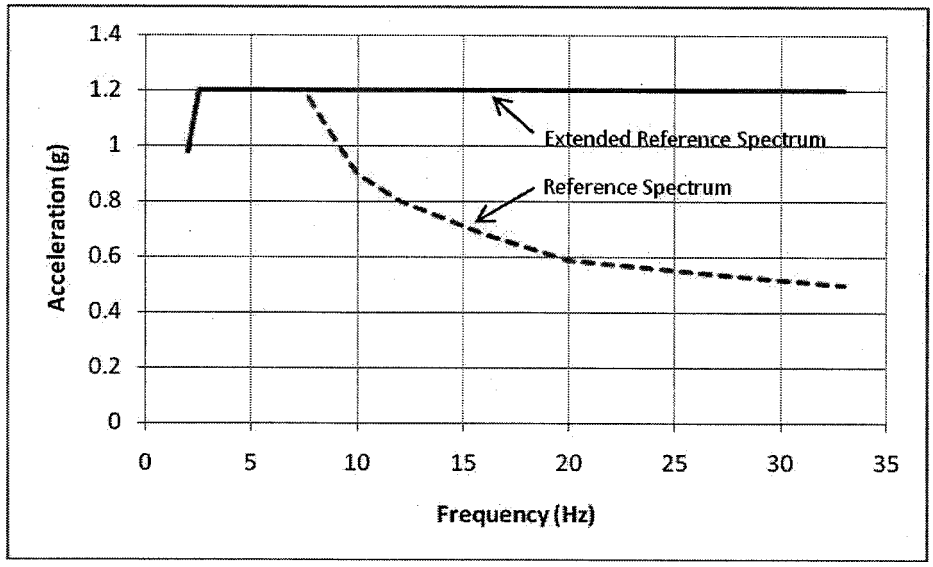

Figure 5-2. Extended Reference Spectrum.

5.1.1.2 Generic Equipment Ruggedness Spectra for Equipment

The GERS represent the seismic capacity of various equipment categories based on seismic qualification testing of nuclear power plant equipment, conditional upon the equipment meeting the intent of the associated caveats for the specific equipment class. In this project, GERS were used to represent equipment seismic capacity in a few instances. Selected GERS are shown in Figures 5-3 to 5-6.

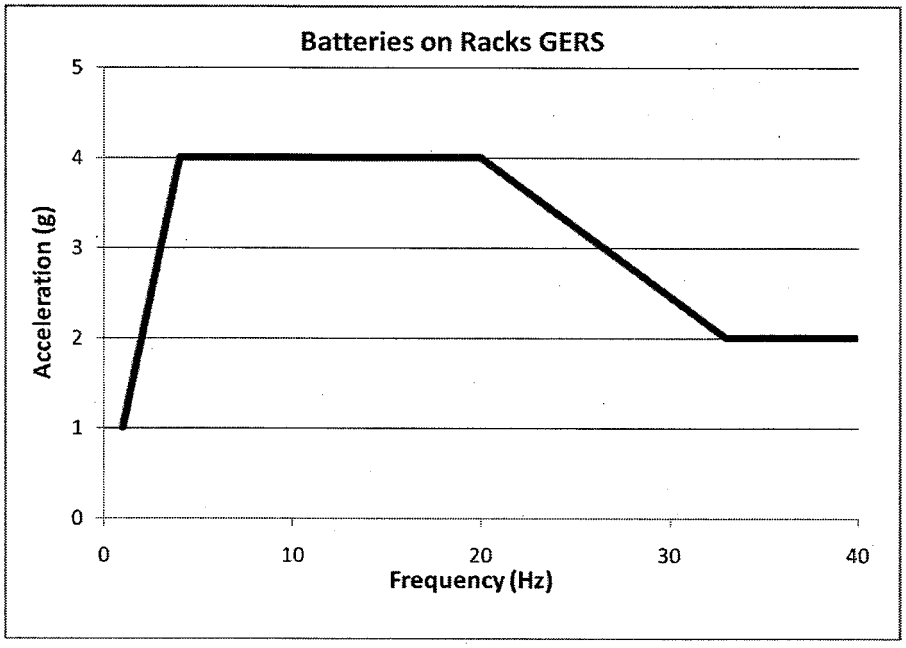

Figure 5-3. Batteries on Racks GERS.

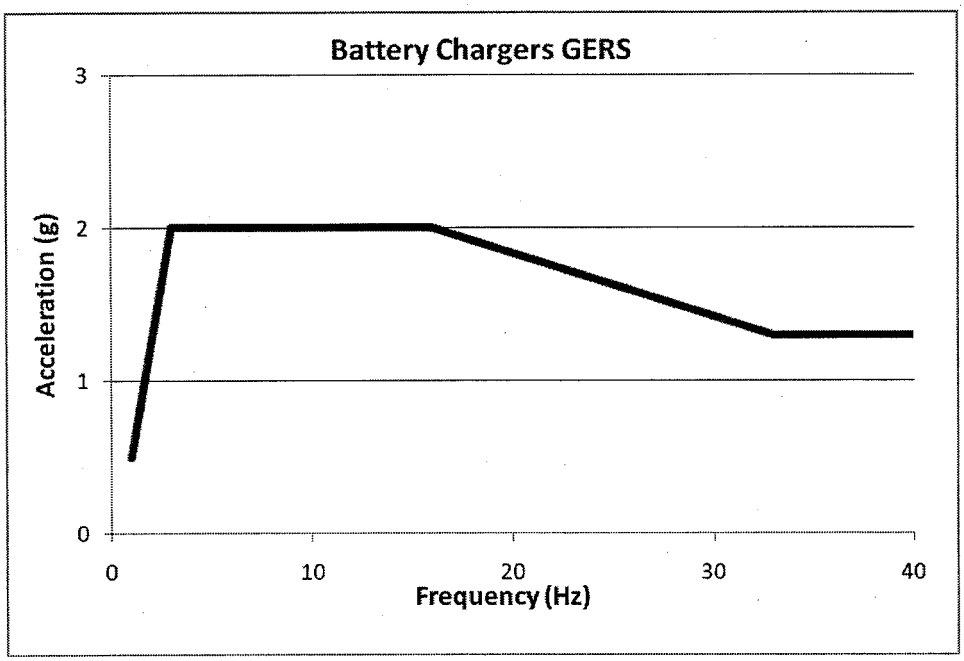

Figure 5-4. Battery Charger GERS.

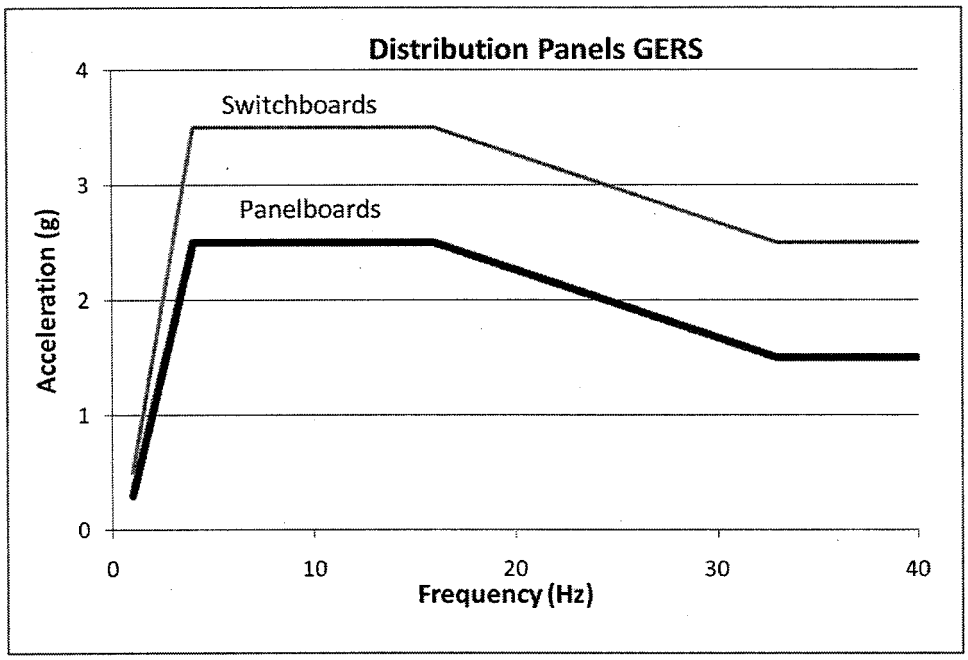

Figure 5-5. Distribution Panels GERS.

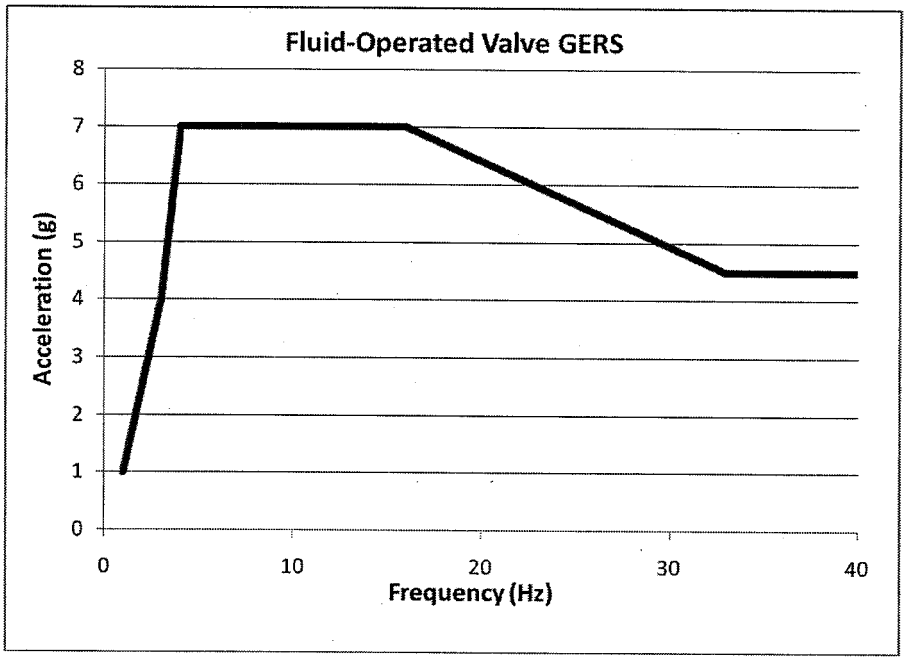

Figure 5-6. Fluid-Operated Valve GERS.

5.1.1.3 Generic Equipment Ruggedness Spectra for Relays

GERS for relays are presented in EPRI NP-7147, *Seismic Ruggedness of Relays,* and its two supplements including errata. The GERS are presented for energized/de-energized (operate/non-operate) and normally open (NO)/normally closed (NC) operational states for a total of four seismic capacity levels. Certain relays also have a transition state capacity. The GERS are defined as spectral acceleration capacities applicable between frequencies of 4 Hz and 16 Hz. The Zero Period Acceleration (ZPA) capacity is 60% of the spectral acceleration capacity.

5.1.2 Seismic Demand

As noted in Section 2.3, SDS are based on ISRS at the equipment support location, including the applicable seismic experience factor. ISRS used for seismic qualification of Seismic Category I equipment in the scope of work are discussed below.

5.1.2.1 TRA-670 Substructure

The TRA-670 substructure constitutes the portion of the building at and below the first floor. ISRS for the TRA-670 substructure were generated by probabilistic seismic response analysis as described in CJC-INL-C-003, *Probabilistic Soil Structure Interaction Analysis of TRA-670,* and CJC-INL-C-004, *Additional Hazard-Consistent In-Structure Response Spectra.* ISRS were provided at selected locations shown in Figures 5-7 to 5-10. ISRS for non-exceedance probabilities (NEPs) of 20%, 50%, and 80% were reported by CJC-INL-C-003 and CJC-INL-C-004. In this project, the SDS were based on the 80% NEP ISRS following the recommendations of RPK-70730, *Applicability of Using 80% Non-Exceedance Probability (NEP) In-Structure-Response Spectra (ISRS).*

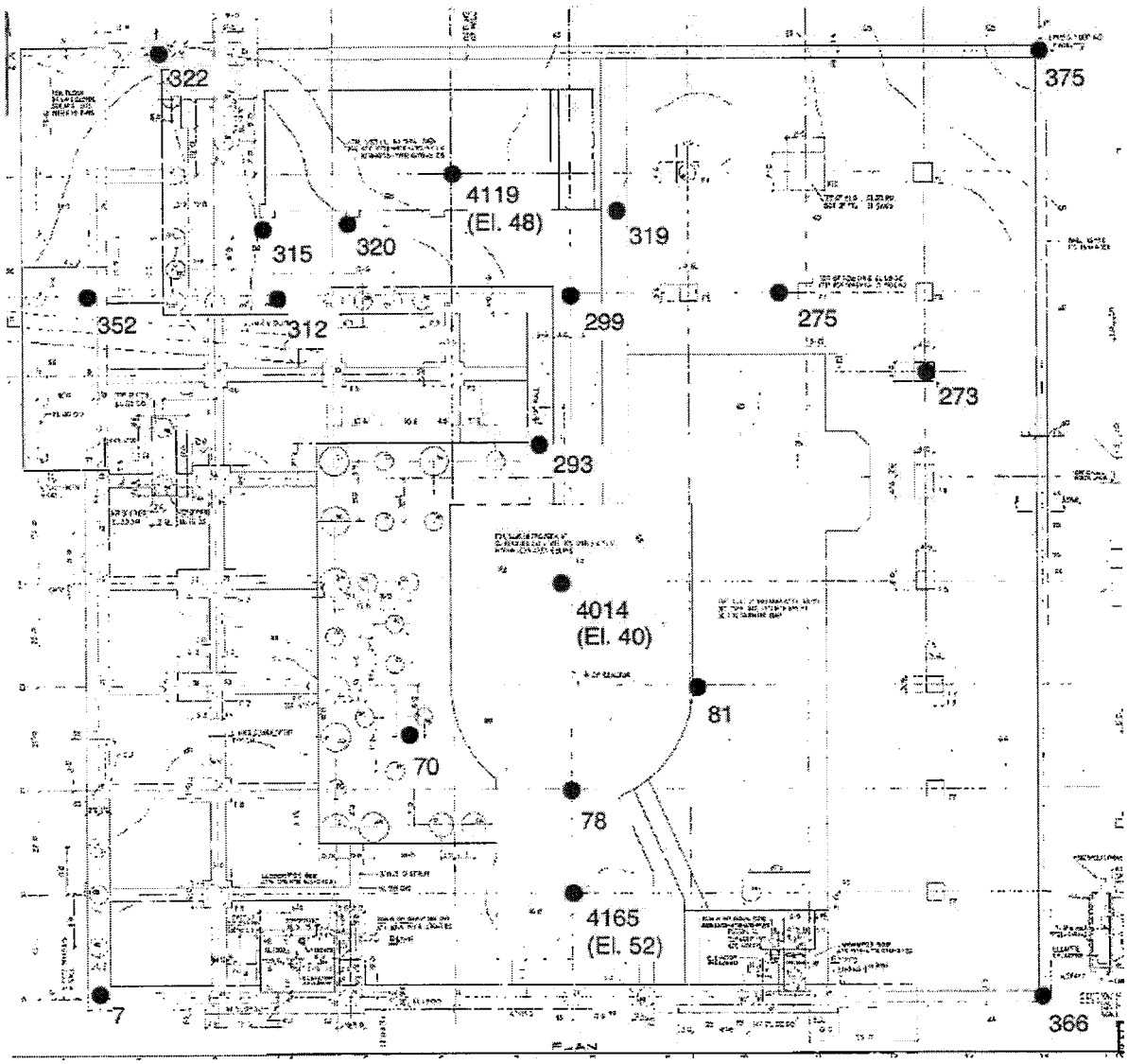

Figure 5-7. Node Locations for Substructure ISRS, Second Basement.

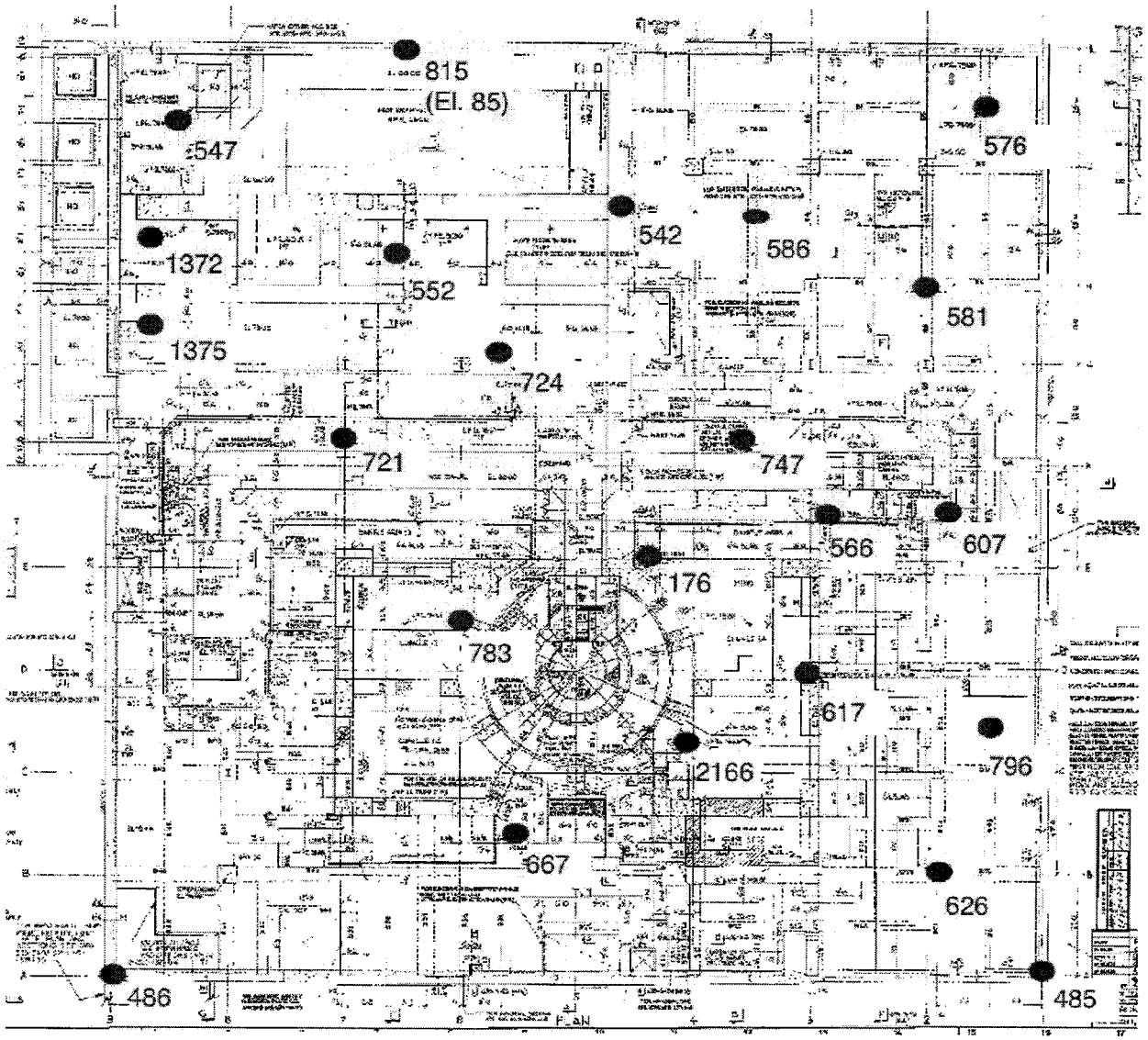

Figure 5-8. Node Locations for Substructure ISRS, First Basement.

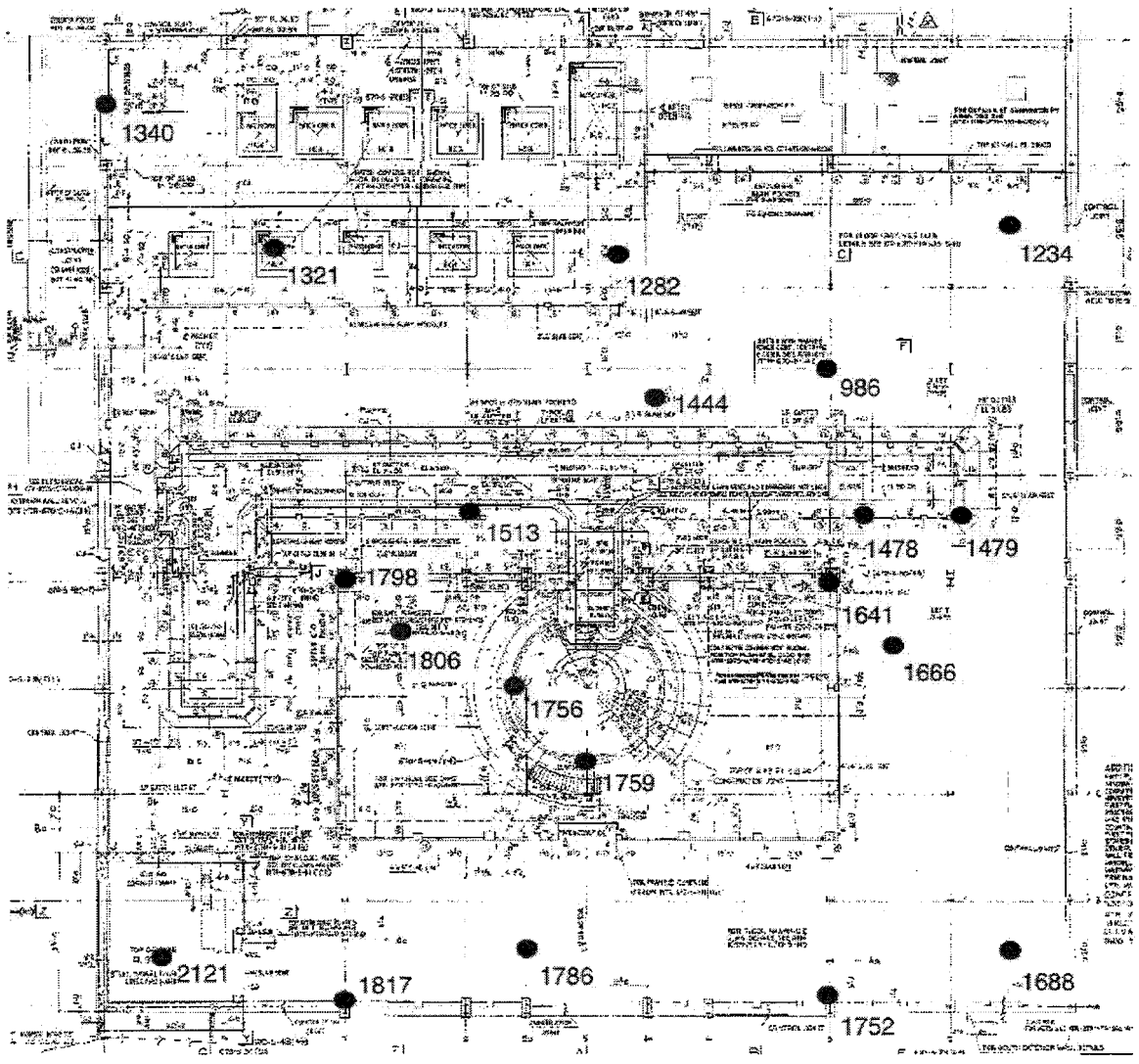

Figure 5-9. Node Locations for Substructure ISRS from CJC-INL-C-003, First Floor.

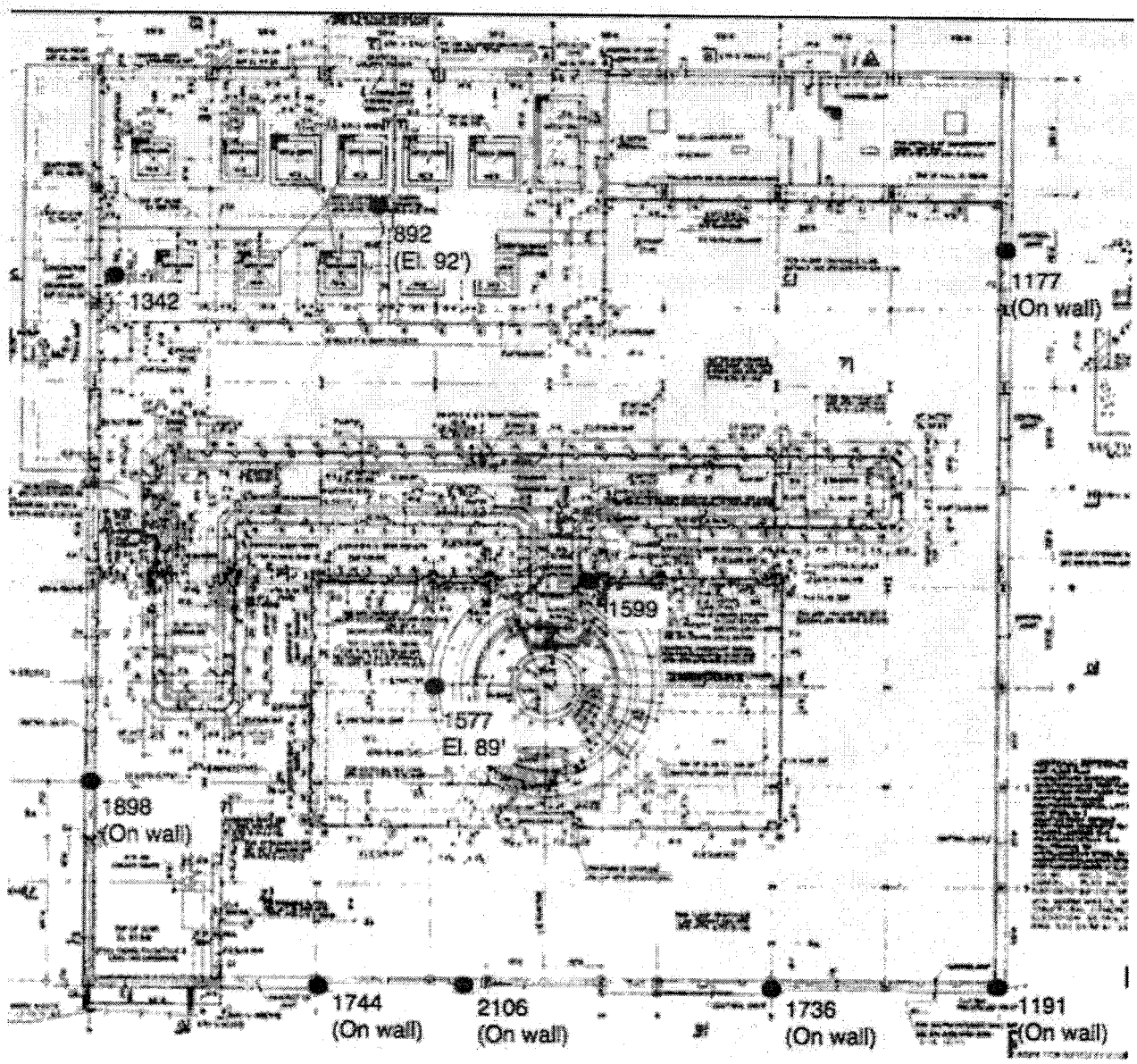

Figure 5-10. Node Locations for Substructure ISRS from CJC-INL-C-004, First Floor.

ISRS at the first and second basements generally exhibit modest amplitudes. ISRS at the first floor exhibit significant variation across the extent of the floor. Relatively high ISRS occur at locations of the first floor having increased structure flexibility in the horizontal and/or vertical directions.

Vertical ISRS at Nodes 576, 586, and 796 (Figure 5-8) were based on responses at the middle of the floor slabs based on conservative boundary conditions. Following BEA's direction, more realistic seismic input for these locations was based on vertical ISRS for nodes at the structural supports for these slabs.

5.1.2.2 TRA-670 Superstructure

The TRA-670 superstructure constitutes the portion of the building above the first floor. ISRS for the TRA-670 superstructure were provided by EDF-ECAR-173, *In-Structure Response Spectra for TRA-670 Superstructure*. The seismic response analysis modeled the superstructure decoupled from the substructure. Seismic input consisted of controlling motions calculated by the deterministic response analysis of TRA-670 documented in 053472-03, *Soil Structure Interaction Analysis, TRA-670 Subgrade Structure*. Superstructure ISRS included peak broadening and clipping following ASCE 4-98 requirements. Superstructure ISRS were reported at the locations shown in Figure 5-11.

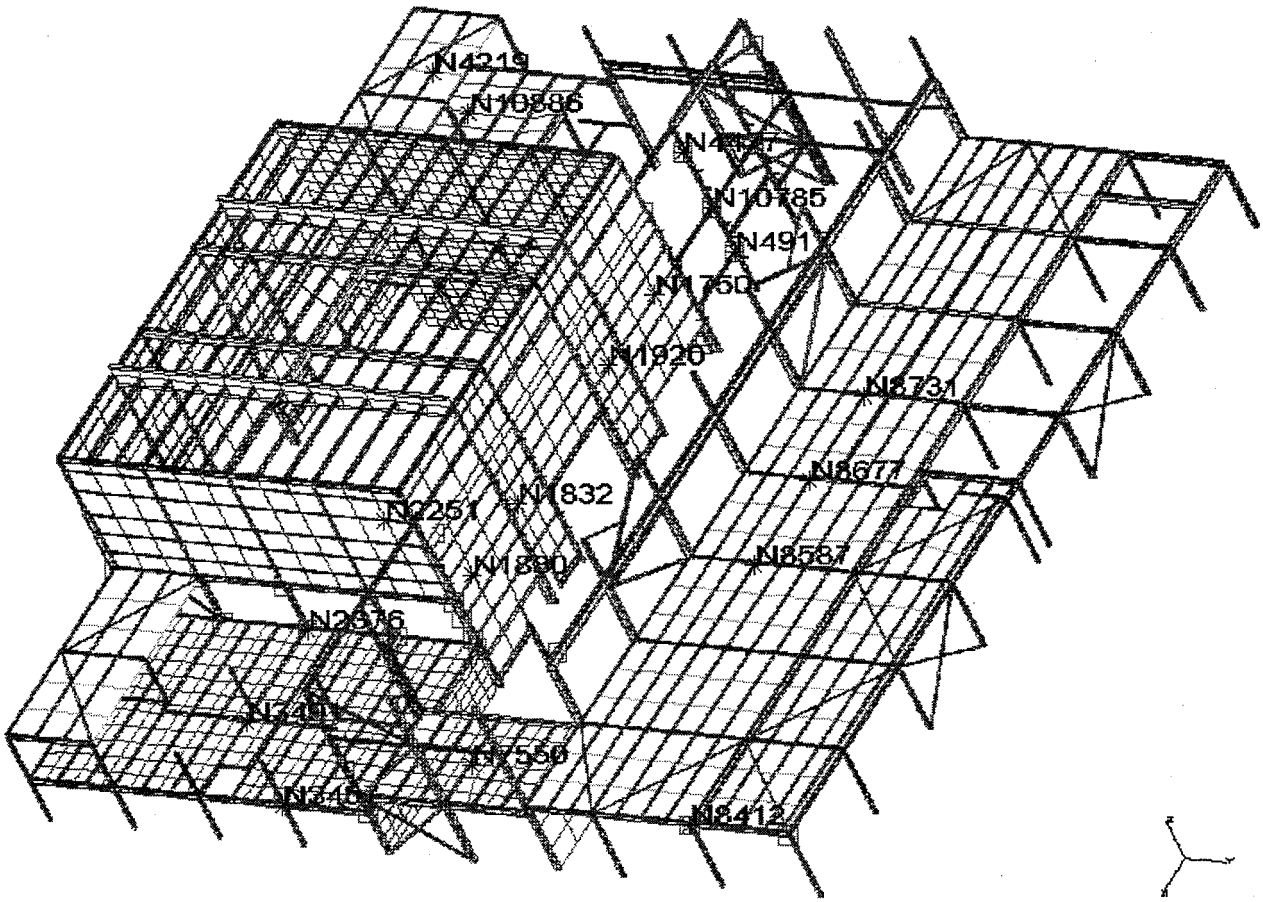

Figure 5-11. Node Locations for Superstructure ISRS.

5.1.2.3 Other Buildings and Locations

Seismic Category I equipment outside of TRA-670 are located on or near floor slabs for buildings and structures founded at the soil surface, or are located on or buried in the soil (e.g., underground firewater system components). The soil-founded buildings or structures include the TRA-670 truck airlock, TRA-601, TRA-619, TRA-633, TRA-650, TRA-672, TRA-674, TRA-688, and TRA-770. The

PC-4 DBE ground response spectra at the top of soil (Figure 2-2) were considered to be applicable to this equipment.

5.1.3 Seismic Capacity-Versus-Demand Comparison

The results of comparisons of seismic capacity-versus-seismic demand are summarized below. Additional details may be obtained from ARES Calculation No. 0602301.01-S-001 (Appendix D).

5.1.3.1 Earthquake Experience Capacity

The seismic capacity for most of the Seismic Category I equipment in the scope of work was based on earthquake experience using the Extended Reference Spectrum (Figure 5-2). The SDS were based on the applicable ISRS or ground response spectra as noted in Section 5.1.2. In TRA-670, ISRS for the node at or close to the specific equipment location were used. The experience data factor is 1.0 when the seismic capacity is based on earthquake experience (Table 2-1). The SDS was consequently equal to the applicable ISRS or ground response spectra.

The earthquake experience-based seismic capacity-versus-seismic demand comparison has historically considered only the horizontal demand, consistent with the development of the Reference Spectrum from the horizontal ground spectra at the database sites. Some of the vertical ISRS for the TRA-670 substructure are relatively high. Consequently, vertical ISRS were also compared to the Extended Reference Spectrum as a first screen.

The Extended Reference Spectrum exceeds all of the SDS at the second basement. A comparison of seismic capacity and seismic demand for Node 273, which is applicable to DC power supply components such as 670-E-23 and 670-E-28, is shown in Figure 5-12. In this and subsequent figures, the X, Y, and Z directions correspond to the east-west, north-south, and vertical directions, respectively.

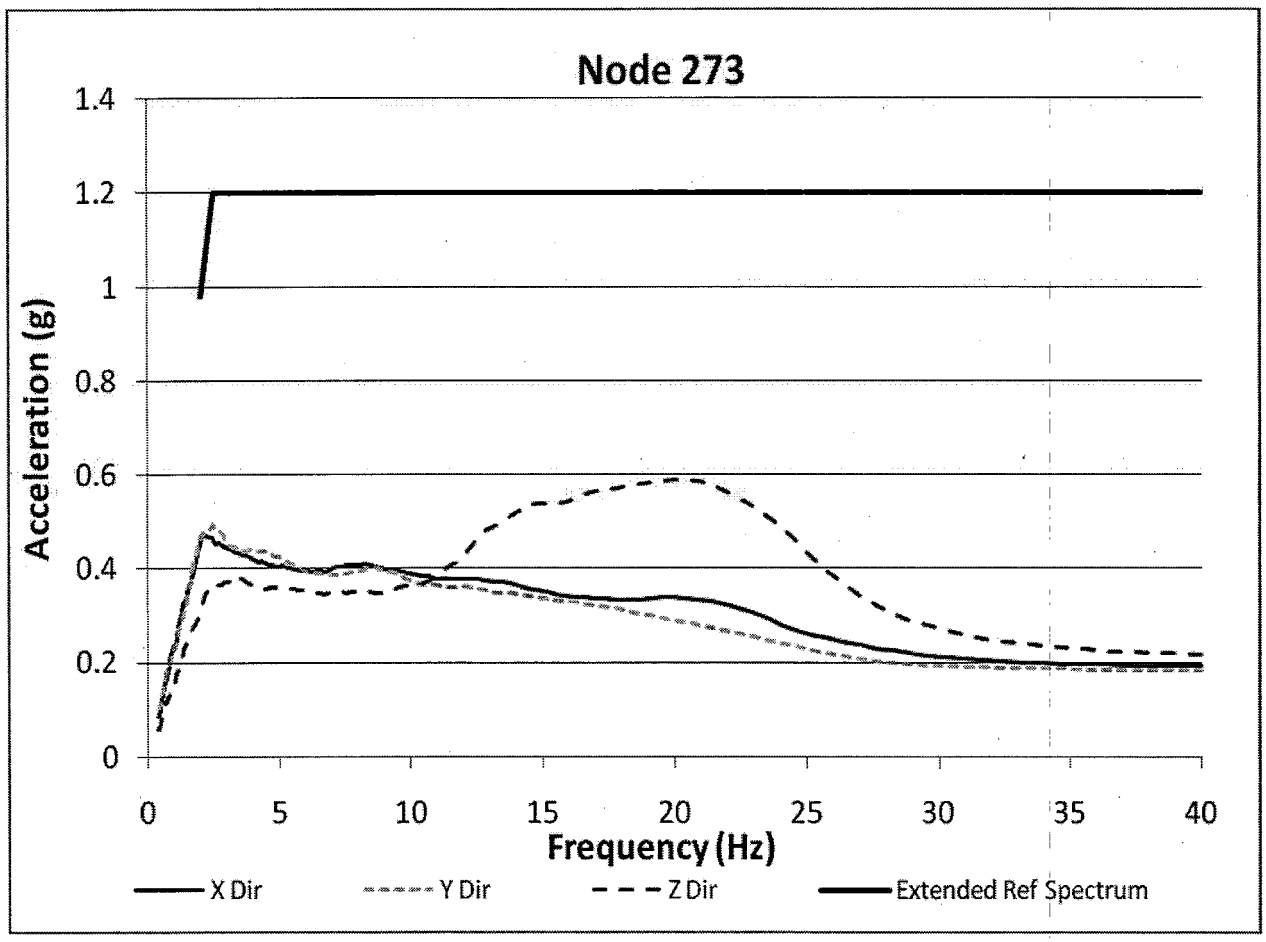

Figure 5-12. Comparison of the Extended Reference Spectrum to SDS for Node 273.

The Extended Reference Spectrum exceeds the horizontal SDS for all locations of Seismic Category I equipment in the scope of work at the first basement. As an example, a comparison of seismic capacity and seismic demand for Node 1375, located near the motors for primary coolant pumps 670-M-10 and 670-M-11, is shown in Figure 5-13. Some of the vertical SDS significantly exceed the Extended Reference Spectrum. For example, Figure 5-14 compares the seismic capacity and seismic demand for Node 626 which is located near rooms housing several components of the Reactor Shutdown System. Further review of exceedances by the vertical SDS is discussed later.

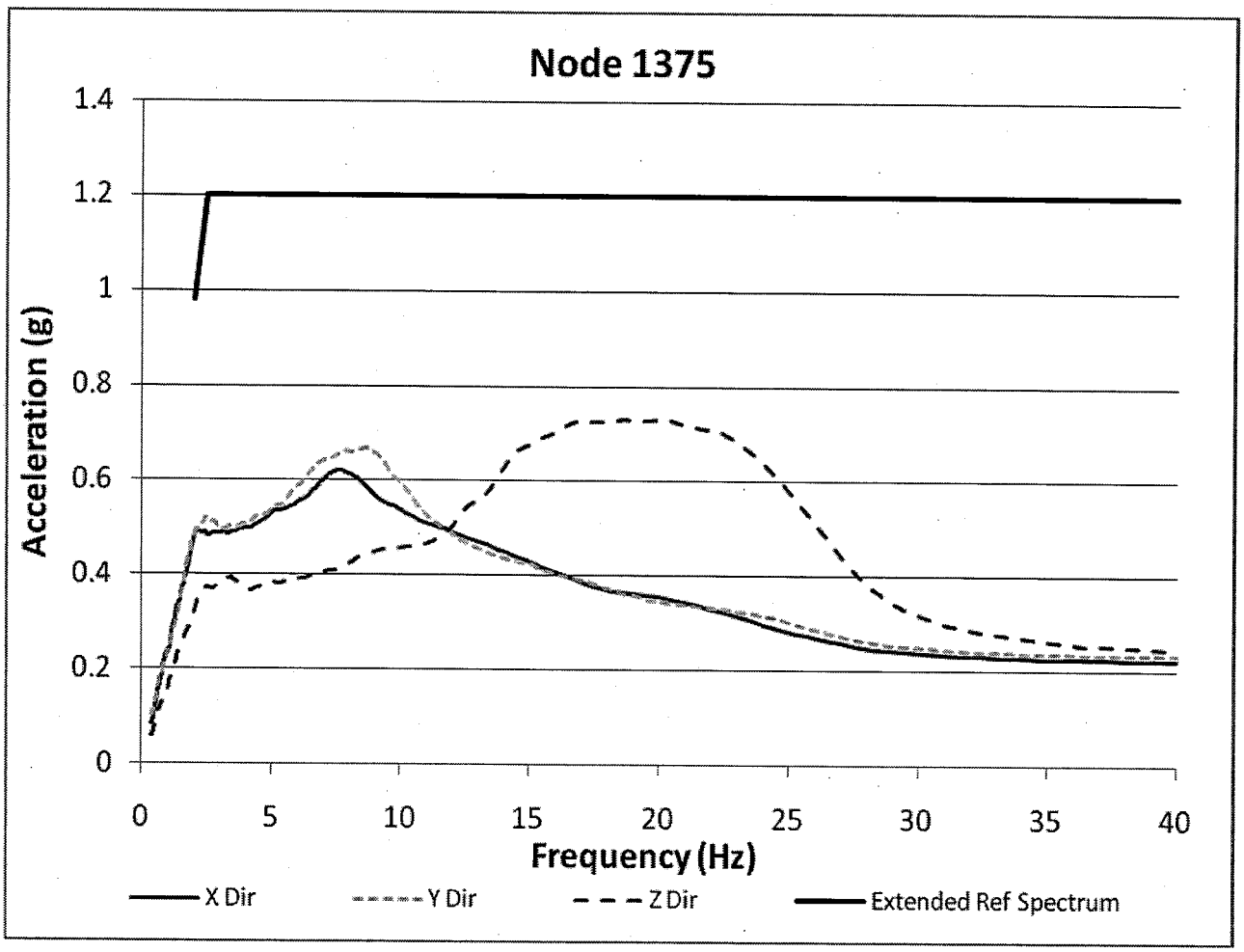

Figure 5-13. Comparison of the Extended Reference Spectrum to SDS for Node 1375.

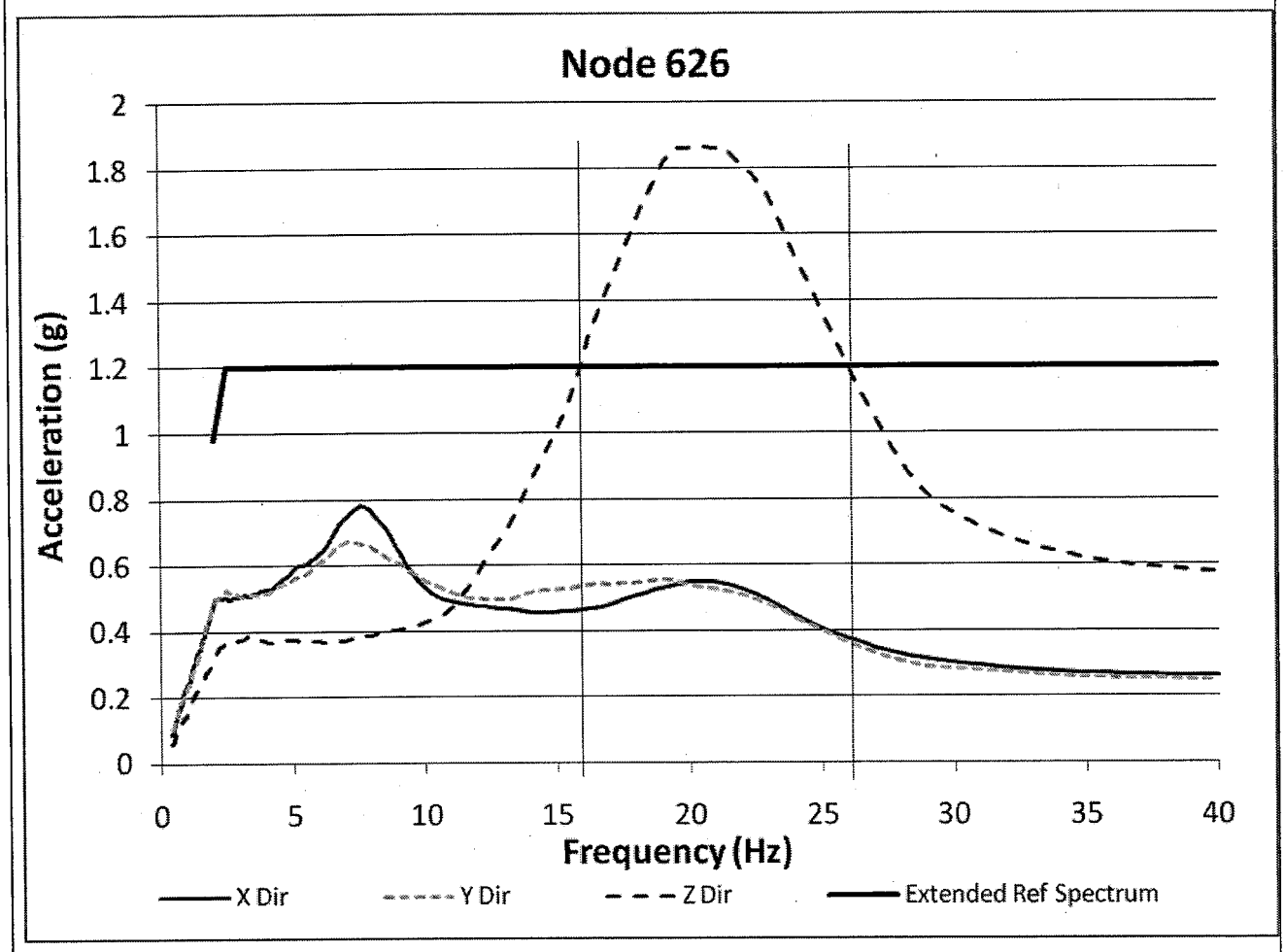

Figure 5-14. Comparison of the Extended Reference Spectrum to SDS for Node 626.

The Extended Reference Spectrum is exceeded by horizontal and vertical SDS at several first floor locations. For example, Figure 5-15 compares the seismic capacity and seismic demand for Node 1666 which is located at the control room.

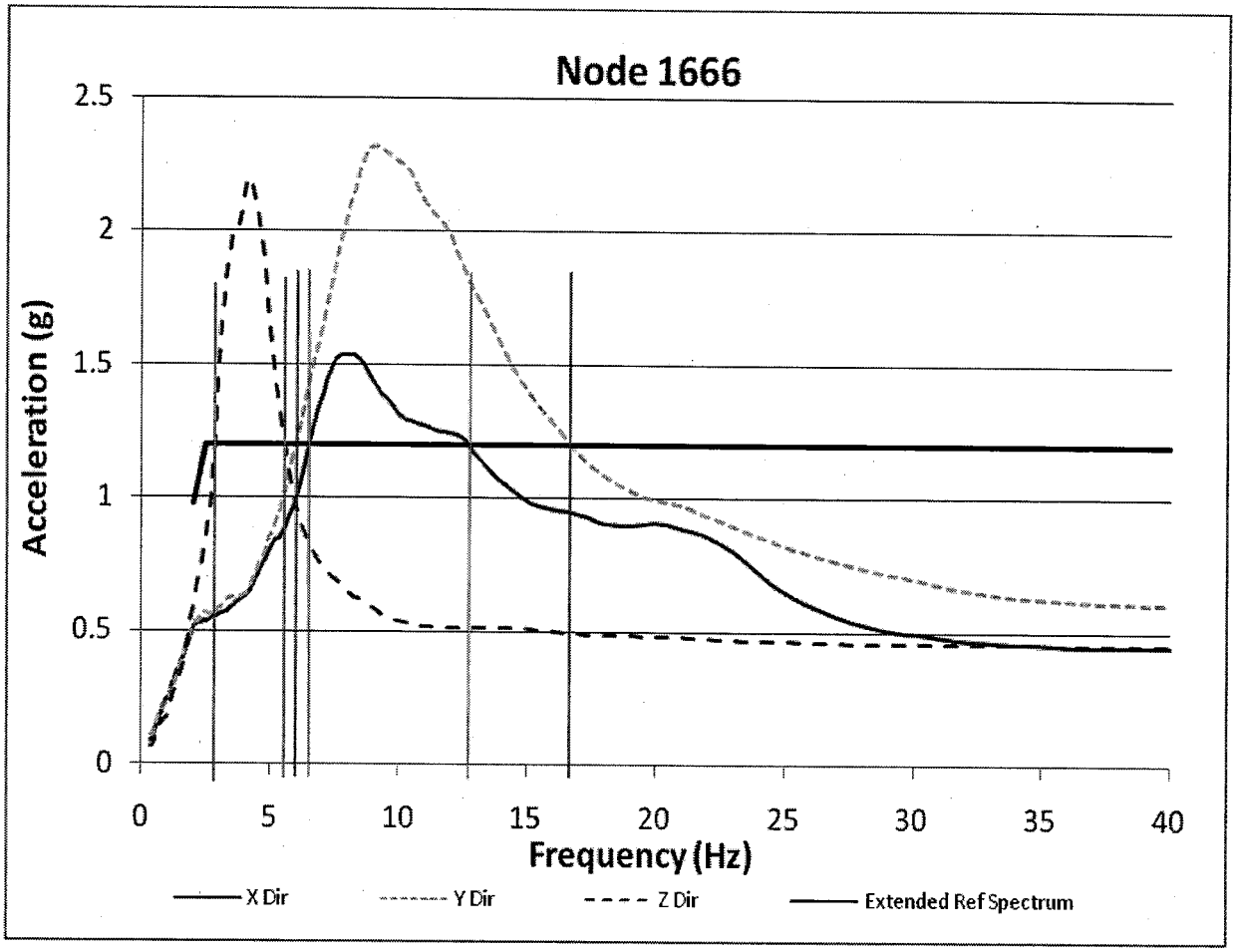

Figure 5-15. Comparison of the Extended Reference Spectrum to SDS for Node 1666.

The Extended Reference Spectrum is exceeded by the SDS at all superstructure locations with Seismic Category I equipment in the scope of work. For example, Figure 5-16 compares the seismic capacity and seismic demand for Node 4219 which is located at the ceiling of the fan room. The exceedances at the superstructure primarily affect components of the Radiation Monitoring and Seal System.

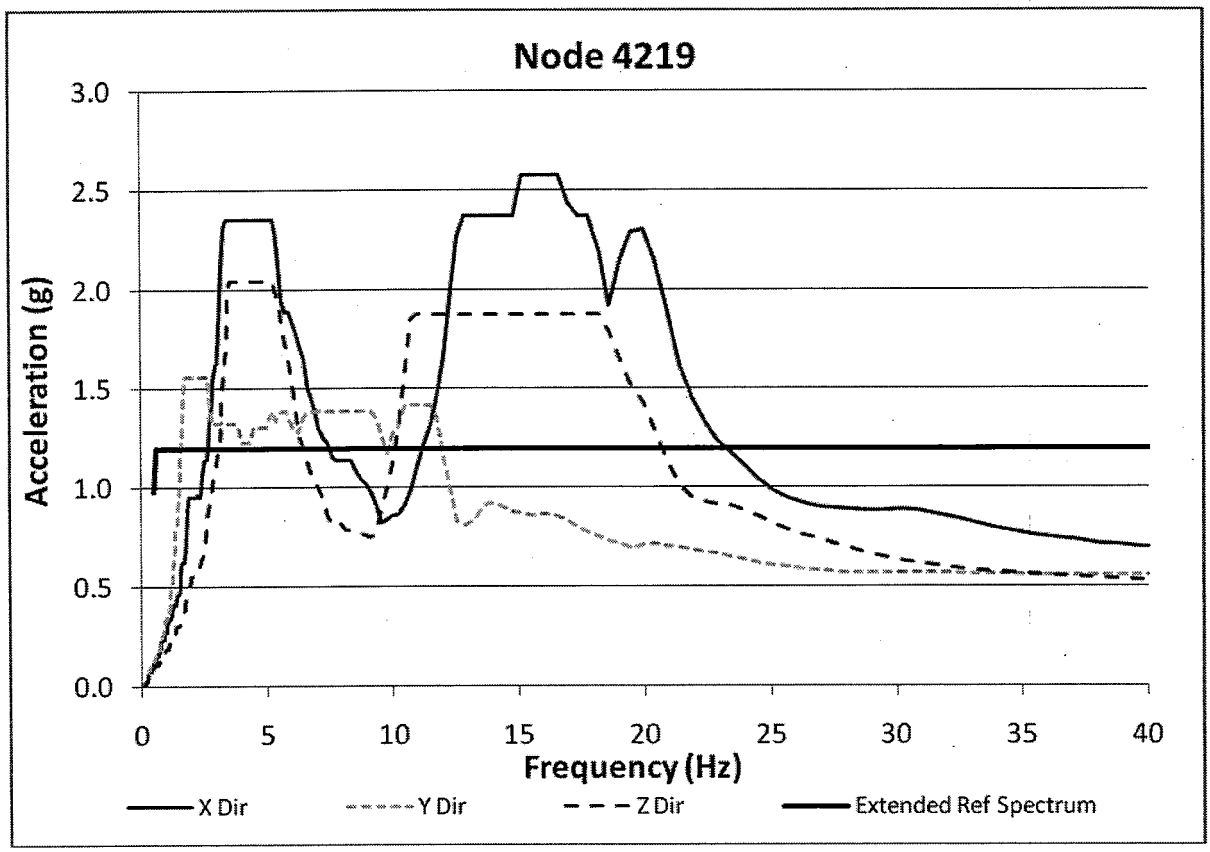

Figure 5-16. Comparison of the Extended Reference Spectrum to SDS for Node 4219.

The PC-4 DBE ground response spectra at the top of soil are compared to the Extended Reference Spectrum in Figure 5-17. As indicated, the seismic capacity exceeds the seismic demand for the equipment located in other buildings or structures, or on or in the soil (Section 5.1.2.3).

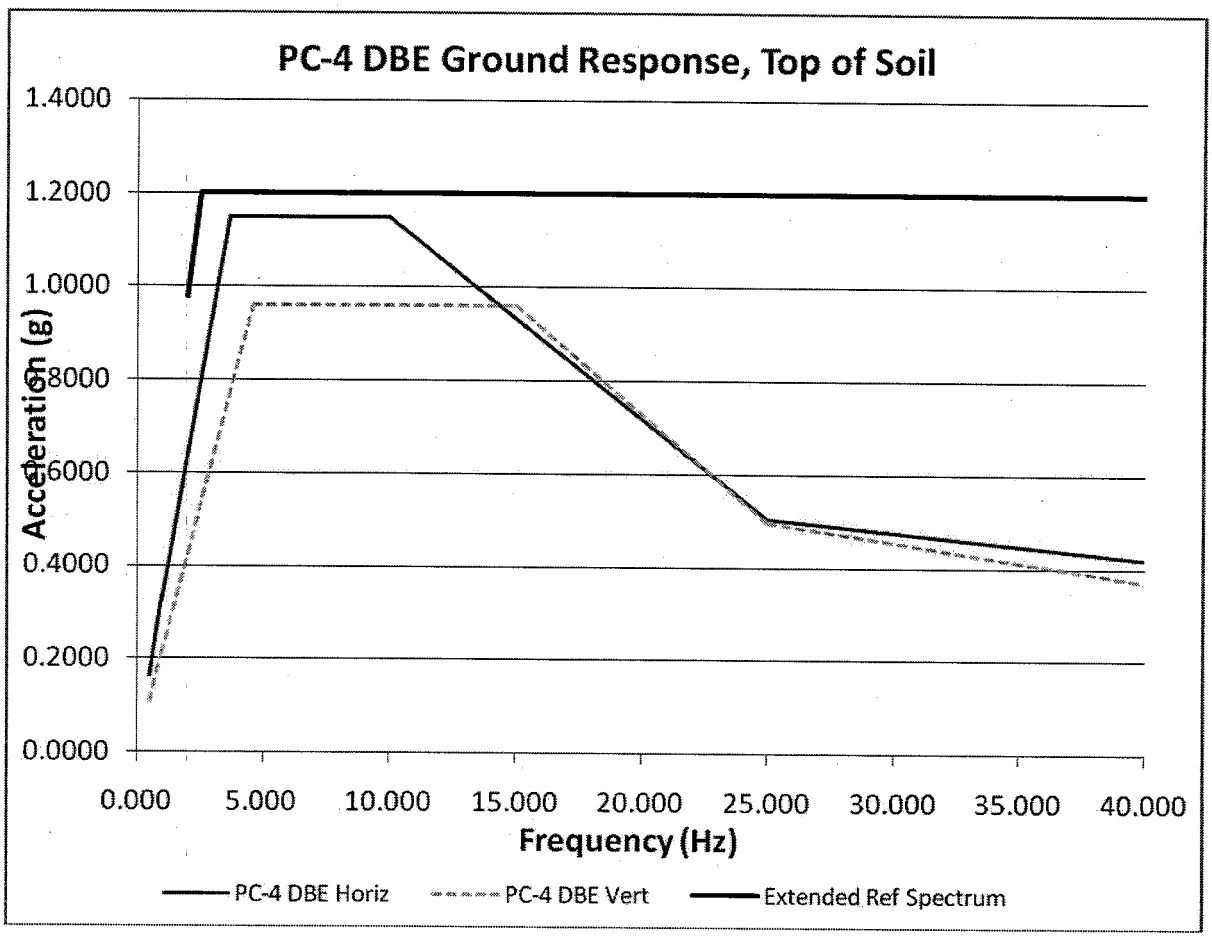

Figure 5-17. Comparison of PC-4 DBE Ground Response Spectra at the Top of Soil to the Extended Reference Spectrum.

When the Extended Reference Spectrum was found to be exceeded by the horizontal SDS, seismic qualification using the GERS was investigated. Application of the GERS is described in Section 5.1.3.2. Seismic Category I equipment items whose horizontal SDS exceed the Extended Reference Spectrum and which could not be qualified by using the GERS were designated as outliers.

As noted above, comparison of seismic capacity has historically considered only the horizontal demand. In this project, the comparison was extended to the vertical SDS due to the relatively high structure vertical responses. Additional reviews were performed when the vertical SDS were found to significantly exceed the Extended Reference Spectrum. These reviews were conducted on an equipment-specific basis, in which the potential for the high vertical input causing structural and/or functional failure was considered. In all instances, it was judged that the vertical input would not cause structural failure or adversely impact equipment function. These reviews were documented in the SEWSs.

5.1.3.2 Test Experience Capacity for Equipment

Test experienced-based seismic capacity in terms of the GERS was used when seismic demand was found to exceed the earthquake experience-based Extended Reference Spectrum (Section 5.1.3.1). The GERS were typically used for equipment subjected to relatively high seismic input. Use of the GERS was conditional on satisfaction of applicable caveats. The SDS included the experience data factor of 1.4 listed in Table 2-1.

The comparison of seismic capacity and seismic demand based on GERS is summarized in Table 5-1. As indicated, several equipment items are seismically qualified using the GERS. For example, Plant Protection System (PPS) batteries and RMSS dampers located in the Diesel Generator Area are seismically qualified using the applicable GERS. Comparisons of seismic capacity and seismic demand for these components are shown in Figures 5-18 and 5-19. The GERS for these components exhibit significant margin above the seismic demand. Seismic qualification of the PPS battery chargers was not demonstrated. Comparison of seismic capacity and seismic demand for these components is shown in Figure 5-20.

5.1.3.3 Test Experience Capacity for Relays

Following the guidance of DOE/EH-0545, seismic qualification of Seismic Category I relays and contactors included in the scope of work implemented the seismic evaluation criteria in EPRI NP-7148, *Procedure for Evaluating Nuclear Power Plant Relay Seismic Functionality*. The methodology of EPRI NP-7148 consists of the following steps:

1. Determine if the relay is a "low-ruggedness relay" in Appendix E of EPRI NP-7148. If this is the case, the relay is an outlier.

2. Determine the seismic demand at the relay mounting point. This consists of the following:

   A. Calculate the SDS at the parent cabinet or panel attachment point to the structure. The SDS is defined in Section 2.3 above. The experience data factor is 1.8 when using relay GERS.

   B. Apply a cabinet amplification factor, as applicable, following EPRI NP-7148.

3. Determine the seismic capacity of the relay from the GERS or an item-specific Test Response Spectrum (TRS).

4. Compare the seismic capacity to the seismic demand at the relay mounting point. If the seismic capacity is greater than the seismic demand, the relay is seismically qualified. If not, it is an outlier.

Table 5-1. Comparison of Seismic Capacity Using GERS and Seismic Demand.

Equipment No.	Description	Node	Equipment GERS	Capacity > Demand?		
				X (E-W)	Y (N-S)	Z (Vert)
E11C	Battery Banks, 32 Vdc PPS Channels A, B, C, D, Spare Combined PPS Battery Banks	1234	Batteries on Racks	Yes	Yes	Yes
E11D	Battery Banks, 32 Vdc PPS Channels A, B, C, D, Spare Combined PPS Battery Banks	1234	Batteries on Racks	Yes	Yes	Yes
E11 Spare	Battery Banks, 32 Vdc PPS Channels A, B, C, D, Spare Combined PPS Battery Banks	1234	Batteries on Racks	Yes	Yes	Yes
670-BDM-5-10	Butterfly Damper, HVE-9A & B Exhaust from Battery Room	1234	Fluid-Operated Valves	Yes	Yes	Yes
670-BDM-5-10A	670-BDM-5-10 Backup Damper	1234	Fluid-Operated Valves	Yes	Yes	Yes
670-BDM-5-8	Butterfly Damper, HVS-5 Basement Air Supply	1234	Fluid-Operated Valves	Yes	Yes	Yes
670-BDM-5-8A	670-BDM-5-8 Backup Damper	1234	Fluid-Operated Valves	Yes	Yes	Yes
670-BDM-5-9	Butterfly Damper, HVS-5 Basement Area Return	1234	Fluid-Operated Valves	Yes	Yes	Yes
670-BDM-5-9A	670-BDM-5-9 Backup Damper	1234	Fluid-Operated Valves	Yes	Yes	Yes
E14C	Distribution panels, 32 Vdc PPS Channel C	1234	Distribution Panels	Yes	Yes	Yes
E14D	Distribution panels, 32 Vdc PPS Channel D	1234	Distribution Panels	Yes	Yes	Yes
E13A	Battery Chargers for PPS Channels A, B, C, D battery banks and 32 Vdc distribution panels	1234	Battery Chargers	Yes	Yes	Yes
E13B	Battery Chargers for PPS Channels A, B, C, D battery banks and 32 Vdc distribution panels	1234	Battery Chargers	Yes	Yes	Yes
E13C	Battery Chargers for PPS Channels A, B, C, D Battery Banks and 32 Vdc Distribution Panels	1234	Battery Chargers	No	No	No
E13D	Battery Chargers for PPS Channels A, B, C, D Battery Banks and 32 Vdc Distribution panels	1234	Battery Chargers	No	No	No
BL-10-166	Emergency Firewater Canal Fill	1478	Solenoid-Operated Valves	Yes	Yes	Yes
LS-19-1	Level Switch, ATR Canal Level Control	1478	Transmitters	Yes	Yes	Yes
PRV-6-840	Pressure Regulator Valve, ATR Canal Level Control	1479	Fluid-Operated Valves	Yes	Yes	Yes

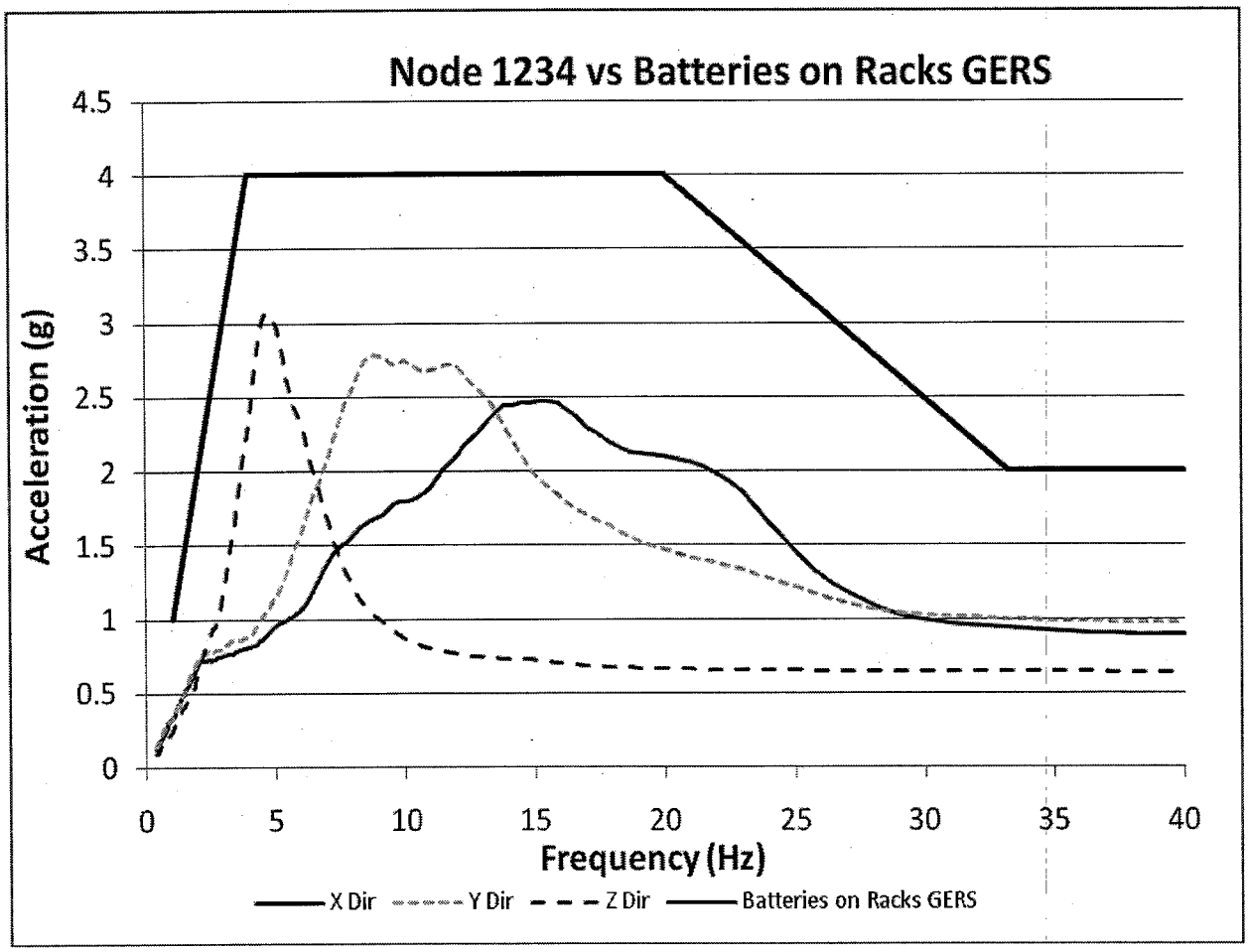

Figure 5-18. Comparison of Battery GERS with SDS at Node 1234.

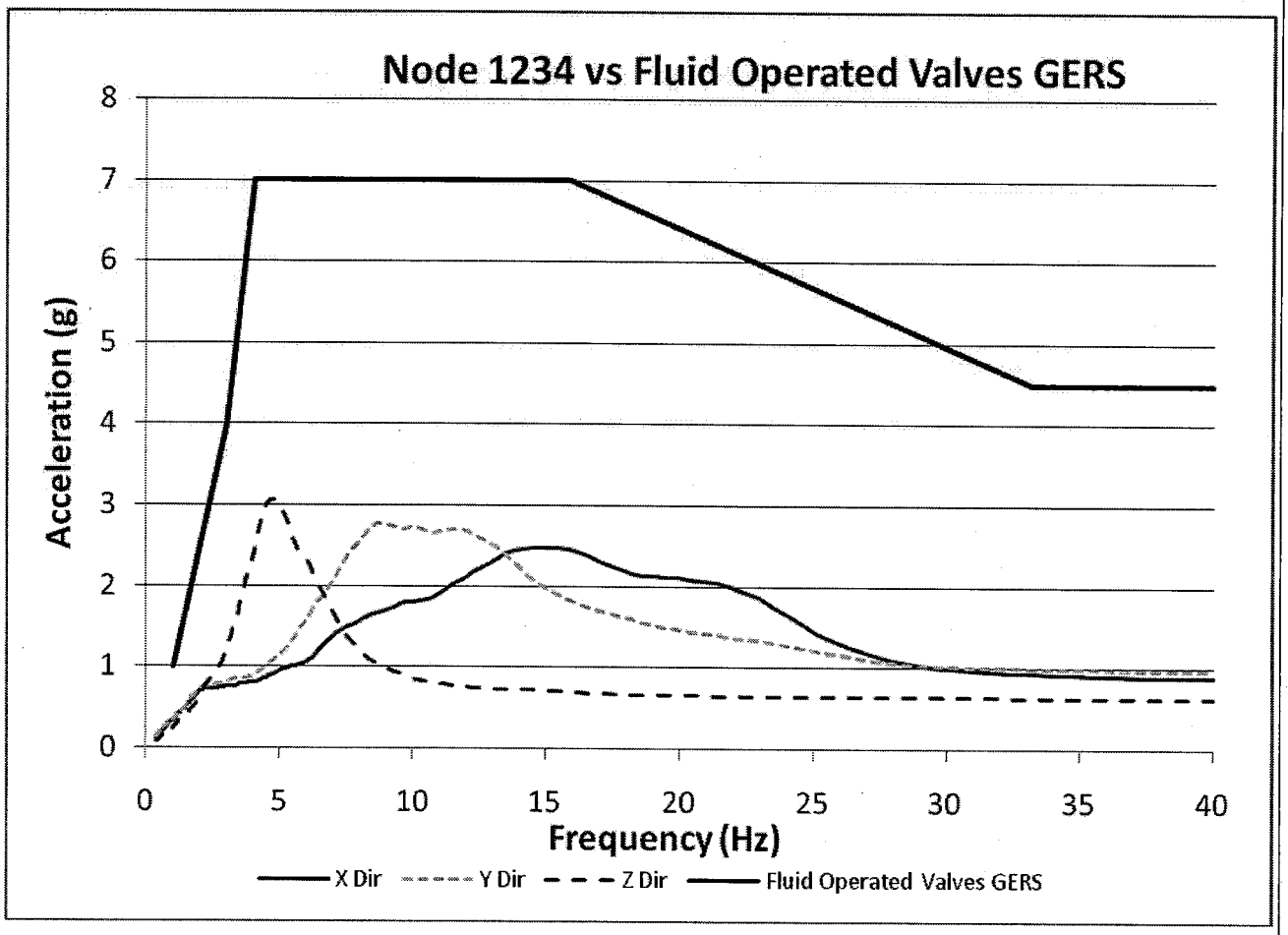

Figure 5-19. Comparison of Fluid-Operated Valve GERS with SDS at Node 1234.

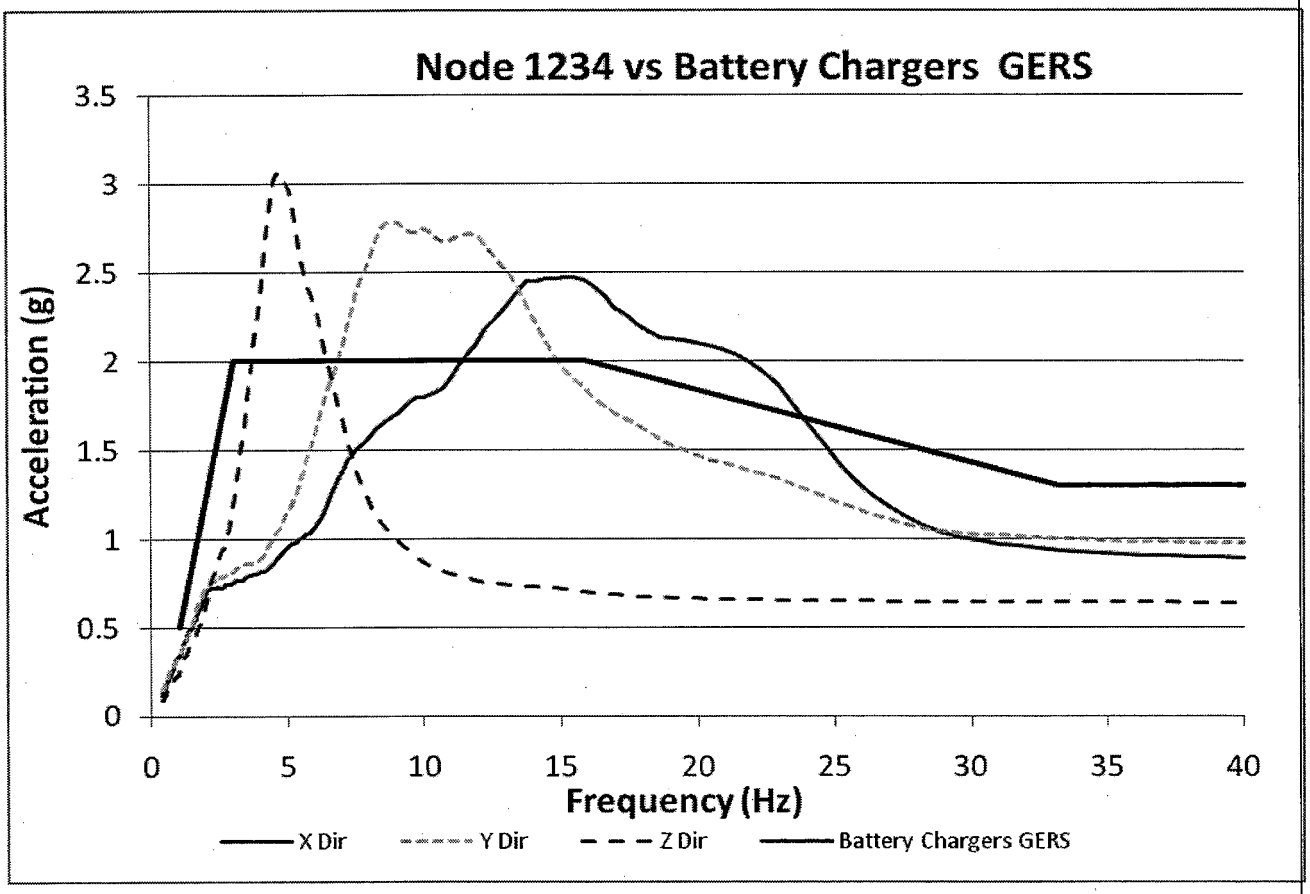

Figure 5-20. Comparison of Battery Charger GERS with SDS at Node 1234.

The Seismic Category I relays included in the scope of work were reviewed against the list of low-ruggedness relays in Appendix E of EPRI NP-7148. No low-ruggedness relays were identified.

The seismic demand at the mounting point of each relay was determined by scaling the peak spectral acceleration of the ISRS for the cabinet or panel location by the applicable in-cabinet amplification factor from NP-7148 and the experience data factor of 1.8. The amplification factors provided by EPRI NP-7148 are 3.0 for low-amplification structures such as floor-mounted MCCs, 4.5 for medium-amplification structures such as floor-mounted control panels and benchboards, and 7.0 for high-amplification structures such as floor-mounted switchgear.

Relay seismic capacities were obtained from EPRI NP-7147 as shown in Table 5-2. As noted, a few of the relays are solid-state units and are not vulnerable to relay chatter.

Table 5-2. Relay Capacities.

Manufacturer	Relay model	Normal State	Capacity (g)	Reference
Agastat	7012AA	De-energized	12.5	NP-7147
Agastat	7022MC	Unknown	4.0	NP-7147
Clare	GP3R221MB	Unknown	9.0	NP-7147-A2
Clare	GP3R22INA6000	De-energized	9.0	NP-7147-A2
Clare	GP3R22IND2000	Both	9.0	NP-7147-A2
Douglas Randal	D08A	De-energized	SS	Solid State
Entrelec	010 059.07	De-energized	0.0	
GE	12HFA51A49H	De-energized	1.0	NP-7147
GE	CR120A08022A	Energized	9.0	NP-7147
GE	CR120X1C	Energized	9.0	NP-7147
Kilovac	PD10AB57	De-energized	SS	Solid State
Potter & Brumfield	CNT-35-96	De-energized	0.0	
Potter & Brumfield	KUP11A15-120	Unknown	10.0	NP-7147-A2
Potter & Brumfield	KUP11D55-24	Unknown	10.0	NP-7147-A2
Potter & Brumfield	SR-240D25R	De-energized	SS	Solid State
Square D	Class 8501, Type X, relay series A	Energized	10.0	NP-7147
Westinghouse	765A651G04	Unknown	4.5	NP-7147
Westinghouse	765A687G01	Unknown	4.5	NP-7147

Table 5-3 lists the seismic capacity-versus-seismic demand comparison for Seismic Category I relays included in the scope of work. As indicated, most of the relays were determined to be seismically qualified. Twenty-eight relays were determined to be outliers. Three (ID Nos. 14, 16, and 17) are Westinghouse ARD relays and six (ID Nos. 22-24, and 33 to 35) are GE HFA relays. The capacity of the Westinghouse ARD relays was taken as 4.5g since the operational state is not known. If the operational state is determined to be other than DE-NC, a capacity of 6.0g would be applicable and the relays would be acceptable. Similarly, the capacity of the GE HFA relays was taken to be 1g because it is not known if the relay contacts are NO or NC. If the contacts are NO, a capacity of 6g would be applicable and the relays would be acceptable. Eight of the outliers are Entrelec relays and four are Potter and Brumfield CNT-35-96 relays. Both of these relay models are electro-mechanical relays that were assigned a capacity of zero due to an inability to establish a capacity level. The remaining seven outlier relays (ID Nos. 40-45 and 48) are outliers due to high horizontal acceleration.

Table 5-3. Relay Seismic Evaluation Results. (3 sheets)

Relay	Equipment No	Parent Cabinet	Manufacturer	Relay model	Screening	
					Horizontal	Vertical
1	VV-R1B	670-VV-RLY-B	Potter & Brumfield	SR-240D25R	OK	OK
2	VV-R1C	670-VV-RLY-B	Potter & Brumfield	SR-240D25R	OK	OK
3	VV-R2B	670-VV-RLY-C	Potter & Brumfield	SR-240D25R	OK	OK
4	VV-R2C	670-VV-RLY-C	Potter & Brumfield	SR-240D25R	OK	OK
5	504XA	E310A	Potter & Brumfield	KUP11D55-24	OK	OK
6	515XA	E310A	Clare	GP3R221MB	OK	OK
7	62/A	E310B	Agastat	7022MC	OK	OK
8	504XA	E310B	Potter & Brumfield	KUP11D55-24	OK	OK
9	515XA	E310B	Clare	GP3R221MB	OK	OK
10	62/A	E310A	Agastat	7022MC	OK	OK
11	504XA	E310C	Potter & Brumfield	KUP11D55-24	OK	OK
12	515XA	E310C	Clare	GP3R221MB	OK	OK
13	62/A	E310C	Agastat	7022MC	OK	OK
14	Pri Pumps RLY-A (670-E-1)	670-E-1	Westinghouse	765A687G01	OUTLIER	OK
15	670-E-15-2K-CR1	670-E-15	Potter & Brumfield	KUP11A15-120	OK	OK
16	Pri Pumps RLY-A (670-E-2)	670-E-2	Westinghouse	765A687G01	OUTLIER	OK
17	670-E-28-CR2	670-E-28	Westinghouse	765A651G04	OUTLIER	OK
18	500/1X	E311A	Clare	GP3R22IND2000	OK	OK
19	502/1X	E311A	Clare	GP3R22IND2000	OK	OK
20	502/4X	E311A	Clare	GP3R22IND2000	OK	OK
21	62-1	E311A	Agastat	7012AA	OK	OK
22	500/ESF-1	E311A	GE	12HFA51A49H	OUTLIER	OUTLIER
23	502/ESF-1	E311A	GE	12HFA51A49H	OUTLIER	OUTLIER
24	502/ESF-1B	E311A	GE	12HFA51A49H	OUTLIER	OUTLIER
25	74-500/1X	E311A	Clare	GP3R22IND2000	OK	OK
26	74-500/ESF-1	E311A	Clare	GP3R22INA6000	OK	OK
27	74-502/1X, 74-502/4X	E311A	Clare	GP3R22IND2000	OK	OK
28	74-502/ESF-1	E311A	Clare	GP3R22INA6000	OK	OK
29	500/4X	E311D	Clare	GP3R22IND2000	OK	OK
30	502/11X	E311D	Clare	GP3R22IND2000	OK	OK
31	502/44X	E311D	Clare	GP3R22IND2000	OK	OK
32	62-4	E311D	Agastat	7012AA	OK	OK
33	500/ESF-4	E311D	GE	12HFA51A49H	OUTLIER	OUTLIER
34	502/ESF-4	E311D	GE	12HFA51A49H	OUTLIER	OUTLIER
35	502/ESF-4B	E311D	GE	12HFA51A49H	OUTLIER	OUTLIER
36	74-500/4X	E311D	Clare	GP3R22IND2000	OK	OK
37	74-500/ESF-4	E311D	Clare	GP3R22INA6000	OK	OK

Table 5-3. Relay Seismic Evaluation Results. (3 sheets)

Relay	Equipment No	Parent Cabinet	Manufacturer	Relay model	Screening	
38	74-502/11X, 74-502/44X	E311D	Clare	GP3R22IND2000	OK	OK
39	74-502/ESF-4	E311D	Clare	GP3R22INA6000	OK	OK
40	BDR1	Panel E	GE	CR120A08022A	OUTLIER	OK
41	BDR2	Panel E	GE	CR120A08022A	OUTLIER	OK
42	BDR3	Panel E	Square D	Class 8501, Type X, relay series A	OUTLIER	OK
43	R1A-A	Panel E	GE	CR120X1C	OUTLIER	OK
44	R1A-B	Panel E	GE	CR120X1C	OUTLIER	OK
45	R1A-C	Panel E	GE	CR120X1C	OUTLIER	OK
46	R1AX2B, R1AX1B, R1A1B, R1A2B	Panel E	Douglas Randal	D08A	OK	OK
47	R1AX2, R1AX1, R1A1, R1A2	Panel F	Douglas Randal	D08A	OK	OK
48	R1A, R1B, R1C	Panel F	GE	CR120X1C	OUTLIER	OK
49	BDR4	670-E-313	Square D	class 8501, Type X, relay series A	OK	OK
50	KM6-IN1-1	RLY-LOCA-ESF-M6	Kilovac	PD10AB57	OK	OK
51	KM6-IN1-2	RLY-LOCA-ESF-M6	Kilovac	PD10AB57	OK	OK
52	KM6-IN4-1	RLY-LOCA-ESF-M6	Kilovac	PD10AB57	OK	OK
53	KM6-IN4-2	RLY-LOCA-ESF-M6	Kilovac	PD10AB57	OK	OK
54	KM6-OUT1-1	RLY-LOCA-ESF-M6	Kilovac	PD10AB57	OK	OK
55	KM6-OUT1-2	RLY-LOCA-ESF-M6	Kilovac	PD10AB57	OK	OK
56	KM6-OUT4-1	RLY-LOCA-ESF-M6	Kilovac	PD10AB57	OK	OK
57	KM6-OUT4-2	RLY-LOCA-ESF-M6	Kilovac	PD10AB57	OK	OK
58	KM7-OUT4-2	RLY-LOCA-ESF-M7	Kilovac	PD10AB57	OK	OK
59	KM7-IN1-1	RLY-LOCA-ESF-M7	Kilovac	PD10AB57	OK	OK
60	KM7-IN1-2	RLY-LOCA-ESF-M7	Kilovac	PD10AB57	OK	OK
61	KM7-IN4-1	RLY-LOCA-ESF-M7	Kilovac	PD10AB57	OK	OK
62	KM7-IN4-2	RLY-LOCA-ESF-M7	Kilovac	PD10AB57	OK	OK
63	KM7-OUT1-1	RLY-LOCA-ESF-M7	Kilovac	PD10AB57	OK	OK
64	KM7-OUT1-2	RLY-LOCA-ESF-M7	Kilovac	PD10AB57	OK	OK
65	KM7-OUT4-1	RLY-LOCA-ESF-M7	Kilovac	PD10AB57	OK	OK
66	KM8-IN1-1	RLY-LOCA-ESF-M8	Kilovac	PD10AB57	OK	OK
67	KM8-IN1-2	RLY-LOCA-ESF-M8	Kilovac	PD10AB57	OK	OK
68	KM8-IN4-1	RLY-LOCA-ESF-M8	Kilovac	PD10AB57	OK	OK
69	KM8-IN4-2	RLY-LOCA-ESF-M8	Kilovac	PD10AB57	OK	OK
70	KM8-OUT1-1	RLY-LOCA-ESF-M8	Kilovac	PD10AB57	OK	OK
71	KM8-OUT1-2	RLY-LOCA-ESF-M8	Kilovac	PD10AB57	OK	OK
72	KM8-OUT4-1	RLY-LOCA-ESF-M8	Kilovac	PD10AB57	OK	OK
73	KM8-OUT4-2	RLY-LOCA-ESF-M8	Kilovac	PD10AB57	OK	OK

Table 5-3. Relay Seismic Evaluation Results. (3 sheets)

Relay	Equipment No	Parent Cabinet	Manufacturer	Relay model	Screening	
74	KM9-IN1-1	RLY-LOCA-ESF-M9	Kilovac	PD10AB57	OK	OK
75	KM9-IN1-2	RLY-LOCA-ESF-M9	Kilovac	PD10AB57	OK	OK
76	KM9-IN4-1	RLY-LOCA-ESF-M9	Kilovac	PD10AB57	OK	OK
77	KM9-IN4-2	RLY-LOCA-ESF-M9	Kilovac	PD10AB57	OK	OK
78	KM9-OUT1-1	RLY-LOCA-ESF-M9	Kilovac	PD10AB57	OK	OK
79	KM9-OUT1-2	RLY-LOCA-ESF-M9	Kilovac	PD10AB57	OK	OK
80	KM9-OUT4-1	RLY-LOCA-ESF-M9	Kilovac	PD10AB57	OK	OK
81	KM9-OUT4-2	RLY-LOCA-ESF-M9	Kilovac	PD10AB57	OK	OK
82	K1-IN-1	TMR-LOCA-ESF-1	Entrelec	010 059.07	OUTLIER	OUTLIER
83	K1-OUT-1	TMR-LOCA-ESF-1	Entrelec	010 059.07	OUTLIER	OUTLIER
84	K2-IN-1	TMR-LOCA-ESF-1	Entrelec	010 059.07	OUTLIER	OUTLIER
85	K2-OUT-1	TMR-LOCA-ESF-1	Entrelec	010 059.07	OUTLIER	OUTLIER
86	TMR-IN-1	TMR-LOCA-ESF-1	Potter & Brumfield	CNT-35-96	OUTLIER	OUTLIER
87	TMR-OUT-1	TMR-LOCA-ESF-1	Potter & Brumfield	CNT-35-96	OUTLIER	OUTLIER
88	K1-IN-4	TMR-LOCA-ESF-4	Entrelec	010 059.07	OUTLIER	OUTLIER
89	K1-OUT-4	TMR-LOCA-ESF-4	Entrelec	010 059.07	OUTLIER	OUTLIER
90	K2-IN-4	TMR-LOCA-ESF-4	Entrelec	010 059.07	OUTLIER	OUTLIER
91	K2-OUT-4	TMR-LOCA-ESF-4	Entrelec	010 059.07	OUTLIER	OUTLIER
92	TMR-IN-4	TMR-LOCA-ESF-4	Potter & Brumfield	CNT-35-96	OUTLIER	OUTLIER
93	TMR-OUT-4	TMR-LOCA-ESF-4	Potter & Brumfield	CNT-35-96	OUTLIER	OUTLIER

5.2 Equipment Caveat Screening

The Seismic Category I equipment items included in the scope of work were screened against the caveats for the applicable equipment class and seismic capacity basis (i.e., earthquake experience, test experience). Caveat screening was performed primarily in the field walkdowns, supplemented by review of available documentation as required.

The caveat screening results were documented in the SEWSs, which may be produced using the ATR Equipment Database (Appendix B). Very few Seismic Category I equipment items included in the scope of work did not meet the intent of the caveats.

5.3 Anchorage Verification

Visual inspection of equipment anchorage was performed in the field walkdowns. Attributes reviewed included the following:

- Anchorage type, size, location, spacing, edge distance, and gaps;
- Equipment base stiffness, strength, and load path;
- Concrete condition and cracking; and
- Essential relays in cabinets.

Existing documentation on anchorage for Seismic Category I equipment included in the scope of work was limited. Aside from cast-in-place anchors for major components (e.g., motors for Pumps 670-M-10 and 670-M-11), essentially no details were available for equipment installed during original ATR construction. Anchorage design drawings and/or calculations were available for a few newer installations, such as direct current (DC) power components that were relocated to the second basement and equipment in TRA-688.

ARES developed an expansion anchor inspection procedure to obtain additional data. This procedure involved the following steps:

- The anchor length was determined either by ultrasonic testing or identification of an end stamp on the top of the stud. The gap between the bottom of the nut or bolt head and the top of the concrete was also measured.
- Anchor tightness was checked by torque test following DOE/EH-0545 procedures.
- A review for any observable deficiencies, such as cracked or spilled concrete, corrosion, and missing washers, was performed.
- The data were recorded on a checklist/data sheet.

BEA performed expansion anchor inspections for electrical equipment accessible only during outages. All anchors of this equipment were inspected, rather than testing a subset as permitted by DOE/EH-0545. Additional equipment items that still require anchor inspection are identified in Section 7.0.

When appropriate, anchorage adequacy was verified during the field walkdowns. The adequacy of anchorage for lightweight items weighing less than about 50 lbs was verified by manual tug-testing. In some instances, anchorage adequacy was confirmed by visual observation and engineering judgment. For example, Firewater System equipment in TRA-688 was observed in the field walkdown to have relatively large anchorage in comparison to the component masses. The adequacy of this anchorage was subsequently confirmed by review of the design calculations.

Quantitative evaluations were performed to seismically qualify the equipment anchorage that could not be screened as described above. To the extent possible, similar equipment having similar anchorage were aggregated into a group, with quantitative evaluation performed for the bounding case of the group.

Anchorage demands were determined following DOE/EH-0545 procedures. Seismic input to the equipment was based on the ISRS or ground response spectra at the equipment support location (Section 5.1.2). Equipment damping was typically taken to be 5% of critical damping, although 3% damping was assigned to certain low-stressed components following DOE/EH-0545 guidance. In many instances, equipment seismic inertial loads were based on the peak spectral accelerations of the ISRS or ground response spectrum, provided undesirable excessive conservatism was not introduced. In some cases, equipment seismic inertial loads were based on spectral accelerations at equipment frequencies either explicitly calculated by finite element models or closed-form solutions, or estimated by

engineering judgment. Anchor shear and tension forces were determined considering the load paths through the equipment to the anchorage and the anchor locations. Anchor forces due to the three orthogonal components of earthquake ground motion were combined by the square-root-of-the-sum-of-the-squares (SRSS) method or 100-40-40 method permitted by DOE/EH-0545. Anchor forces due to seismic loads were combined with other applicable concurrent loads (e.g., dead load).

Anchorage capacities were also determined following DOE/EH-0545 procedures. Nearly all of the Seismic Category I equipment included in the scope of work are anchored by post-installed anchors (e.g., concrete expansion anchors). A few are anchored by cast-in-place anchors, such as the motors for the 670-M-10 and 670-M-11 primary emergency cooling pumps and the 688-M-1 and 688-M-2 diesel firewater pumps. Allowable anchor capacities were based on the product of the nominal capacities and applicable reduction factors (e.g., spacing, edge distance, etc.).

Capacities of anchors placed in concrete were based on a concrete compressive strength of 3,000 psi. This value corresponds to the minimum specified 28-day strength for original construction of TRA-670 (Specification S-3, *ATR Specification for Concrete*). It was considered to be an appropriate value for the other buildings and structures housing Seismic Category I equipment in the scope of work.

Specification S-6, *ATR Specification for Steel Reinforcement and Steel Insert Material,* permitted lead cinch anchors in the original ATR construction. Although the INL has not observed the use of lead cinch anchors for Seismic Category I equipment, their use cannot be conclusively precluded without component-specific examination. In such instances, the anchorage evaluation first used DOE/EH-0545 capacities for lead cinch anchors. If the assumed lead cinch anchors were found to be acceptable, no further evaluation was required since higher capacities would be achieved by concrete expansion anchors. If the assumed lead cinch anchors were found to be unacceptable, the evaluation was repeated assuming concrete expansion anchors (of unknown type) were used.

Some of the Seismic Category I equipment included in the scope of work are anchored to concrete block walls. The types of anchors used for most of these items are unknown. The adequacy of anchorage for some of the block wall-mounted components was verified by tug-testing. In-situ testing should be performed to verify the adequacy of the remaining anchors set into block walls (Section 7.0).

The quantitative anchorage evaluation results are summarized in Table 5-4. As noted, some of the anchorage groups do not satisfy PC-4 seismic criteria. General reasons for these non-compliances include poor anchorage and/or load path details, high seismic input at the first floor, and missing anchors. Some of the anchorage groups that satisfy PC-4 seismic criteria require further follow-up actions (Section 7.0).

A few of the Seismic Category I equipment included in the scope of work are founded on housekeeping pads. The pad for 670-E-23 and 670-E-28, which were relocated to the second basement, is adequately anchored to the concrete floor. However, documentation on anchorage of the pads for 670-E-15 and 670-E-26 is unavailable. Lacking such documentation, it should be assumed that these pads are not doweled to the concrete floors. This potential lack of anchorage should be considered when designing seismic strengthening for these components.

Table 5-4. Quantitative Anchorage Evaluation Results.

Calculation No.	Group	Equipment	PC-4 Criteria Satisfied?
0602301.01-S-101	F-4	670-E-58, -59	Yes[1]
0602301.01-S-102	F-3	E11A, B,	Yes[1]
		E11C, D, Spare	No, if lead anchors Yes[1], if concrete exp. anchors
0602301.01-S-103	W-4, W-5	I52A, B, C; NLPA 31 A, B, C; RAm-511A, B, C; E310A, B, C; E311A, D	Yes[2, 3]
0602301.01-S-104	W-1	E13A, B, C, D	Yes
0602301.01-S-105	F-10	670-E-104, 670-E-116	Yes
0602301.01-S-106	F-15	670-E-26	No
		670-E-459	Yes
0602301.01-S-107	F-6	670-E-15	No
0602301.01-S-108	F-1	VVS Instrument Racks – First Basement and First Floor	Yes[1, 5]
0602301.01-S-109	F-19	670-E-23, 670-E-28	Yes
0602301.01-S-110	F-2	PT-10-6 (EFIS), LT-10-133, LT-514B, dPT-1-21, -22, -23, -24, LT-514C, LT-514A	Yes[1]
0602301.01-S-111	F-7	P11	Yes[4]
0602301.01-S-112	F-5	670-E-4, 670-E-5, 670-E-6, 670-E-7, 670-E-8, 670-E-9, ATS 670-E-228	No
0602301.01-S-113	F-12	670-M-10, 670-M-11	Yes
0602301.01-S-114	F-23	674-M-10	Yes
0602301.01-S-115	F-20	674-M-8	No
0602301.01-S-116	F-9	Reactor Console	No
0602301.01-S-117	F-14	I51A, I51B, I51C	Yes
0602301.01-S-118	F-16	MTS 670-E-457	Yes[2]
0602301.01-S-119	F-26	670-E-117	No
0602301.01-S-120	F-27	670-M-42, -43	Yes
0602301.01-S-121	F-22	674-E-5	No
0602301.01-S-122	F-24	674-M-20	Yes[1]

Notes:

1. Anchor tightness check required.
2. Capacity of anchors in block walls requires verification.
3. Ram-511C requires replacement of missing anchors.
4. Requires verification that control panels develop integral behavior.
5. Requires verification that lead anchors were not used.

5.4 Interaction Screening

5.4.1 Field Walkdown Observations

The Seismic Category I equipment included in the scope of work were reviewed for adverse seismic interactions during the field walkdowns. Potential seismic interactions considered included those due to proximity (i.e., impact between adjacent structures or equipment), falling of overhead or adjacent SSCs, flexibility of attached lines and differential displacement, and water, spray, and fire hazards.

Relatively few seismic interactions with the potential to adversely affect Seismic Category I equipment included in the scope of work were identified in the field walkdowns. Example observations are as follows:

- Carts and tables on wheels were chained to prevent them from rolling and impacting Seismic Category I equipment (Figure 5-21). Plant housekeeping with respect to seismic interaction concerns was observed to be good.
- Seismic Category I items 670-E-23 and 670-E-28 are in close proximity to non-Seismic Category I items 670-E-103, 670-E-105, and 670-E-459 (Figure 5-22). 670-E-28 contains essential relays. All of these components were observed to be bolted together. The anchorage for all of these components was confirmed to satisfy PC-4 seismic criteria.
- The control room ceiling was generally observed to consist of lightweight acoustical tile and unlikely to damage Seismic Category I components if it were to fall. The light fixtures were observed to be sufficiently tied to the floor above (Figure 5-23).
- Rod-supports for utilities near the control room panels were observed to be attached to overhead steel framing by beam clamps (Figure 5-24). Tug-testing of a sampling of beam clamps confirmed that they are adequately secured.
- Cables to Batteries 670-E-59 were observed to have sufficient slack to accommodate relatively seismic displacements (Figure 5-25).
- Gas bottles were restrained by two sets of chains to prevent them from falling (Figure 5-26).

Examples of potentially adverse seismic interactions that should be addressed include the following:

- The air accumulator at TRA-770 is oriented vertically and attached to a concrete pier by horizontal U-bolts (Figure 5-27). This attachment detail relies on friction to hold the accumulator in place. The accumulator could slip due to vertical seismic excitations and fail attached tubing that runs to various RMSS components.
- Unanchored storage lockers were observed in the PPS battery rooms (Figure 5-28). These lockers could topple and impact the batteries.
- An unanchored storage locker was observed in TRA-672 (Figure 5-29). The locker could topple and impact Seismic Category I equipment that serve the deep well pump.

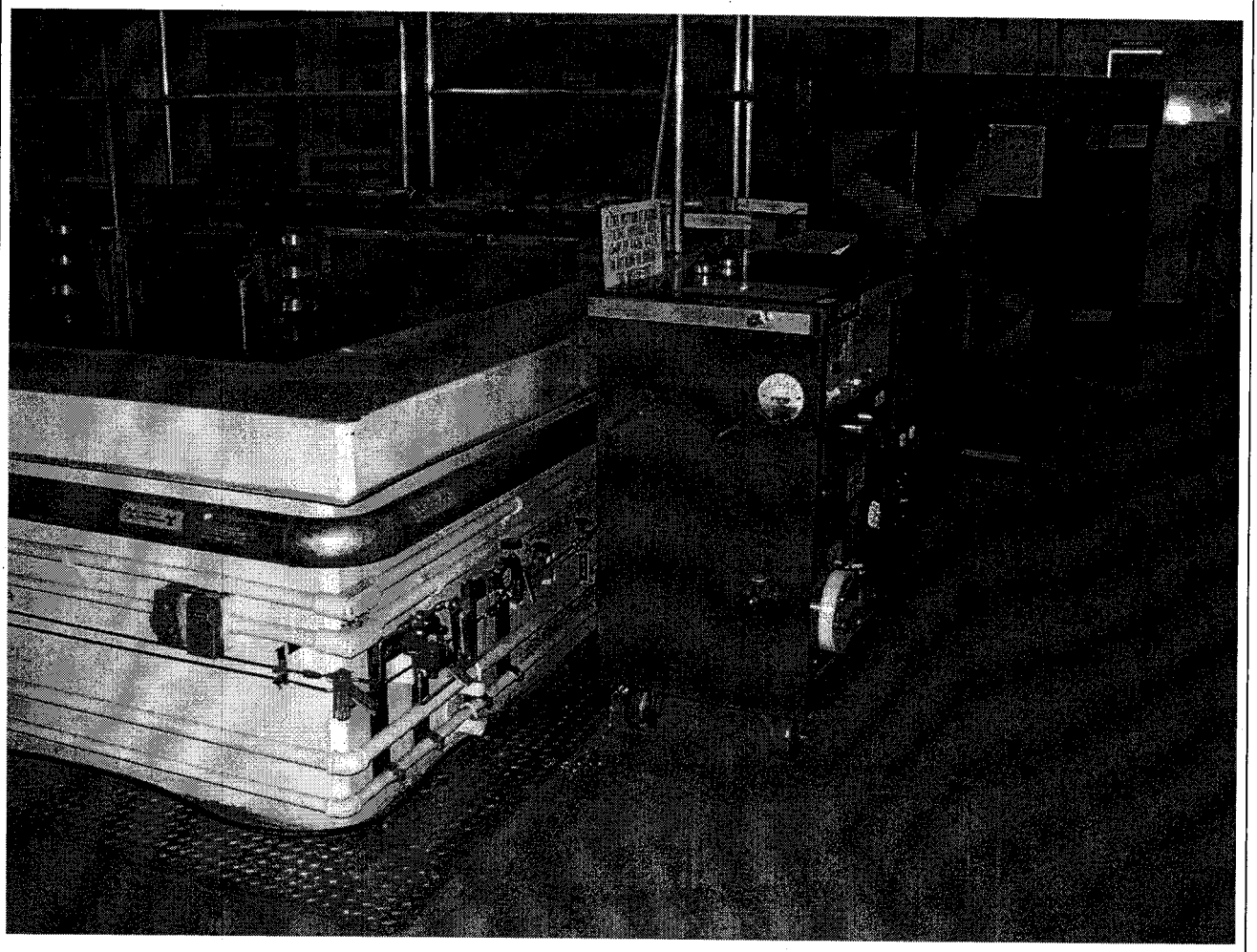

Figure 5-21. Constant Air Monitor Chained to the Floor.

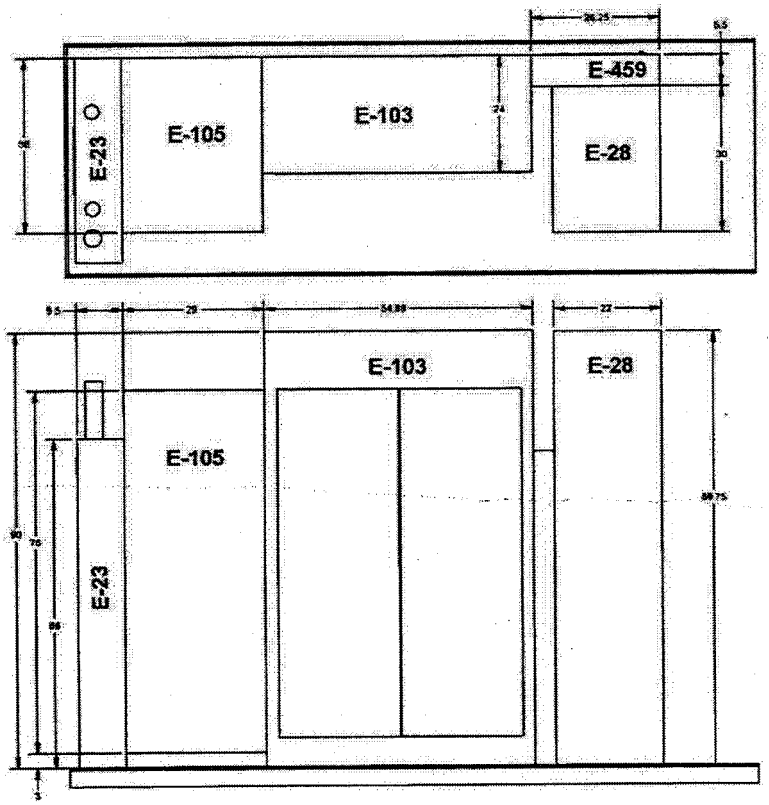

Figure 5-22. 670-E-23, 670-E-28, and Adjacent Non-Seismic Category I Components.

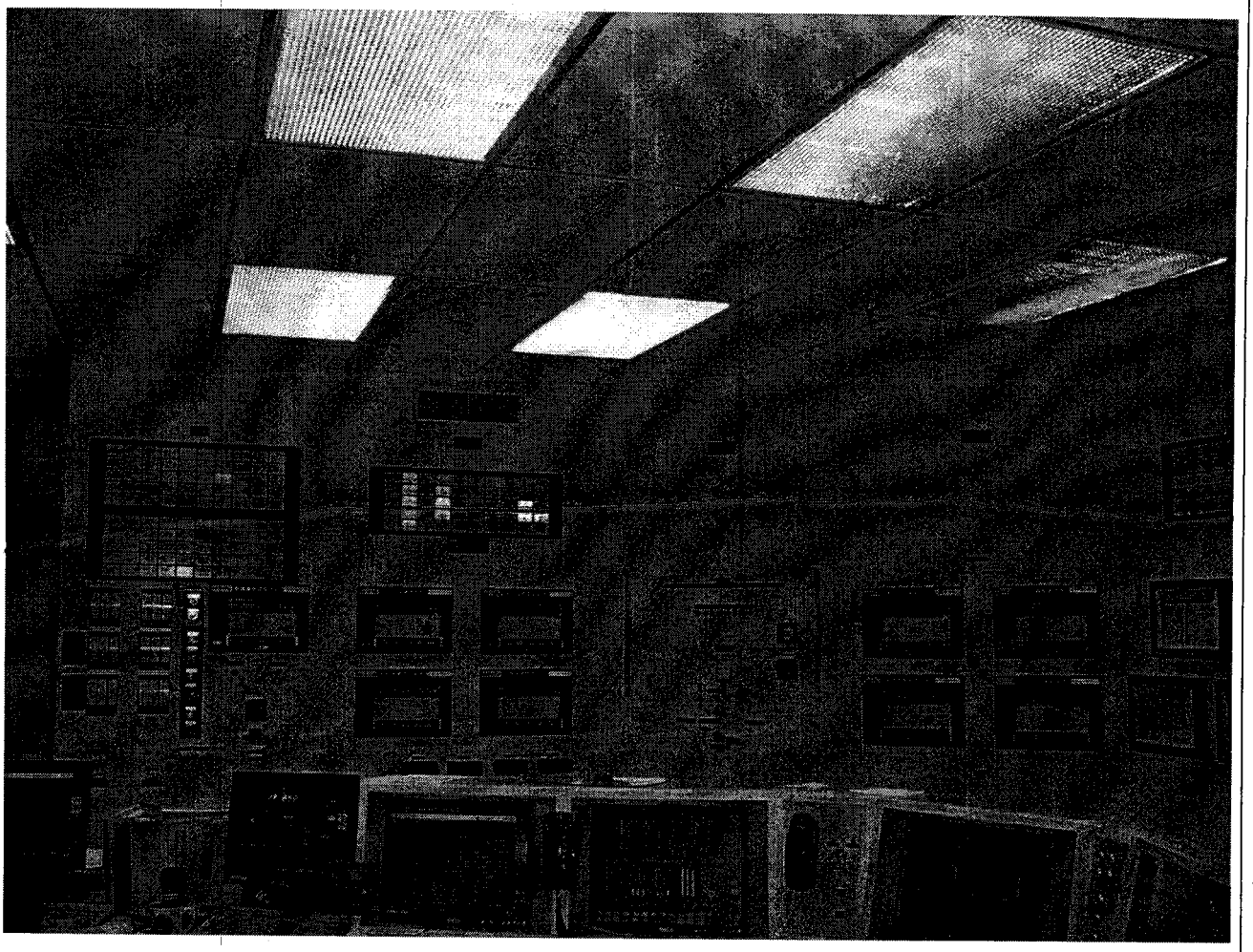

Figure 5-23. Control Room Ceiling.

Figure 5-24. Beam Clamps for Rod-Supported Utilities Near the Control Panels.

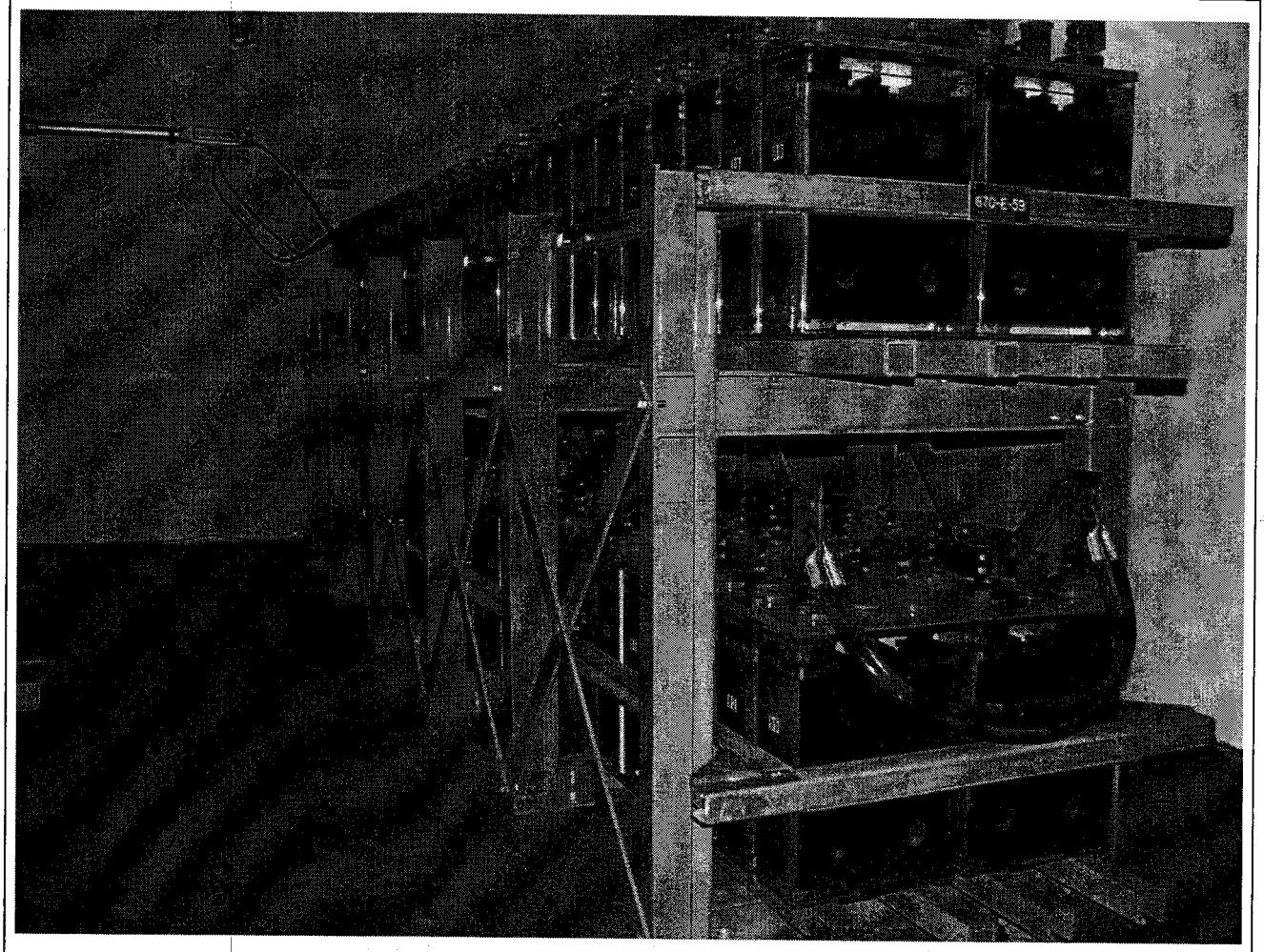

Figure 5-25. Cables for Battery 670-E-59.

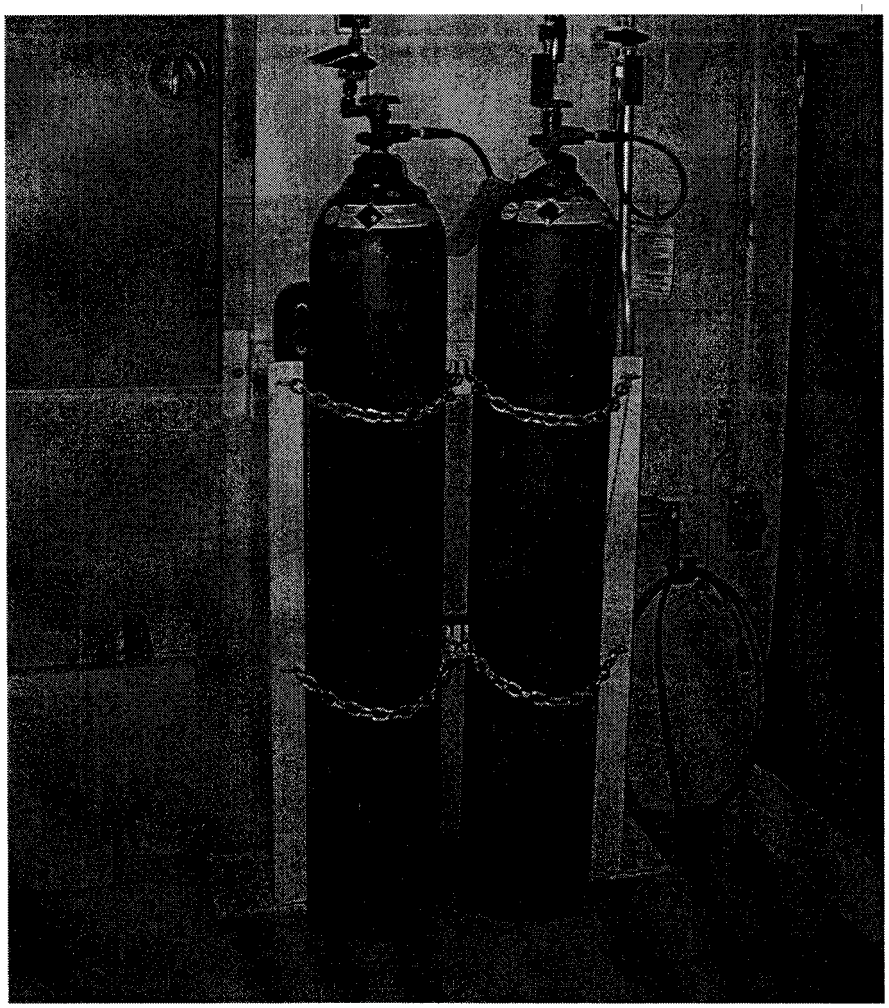

Figure 5-26. Chained Gas Bottles.

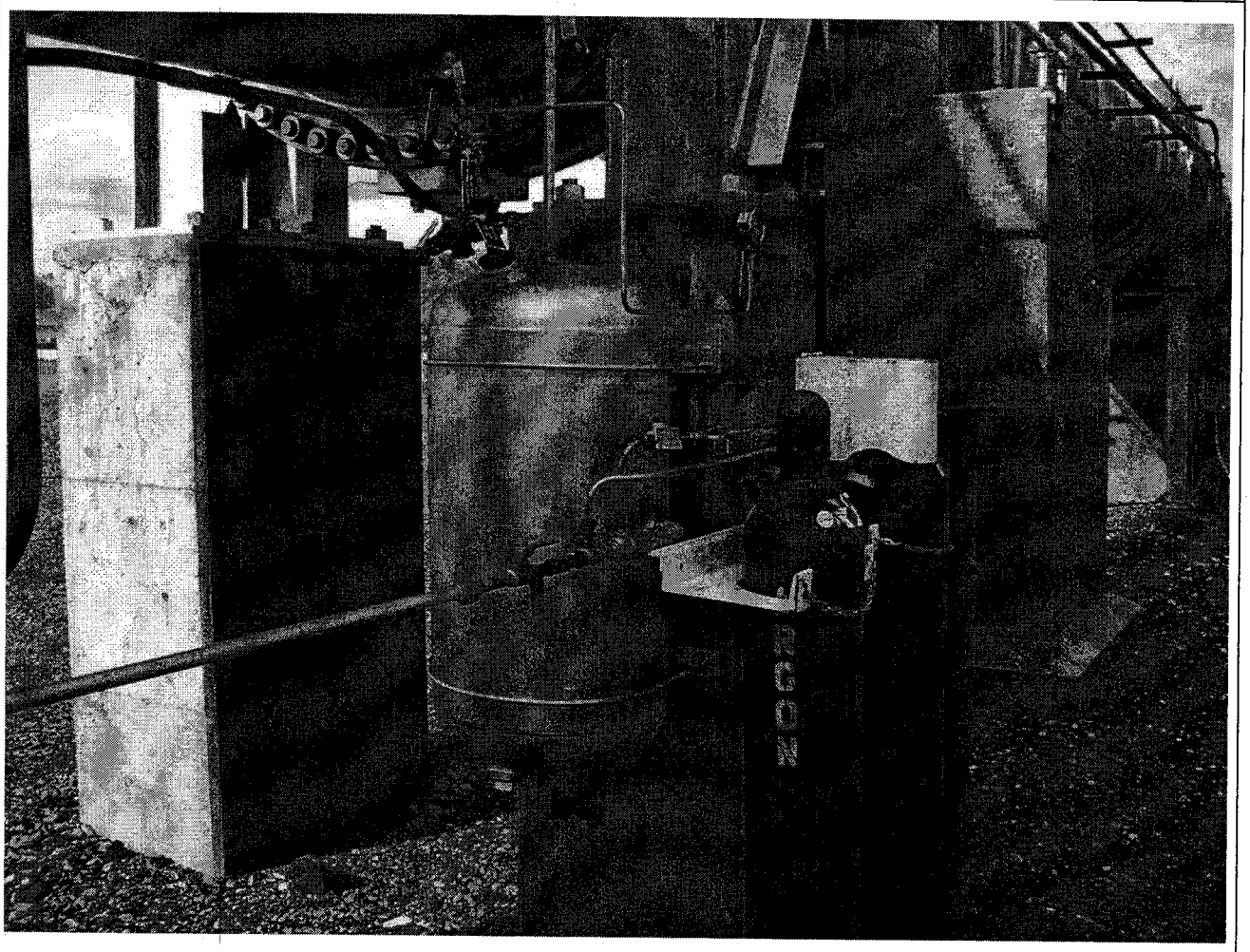

Figure 5-27. Air Accumulator at TRA-770.

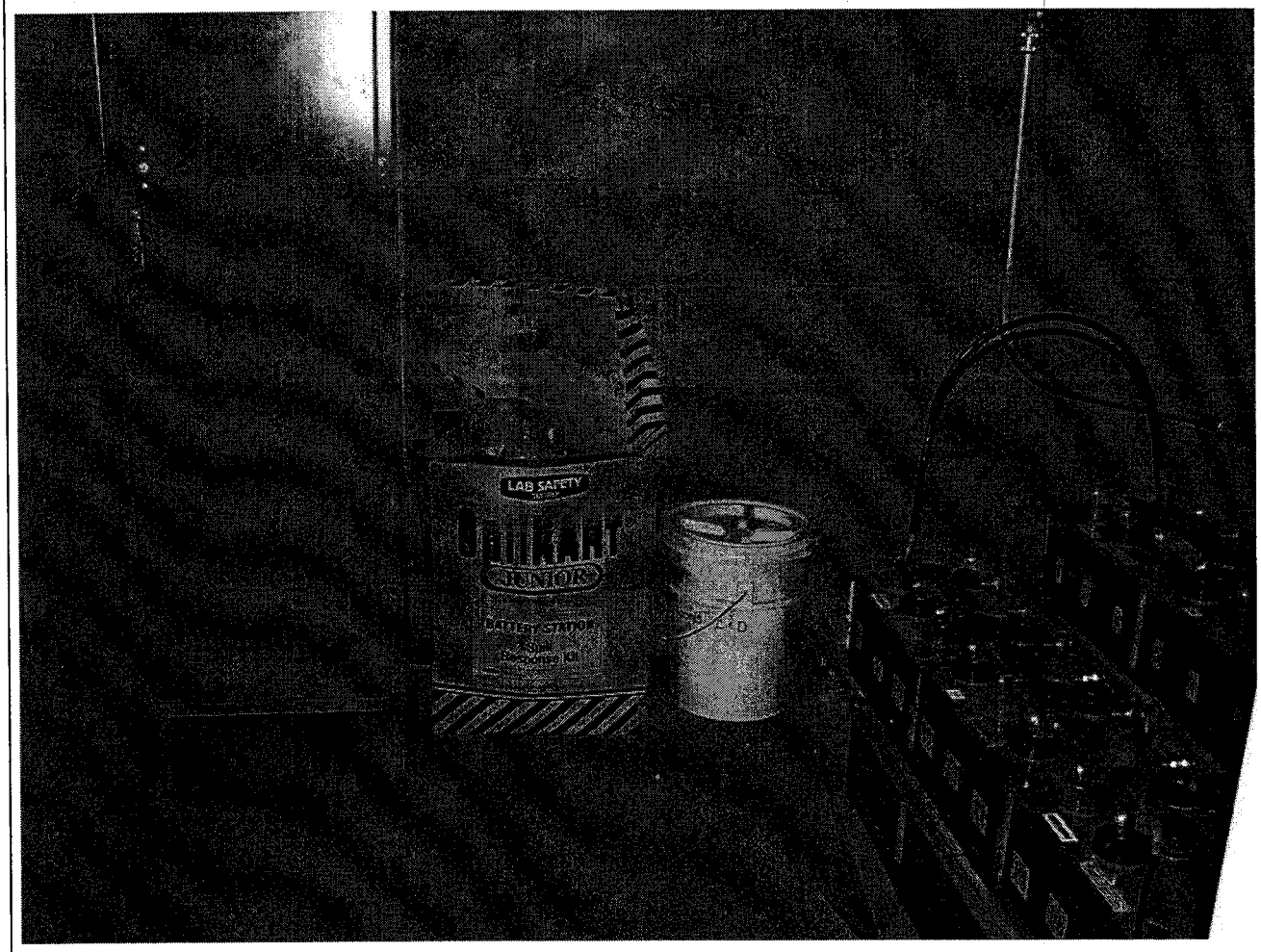

Figure 5-28. Unanchored Storage Locker Near Battery 11C.

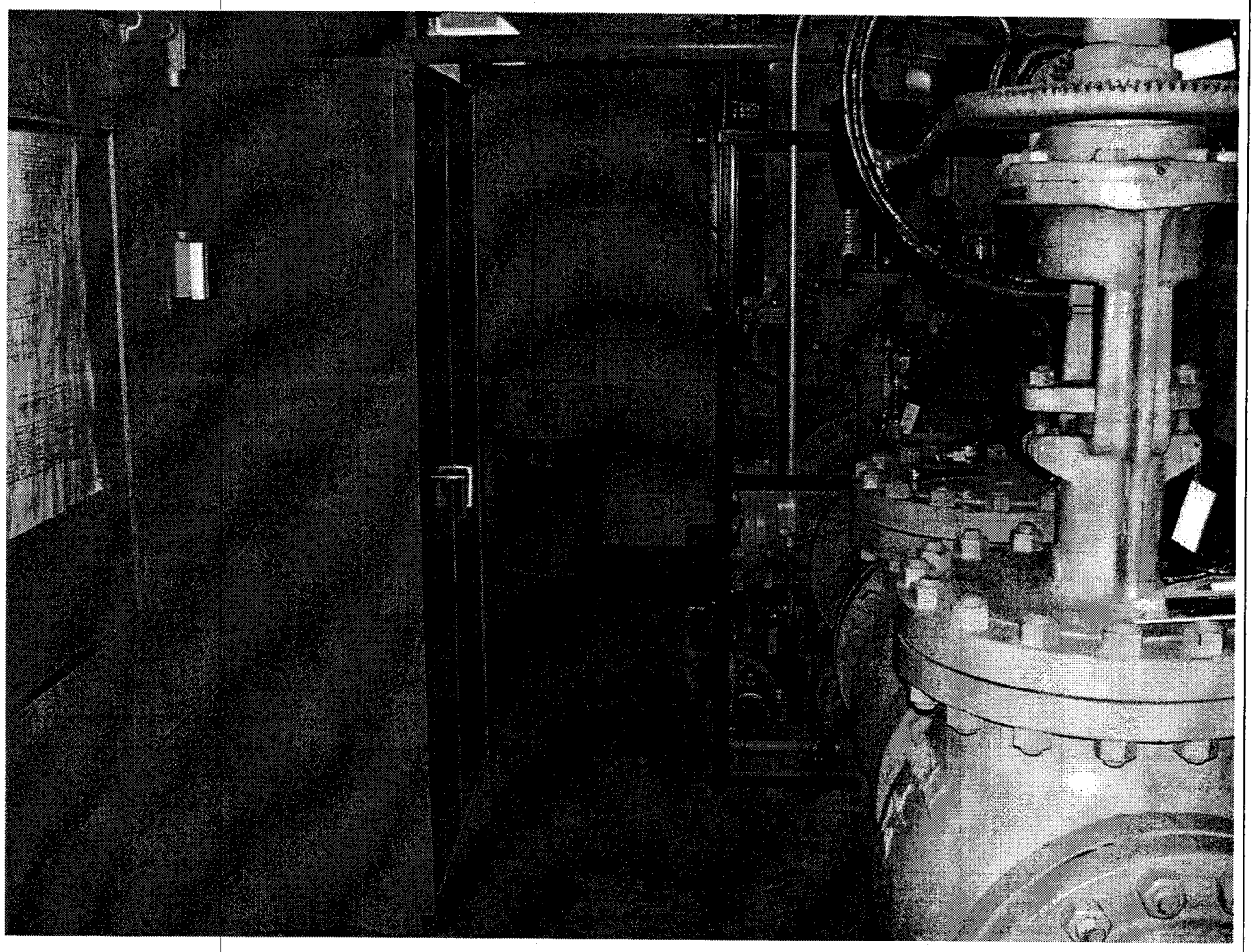

Figure 5-29. Unanchored Storage Locker in TRA-672.

5.4.2 Quantitative Evaluation of Seismic Interaction Sources

Quantitative evaluations were performed to assess the potential for the concrete block and shielding walls, TRA-770 Ventilation Stack, and Diesel Generators 670-M-42 and 670-M-43 to fail and adversely affect Seismic Category I equipment included in the scope of work. These evaluations are summarized below.

5.4.2.1 Concrete Block and Shielding Wall Evaluation

Concrete block and shielding walls in TRA-670 support or are located in proximity to Seismic Category I equipment included in the scope of work. Seismic evaluation of these walls was performed to determine if they could adversely affect this equipment. This evaluation is summarized below. Details may be obtained from ARES Calculation No. 0602301.01-S-007 (Appendix J).

Data on the TRA-670 concrete block and shielding walls were obtained from field walkdowns and existing documentation. Each wall was assigned an identification number formatted as XX-YY-Z. Designator XX represents the floor at which the wall is located, where FF, 1B, and 2B signify the first floor, first basement, and second basement, respectively. Designator YY represents the bay bounded by four column lines in which the wall is located. The bay is identified by the two column lines, one in the north-south direction and one in the east-west direction, that intersect at the southwest corner of the bay. Designator Z is a number sequentially assigned to each of the walls within the bay.

The concrete block and shielding walls were aggregated into groups with bounding cases from each group selected for evaluation. The walls of each group have similar attributes significant to seismic capacity (e.g., thickness, height, reinforcement, seismic input). Some of the groups may consist of single, unique walls. Table 5-5 identifies the wall groups.

Table 5-5. Concrete Block and Shielding Wall Groups.

Group No.	Description
1	Typical 6-inch thick concrete block walls at the first and second basements
2	Typical 8-inch thick concrete block walls at the first and second basements
3	Concrete block walls enclosing the PPS electronics and battery rooms
4	Typical 4-inch thick concrete block walls at the first floor
5	Shielding and high-density walls at the first and second basements
6	Narrow concrete block walls located over doors or openings
7	Wall 2B-G9-1 (unique support configuration)
8	Walls 1B-J2-1 and 1B-J2-2 which enclose the station battery room at the first basement
9	Wall 1B-F5-1 (unique support configuration)
10	6-inch thick concrete block walls at the first floor with heights of 11.5 feet or less
11	Wall FF-H4-1
12	Typical 8-inch thick concrete block walls at the first floor
13	Typical 12-inch thick concrete block walls at the first floor
14	Concrete block walls at the first floor along Column Line 7
15	12-inch thick concrete block walls at the first floor with heights of 3.5 feet or less

Seismic input to the walls consisted of the ISRS from CJC-INL-C-003, CJC-INL-C-004, and EDF-ECAR-173 (Section 5.1.2). For walls spanning primarily in the vertical direction which are laterally supported at the top and bottom, the average of spectral accelerations from ISRS at the floors above and below was used as permitted by DOE/EH-0545.

Seismic demands on reinforced concrete block walls were determined following the requirements of DOE-STD-1020-2002, ASCE 4-98, and ASCE/SEI 43-05. Seismic capacities were determined in accordance with ACI 530-05/ASCE 5-05/TMS 402-05, 2005, *Building Code Requirements for Masonry Structures* and Appendix R of EPRI NP-6041-SL, *A Methodology for Assessment of Nuclear Power Plant Seismic Margin*. Unreinforced concrete block and shielding walls were evaluated by the elastic, reserve energy, and/or arching action methods permitted by DOE/EH-0545.

The concrete block walls in TRA-670 typically have vertical reinforcement and horizontal joint reinforcement. They were modeled as one-way walls spanning in the vertical direction and evaluated following Appendix R of EPRI NP-6041-SL. Drift limits for these walls varied. Lateral drifts for concrete block walls supporting Seismic Category I equipment were limited to values at which utilities

(e.g., conduit, tubing) routed to these equipment could fail. Lateral drifts for concrete block walls in proximity to Seismic Category I equipment were limited to values at which imposed displacement on equipment anchorage would be unacceptable. Lateral drifts for concrete block walls located appreciable distances from Seismic Category I equipment were limited to values at which collapse could occur.

The 4-inch thick concrete block walls at the first floor (Group 4) are unreinforced. These walls were evaluated considering arching action following methods in DOE/EH-0545 and *Development of Seismic Evaluation Criteria for URM Infill Frames Including Independent Review of Oak Ridge HCTW Test Program* (EQE, 1998). The first mezzanine floor above these walls was considered to provide confinement. Because this floor is not reinforced against an upward thrust due to block wall arching, its confining capacity is limited by concrete cracking.

The shielding walls of Group 5 are confined by heavy concrete beams or slabs. These walls were also evaluated considering arching action. Confinement by the heavy concrete members provides considerable out-of-plane seismic capacity.

The mortar joints between concrete block walls enclosing the station batteries (Group 8) and the overhead slab were observed to be in very poor condition (Figure 5-30). The seismic evaluation of these walls assumed that they will be strengthened by adding anchorage between the top of the walls and the floor above.

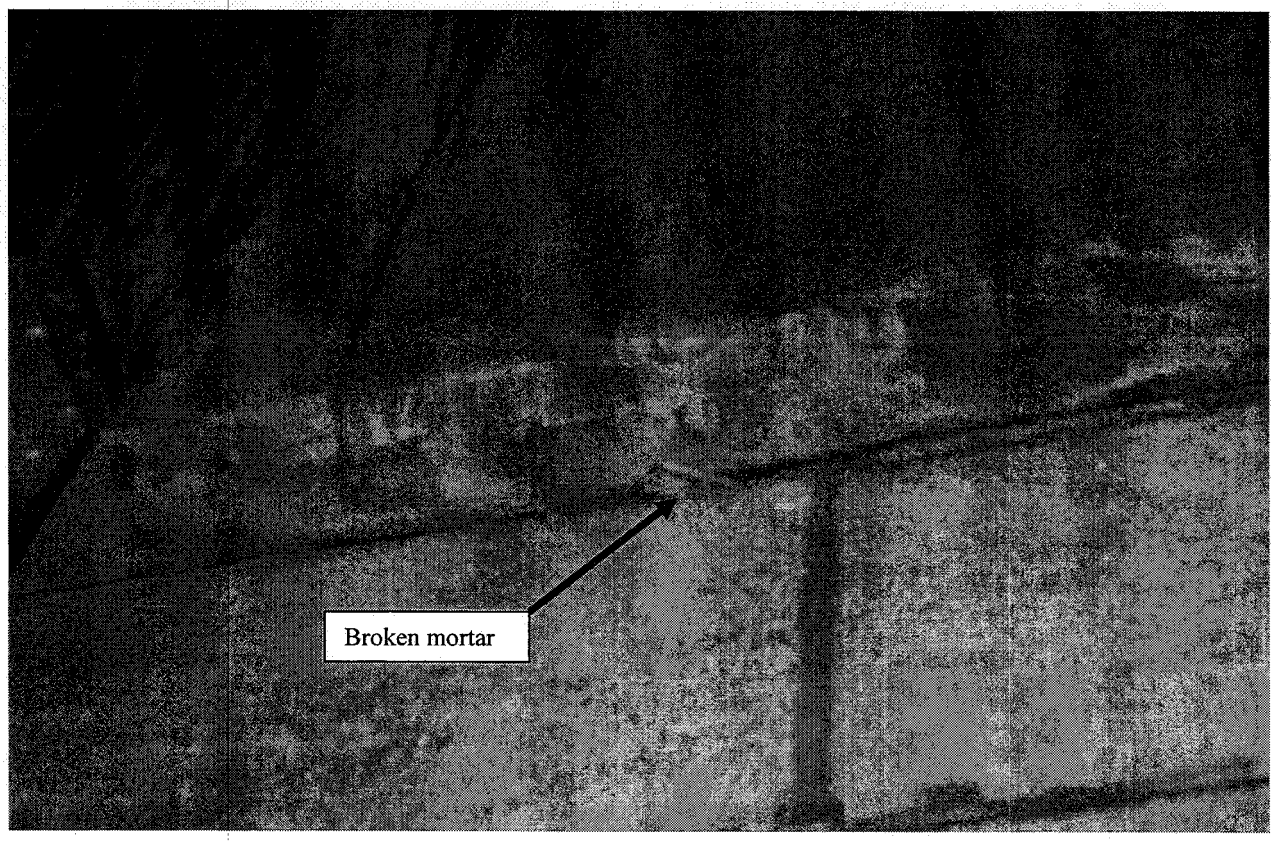

Figure 5-30. Mortar Joint at the Top of the Station Battery Room Enclosure Wall.

Wall 1B-F5-1 (Group 9) encloses a steel sliding door (Figure 5-31). Out-of-plane seismic response of this wall was analyzed using a finite element model. Lateral support by the door frame, which is anchored to the canal wall (Figure 5-32), was considered. The seismic capacity of the wall was determined to be limited by anchorage of the door frame brackets to the canal wall.

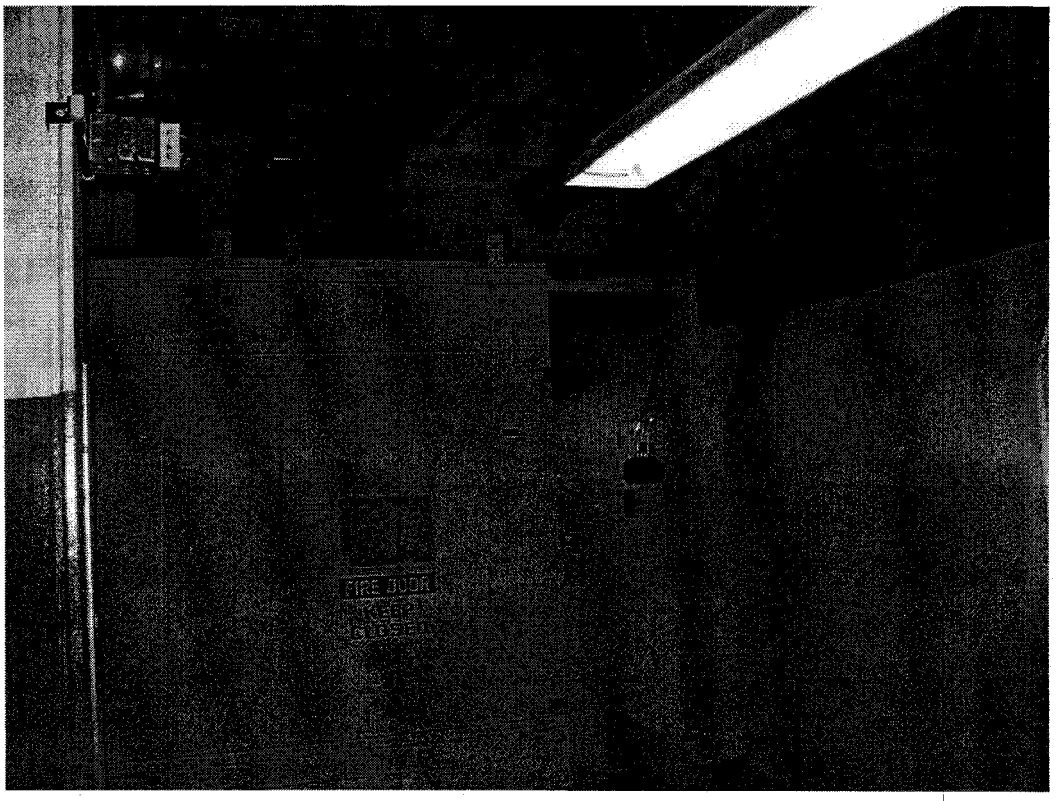

Figure 5-31. Wall 1B-F5-1 Looking East.

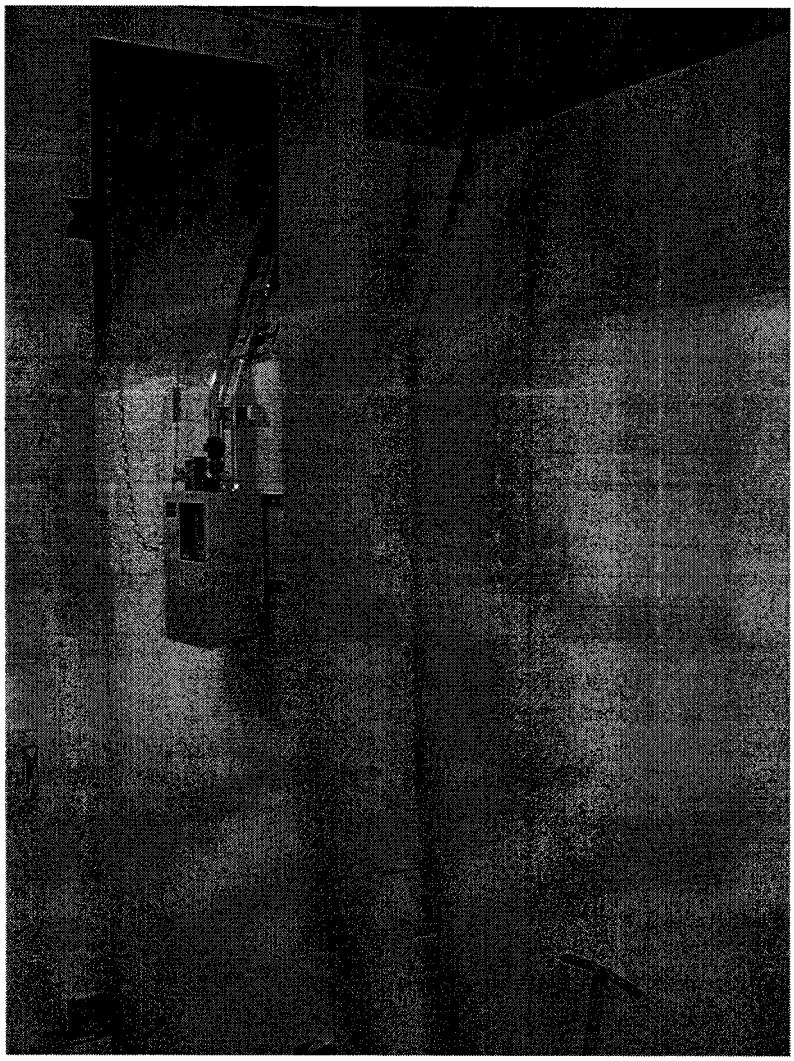

Figure 5-32. Door Frame Anchorage to Canal Wall.

The seismic evaluation results of the concrete block and shielding walls were expressed in terms of demand-to-capacity (D/C) ratios. A value of 1.0 or less signifies that PC-4 seismic criteria are satisfied. The seismic evaluation results are listed in Table 5-6. As indicated, the four inch thick concrete block walls at the first floor (Group 4) and Wall 1B-F5-1 (Group 9) do not satisfy PC-4 seismic criteria. A D/C ratio of 1.03 was obtained for Wall FF-E8-1 of Group 12. This slight exceedance of the acceptable value of 1.0 is within the level of accuracy of the evaluation and may be neglected. This wall is considered to satisfy PC-4 seismic criteria.

Table 5-6. Concrete Block and Shielding Wall Demand-to-Capacity Ratios.

Group	Bounding Case	D/C Ratio
1	Wall 1B-B6-2	0.87
	Wall 2B-G3-1	0.34
2	Wall 1B-F2-2	0.66
3	PPS battery room walls	0.53
4	Wall FF-C2-1	4.22
5	Wall1B-B5-1	0.69
6	-	-[1]
7	Wall 2B-G9-1	0.77
8	Wall 1B-J2-1	0.39
9	Wall 1B-F5-1	1.93
10	Wall FF-E2-1	0.51
11	Wall FF-H4-1	0.43
12	Wall FF-H6-2	0.67
	Wall FF-E8-1	1.03
13	Walls FF-H1-1, FF-J1-1	0.46
14	-	-[2]
15	-	-[1]

Notes:
1. Judged to be acceptable based on inspection.
2. Evaluated by BEA.

TRA-650 and TRA-672 house Deep Well Pump Nos. 3 and 4, respectively. These structures are enclosed by concrete block walls. Seismic qualification of these block walls was excluded from the scope of work.

5.4.2.2 TRA-770 Ventilation Stack

TRA-770 is the ventilation stack that exhausts air from TRA-670 (Figure 5-33). TRA-770 is not Seismic Category I, but it could damage nearby Seismic Category I components of the RMSS if it were to collapse (Figure 5-34). The seismic evaluation of TRA-770 was documented in ARES Calculation No. 0602301.05-S-005 (Appendix H). This evaluation is summarized below.

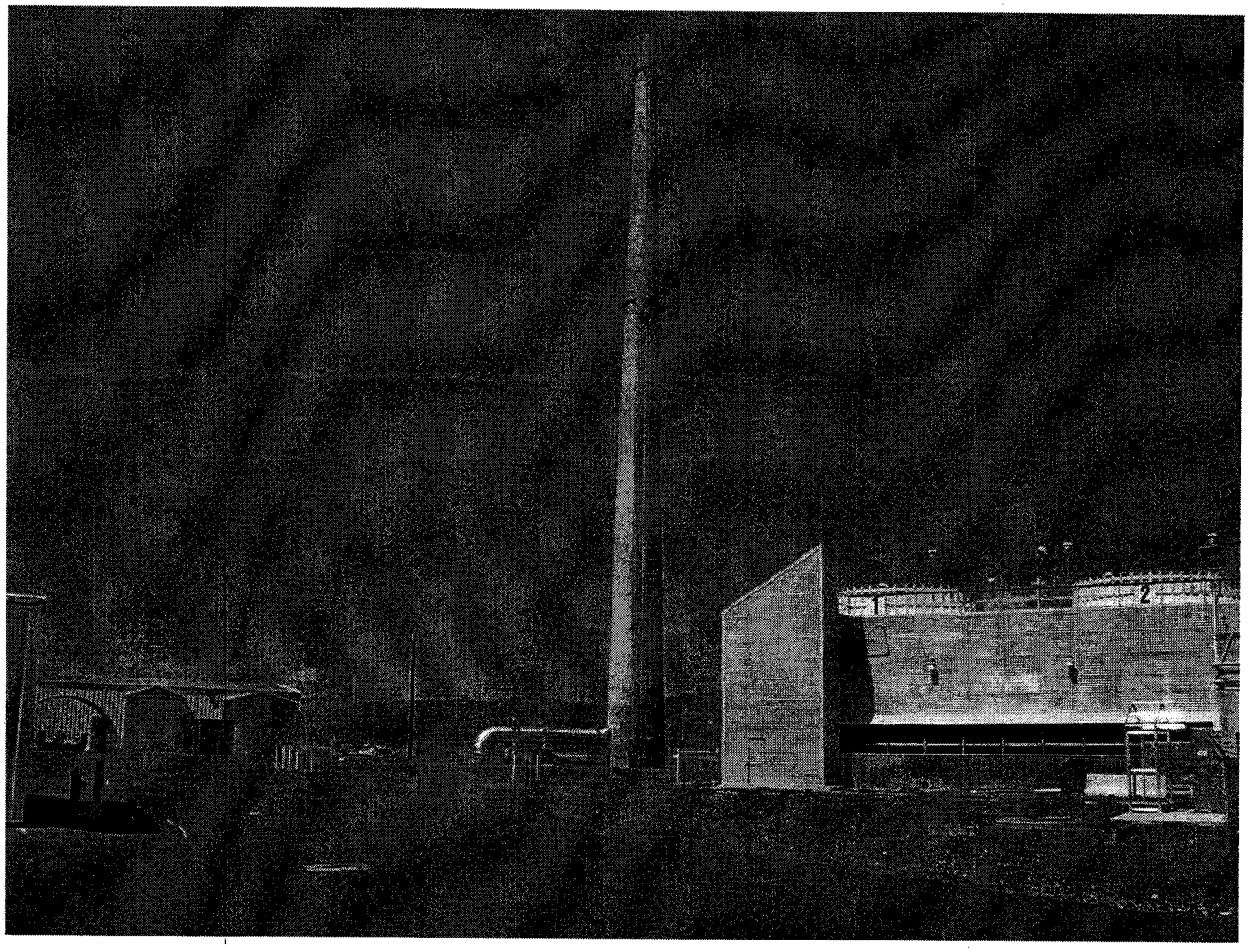

Figure 5-33. TRA-770 Ventilation Stack.

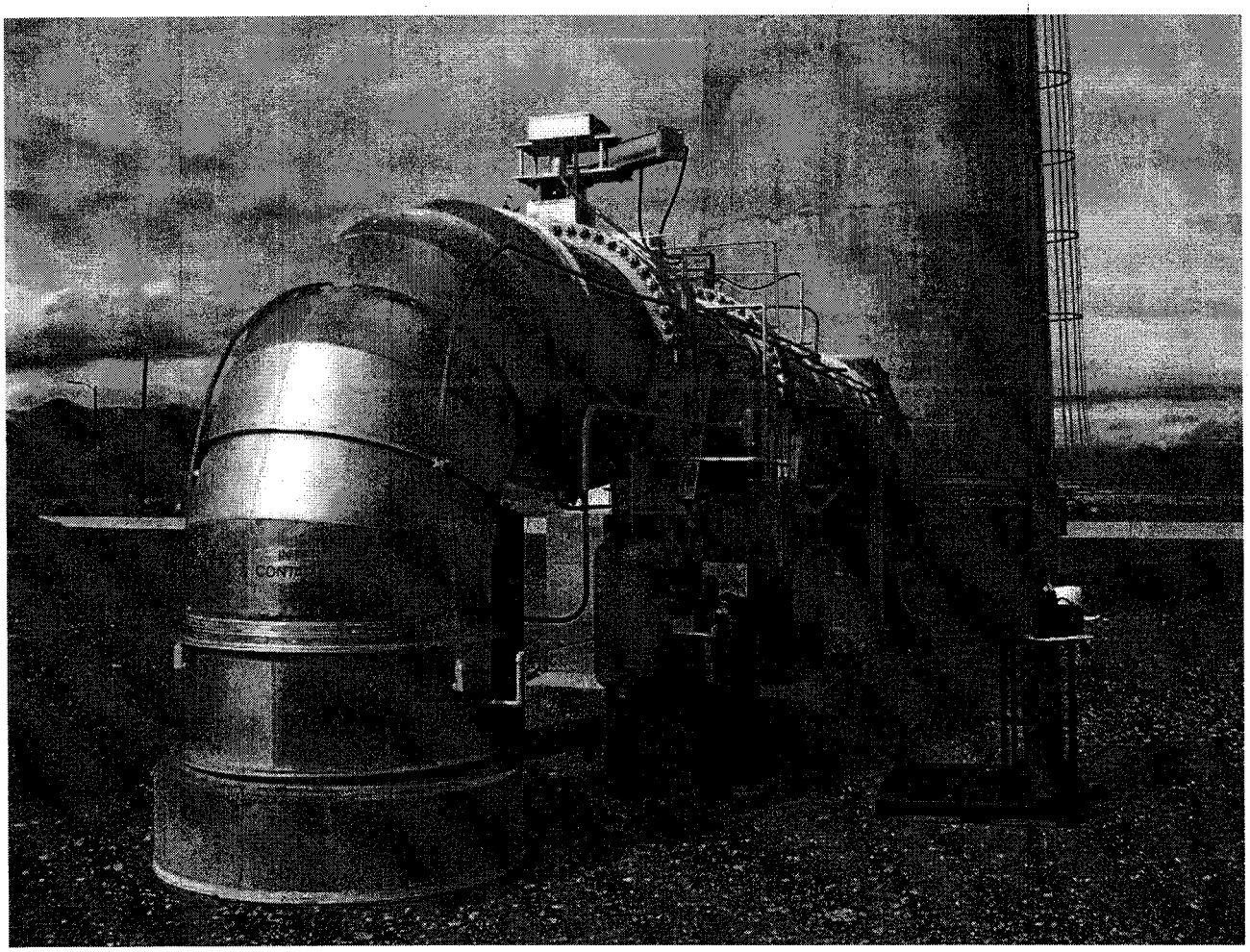

Figure 5-34. RMSS Components at the Base of TRA-770.

Seismic evaluation of TRA-770 was performed following the requirements of DOE-STD-1020-2002, ASCE 4-98, and ASCE/SEI 43-05. Seismic response analysis of TRA-770 was performed by a lumped mass stick model using computer program SAP2000. This model consisted of a series of vertically-oriented frame elements with equivalent stiffness properties accounting for potential concrete cracking. A fixed-base condition was assigned at the foundation. A sensitivity study confirmed that soil-structure interaction effects are negligible. The fundamental horizontal frequency of TRA-770 was determined to be 0.478 Hz. This low frequency is indicative of the structure's flexibility.

Seismic demands on TRA-770 were obtained by response spectrum analysis. Earthquake ground motion input consisted of the PC-4 DBE horizontal and vertical ground response spectra at the top of soil (Figure 2-2). Ten percent damping was considered to be applicable. This value is permitted by Table 2-2 of DOE-STD-1020-2002 for reinforced concrete structures at Response Level 3.

Based upon review of the structural configuration, detailing, and force distribution, the potentially controlling failure modes were determined to be overturning moment on the stack cross-section and soil

bearing pressure. Both of these failure modes are associated with seismic-induced overturning moments, which are relatively large due to the tall height of TRA-770. The capacity of TRA-770 against combined overturning moment and axial (vertical) force was determined using basic principles for strength design of reinforced concrete in Sections 10.2 and 10.3 of ACI 349-01, *Code Requirements for Nuclear Safety Related Concrete Structures*. The soil bearing pressure was conservatively limited to its allowable value listed on the design drawings.

D/C ratios for soil bearing pressure and axial force/overturning moment on the TRA-770 cross-section were determined to be 0.97 and 0.54, respectively. Both values are less than the maximum acceptable D/C ratio of 1.0, signifying that PC-4 seismic criteria are satisfied.

5.4.2.3 Diesel Generators 670-M-42 and 670-M-43

Diesel Generators 670-M-42 and 670-M-43 are not Seismic Category I. However, they constitute potential seismic/fire interaction hazards to nearby Seismic Category I equipment including the PPS battery chargers and distribution panels, and RMSS dampers and valves. The seismic evaluation of these diesel generators was documented in ARES Calculation No. 0602301.01-S-120 (Appendix FF). This evaluation is summarized below.

The diesel generators are large units located at the first floor at the northeast corner of TRA-670. Each unit is founded on 32 vibration isolators (Figure 5-35) equally divided between the two skids. Each vibration isolator consists of six springs within upper and lower housings made of "cast semi-steel." Spring-isolated mechanical equipment has failed in past earthquakes.

As observed in Figure 5-35, the springs are loaded close to their limits under the diesel generator dead weight. At small response levels, the diesel generator behaves as a linear system. The gaps between the spring coils will close under additional vertical displacement due to vertical seismic response and rocking induced by horizontal seismic response. After the gaps close, the diesel generator essentially rotates as a rigid body about the bottomed-out isolators. Horizontal response of the diesel generator is consequently nonlinear.

Seismic response analysis of the diesel generator considering this nonlinearity was performed by the Reserve Energy Method. The nonlinear relationship between the resisting moment and rocking rotation was developed. By the Reserve Energy Method, the nonlinear moment-rotation relationship is approximated by a linear relationship that maintains the same strain energy at a specified maximum rotation as does the actual nonlinear relationship. Seismic responses in the transverse and longitudinal directions of the diesel generator were calculated and combined by the SRSS method.

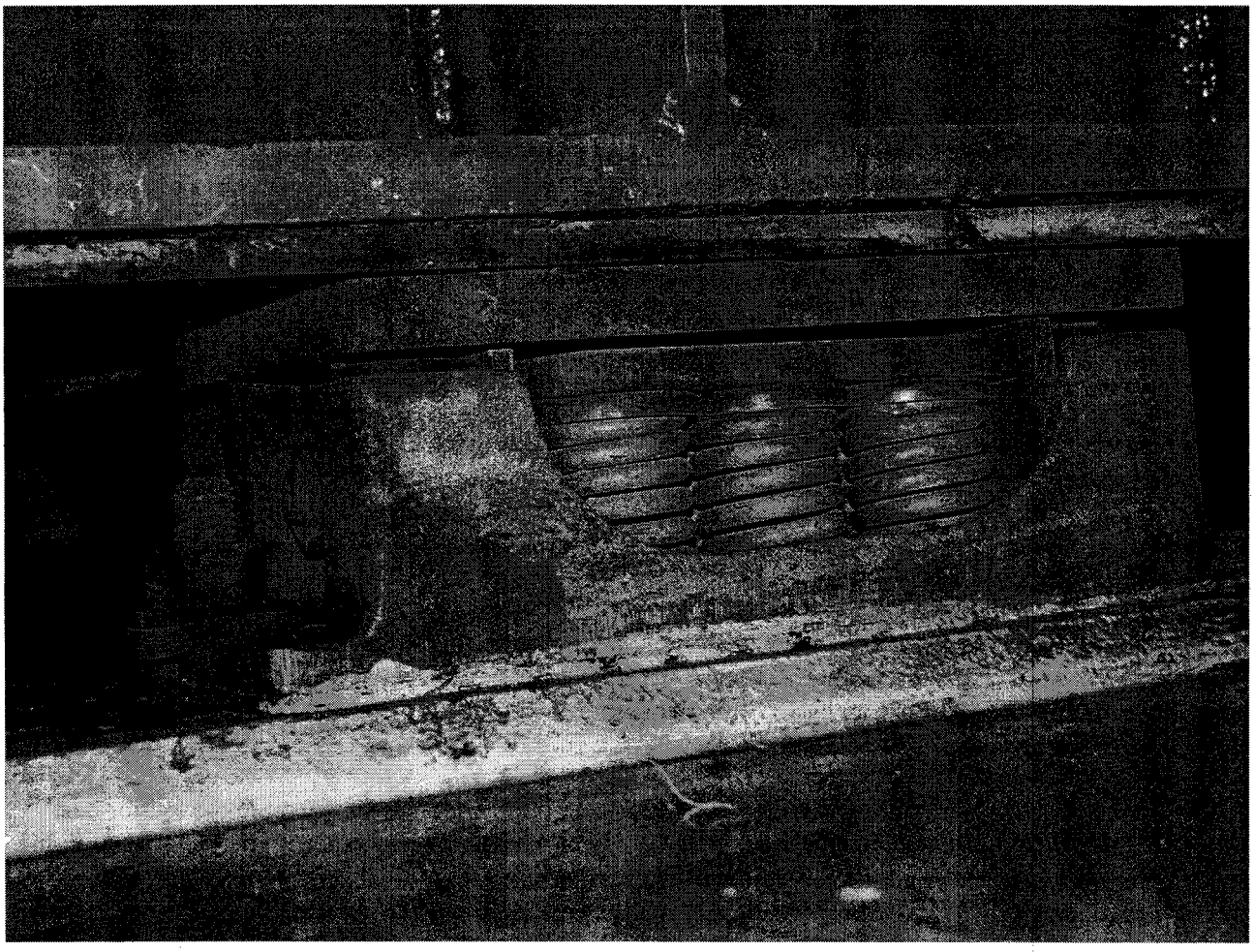

Figure 5-35. Vibration Isolators for Diesel Generators 670-M-42 and 670-M-43.

The seismic capacity of the vibration isolators was determined to be limited by the capacity of interior steel plates that transmit longitudinal seismic reactions from the upper housing to the lower housing. A D/C ratio of 0.77 was calculated for these plates, signifying that PC-4 seismic criteria are satisfied.

The diesel generators will experience relatively large seismic displacements due to the PC-4 DBE since they are flexibly supported on the vibration isolators. In the field walkdown, the diesel fuel lines were observed to have flexible hoses at the connections to the units (Figure 5-36). These hoses have sufficient flexibility to accommodate the expected seismic displacements of the diesel generators. However, connections for the lube oil lines at the units use couplings that are judged to lack sufficient flexibility (Figure 5-37). Recommendations to address the potential seismic/fire interaction hazard posed by release of lube oil are included in Section 7.0.

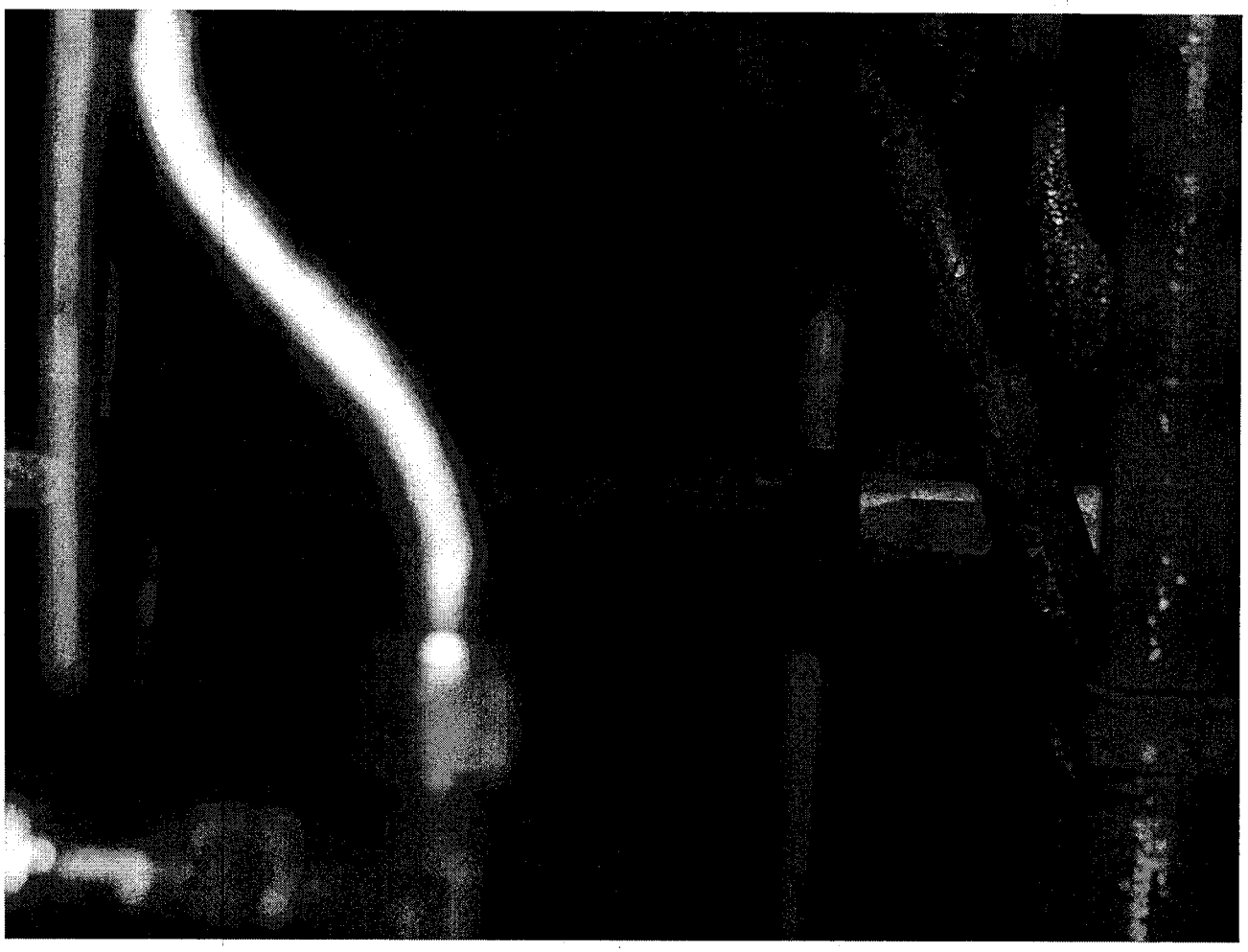

Figure 5-36. Flexible Hose Connection for Diesel Generator Fuel Oil Lines.

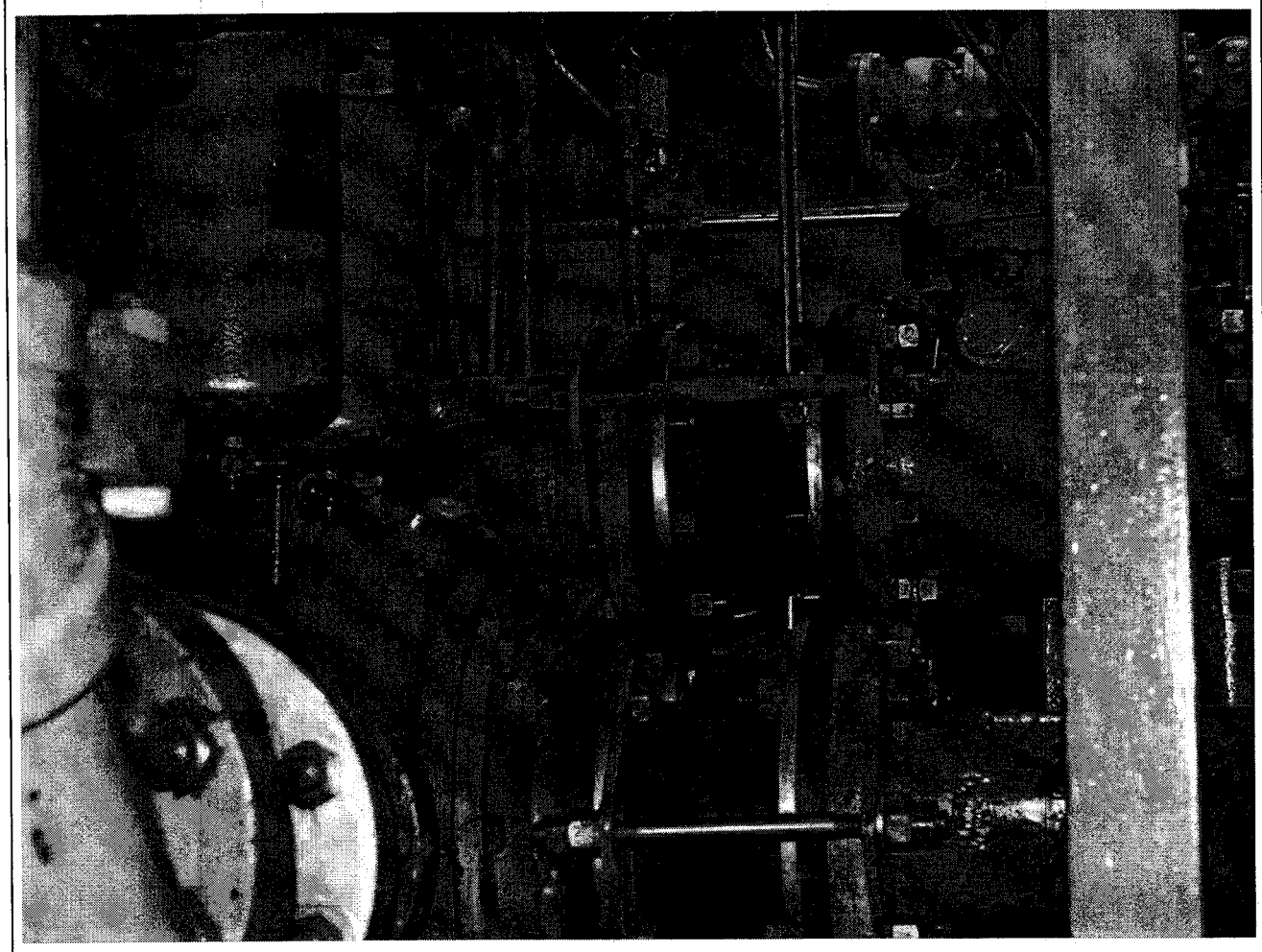

Figure 5-37. Coupling Connection for Diesel Generator Lube Oil Lines.

5.5 Cable Tray Limited Analytical Review

Seismic evaluation of cable trays was performed following the LAR procedures of DOE/EH-0545. The cable tray LAR was documented in ARES Calculation No. 0602301.01-S-006 (Appendix I). This review is summarized below.

The four cable tray support configurations shown in Figures 5-38 to 5-41 were identified as bounding cases in the field walkdown. All of the bounding cases are located at the second basement. They were selected based on their supported weight and support details.

- Support 2B-C-1 (Figure 5-38) is a representative braced cable tray support.
- Support 2B-C-2 (Figure 5-39) consists of a Unistrut P1001 section. One side of the P1001 section is attached to the floor above by a concrete expansion anchor and the other side is bolted to an embedded Unistrut P3200 concrete insert.

- Support 2B-C-3 (Figure 5-40) consists of a Unistrut P1001 section that is bolted to an embedded Unistrut P3200 concrete insert. Plan eccentricity of the cable trays from the P1001 section introduces a moment at this connection due to dead load.

- Support 2B-C-4 (Figure 5-41) also supports the weight of a vertical cable tray run that passes down from the first basement above.

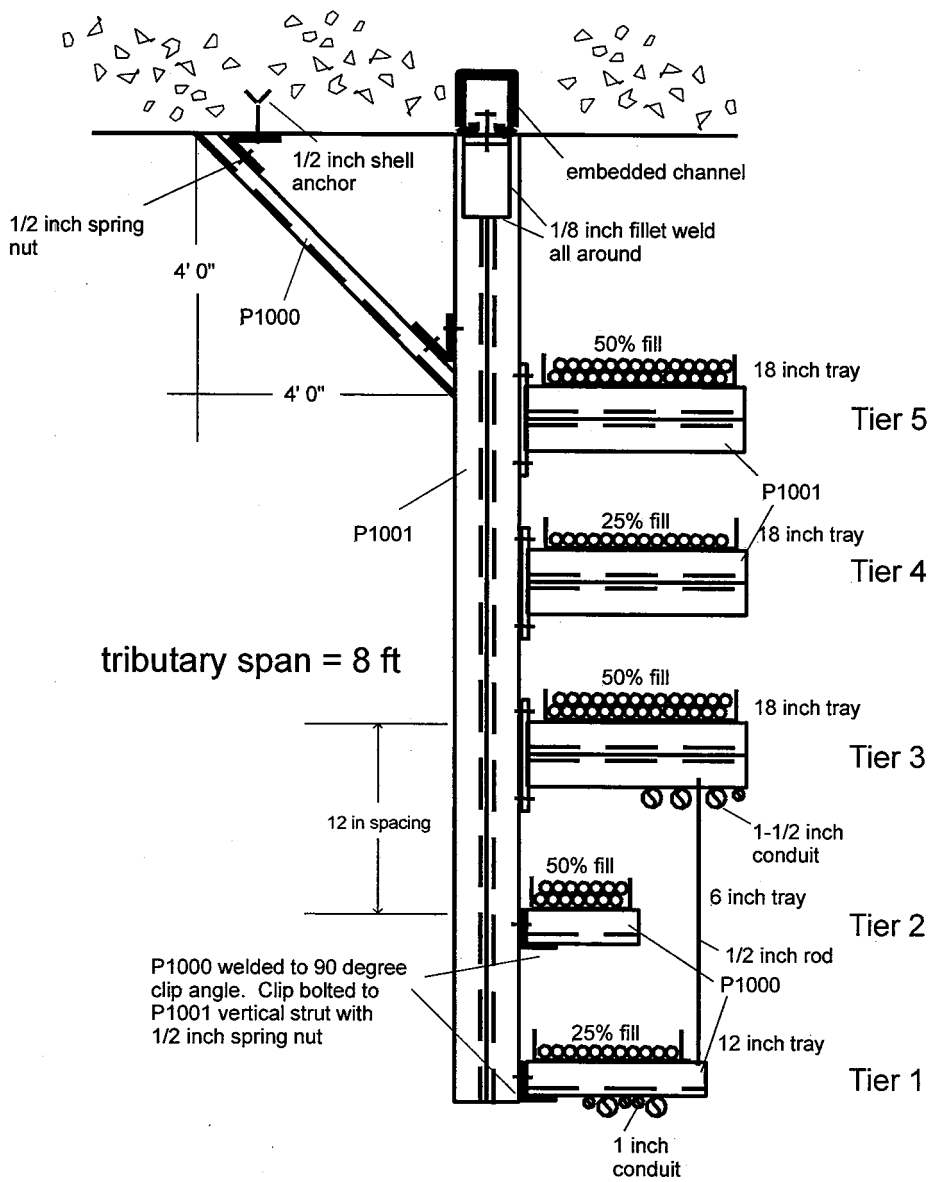

Figure 5-38. Bounding Case Cable Tray Support 2B-C-1.

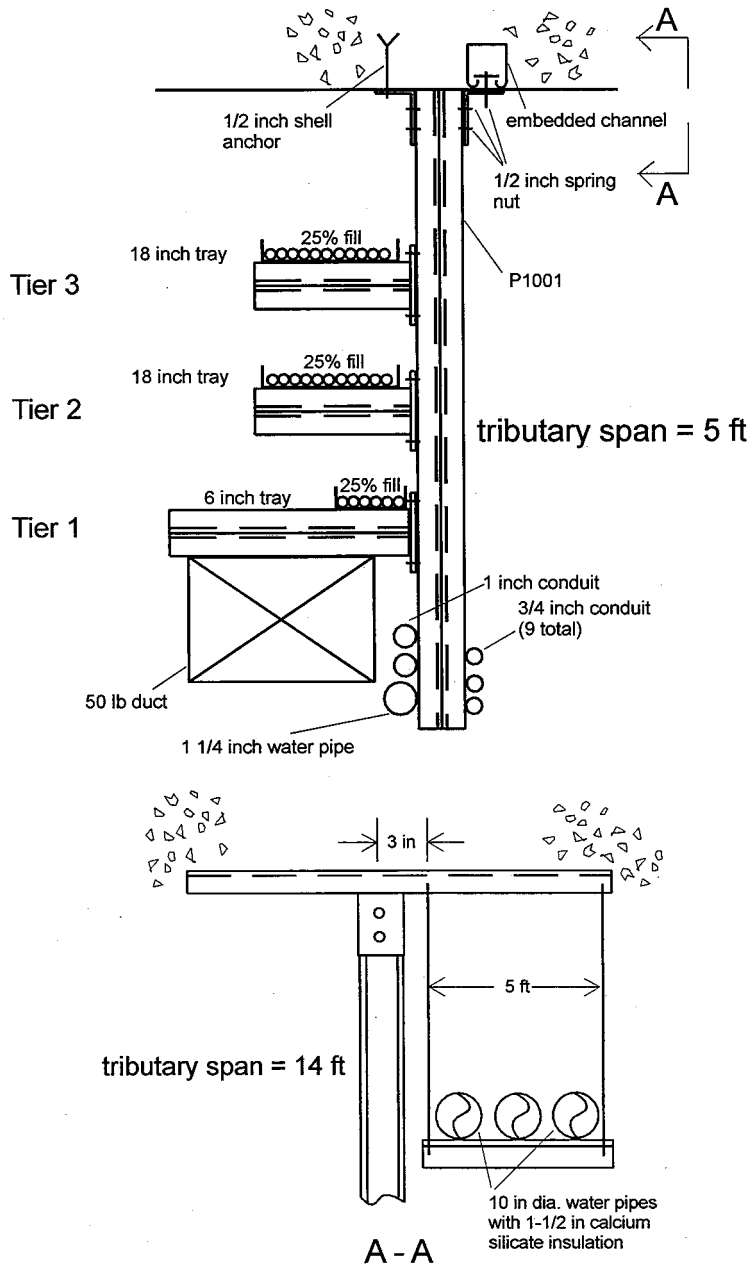

Figure 5-39. Bounding Case Cable Tray Support 2B-C-2.

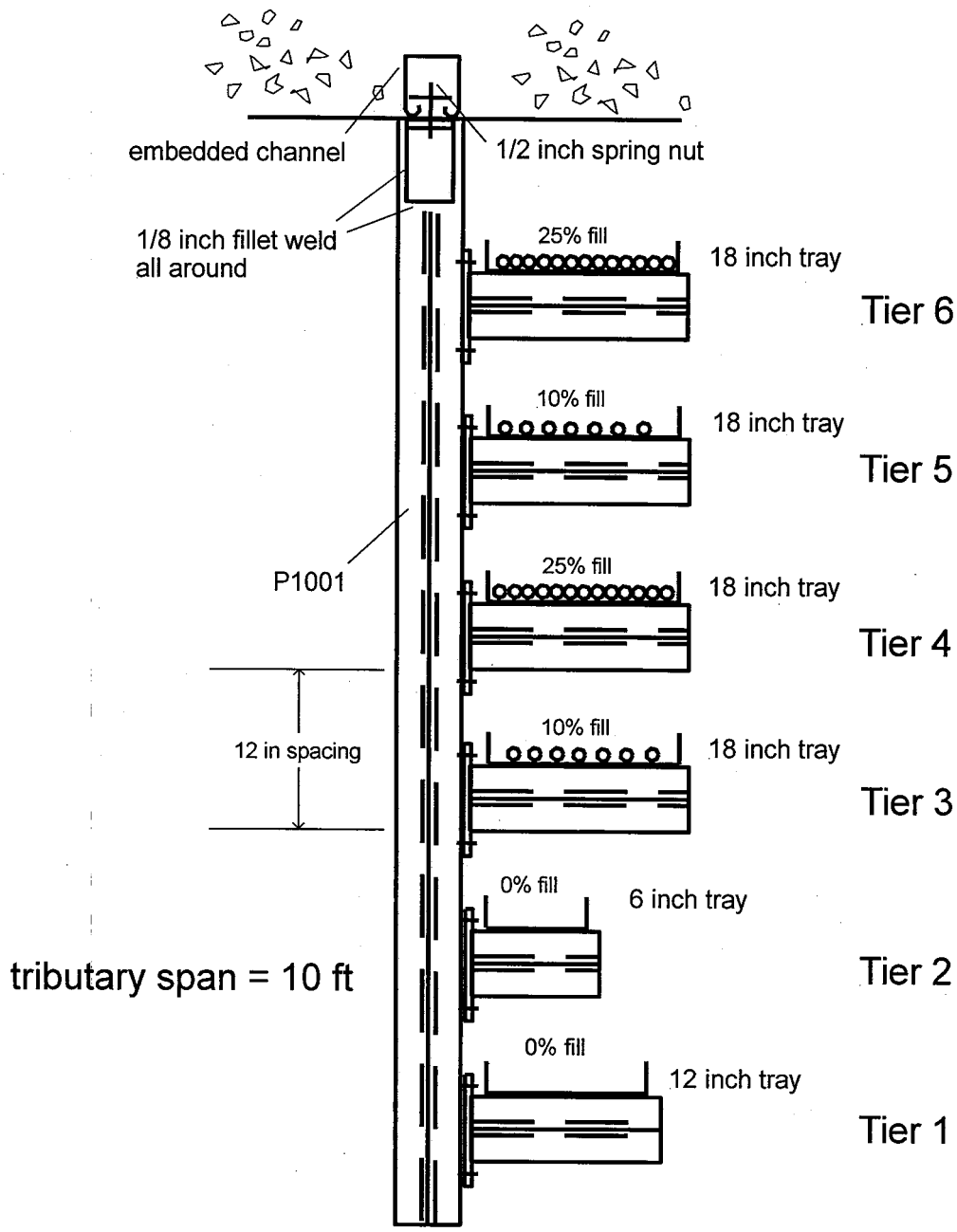

Figure 5-40. Bounding Case Cable Tray Support 2B-C-3.

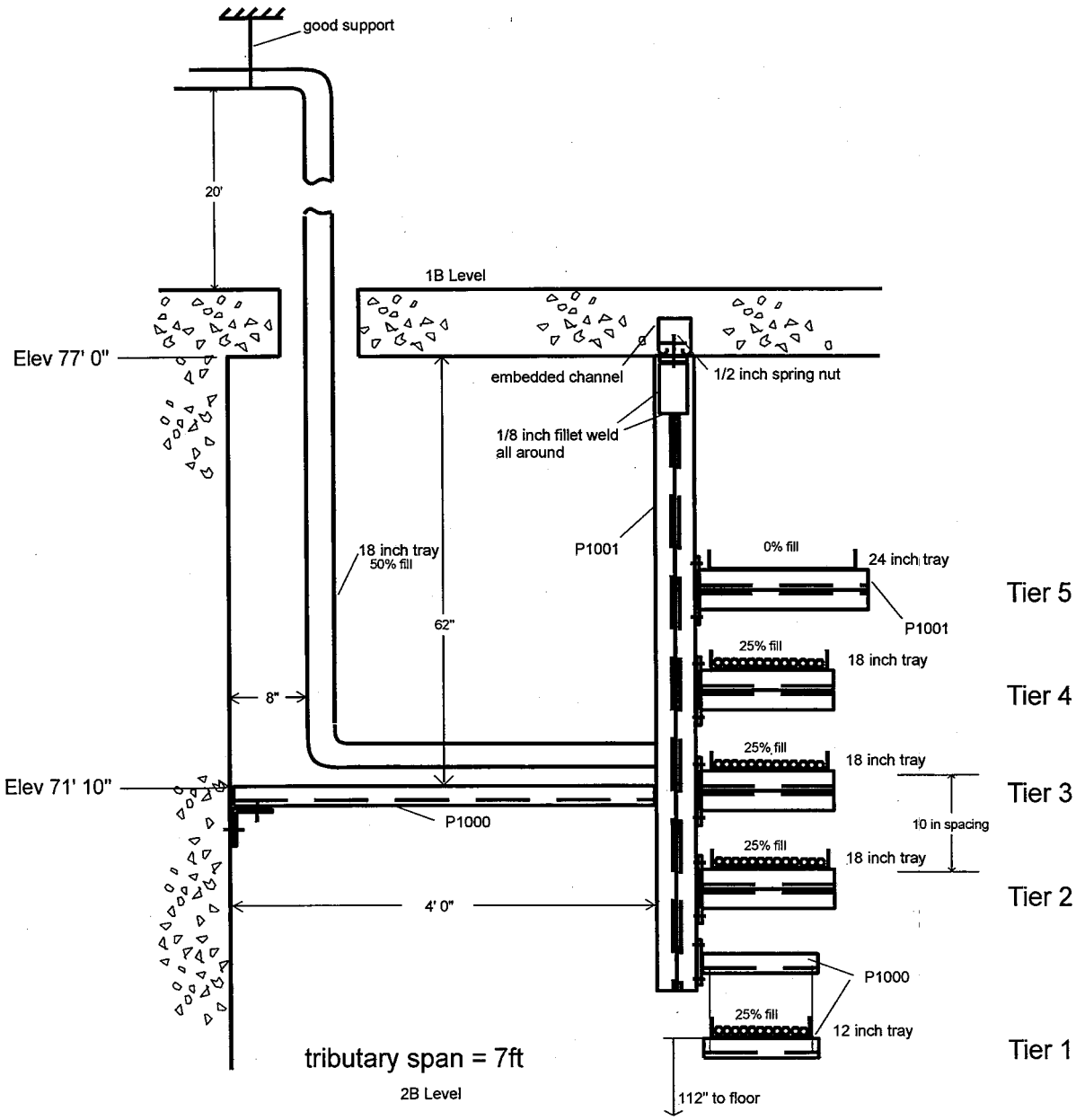

Figure 5-41. Bounding Case Cable Tray Support 2B-C-4.

In the field walkdown, a ladder was used to access the cable trays for estimation of cable fill.

As noted, the cable trays are typically attached to Unistrut P3200 concrete inserts embedded in the underside of the floor slabs above. These inserts are shown in Figure 5-42 from *General Engineering Catalog* (Unistrut, 2008). Inserts with lengths of 12 inches or longer have an allowable point load of 2,000 lbs based on manufacturer recommendations. Following DOE/EH-0545, this value is applicable to the cable tray dead load check. However, more realistic allowable capacities may be used in the other checks.

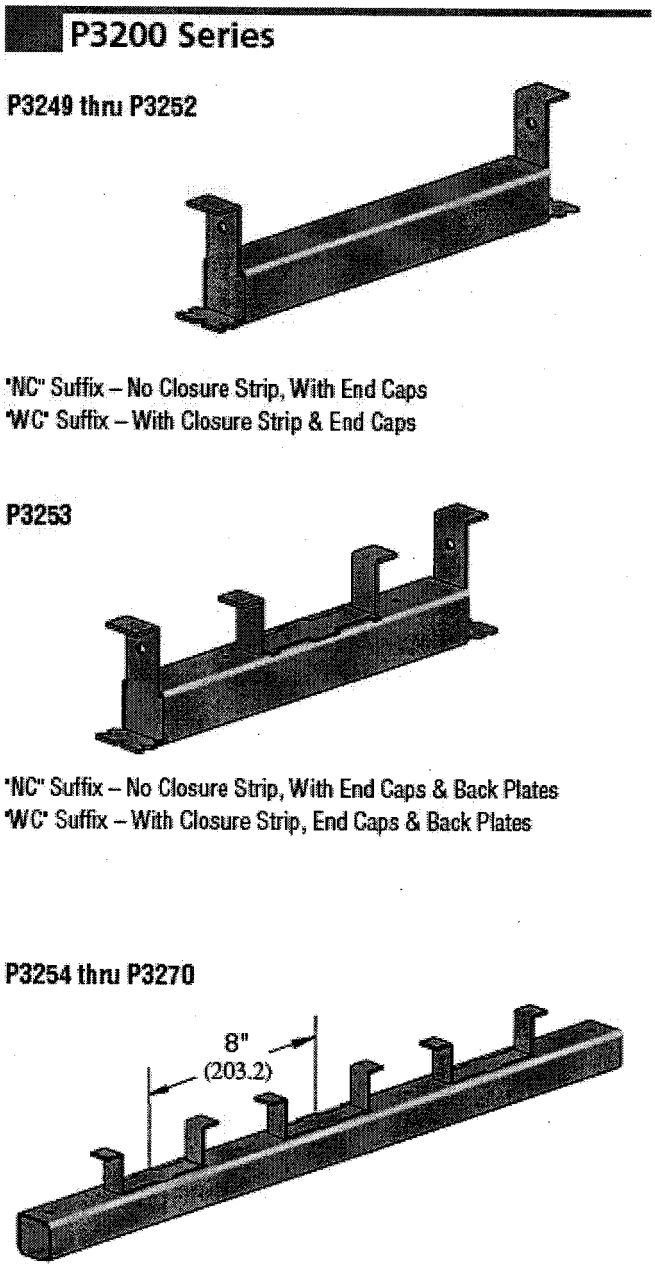

Figure 5-42. Unistrut P3200 Concrete Inserts.

Strength test data provided by the manufacturer were used to develop more realistic allowable capacities. In developing performance goals for design of nuclear facilities, ASCE/SEI 43-05 defines a median strength conservatism ratio, R_S, which represents the ratio of the median strength to the design strength.

$S_{50\%}$ = Median strength
= $R_S S_{STD}$

S_{STD} = Design strength

Equation C1.3-6 of ASCE/SEI 43-05 expresses the ratio as follows:

$R_S = e^{2.054\beta s}$ For ductile failure modes
$R_S = 1.33e^{2.054\beta s}$ For non-ductile failure modes

β_s = Strength lognormal standard deviation

Statistical analysis of the available test data was performed to determine the median strength and associated lognormal standard deviation. With the latter, the required strength ratio, R_S, was determined. The appropriate allowable capacity was then obtained by dividing the median strength by the required strength ratio.

$S_{STD} = S_{50\%}/(e^{2.054\beta s})$ For ductile failure modes
$S_{STD} = S_{50\%}/(1.33e^{2.054\beta s})$ For non-ductile failure modes

The latter formulation was used since failure of the concrete inserts occurred in non-ductile modes. Additional corrections were included to account for differences in concrete strength between the test specimens and ATR concrete and spacing of applied loadings.

For concrete inserts subjected to loads greater than 12 inches apart:

P_{all} = Allowable capacity (lbs)
= $3{,}600 f_\ell^{0.85}$
ℓ = Insert length (in) Single loads
= Distance from edge of the insert to midway between loads (in) Multiple loads
f_ℓ = $\ell/12$ ≤ 1.0

For concrete inserts subjected to multiple loads spaced a distance s apart, with s less than or equal to 12 inches:

ΣP_{all} = Total allowable capacity against the sum of the applied loads (lbs)
= $3{,}600 f_{\ell e}$
s = Load spacing (less than or equal to 12 inches) (in)
ℓ_e = Effective insert length (in)
= $(s + 12)$ $\leq \ell$
$f_{\ell e}$ = $\ell_e/12$ ≤ 2.0

For example, a 12-inch long concrete insert subjected to a single pullout load has a realistic allowable capacity of 3,600 lbs.

In addition to the concrete inserts, other elements of the cable tray supports were evaluated, including framing members and other connection details. Dead Load and Vertical Capacity Checks were performed. Lateral Load Checks were not required since the support configurations were determined to be ductile. Cable tray supports 2B-C-1, 2B-C-2, and 2B-C-4 were determined to satisfy the LAR. Cable tray support 2B-C-3 does not satisfy the Dead Load Check. The moment at the top of the support causes a pullout force that exceeds the design capacity of the embedded Unistrut P3200 channel. This support was observed to be slightly rotated from vertical. It is recommended that this support be braced back to the adjacent concrete block wall.

5.6 Other Analytical Evaluations

Analytical evaluations were performed to address the following Seismic Category I items having unusual support configurations:

- Panel 670-E-67 is attached to a steel plate (Figure 5-43). The steel plate is in turn attached to a steel frame. The bottom of the frame is anchored to the floor and the top of the frame is attached to overhead cable tray supports.

- Lubricating oil and filtration equipment for the deep well pumps are mounted to steel plates at the floors of TRA-650 and TRA-672 (Figure 5-44). The plates are bolted to light gauge channel sections. The assemblies are bolted to the concrete floors.

The supports and anchorage for Panel 670-E-67 and the equipment skid in TRA-672 were determined to satisfy PC-4 seismic criteria. The equipment skid in TRA-650 will also satisfy PC-4 seismic criteria after one deficient anchor is re-installed.

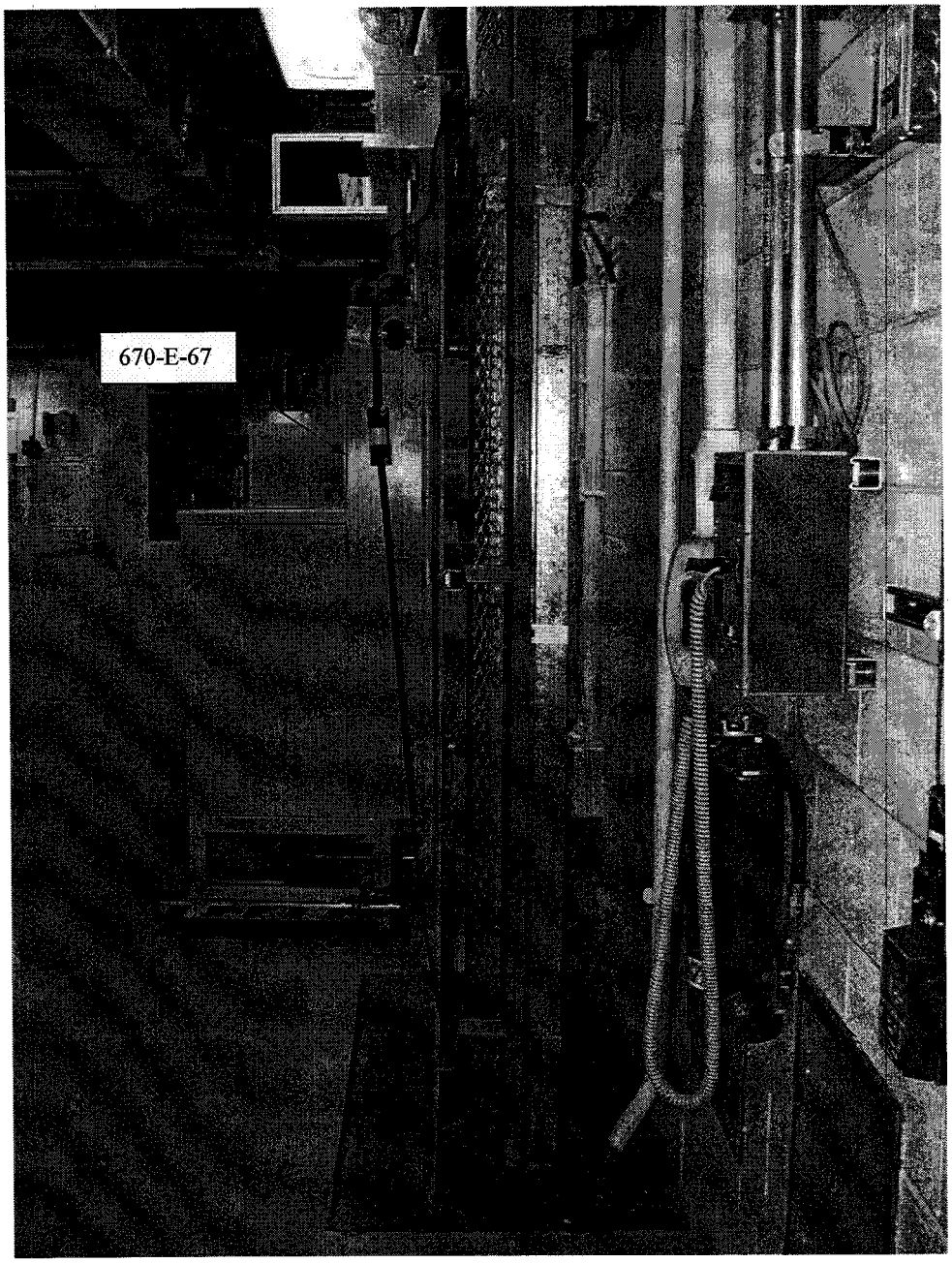

Figure 5-43. Panel 670-E-67.

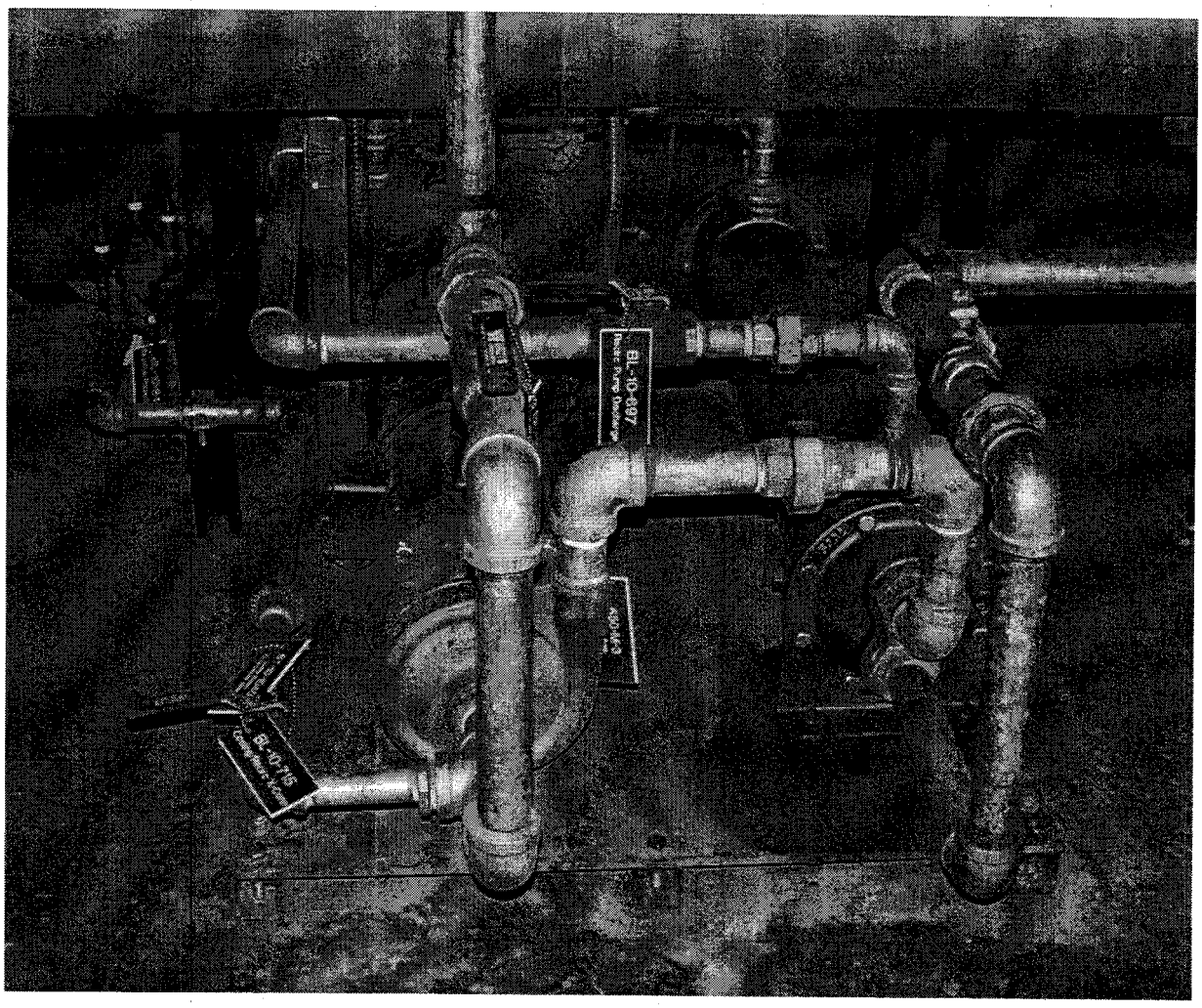

Figure 5-44. Skid for Deep Well Pump No. 3 in TRA-650.

5.7 Equipment Seismic Qualification Results

Based on the reviews and evaluations summarized in Sections 5.1 to 5.6, most of the Seismic Category I equipment included in the scope of work were determined to be seismically qualified for PC-4 seismic criteria following DOE/EH-0545 procedures. Table 5-7 identifies the outliers. This table identifies the equipment number, equipment description, and reason for the outlier designation. These reasons include the following:

- Equipment Class: The equipment does not correspond to any of the equipment classes that are covered by the experience-based procedures of DOE/EH-0545.
- Capacity vs. Demand (Cap vs. Dem): The equipment seismic capacity does not exceed the seismic demand.

- Caveats: The equipment does not satisfy the earthquake experience screening caveats for the applicable equipment class.
- GERS: The GERS caveats are not satisfied.
- Anchorage: The equipment anchorage does not satisfy DOE/EH-0545 requirements.
- Interaction: The equipment may be subject to seismic interaction hazards that cannot be screened.

Many of these outliers were resolved by methods other than the experience-based methods as described in Section 6.0. Recommendations for further actions to address the remaining outliers are presented in Section 7.0.

Table 5-7. Outliers for PC-4 Seismic Criteria. (12 sheets)

Equipment No.	Equipment Description	Equip Class	Cap vs. Dem	Caveats	GERS	Anchorage	Interaction
404695-1	Guide tube, safety rod (N, E, SE, S, SW, and W)	X					
405815	Flux trap fillers (N, E, SE, S, SW, and W)	X					
405904	Hafnium absorber plate assembly, safety rod (N, E, SE, S, SW, and W)	X					
417977-2	Latch assembly, safety rod hafnium absorber plate (N, E, SE, S, SW, and W)	X					
500/ESF-1	Relays, Primary Pump Shutoff ESF Logic				X		
500/ESF-4	Relays, Primary Pump Shutoff ESF Logic				X		
502/ESF-1	Relays, Pressurizing and Gland Seal Pump Shutoff ESF Logic				X		
502/ESF-1B	Relays, Pressurizing and Gland Seal Pump Shutoff ESF Logic				X		
502/ESF-4	Relays, Pressurizing and Gland Seal Pump Shutoff ESF Logic				X		
502/ESF-4B	Relays, Pressurizing and Gland Seal Pump Shutoff ESF Logic				X		
650-M-3	Oil Cooling Pump					X	
670-BDM-1	Butterfly damper, supply air from HVA-2		X				
670-BDM-1-1	Butterfly damper, HVS-1 supply to reactor area		X				
670-BDM-1-1A	670-BDM-1-1 Backup damper		X				

Table 5-7. Outliers for PC-4 Seismic Criteria. (12 sheets)

Equipment No.	Equipment Description	Equip Class	Cap vs. Dem	Caveats	GERS	Anchorage	Interaction
670-BDM-1-2	Butterfly damper, HVS-1 supply to basements		X				
670-BDM-1-2A	670-BDM-1-2 Backup damper		X				
670-BDM-1-3	Butterfly damper, return air to HVS-1 plenum		X				
670-BDM-1-3A	670-BDM-1-3 Backup damper		X				
670-BDM-1A	670-BDM-1 Backup damper		X				
670-BDM-2	Butterfly damper, return air to HVA-2		X				
670-BDM-2A	670-BDM-2 Backup damper		X				
670-BDM-4-8	Butterfly damper, RDAS room return to HVS-4		X				
670-BDM-4-8A	670-BDM-4-8 Backup damper		X				
670-BDM-5-10	Butterfly damper, HVE-9A & B exhaust from battery room		X		X		X
670-BDM-5-10 A	670-BDM-5-10 Backup damper		X		X		X
670-BDM-5-8	Butterfly damper, HVS-5 basement air supply		X		X		X
670-BDM-5-8A	670-BDM-5-8 Backup damper		X		X		X
670-BDM-5-9	Butterfly damper, HVS-5 basement area return		X		X		X
670-BDM-5-9A	670-BDM-5-9 Backup damper		X		X		X
670-E-1	Commercial Bus A					X	
670-E-106	Distribution Panel, RDAS Power (DAN)						X
670-E-117	Distribution panel, instrument UPS					X	
670-E-15	Motor Control Center, Diesel Commercial					X	
670-E-2	Commercial Bus B					X	
670-E-26	Bus, 250 Vdc instrument power control center					X	
670-E-28-CR2	Relay, Primary emergency coolant pump hardwired autostart logic				X		
670-E-3	Diesel Bus, 4160 V					X	
670-E-30	Distribution Panel, RDAS Backup (DAC)			X			X
670-E-313	Relay panel		X				
670-E-4	4160 V to 480 V Transformer Feed to 480 V Commercial Bus A 670-E-5					X	X

Table 5-7. Outliers for PC-4 Seismic Criteria. (12 sheets)

Equipment No.	Equipment Description	Equip Class	Cap vs. Dem	Caveats	GERS	Anchorage	Interaction
670-E-456	Power panel, Utility/Instrument UPS Power panel						X
670-E-5	Commercial Bus A					X	
670-E-58	Battery bank, utility UPS						X
670-E-59	Battery bank, instrument UPS						X
670-E-6	4160 V to 480 V Transformer Feed to Commercial Bus B 670-E-7					X	
670-E-7	Commercial Bus B					X	
670-E-8	4160 V to 480 V Transformer Feed to 480 V Diesel Bus 670-E-9					X	X
670-E-9	Diesel Bus, 480 V					X	X
670-IP1	Instrument power channel #1 power distribution panel						X
670-IP2	Instrument power channel #2 power distribution panel						X
670-M-42 & 670-M-43	Enterprise Diesels						X
670-M-459 120557	Rack tube assembly (N, E, SE, S, SW, and W)	X					
670-VV-RLY-B	Panel, Vessel Vent Relay Control Cabinets		X				
670-VV-RLY-C	Panel, Vessel Vent Relay Control Cabinets		X				
672-M-2	Oil Cooling Pump						X
672-MS-4	Deep Well Pump #4 Breaker					X	
674-E-1	ATR-674 C/D 480V ac Bus					X	X
674-E-2	ATR-674 Transformer					X	X
674-E-3	ATR-674 C/D 120/208 V Bus					X	
674-E-5	Emergency Generator Feeder Breaker					X	X
674-M-8	Radiator Fan for DG M-6					X	
688-M-1 Batteries	Diesel firewater pump start batteries			X			
688-M-2 Batteries	Diesel firewater pump start batteries			X			
ATR-776	Fuel Oil Transfer Tank					X	
ATS 670-E-228	Automatic Transfer Switch, transfer between 670-E-7 and 670-E-9 (670-E-15 Backup power feed)					X	

Table 5-7. Outliers for PC-4 Seismic Criteria. (12 sheets)

Equipment No.	Equipment Description	Equip Class	Cap vs. Dem	Caveats	GERS	Anchorage	Interaction
BDR1	Relays, RMS-1 backup damper actuation				X		X
BDR2	Relays, RMS-1 backup damper actuation				X		X
BDR3	Relays, RMS-1 backup damper actuation				X		X
Cable Tray Support 2B-C-3	Cable tray support (see Section 5.5)					X	
BF-10-12	BV FW loop	X					
BF-10-13	BV FW loop	X					
BF-10-2058	BV raw water to FW loop	X					
BF-10-2061	BV raw water to FW loop	X					
BF-10-2116	BV RTC to ATR FW loop	X					
BF-10-2117	BV RTC to ATR FW loop	X					
BF-10-2125	BV RTC to ATR FW loop	X					
BF-10-2126	BV RTC to ATR FW loop	X					
BL-10-164	Emergency Firewater Canal Fill		X				
BL-10-167	Emergency Firewater Canal Fill		X				
BL-10-168	Emergency Firewater Canal Fill		X				
BL-10-2120	BV CK-10-2118 bypass	X					
BL-10-2121	BV CK-10-2119 supply test	X					
BL-10-2122	BV CK-10-2119 bypass	X					
BL-10-2123	BV CK-10-2119 test isolation	X					
BL-10-2124	BV test header outlet	X					
BL-10-2129	BV CK-10-2118 bypass	X					
BL-10-2130	BV CK-10-2119 supply test	X					
BL-10-2131	BV CK-10-2119 bypass	X					
BL-10-2132	BV CK-10-2119 test isolation	X					
BL-10-2133	BV test header outlet	X					
BL-1-623	Upper Vessel EFIS Supply Drain		X				
C31A, B, C bays 1, 2, 3	Comparator cabinets					X	
CK-10-2059	Check valve raw water to FW loop	X					
CK-10-2060	Check valve raw water to FW loop	X					
CK-10-2062	Check valve raw water to FW loop	X					
CK-10-2063	Check valve raw water to FW loop	X					

Table 5-7. Outliers for PC-4 Seismic Criteria. (12 sheets)

Equipment No.	Equipment Description	Equip Class	Cap vs. Dem	Caveats	GERS	Anchorage	Interaction
CK-10-2118	Check valve RTC to ATR FW loop	X					
CK-10-2119	Check valve RTC to ATR FW loop	X					
CK-10-2127	Check valve RTC to ATR FW loop	X					
CK-10-2128	Check valve RTC to ATR FW loop	X					
CK-6-1012	Check valve, instrument air supply						X
CK-6-969	Check valve, supply to door seals		X				
D-13, D-15, D-51	Doors, gas-tight vertical lift	X					
D-13, D-15, D-51,	Seals, gas-tight door	X					
D-14, D-18, D-25	Doors, gas-tight personnel	X					
D-202, D-314, D-412	Doors, gas-tight personnel	X					
D-30, D-54, D-35	Doors, gas-tight personnel	X					
D-39, D-43, D-44	Doors, gas-tight personnel	X					
D-442, D-443	Doors, gas-tight personnel	X					
D-49, D-50, D-67	Doors, gas-tight personnel	X					
D-52, D-441 doors	Doors, gas-tight rolling	X					
D-52, D-441 seals	Seals, gas-tight door	X					
E11 Spare	Battery banks, 32 Vdc PPS Channels A, B, C, D, spare Combined PPS Battery Banks				X	X	
E11B	Battery banks, 32 Vdc PPS Channels A, B, C, D, spare Combined PPS Battery Banks						X
E11C	Battery banks, 32 Vdc PPS Channels A, B, C, D, spare Combined PPS Battery Banks				X	X	
E11D	Battery banks, 32 Vdc PPS Channels A, B, C, D, spare Combined PPS Battery Banks				X	X	

Table 5-7. Outliers for PC-4 Seismic Criteria. (12 sheets)

Equipment No.	Equipment Description	Equip Class	Cap vs. Dem	Caveats	GERS	Anchorage	Interaction
E13C	Battery Chargers for PPS Channels A, B, C, D battery banks and 32 Vdc distribution panels		X				X
E13D	Battery Chargers for PPS Channels A, B, C, D battery banks and 32 Vdc distribution panels		X				X
E14C	Distribution panels, 32 Vdc PPS Channel C						X
E14D	Distribution panels, 32 Vdc PPS Channel D						X
E15A/D	Switches and enclosures, remote, manual scram subsystem		X				X
E312	Rod Clutch Coil Controller (RCCC) Current adjust circuitry cabinet						X
FH-10-658	Fire Hydrant	X					
FH-30	Fire Hydrants	X					
FH-31	Fire Hydrant	X					
FH-32	Fire Hydrant	X					
FH-33	Fire Hydrant	X					
FH-34	Fire Hydrant	X					
FH-35	Fire Hydrant	X					
FH-36	Fire Hydrant	X					
FH-38	Fire Hydrant	X					
FH-39	Fire Hydrant	X					
FH-40	Fire Hydrant	X					
FH-43	Fire Hydrant	X					
GT-10-14		X					
GT-10-15	Block Valves to Fire Hydrants	X					
GT-10-17	Block Valves to Fire Hydrants	X					
GT-10-18	BV	X					
GT-10-19	Block valve, F.W. ATR loop isolation	X					
GT-10-20	BV	X					
GT-10-2055		X					
GT-10-2057	TRA-781 Firewater Isolation	X					
GT-10-22	BV	X					
GT-10-24	BV, FW ATR loop isolation	X					
GT-10-25	BV	X					

Table 5-7. Outliers for PC-4 Seismic Criteria. (12 sheets)

Equipment No.	Equipment Description	Equip Class	Cap vs. Dem	Caveats	GERS	Anchorage	Interaction
GT-10-27	BV	X					
GT-10-29	BV	X					
GT-10-32	BV	X					
GT-10-34	Block valve, F.W. ATR loop isolation	X					
GT-10-35	BV ATR lower EFIS	X					
GT-10-36	BV ATR FW loop	X					
GT-10-37	Block Valve to Fire Hydrant	X					
GT-10-45	Block valve, to TRA 670 fire sprinklers	X					
GT-10-46	Block valve, to TRA 670 fire sprinklers	X					
GT-10-47	BV, FW to ATR Reactor Spray	X					
GT-10-48	BV, to TRA-670 fire sprinkler #5	X					
GT-10-49	BV, to TRA-670 fire sprinkler #6	X					
GT-10-52	Block valve, to TRA 670 fire sprinklers	X					
GT-10-56	BV, FW ATR loop isolation	X					
GT-10-58		X					
GT-10-61	Block valves, F.W. to TRA-625	X					
GT-10-613	BV ATR FW Loop	X					
GT-10-614	BV, FW ATR loop isolation	X					
GT-10-62	BVs, FW to TRA-634	X					
GT-10-625		X					
GT-10-63	Block valve to upper vessel EFIS	X					
GT-10-64		X					
GT-10-657	FH-10-658 Isolation	X					
GT-10-659	TRA-688 South Loop Isolation	X					
GT-10-660	TRA-688 North Loop Isolation	X					
GT-10-671	TRA-688 Discharge Isolation	X					
GT-1-614	Block valve, main firewater to upper vessel		X				
GT-1-622	Upper Vessel EFIS LDW Discharge Block		X				
GT-1-628	Upper Vessel EFIS LDW Discharge Block		X				
GT-1-629	Upper Vessel EFIS Supply Vent		X				

Table 5-7. Outliers for PC-4 Seismic Criteria. (12 sheets)

Equipment No.	Equipment Description	Equip Class	Cap vs. Dem	Caveats	GERS	Anchorage	Interaction
GT-6-1000	Block valve, backup nitrogen bottle						X
GT-6-1001	Block valve, accumulator drain						X
GT-6-1002	Block valve, PS-6-1009 and PS-6-1010						X
GT-6-1003	Block valve, PS-6-1009						X
GT-6-1004	Block valve, PS-6-1010						X
GT-6-1005	Block valve, vent for PS-6-1009						X
GT-6-1006	Block valve, vent for PS-6-1010						X
GT-6-625, CK-6-626	Air/Nitrogen supply to D-51		X				
GT-6-629, CK-6-630	Air/Nitrogen supply to D-52		X				
GT-6-633, CK-6-634	Air/Nitrogen supply to D-13		X				
GT-6-637, CK-6-638	Air/Nitrogen supply to D-15		X				
GT-6-902	Boundary valves for backup Nitrogen supply to door seals						
GT-CC-19-1	Recycle Isolation Valve		X				
GT-CC-19-10	Recycle Isolation Valve		X				
GT-S-6-290	Isolation Valves, ATR Canal Level Control		X				
K1-IN-1	Relays, Bypass				X		
K1-IN-4	Relays, Bypass				X		
K1-OUT-1	Relays, Bypass				X		
K1-OUT-4	Relays, Bypass				X		
K2-IN-1	Relays, Trip				X		
K2-IN-4	Relays, Trip				X		
K2-OUT-1	Relays, Trip				X		
K2-OUT-4	Relays, Trip				X		
L 1	Block valve, FW pump outlet cross tie	X					
L 21	Block valve, F.W. to TRA 627	X					
L 26	Block valve, F.W. to TRA 607	X					
L 3	Block valve, FW pump outlet cross tie	X					
L 8	Block valve, deepwell discharge to 619-10 discharge	X					
L-10	Block valve, F.W. to diesel fuel storage area	X					

Table 5-7. Outliers for PC-4 Seismic Criteria. (12 sheets)

Equipment No.	Equipment Description	Equip Class	Cap vs. Dem	Caveats	GERS	Anchorage	Interaction
L-11	Block valve, F.W. to diesel fuel storage area	X					
L-12	BV raw water to FW loop	X					
L-13	BV raw water to FW loop	X					
L-14	Check valve	X					
L-15	Check valve	X					
L-16	BV FW loop	X					
L-17	BV 633-1 discharge	X					
L-2	BV FW loop	X					
L-21	BV, FW to TRA-627	X					
L-22	Block valve, F.W. to TRA-614	X					
L-23	Block valve, F.W. to TRA-622	X					
L-24	Block valve, F.W. to TRA-609	X					
L-25	Block valve, F.W. to TRA-608	X					
L-26	BV, FW to TRA-607	X					
L-27	Block valve, F.W. to TRA-628	X					
L-31	BV	X					
L31A, B, C, D bays 1, 2	Logic cabinets					X	
L-32	Block Valves to Fire Hydrants	X					
L-34	Block Valves to Fire Hydrants	X					
L-37	Block Valves to Fire Hydrants	X					
L-39	Block Valves to Fire Hydrants	X					
L-4	BV FW loop	X					
L-40	Block Valves to Fire Hydrants	X					
L-42	BV	X					
L-5	BV FW loop	X					
L-6	BV FW loop	X					
L-7	BV FW loop	X					
L-8	BV, deep well pump discharge to FW loop	X					
LS-19-1	Level Switch, ATR Canal Level Control				X		
M-5	BV ATR FW loop	X					
MTS 670-E-457	Manual transfer switch, transfer between feed from Panel 670-E-115 and 670-E-117					X	
ND-10-811	PI-10-122 Secondary Isolation Valve		X				
ND-10-813	PS-1-110 Secondary Isolation Valve		X				

Table 5-7. Outliers for PC-4 Seismic Criteria. (12 sheets)

Equipment No.	Equipment Description	Equip Class	Cap vs. Dem	Caveats	GERS	Anchorage	Interaction
ND-10-814	PS-1-110 Vent Valve		X				
ND-10-815	PS-1-110 & PI-10-122 Isolation Valve		X				
ND-6-837, 838 and 839	Isolation Valves, ATR Canal Level Control		X				
None 1	Bubbler Tube, ATR Canal Level Control	X					
None 13	Rotameter, ATR Canal Level Control		X				
None 15C	FIS Transmitter Cabinet C		X				
None 16	Tubing to BDM-1-5 and BDM-1-5A downstream of instrument air supply check valve						X
None 17	Pillows, Canal Impact Absorbing	X					
None 18	Bellows Between Canal and Reactor Vessel	X					
None 2	Viewing Window	X					
None 20	Fiber Optic Cable, SER		X				X
None 4	Sequence of Events Recorder, (SER), Units 1 and 2		X			X	X
P11	Annunciator Panel, RCR Panel P11		X				
Panel E	Radiation Monitoring and Seal Control Panel		X			X	X
Panel F	Radiation Monitoring and Seal Control Panel		X			X	X
PI-6-127, PI-6-134	Air/ Nitrogen pressure to D-441 door seal		X				
PI-6-647	Air/Nitrogen pressure to D-52 door seal		X				
PI-6-648	Air/Nitrogen pressure to D-13 door seal		X				
PI-6-649	Air/Nitrogen pressure to D-15 door seal		X				
Pri Pumps RLY-A (670-E-1)	Relays, Primary emergency coolant pump hardwired autostart logic				X		
Pri Pumps RLY-A (670-E-2)	Relays, Primary emergency coolant pump hardwired autostart logic				X		
PRV-6-631, SOV-6-632	Air/Nitrogen supply to D-52		X				

Table 5-7. Outliers for PC-4 Seismic Criteria. (12 sheets)

Equipment No.	Equipment Description	Equip Class	Cap vs. Dem	Caveats	GERS	Anchorage	Interaction
PRV-6-635, SOV-6-636	Air/Nitrogen supply to D-13		X				
PRV-6-639, SOV-6-640	Air/Nitrogen supply to D-15		X				
R1	Block valve, tank 718 outlet to F.W. header	X					
R1A	R1A				X		X
R1B	R1B				X		X
R1C	R1C				X		X
R1A-A	Relays, RMS damper actuation				X		X
R1A-B	Relays, RMS damper actuation				X		X
R1A-C	Relays, RMS damper actuation				X		X
R-128	BV on discharge of Deep Well Pump #4	X					
R-129	BV on common discharge of Deep Well Pump #1 & #3	X					
RAm-511A, B, C	Gamma level drawer with integral HVPS, fission break subsystem					X	
RCR Panel R1	Control Room Panel R1		X			X	
RCR Panel R4	Control Room Panel R4		X			X	X
RCR Panel R6	Control Room Panel R6		X			X	X
RCR Panel R8	Control Room Panel R8		X			X	X
RCR Panel R9	Control Room Panel R9		X			X	X
RE-510A-1, A-2, B-1, B-2, C-1, C-2, D (installed spare)	Ion chambers, neutron level subsystem	X					
RE-511A, B, C	Gamma Ionization Chambers, fission break subsystem	X					
RE-512A, B, C, D (installed spared)	Detector assembly, wide range neutron subsystem	X					
RE-530A/B/C	Gamma ionization chambers, ATR vent stack	X					
RX-511A, B, C	Check source, shield assembly, power supply, fission break subsystem	X					
Storage Locations 1,2	Transfer Station	X					
TMR-IN-1	Relays, Time Delay				X		
TMR-IN-4	Relays, Time Delay				X		
TMR-OUT-1	Relays, Time Delay				X		

Table 5-7. Outliers for PC-4 Seismic Criteria. (12 sheets)

Equipment No.	Equipment Description	Equip Class	Cap vs. Dem	Caveats	GERS	Anchorage	Interaction
TMR-OUT-4	Relays, Time Delay				X		
TW-6-1029	ATR Control Valve for HVS-5 Supply Damper BDM-5-8		X				X
TW-6-1030	ATR Control Valve for HVS-5 Backup Damper BDM-5-8A		X				X
TW-6-1039	ATR Control Valve for HVS-5 Return Damper BDM-5-9		X				X
TW-6-1040	ATR Control Valve for HVS-5 Backup Damper BDM-5-9A		X				X
TW-6-1049	ATR Control Valve for HVE-9 Exhaust Damper BDM-5-10		X				X
TW-6-1050	ATR Control Valve for HVE-9 Backup Damper BDM-5-10A		X				X
TW-6-1058	ATR Control Valve for HVS-1 Supply Damper BDM-1-1		X				
TW-6-1067	ATR Control Valve for HVS-1 Supply Damper BDM-1-2		X				
TW-6-1068	ATR Control Valve for HVS-1 Backup Damper BDM-1-2A		X				
TW-6-1077	ATR Control Valve for HVS-1 Return Damper BDM-1-3		X				
TW-6-1078	ATR Control Valve for HVS-1 Backup Damper BDM-1-3A		X				
TW-6-1087	ATR Control Valve for HVR-1 reactor operating area exhaust BDM-1-4		X				
TW-6-1088	ATR Control Valve for HVS-1 Backup Damper BDM-1-1A		X				
TW-6-1097	ATR Control Valve for HVA-2 Return Damper BDM-1		X				
TW-6-1098	ATR Control Valve for HVA-2 Backup Damper BDM-1A		X				
TW-6-1208	ATR Control Valve for HVA-2 Supply Damper BDM-2		X				
TW-6-1209	ATR Control Valve for HVA-2 Backup Damper BDM-2A		X				
TW-6-1218	ATR Control Vale for HVS-4 Return Damper BDM-4-8		X				
TW-6-1219	ATR Control Valve for HVS-4 Backup Damper BDM-4-8A		X				
Unnumbered 11	Siphon breaker line assembly	X					
Unnumbered 15	Transformer #1, 10KVA isolat'n, for bus 670-IP2		X				

Table 5-7. Outliers for PC-4 Seismic Criteria. (12 sheets)

Equipment No.	Equipment Description	Equip Class	Cap vs. Dem	Caveats	GERS	Anchorage	Interaction
Unnumbered 18	Exterior walls, sandwich panel	X					
Unnumbered 19	Gas-tight equipment floor hatches	X					
Unnumbered 24	Drain valve cover plates (Irradiated Fuel Storage Area)	X					
Unnumbered 27	Snubber tubes	X					
Unnumbered 29	Canal low-level alarm system				X		
Unnumbered 3	Fuel elements	X					
Unnumbered 41	Transformer #2, 10KVA isolat'n, for bus 670-IP1		X				
Unnumbered 45	Reactor console		X				
Unnumbered 46	Steel liners, canals (working and storage - not ATRC)	X					
Unnumbered 47	Tubing to door seals, downstream of CK-6-969	X					
Unnumbered 52	Concrete block, fire and isolation walls	X					
Unnumbered 55	Canal bulkheads, Standard and Short	X					
Unnumbered 59	Concrete equipment foundations	X					
Unnumbered 60	Windows, gas-tight	X					
Unnumbered 61	Backup Nitrogen bottles for dampers 670-BDM-1-5 and 670-BDM-1-5A					X	
Unnumbered 64	Concrete, lower perimeter wall	X					
Unnumbered 7	Roofing panels	X					
Unnumbered 8	Support and liner, reactor vessel	X					
Unnumbered 9	Steel liners, misc. gas-tight walls	X					
VVS Control Panel - 1B	VVS Control Panel - Main Floor 1B		X				
-	Cable Tray Support 2B-C-3 (see Section 5.5)					X	
-	Conduit to AC emergency pump motor						X

6.0 SEISMIC QUALIFICATION BY OTHER METHODS

Many of the outliers (Table 5-7) were seismically qualified for PC-4 seismic criteria by implementing other methods besides the experience-based procedures of DOE/EH-0545. The further evaluations and reviews performed to resolve these outliers are summarized below.

6.1 Underground Firewater System

The ATR and Test Reactor Area (TRA) underground firewater system highlighted in Figure 6-1 is designated Seismic Category I. This system, including the piping, fire hydrants, valves and other in-line components, were considered to be outliers. DOE/EH-0545 procedures for underground piping require ductile pipe behavior with joints which are stronger than the pipe. The Seismic Category I underground firewater piping is typically constructed of ductile iron with rubber-gasketed bell-and-spigot joints which are weaker than the pipe. In addition, DOE/EH-0545 procedures do not address the fire hydrants, and post-indicator and road valves which must maintain the system pressure boundary.

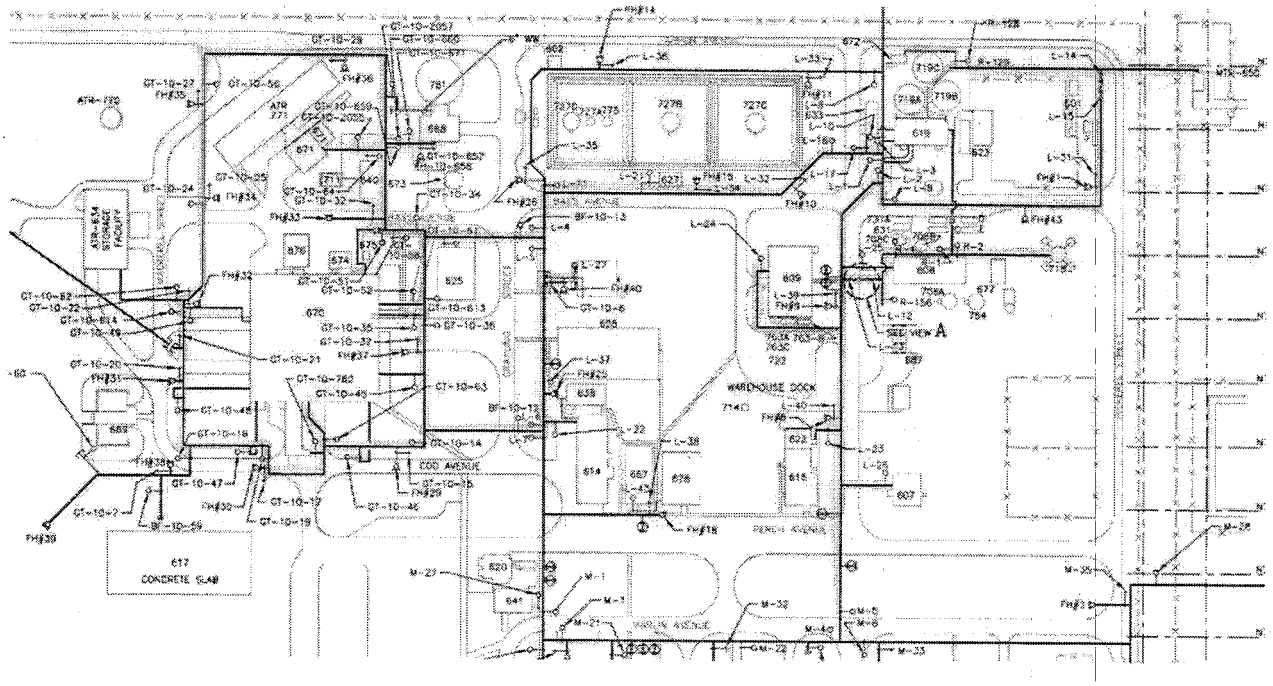

Figure 6-1. Seismic Category I Underground Firewater System.

DOE/EH-0545 references BNL-52361, *Seismic Design and Evaluation Guidelines for the Department of Energy High-Level Waste Storage Tanks and Appurtenances* for methods to evaluate underground piping. Additional guidance is provided by ASCE 4-98 and *Seismic Guidelines for Water Pipelines* (ALA, 2005). Based upon review of these documents, the seismic evaluation of the underground firewater system should address the following:

- An assessment of the existing system condition should verify that there has not been significant degradation in the strength, ductility, wall thickness, and joint integrity.
- The system should be evaluated for seismic loads due to seismic wave passage, seismic anchor motion, and significant soil movements.

Following this guidance, seismic evaluation of the Seismic Category I underground firewater system was performed as follows:

- A recently prepared report on the condition of the ATR buried piping systems was reviewed to confirm that the underground firewater system is in good condition.
- The underground piping was evaluated for seismic wave passage effects. Pullout and compression at rubber-gasketed joints, and restraint at thrust blocks were considered.
- Seismic displacements at piping penetrations at the exterior walls of TRA-670 were evaluated to verify that gaps between the piping and the walls do not close.
- A review of the past earthquake performance of fire hydrants and underground valves was performed.

Each of these activities is summarized below. Underground firewater system outliers that were resolved are listed in Table 6-1.

6.1.1 Condition Assessment

A recent condition assessment of the underground firewater, raw water, and low pressure demineralized water systems was documented in NISYS-1255-TR003/R1, *Material Condition Assessment of ATR Buried Piping for the Raw Water, Firewater, and Low Pressure Demineralized Water Systems*. Conclusions obtained by this review were as follows:

- "The useful life of ATR buried piping is governed by the condition of the OD coatings and integrity of the underlying piping. Data obtained in this assessment indicates that the OD pipe coatings and piping of the Firewater system are in good condition."
- "Analytical model results indicate an estimated remaining life of several decades for the ATR buried piping."
- "Previous problems associated with valves and leaks in similar piping systems at ATR can be attributed to unique events rather than aging damage mechanisms. Valve failures caused by significant corrosion problems are unlikely."

NISYS-1255-TR003/R1 established that the condition of the underground firewater system (including fire hydrants and valves) is good. Degradation resulting in a significant reduction of the system seismic capacity was consequently considered to be unlikely.

6.1.2 Evaluation of Seismic Wave Passage Effects

The typical Seismic Category I underground ductile iron piping with rubber-gasketed joints was considered to control over the other piping configurations which occur in only isolated instances (e.g., mechanical joints). Evaluations of pullout and compression at the joints due to wave passage effects and hydrodynamic thrust on thrust block restraints were performed.

Table 6-1. Resolved Underground Firewater System Outliers. (3 sheets)

Equipment No.	Description
BF-10-12	BV FW loop
BF-10-13	BV FW loop
BF-10-2058	BV raw water to FW loop
BF-10-2061	BV raw water to FW loop
BF-10-2116	BV RTC to ATR FW loop
BF-10-2117	BV RTC to ATR FW loop
BF-10-2125	BV RTC to ATR FW loop
BF-10-2126	BV RTC to ATR FW loop
BL-10-2120	BV CK-10-2118 bypass
BL-10-2121	BV CK-10-2119 supply test
BL-10-2122	BV CK-10-2119 bypass
BL-10-2123	BV CK-10-2119 test isolation
BL-10-2124	BV test header outlet
BL-10-2129	BV CK-10-2118 bypass
BL-10-2130	BV CK-10-2119 supply test
BL-10-2131	BV CK-10-2119 bypass
BL-10-2132	BV CK-10-2119 test isolation
BL-10-2133	BV test header outlet
CK-10-2059	Check valve raw water to FW loop
CK-10-2060	Check valve raw water to FW loop
CK-10-2062	Check valve raw water to FW loop
CK-10-2063	Check valve raw water to FW loop
CK-10-2118	Check valve RTC to ATR FW loop
CK-10-2119	Check valve RTC to ATR FW loop
CK-10-2127	Check valve RTC to ATR FW loop
CK-10-2128	Check valve RTC to ATR FW loop
FH-10-658	Fire Hydrant
FH-30	Fire Hydrants
FH-31	Fire Hydrant
FH-32	Fire Hydrant
FH-33	Fire Hydrant
FH-34	Fire Hydrant
FH-35	Fire Hydrant
FH-36	Fire Hydrant
FH-38	Fire Hydrant
FH-39	Fire Hydrant
FH-40	Fire Hydrant

Table 6-1. Resolved Underground Firewater System Outliers. (3 sheets)

Equipment No.	Description
FH-43	Fire Hydrant
GT-10-14	
GT-10-15	Block Valves to Fire Hydrants
GT-10-17	Block Valves to Fire Hydrants
GT-10-18	BV
GT-10-19	Block valve, F.W. ATR loop isolation
GT-10-20	BV
GT-10-2055	
GT-10-2057	TRA-781 Firewater Isolation
GT-10-22	BV
GT-10-24	BV, FW ATR loop isolation
GT-10-25	BV
GT-10-27	BV
GT-10-29	BV
GT-10-32	BV
GT-10-34	Block valve, F.W. ATR loop isolation
GT-10-35	BV ATR lower EFIS
GT-10-36	BV ATR FW loop
GT-10-37	Block Valve to Fire Hydrant
GT-10-45	Block valve, to TRA 670 fire sprinklers
GT-10-46	Block valve, to TRA 670 fire sprinklers
GT-10-47	BV, FW to ATR Reactor Spray
GT-10-48	BV, to TRA-670 fire sprinkler #5
GT-10-49	BV, to TRA-670 fire sprinkler #6
GT-10-52	Block valve, to TRA 670 fire sprinklers
GT-10-56	BV, FW ATR loop isolation
GT-10-58	
GT-10-61	Block valves, F.W. to TRA-625
GT-10-613	BV ATR FW Loop
GT-10-614	BV, FW ATR loop isolation
GT-10-62	BVs, FW to TRA-634
GT-10-625	
GT-10-63	Block valve to upper vessel EFIS
GT-10-64	
GT-10-657	FH-10-658 Isolation
GT-10-659	TRA-688 South Loop Isolation
GT-10-660	TRA-688 North Loop Isolation
GT-10-671	TRA-688 Discharge Isolation
L 1	Block valve, FW pump outlet cross tie

Table 6-1. Resolved Underground Firewater System Outliers. (3 sheets)

Equipment No.	Description
L 21	Block valve, F.W. to TRA 627
L 26	Block valve, F.W. to TRA 607
L 3	Block valve, FW pump outlet cross tie
L 8	Block valve, deepwell discharge to 619-10 discharge
L-10	Block valve, F.W. to diesel fuel storage area
L-11	Block valve, F.W. to diesel fuel storage area
L-12	BV raw water to FW loop
L-13	BV raw water to FW loop
L-14	Check valve
L-15	Check valve
L-16	BV FW loop
L-17	BV 633-1 discharge
L-2	BV FW loop
L-21	BV, FW to TRA-627
L-22	Block valve, F.W. to TRA-614
L-23	Block valve, F.W. to TRA-622
L-24	Block valve, F.W. to TRA-609
L-25	Block valve, F.W. to TRA-608
L-26	BV, FW to TRA-607
L-27	Block valve, F.W. to TRA-628
L-31	BV
L-32	Block Valves to Fire Hydrants
L-34	Block Valves to Fire Hydrants
L-37	Block Valves to Fire Hydrants
L-39	Block Valves to Fire Hydrants
L-4	BV FW loop
L-40	Block Valves to Fire Hydrants
L-42	BV
L-5	BV FW loop
L-6	BV FW loop
L-7	BV FW loop
L-8	BV, deep well pump discharge to FW loop
M-5	BV ATR FW loop
R1	Block valve, tank 718 outlet to F.W. header
R-128	BV on discharge of Deep Well Pump #4
R-129	BV on common discharge of Deep Well Pump #1 & #3

6.1.2.1 Evaluation of Joint Pullout

The maximum ground strain in the axial direction of the pipe due to wave passage effects was determined in accordance with Section 7.5.4 of BNL-52361 as follows:

$(\varepsilon_a)_{max}$	=	Maximum axial strain
	=	$PGV/(\alpha_\varepsilon C)$
PGV	=	Peak ground velocity
C	=	Apparent wave velocity
α_ε	=	Coefficient dependent on wave type

Using ground motion and site soil data from INEEL/EXT-03-00942, the maximum axial strain was determined to be 2.120×10^{-4} in/in. For the typical pipe segment length of 20 feet, the maximum pullout displacement was determined to be only 0.05 inches.

Specific guidelines on permissible pullout displacement capacities for ductile iron pipe with rubber-gasketed joints are not available. Based on test data reported in *Pull Out and Bending Experiments in Buried Pipes* (Singhal and Benavides, 1983) and including a fit-up tolerance in construction of 0.25 inches suggested by ALA (2005), a joint pullout displacement capacity of 1.0 inches was considered to be appropriate. Rubber-gasketed joints for PVC piping were considered to have a similar capacity since this piping is installed in a similar manner. The joint pullout capacity of 1.0 inches is well in excess of the maximum pullout displacement of 0.05 inches, signifying that joint pullout should not occur.

6.1.2.2 Evaluation of Pipe Compression

Section 7.3.1 of ALA (2005) notes that compression failures of ductile iron pipes are rare and that the larger concern is pullout at the joints. A conservative bounding analysis was performed to confirm that pipe compression is not a concern. An upper bound on the pipe axial strain corresponding to the maximum longitudinal strain in the soil was used, conservatively assuming that the pipe and soil are perfectly bonded and that slip does not occur. An upper-bound compression stress of only about 5 ksi was calculated. Static testing of ductile iron pipe with rubber-gasketed joints reported in *Behavior of Underground Piping Joints Due to Static and Dynamic Loading* (Meis, et al., 2003) obtained maximum compression stresses ranging from about 36 ksi to 50 ksi. It was concluded that compression failure of Seismic Category I ductile iron piping will not occur due to the PC-4 DBE.

In static axial testing of PVC piping by Meis, et al. (2003), the spigot end extruded into the bell end, and the piping did not fail for all samples tested. The PVC piping was capable of sustaining maximum displacements between 6 cm (2.4 inches) and 12 cm (4.7 inches). Compressive failure of the Seismic Category I PVC piping due to the PC-4 DBE resulting in a loss of water-retention capability was consequently judged to be very unlikely.

6.1.3 Evaluation of Thrust Restraint

Thrust blocks are typically used at discontinuities (e.g., elbows, tees, etc.) in the underground firewater system to provide restraint against thrust forces. Evaluation of the thrust blocks was based upon comparison of the piping pressure due to normal operating and seismic loads against the system design pressure.

EDF-1286, *TRA Firewater Piping Evaluation,* reports that the normal pressure in the firewater system due to static head from the raw water overhead tank is 80 psi. A seismic hydrodynamic pressure in the underground firewater piping of 124 psi was determined following the approach recommended by ALA (2005), resulting in a net pressure of 204 psi. Based on firewater design requirements reported in EDF-1286, the underground firewater piping system was designed for a pressure of at least 350 psi, which exceeds the net static plus seismic pressure.

6.1.4 Evaluation of Seismic Displacements at Piping Penetrations

The Seismic Category I underground firewater piping enters TRA-670 at the two locations shown in Figure 6-1. The building penetrations at both locations have gaps separating the piping from the building walls. Significant piping forces due to seismic anchor motion cannot occur until the relative seismic displacement between the building and the soil enclosing the piping is sufficient to close the gaps. The gaps at the south and east exterior walls of TRA-670 are 1.5 inches and 6 inches, respectively.

Seismic displacement of the piping relative to the building wall consists of the following three components:

- Displacement due to seismic response of soil was estimated from effective soil strains reported in INL/EXT-03-00942.
- Displacement due to seismic response of TRA-670 was inferred from analysis results reported in CJC-INL-C-003.
- Displacement due to inertial response of the piping inside TRA-670 was obtained from an existing seismic piping seismic analysis documented in EDF-TRA-ATR-1208, *Design Report for the ATR Fire Water Redundant Line and the ATR Vessel Vent and Relief Systems.*

A total seismic displacement of 0.30 inches due to the PC-4 DBE was calculated. The minimum gap of 1.5 inches at TRA-670 piping penetrations is well in excess of this displacement. Piping failure at the penetrations due to the PC-4 DBE will not occur.

6.1.5 Review of Earthquake Experience Data on Fire Hydrants and Valves

Other components mounted in-line on the underground firewater piping include fire hydrants (Figure 6-2) and valves. The valves include both post-indicator valves (Figure 6-3) and "road" valves (i.e., an underground valve with a vertical access sleeve extending up to the roadway surface) (Figure 6-2). Several post-earthquake investigation reports were reviewed to identify information on the

past earthquake performance of fire hydrants and valves. Although fire hydrants and associated valves are common in urban areas of the United States, the dearth of reported earthquake damage implies that they are relatively robust. In comparison, reported damage to water distribution pipeline systems is more common. It was judged that the fire hydrants and valves have sufficient capacity against the PC-4 DBE.

Figure 6-2. Typical Fire Hydrant and Road Valve.

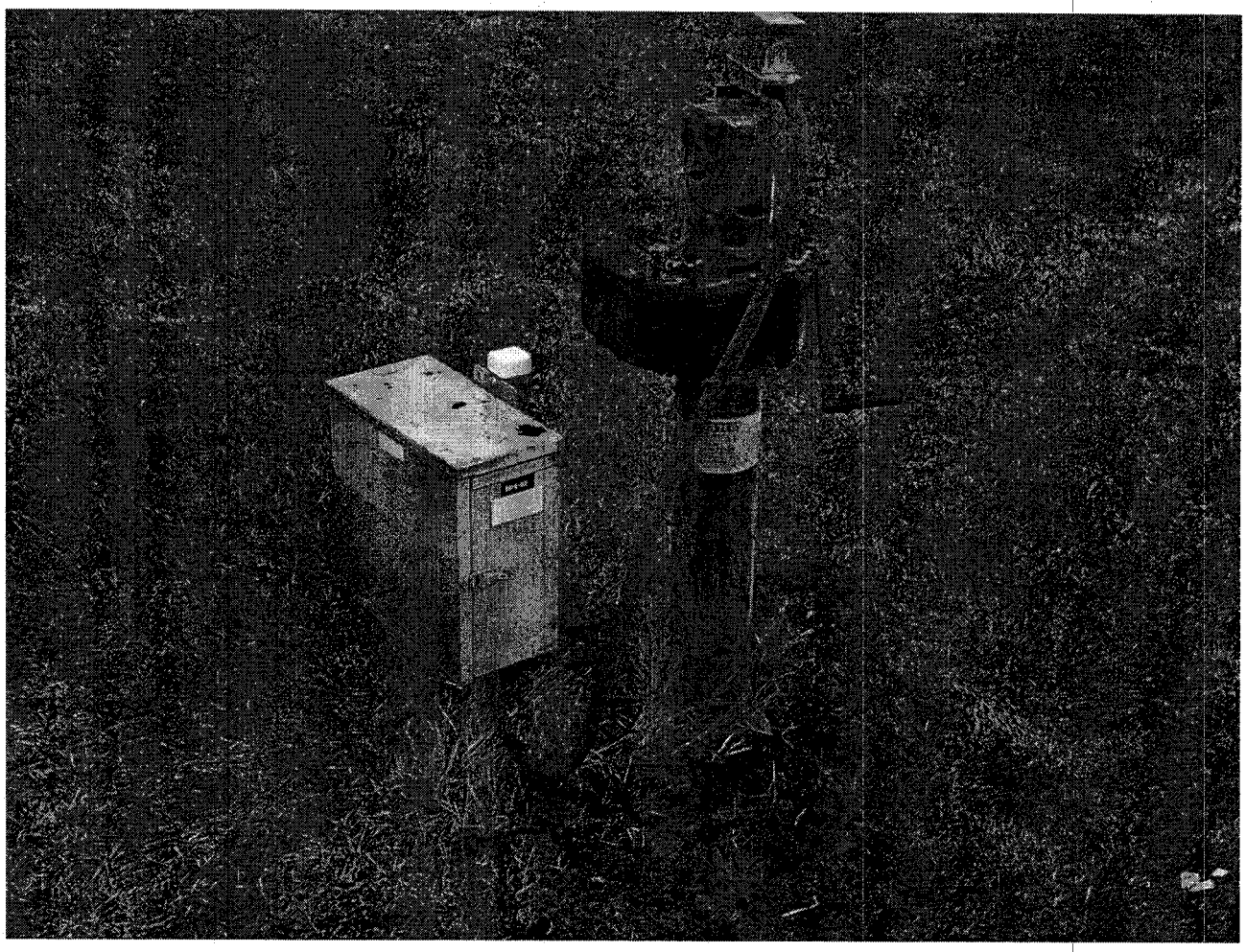

Figure 6-3. Typical Post-Indicator Valve.

6.2 Deep Well Pumps

Deep Well Pump Nos. 3 and 4 (Figures 6-4 to 6-7) were considered to be outliers since they exhibit a dissimilarity from the equipment class of Vertical Pumps in DOE/EH-0545. Vertical pumps in the earthquake experience database typically had shaft lengths of 10 to 20 feet. The shaft lengths for Deep Well Pump Nos. 3 and 4 are 585 feet and 520 feet, respectively.

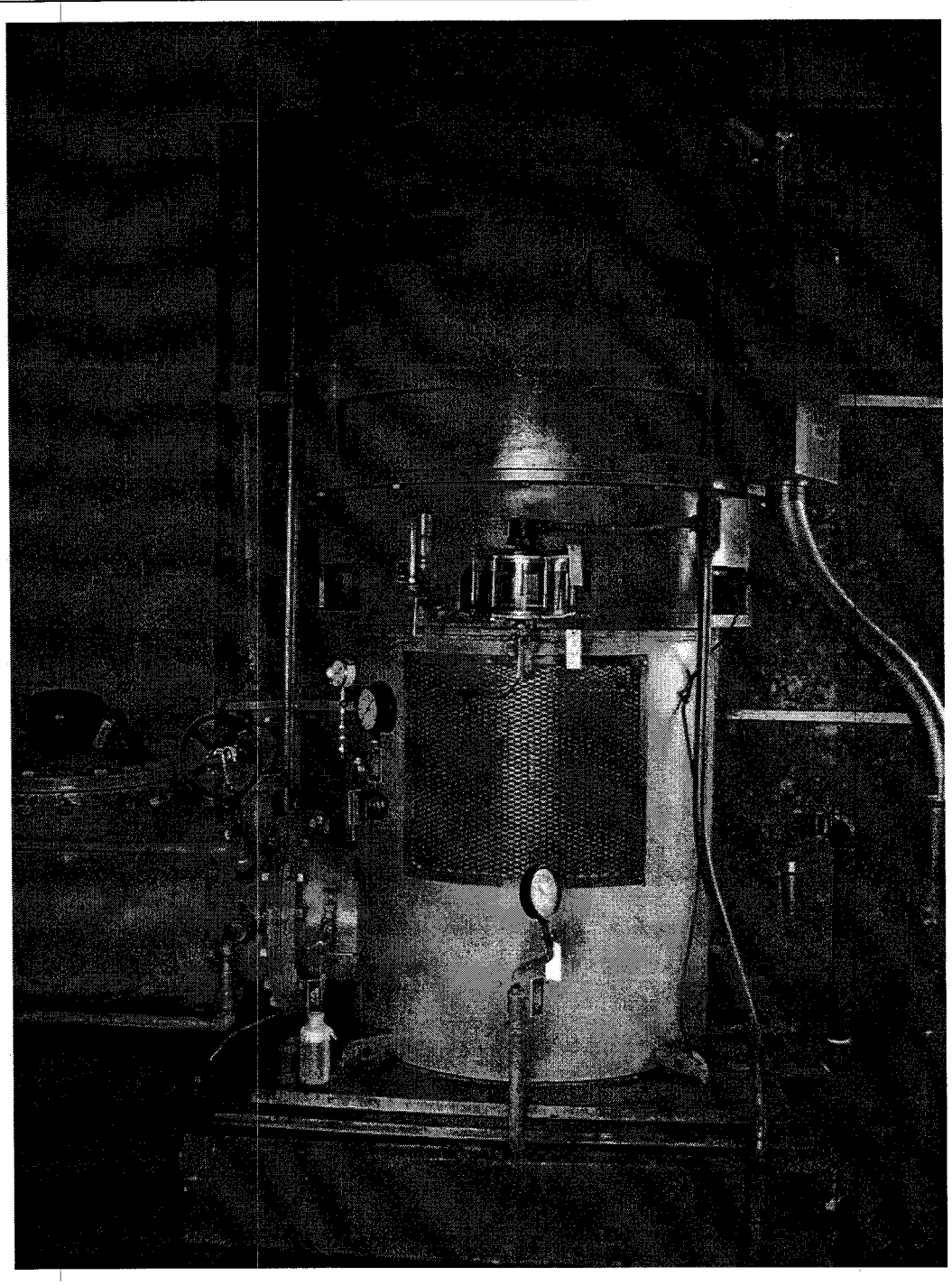

Figure 6-4. Deep Well Pump No. 3.

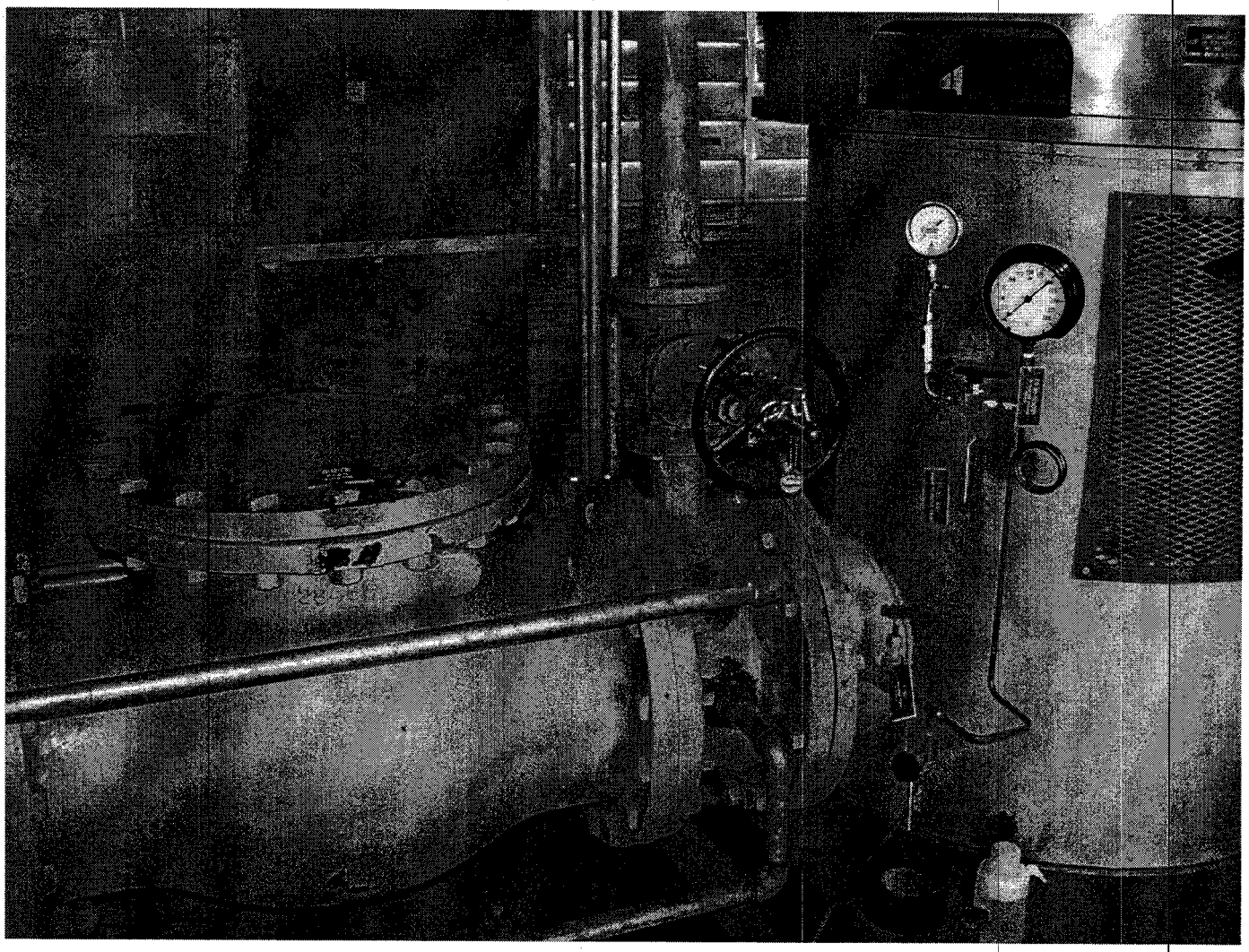

Figure 6-5. Discharge Piping for Deep Well Pump No. 3.

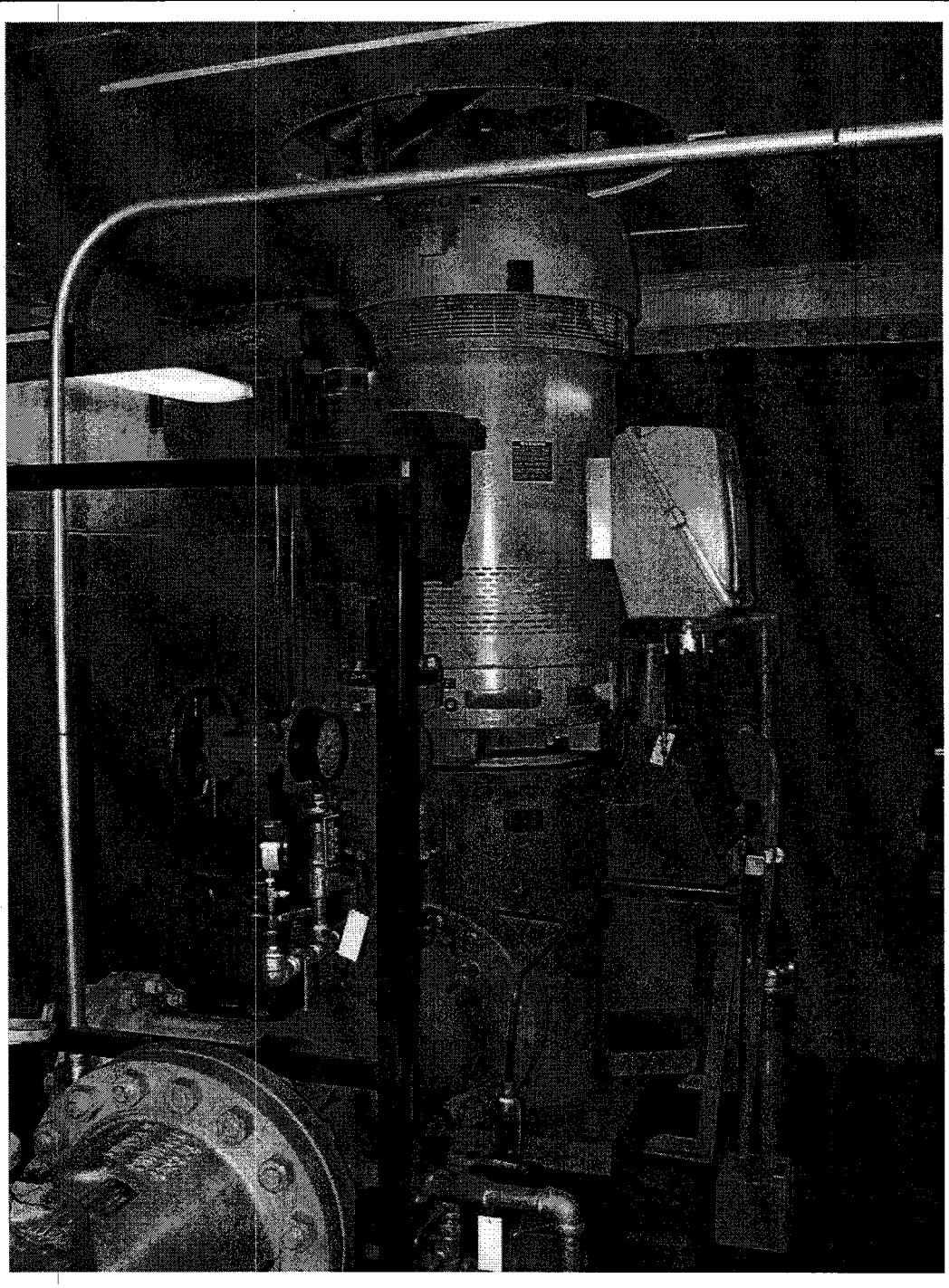

Figure 6-6. Deep Well Pump No. 4.

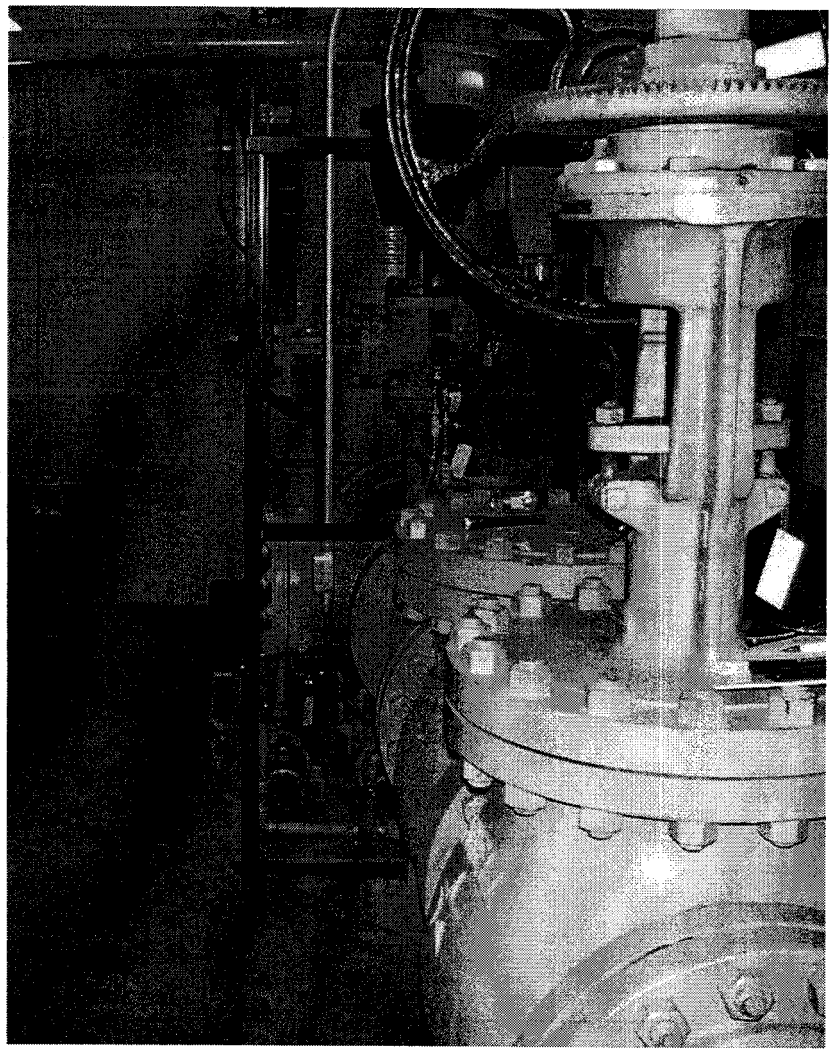

Figure 6-7. Discharge Piping for Deep Well Pump No. 4.

Seismic evaluation of Deep Well Pump Nos. 3 and 4 consisted of the following steps:

- Data on the past earthquake performance of long deep well pumps was collected and reviewed. The expected performance of Deep Well Pump Nos. 3 and 4 for the PC-4 DBE was inferred from these data.
- A geotechnical evaluation was conducted to determine the potential for soil failure modes which could impair pump function.
- Deep Well Pump Nos. 3 and 4 were screened against applicable caveats for the equipment class of Vertical Pumps specified by DOE/EH-0545.
- Anchorage of the pumps to their foundations was evaluated.
- The pump casing was evaluated.

Seismic evaluation of Deep Well Pump Nos. 3 and 4 was documented in ARES Calculation No. 0602301.01-S-003 (Appendix F). This evaluation is summarized below.

6.2.1 Review of Earthquake Experience Data

A number of post-earthquake investigation reports was reviewed to obtain earthquake experience data on deep wells. Sources of earthquake damage to deep well pumps resulting in loss of well function are summarized in Table 6-2. Loss of electrical power from the power grid is not included. Quantities of damaged pumps attributable to the different sources are listed when known. The most common sources were the following:

- Significant soil movement, (i.e., liquefaction, lateral spreading, and fault rupture).
- Sanding (i.e., sand infiltration into the well casing through the casing slots).
- Damage to the wellhouse structure, attached piping, and local electrical power.

Table 6-2. Sources of Earthquake Damage.

Earthquake	Number of Damaged Deep Well Pumps				Notes
	Soil Movement	Sanding	Wellhouse, Piping, Cabling Damage	Other or Unknown	
1933 Long Beach					No damage reported.
1952 Kern County	X[1]				
1971 San Fernando	3			1	Pump for Well No. 5 shifted.
1984 Morgan Hill					No damage to pumps. Only lack of power.
1985 Chile	2			1	One cracked casing at an old weld repair.
1986 Palm Springs				1	Loose debris.
1986 San Salvador				1	One pump burned out; cause unknown.
1987 Whittier					No damage reported.
1989 Loma Prieta		3			
1990 Philippines	6	3	3	4	One pump bowl cracked. Three pump motors burned out due to voltage fluctuation and sanding.
1992 Erzincan					No damage to pumps. Only lack of power.
1993 Guam					No damage reported.
1994 Northridge					No damage reported.
1999 Chi-Chi					No damage reported.
2001 Bhuj	X[1]	X[1]	X[1]		Detailed information not available.
2001 El Salvador					No damage reported.
2002 Denali				2	Two casings ejected.
2003 San Simeon					No damage reported.

Notes:
1. Quantity unknown.

The actual number of deep well pumps that have experienced significant earthquakes is not known exactly. It is estimated to be in the thousands. The number of deep well pumps that have experienced damage resulting in a loss of function (excluding loss of power from the electrical grid) appears to be a relatively small fraction of the total number of earthquake-affected deep well pumps.

Excluding damage to the well house and supporting components, the more frequent sources of damage to deep well pumps appear to be significant soil movement and sanding. Further review of Deep Well Pump Nos. 3 and 4 was consequently performed to address the potential for significant soil movement and sanding causing a loss of function to the portion of the well that is below the pump motor foundation. The seismic adequacy of the pump motor, shaft, and pump anchorage were evaluated. Seismic evaluation of the pumphouses was outside the scope of this project.

6.2.2 Geotechnical Evaluation

A geotechnical evaluation was performed by Geomatrix Consultants. This evaluation was performed to address soil-related hazards to Deep Well Pump Nos. 3 and 4, which have caused damage to similar deep well pumps in past earthquakes. The geotechnical evaluation is documented in Geomatrix Report No. 060230101-002, *Geotechnical Evaluation of Seismic Performance of Deep Well Pump No. 3 and No. 4 at the Advanced Test Reactor*. The following results were obtained:

- The site is unlikely to be subjected to ground movement due to liquefaction-related settlement, ground failure, lateral spreading, and fault rupture.
- Sanding of the wells should be prevented since the well casing slots are located in the basalt rock and because the wells appear to have been constructed with well-graded gravel pack.
- Significant changes to the water table should not occur since the regional groundwater conditions are relatively flat.

It was concluded that the soil-related hazards which have caused the failure of deep well pumps in past earthquakes are unlikely to affect Deep Well Pump Nos. 3 and 4.

6.2.3 Review of Applicable Caveats for Vertical Pumps

Deep Well Pump Nos. 3 and 4 were reviewed for the DOE/EH-0545 caveats for vertical pumps. Caveats 1, 3, and 4 were clearly satisfied. More detailed review was performed to address Caveat 2.

To satisfy Caveat 2, the impeller shaft and casing should not be cantilevered more than 20 feet below the pump mounting flange and the pump should have a radial bearing at the bottom of the casing to support the impeller shaft. The shaft for each of the deep well pumps is housed within the oil-filled shaft enclosure tube. Shaft couplings are spaced at 10-foot intervals. The shaft is restrained by the tight clearances between its shaft couplings and the inside surface of the enclosure tube. The shaft enclosure tube is restrained within the pump casing by "spiders" spaced at 20-foot intervals. Bushings located at 5-foot intervals along the shaft prevent the bowls (impellers) from impacting the casing. Restraint of the shaft and shaft enclosure tube consequently satisfies the caveat.

The pump casing is unrestrained within the well casing. However, as discussed above, pump failures in past earthquakes have been primarily due to significant soil movements, sanding, and damage to the wellhouse structure, attached piping, and local electrical power. The lack of pump casing restraint does not appear to have resulted in pump failure in past earthquakes. Consequently, the unrestrained pump casing was not considered to be a concern.

6.2.4 Anchorage Evaluation

Both of the pumps are supported on concrete pedestals that are elevated above the pumphouse floors. The base plate for Deep Well Pump No. 4 is anchored to the pedestal (Figure 6-6). Deep Well Pump No. 3 lacks anchorage (Figure 6-4). For this pump, sliding is resisted by static friction generated by the pump dead weight. Similarly, overturning is resisted by the restoring force associated with the pump dead weight. Deep Well Pump No. 3 was evaluated for shear and overturning at the base plates on the concrete pedestal.

Seismic reactions onto the pedestal result from inertia of the above-grade components (pump motor, well head, discharge piping) and below-grade components (pump, pump casing, shaft, shaft enclosure tube, etc.). For the former, the pump motor and well head were judged to respond at horizontal and vertical frequencies of 25 Hz and the discharge piping was judged to experience the peak spectral accelerations for the ground response spectra. Seismic reactions for the below-grade components were obtained by response spectrum analysis using a simple finite element model. Seismic reactions from the above- and below-grade components were calculated individually and then combined.

Resistance against sliding was based on the pump and discharge piping dead weight and a 95% confidence of exceedance static coefficient of friction of 0.3. A maximum D/C ratio of 0.58 was obtained, demonstrating that sliding will not occur due to the PC-4 DBE.

Although Deep Well Pump No. 3 is not anchored to its concrete pedestal, it is prevented from overturning by the restoring moment associated with the pump dead weight. Should the pump uplift due to overturning moment, it will rotate about the edge of the well head which is welded to one of the base plates. A maximum D/C ratio of 0.67 was obtained, demonstrating that overturning will not occur due to the PC-4 DBE.

6.2.5 Pump Casing Evaluation

A simplified evaluation of the pump casing based on elastic axial and bending stresses on the casing body was performed. A low combined axial and bending stress due to dead and seismic loads of only 9.7 ksi was obtained. The pump casing was concluded to be acceptable for the PC-4 DBE.

The maximum elastic horizontal seismic displacement of the pump casing was determined to be 23 inches, which exceeds the separation between the pump and well casings. The impact velocity should be low since the fundamental pump casing frequency is very low. Damage to the pump due to impact between the pump and well casings was considered to be unlikely. Deep Well Pump Nos. 3 and 4 are similar to deep well pumps that have experienced past earthquakes. As noted above, such pumps have experienced only limited instances of damage, other than sources such as soil movement, sanding,

and wellhouse, piping, and cabling damage. It may be inferred that impact between pump and well casings has not caused deep well pump failures in past earthquakes.

6.3 Small Valves and Mechanical Components

A number of water, air, and nitrogen valves and small air/nitrogen supply mechanical components were designated outliers because the seismic demand exceeds the seismic capacity. These components are located primarily at the first floor where the seismic input is high.

Further review of these small valves and mechanical components was performed. Because they are small and have low mass, their seismic inertial loads are low despite the high seismic input. These items were observed to be adequately supported. They are all passive components that are required to maintain structural integrity and pressure boundary only. The small valves and mechanical components listed in Table 6-3 were consequently judged to be seismically qualified based on engineering judgment.

6.4 Control Room Switches

Table 6-4 lists control room switch outliers that are considered to be resolved. These switches are categorized as being outliers because seismic demand exceeds seismic capacity for their parent components. Switches HS-516A, B, and C are located on the reactor console and the other switches are located on Panel P11. The parent components for these switches are outliers since the seismic demand exceeds seismic capacity. The switches are all relatively simple devices (e.g., manual toggle switches) that essentially only need to maintain their position on the console or panel. Catastrophic structural integrity failure of the reactor console and Panel P11 resulting in loss of function of the switches was judged to be unlikely.

Switches E15A/D are mounted to a concrete block wall enclosing the outage control office. These switches are also simple devices that are expected to maintain their position. However, they are still considered to be outliers since the 4-inch thick concrete block wall to which they are attached does not satisfy PC-4 seismic criteria.

6.5 Other Resolved Outliers

Other outliers that are considered to be resolved are listed in Table 6-5. These components were designated as outliers because the seismic demand exceeds the seismic capacity. However, Panels 670-E-313, 670-VV-RLY-B, and 670-VV-RLY-C are very lightweight and should have low seismic inertial loads. Loads imposed by anchorage tug-testing are expected to exceed the inertial loads. They were judged to be seismically qualified. Transformers #1 and #2 are not subject to the coil displacement vulnerabilities present in most three-phase transformers. They were also judged to be seismically qualified.

Table 6-3. Resolved Small Valve and Mechanical Component Outliers.

Equipment No.	Description
BL-10-164	Emergency Firewater Canal Fill
BL-10-167	Emergency Firewater Canal Fill
BL-10-168	Emergency Firewater Canal Fill
BL-1-623	Upper Vessel EFIS Supply Drain
CK-6-969	Check valve, supply to door seals
GT-1-614	Block valve, main firewater to upper vessel
GT-1-622	Upper Vessel EFIS LDW Discharge Block
GT-1-628	Upper Vessel EFIS LDW Discharge Block
GT-1-629	Upper Vessel EFIS Supply Vent
GT-6-625, CK-6-626	Air/Nitrogen supply to D-51
GT-6-629, CK-6-630	Air/Nitrogen supply to D-52
GT-6-633, CK-6-634	Air/Nitrogen supply to D-13
GT-6-637, CK-6-638	Air/Nitrogen supply to D-15
GT-CC-19-1	Recycle Isolation Valve
GT-CC-19-10	Recycle Isolation Valve
GT-S-6-290	Isolation Valves, ATR Canal Level Control
ND-10-811	PI-10-122 Secondary Isolation Valve
ND-10-813	PS-1-110 Secondary Isolation Valve
ND-10-814	PS-1-110 Vent Valve
ND-10-815	PS-1-110 & PI-10-122 Isolation Valve
ND-6-837, 838 and 839	Isolation Valves, ATR Canal Level Control
None 13	Rotameter, ATR Canal Level Control
PI-6-127, PI-6-134	Air/ Nitrogen pressure to D-441 door seal
PI-6-647	Air/Nitrogen pressure to D-52 door seal
PI-6-648	Air/Nitrogen pressure to D-13 door seal
PI-6-649	Air/Nitrogen pressure to D-15 door seal
PRV-6-631, SOV-6-632	Air/Nitrogen supply to D-52
PRV-6-635, SOV-6-636	Air/Nitrogen supply to D-13
PRV-6-639, SOV-6-640	Air/Nitrogen supply to D-15
TW-6-1058	ATR Control Valve for HVS-1 Supply Damper BDM-1-1
TW-6-1067	ATR Control Valve for HVS-1 Supply Damper BDM-1-2
TW-6-1068	ATR Control Valve for HVS-1 Backup Damper BDM-1-2A
TW-6-1077	ATR Control Valve for HVS-1 Return Damper BDM-1-3
TW-6-1078	ATR Control Valve for HVS-1 Backup Damper BDM-1-3A
TW-6-1087	ATR Control Valve for HVR-1 reactor operating area exhaust BDM-1-4
TW-6-1088	ATR Control Valve for HVS-1 Backup Damper BDM-1-1A
TW-6-1097	ATR Control Valve for HVA-2 Return Damper BDM-1
TW-6-1098	ATR Control Valve for HVA-2 Backup Damper BDM-1A
TW-6-1208	ATR Control Valve for HVA-2 Supply Damper BDM-2
TW-6-1209	ATR Control Valve for HVA-2 Backup Damper BDM-2A
TW-6-1218	ATR Control Vale for HVS-4 Return Damper BDM-4-8
TW-6-1219	ATR Control Valve for HVS-4 Backup Damper BDM-4-8A

Table 6-4. Resolved Control Room Switch Outliers.

Equipment No.	Description
MTBH-1	FIS Bottom head, manual trip switches
MTBH-2	FIS Bottom head, manual trip switches
MTUV-1	FIS Upper vessel, manual trip switches
MTUV-2	FIS Upper vessel, manual trip switches
SW-23-1	Switches, manual actuation of Vessel Vent Valves
SW-23-2	Switches, manual actuation of Vessel Vent Valves
HS-516A	Switches, manual scram subsystem
HS-516B	Switches, manual scram subsystem
HS-516C	Switches, manual scram subsystem

Table 6-5. Other Resolved Outliers.

Equipment No.	Description
670-E-313	Relay panel
670-VV-RLY-B	Panel, Vessel Vent Relay Control Cabinets
670-VV-RLY-C	Panel, Vessel Vent Relay Control Cabinets
Unnumbered 15	Transformer #1, 10KVA isolat'n, for bus 670-IP2
Unnumbered 41	Transformer #2, 10KVA isolat'n, for bus 670-IP1

7.0 RECOMMENDATIONS FOR FURTHER ACTIONS

Outliers that remain unresolved are listed in Table 7-1. This listing also provides recommendations for further actions that may be taken to resolve these remaining outliers. Once these (or similar) actions are implemented, the outliers will be seismically qualified.

Panel P11 and the VVS control panel at the first basement satisfy PC-4 seismic criteria provided their anchorage does not consist of lead. Also, seismic qualification of Panel P11 is dependent on confirmation that the control panel line-up behaves in an integral manner and that the other control panels (e.g., R1, R2, etc.) have adequate anchorage. These conditions should be verified.

Table 7-1. Recommendations for Further Actions to Resolve Remaining Outliers. (15 sheets)

Equipment No	Equipment Description	Outlier Reason	Recommendation
404695-1	Guide tube, safety rod (N, E, SE, S, SW, and W)	No applicable experience data equipment class.	
405815	Flux trap fillers (N, E, SE, S, SW, and W)	No applicable experience data equipment class.	
405904	Hafnium absorber plate assembly, safety rod (N, E, SE, S, SW, and W)	No applicable experience data equipment class.	
417977-2	Latch assembly, safety rod hafnium absorber plate (N, E, SE, S, SW, and W)	No applicable experience data equipment class.	
500/ESF-1	Relays, Primary Pump Shutoff ESF Logic	Capacity does not bound demand.	Perform circuit analysis to determine consequences of relay chatter or replace with a seismically qualified relay.
500/ESF-4	Relays, Primary Pump Shutoff ESF Logic	Capacity does not bound demand.	Perform circuit analysis to determine consequences of relay chatter or replace with a seismically qualified relay.
502/ESF-1	Relays, Pressurizing and Gland Seal Pump Shutoff ESF Logic	Capacity does not bound demand.	Perform circuit analysis to determine consequences of relay chatter or replace with a seismically qualified relay.
502/ESF-1B	Relays, Pressurizing and Gland Seal Pump Shutoff ESF Logic	Capacity does not bound demand.	Perform circuit analysis to determine consequences of relay chatter or replace with a seismically qualified relay.
502/ESF-4	Relays, Pressurizing and Gland Seal Pump Shutoff ESF Logic	Capacity does not bound demand.	Perform circuit analysis to determine consequences of relay chatter or replace with a seismically qualified relay.
502/ESF-4B	Relays, Pressurizing and Gland Seal Pump Shutoff ESF Logic	Capacity does not bound demand.	Perform circuit analysis to determine consequences of relay chatter or replace with a seismically qualified relay.
650-M-3	Oil Cooling Pump	All four anchors show shell being above drilled hole, indicating that anchors have little, if any, pullout capacity.	Upgrade anchorage.

Table 7-1. Recommendations for Further Actions to Resolve Remaining Outliers. (15 sheets)

Equipment No	Equipment Description	Outlier Reason	Recommendation
670-BDM-1	Butterfly damper, supply air from HVA-2	Capacity does not bound demand.	Research experience database for similar dampers at high acceleration sites. Search available test qualification for similar dampers. Qualify by shake table testing.
670-BDM-1-1	Butterfly damper, HVS-1 supply to reactor area	Capacity does not bound demand.	Research experience database for similar dampers at high acceleration sites. Search available test qualification for similar dampers. Qualify by shake table testing.
670-BDM-1-1A	670-BDM-1-1 Backup damper	Capacity does not bound demand.	Research experience database for similar dampers at high acceleration sites. Search available test qualification for similar dampers. Qualify by shake table testing.
670-BDM-1-2	Butterfly damper, HVS-1 supply to basements	Capacity does not bound demand.	Research experience database for similar dampers at high acceleration sites. Search available test qualification for similar dampers. Qualify by shake table testing.
670-BDM-1-2A	670-BDM-1-2 Backup damper	Capacity does not bound demand.	Research experience database for similar dampers at high acceleration sites. Search available test qualification for similar dampers. Qualify by shake table testing.
670-BDM-1-3	Butterfly damper, return air to HVS-1 plenum	Capacity does not bound demand.	Research experience database for similar dampers at high acceleration sites. Search available test qualification for similar dampers. Qualify by shake table testing.
670-BDM-1-3A	670-BDM-1-3 Backup damper	Capacity does not bound demand.	Research experience database for similar dampers at high acceleration sites. Search available test qualification for similar dampers. Qualify by shake table testing.
670-BDM-1A	670-BDM-1 Backup damper	Capacity does not bound demand.	Research experience database for similar dampers at high acceleration sites. Search available test qualification for similar dampers. Qualify by shake table testing.

Table 7-1. Recommendations for Further Actions to Resolve Remaining Outliers. (15 sheets)

Equipment No	Equipment Description	Outlier Reason	Recommendation
670-BDM-2	Butterfly damper, return air to HVA-2	Capacity does not bound demand.	Research experience database for similar dampers at high acceleration sites. Search available test qualification for similar dampers. Qualify by shake table testing.
670-BDM-2A	670-BDM-2 Backup damper	Capacity does not bound demand.	Research experience database for similar dampers at high acceleration sites. Search available test qualification for similar dampers. Qualify by shake table testing.
670-BDM-4-8	Butterfly damper, RDAS room return to HVS-4	Capacity does not bound demand.	Research experience database for similar dampers at high acceleration sites. Search available test qualification for similar dampers. Qualify by shake table testing.
670-BDM-4-8A	670-BDM-4-8 Backup damper	Capacity does not bound demand.	Research experience database for similar dampers at high acceleration sites. Search available test qualification for similar dampers. Qualify by shake table testing.
670-BDM-5-10	Butterfly damper, HVE-9A & B exhaust from battery room	Capacity does not bound demand and fire concern due to insufficient flex in M42/M43 lube oil lines.	Modify M42/M43 lube oil connection lines to allow for greater displacement. Research experience database for similar dampers at high acceleration sites. Search available test qualification for similar dampers. Qualify by shake table testing.
670-BDM-5-10A	670-BDM-5-10 Backup damper	Capacity does not bound demand and fire concern due to insufficient flex in M42/M43 lube oil lines.	Modify M42/M43 lube oil connection lines to allow for greater displacement. Research experience database for similar dampers at high acceleration sites. Search available test qualification for similar dampers. Qualify by shake table testing.
670-BDM-5-8	Butterfly damper, HVS-5 basement air supply	Capacity does not bound demand and fire concern due to insufficient flex in M42/M43 lube oil lines.	Modify M42/M43 lube oil connection lines to allow for greater displacement. Research experience database for similar dampers at high acceleration sites. Search available test qualification for similar dampers. Qualify by shake table testing.

Table 7-1. Recommendations for Further Actions to Resolve Remaining Outliers. (15 sheets)

Equipment No	Equipment Description	Outlier Reason	Recommendation
670-BDM-5-8A	670-BDM-5-8 Backup damper	Capacity does not bound demand and fire concern due to insufficient flex in M42/M43 lube oil lines.	Modify M42/M43 lube oil connection lines to allow for greater displacement. Research experience database for similar dampers at high acceleration sites. Search available test qualification for similar dampers. Qualify by shake table testing.
670-BDM-5-9	Butterfly damper, HVS-5 basement area return	Capacity does not bound demand and fire concern due to insufficient flex in M42/M43 lube oil lines.	Modify M42/M43 lube oil connection lines to allow for greater displacement. Research experience database for similar dampers at high acceleration sites. Search available test qualification for similar dampers. Qualify by shake table testing.
670-BDM-5-9A	670-BDM-5-9 Backup damper	Capacity does not bound demand and fire concern due to insufficient flex in M42/M43 lube oil lines.	Modify M42/M43 lube oil connection lines to allow for greater displacement. Research experience database for similar dampers at high acceleration sites. Search available test qualification for similar dampers. Qualify by shake table testing.
670-E-1	Commercial Bus A	Insufficient anchorage. Few anchors, and only present on selected cubicles.	Upgrade anchorage so that entire switchgear lineup is adequately anchored.
670-E-106	Distribution Panel, RDAS Power (DAN)	Interaction from adjacent unanchored storage cabinet and four inch wall.	Strengthen 4-inch wall per suggestions in ARES Calculation No. 0602301.01-S-007 (Appendix J). Anchor or move storage cabinet.
670-E-117	Distribution panel, instrument UPS	Inadequate anchorage.	Upgrade anchorage in accordance with suggestions in ARES Calculation No. 0602301.01-S-119 (Appendix EE).
670-E-15	Motor Control Center, Diesel Commercial	Inadequate anchorage.	Upgrade anchorage in accordance with suggestions in ARES Calculation No. 0602301.01-S-107 (Appendix S).
670-E-2	Commercial Bus B	Insufficient anchorage. Few anchors, and only present on selected cubicles.	Upgrade anchorage so that entire switchgear lineup is adequately anchored.
670-E-26	Bus, 250 Vdc instrument power control center	Inadequate anchorage.	Upgrade anchorage in accordance with suggestions in ARES Calculation No. 0602301.01-S-107 (Appendix R).

Table 7-1. Recommendations for Further Actions to Resolve Remaining Outliers. (15 sheets)

Equipment No	Equipment Description	Outlier Reason	Recommendation
670-E-28-CR2	Relay, Primary emergency coolant pump hardwired autostart logic	Capacity does not bound demand.	Perform circuit analysis to determine consequences of relay chatter or replace with a seismically qualified relay.
670-E-3	Diesel Bus, 4160 V	Unanchored.	Upgrade anchorage so that entire switchgear lineup is adequately anchored.
670-E-30	Distribution Panel, RDAS Backup (DAC)	Latch is broken and door cannot be positively secured. Interaction from adjacent unanchored cooler and four inch wall.	Strengthen four inch wall per suggestions in ARES Calculation No. 0602301.01-S-007 (Appendix J). Anchor or move storage cabinet.
670-E-4	4160 V to 480 V Transformer Feed to 480 V Commercial Bus A 670-E-5	Inadequate anchorage. Interaction concern from adjacent unanchored 670-E-3.	Upgrade anchorage of both 670-E-4 and adjacent 670-E-3.
670-E-456	Power panel, Utility/Instrument UPS Power panel	Subject to interaction from adjacent panel MTS-670-E-457.	Perform pull test on anchorage for MTS-670-E-457.
670-E-5	Commercial Bus A	Inadequate anchorage.	Upgrade anchorage.
670-E-58	Battery bank, utility UPS	Interaction from adjacent unanchored cabinet. Block wall requires lateral restraint.	Anchor or move adjacent unanchored cabinet. Add lateral restraint to wall in accordance with suggestion in ARES Calculation No. 0602301.01-S-007 (Appendix J).
670-E-59	Battery bank, instrument UPS	Block wall requires lateral restraint.	Add lateral restraint to wall in accordance with suggestion in ARES Calculation No. 0602301.01-S-007 (Appendix J).
670-E-6	4160 V to 480 V Transformer Feed to Commercial Bus B 670-E-7	Inadequate anchorage and interaction potential from adjacent inadequately anchored 670-E-5.	Upgrade anchorage of both 670-E-5 and 670-E-6.
670-E-7	Commercial Bus B	Inadequate anchorage.	Upgrade anchorage.
670-E-8	4160 V to 480 V Transformer Feed to 480 V Diesel Bus 670-E-9	Inadequate anchorage and interaction potential from adjacent inadequately anchored 670-E-3.	Upgrade anchorage of both 670-E-8 and 670-E-3.
670-E-9	Diesel Bus, 480 V	Inadequate anchorage and interaction potential from adjacent inadequately anchored 670-E-3.	Upgrade anchorage of both 670-E-8 and 670-E-3.

Table 7-1. Recommendations for Further Actions to Resolve Remaining Outliers. (15 sheets)

Equipment No	Equipment Description	Outlier Reason	Recommendation
670-IP1	Instrument power channel #1 power distribution panel	Block wall that panel is mounted on is both inadequate in strength and an interaction source.	Strengthen wall (See ARES Calculation No. 0602301.01-S-007 [Appendix J]).
670-IP2	Instrument power channel #2 power distribution panel	Block wall that panel is mounted on is both inadequate in strength and an interaction source.	Strengthen wall (See ARES Calculation No. 0602301.01-S-007 [Appendix J]).
670-M-42 & 670-M-43	Enterprise Diesels	Lube oil connections have insufficient flexibility to accommodate anticipated seismic displacement of diesel generator.	Modify M42/M43 lube oil connection lines to allow for greater displacement.
670-M-459 120557	Rack tube assembly (N, E, SE, S, SW, and W)	No applicable experience data equipment class.	
672-M-2	Oil Cooling Pump	Interaction from adjacent unanchored cabinet.	Anchor or move adjacent unanchored cabinet.
672-MS-4	Deep Well Pump #4 Breaker	Inadequate anchorage.	Upgrade anchorage.
674-E-1	ATR-674 C/D 480V ac Bus	Inadequate anchorage - base rests on diamond plate that covers trench. Interaction from adjacent inadequately anchored electrical components 674-E-2, -E-3, and -E-5.	Provide top anchorage. Upgrade anchorage for adjacent inadequately anchored components.
674-E-2	ATR-674 Transformer	Inadequate anchorage - base rests on diamond plate that covers trench. Interaction from adjacent inadequately anchored electrical components 674-E-1, -E-3, and -E-5.	Upgrade anchorage. Upgrade anchorage for adjacent inadequately anchored components.
674-E-3	ATR-674 C/D 120/208 V Bus	Inadequate anchorage.	Upgrade anchorage.
674-E-5	Emergency Generator Feeder Breaker	Inadequate anchorage. Interaction from adjacent inadequately anchored 674-E-1.	Upgrade anchorage. Upgrade anchorage for adjacent inadequately anchored components.
674-M-8	Radiator Fan for DG M-6	Inadequate anchorage.	Upgrade anchorage in accordance with suggestions in ARES Calculation No. 0602301.01-S-115 (Appendix AA).

Table 7-1. Recommendations for Further Actions to Resolve Remaining Outliers. (15 sheets)

Equipment No	Equipment Description	Outlier Reason	Recommendation
688-M-1 Batteries	Diesel firewater pump start batteries	No spacers between cells and no lateral restraint. Seismic motion could cause brittle plates to fail.	Insert spacers between batteries and install battery restraint similar to that used on batteries 633 fire pump engine.
688-M-2 Batteries	Diesel firewater pump start batteries	No spacers between cells. Seismic motion could cause brittle plates to fail.	Insert spacers between batteries and install battery restraint similar to that used on batteries 633 fire pump engine.
ATR-776	Fuel Oil Transfer Tank	Unable to access, but prior documentation indicates that tank is not anchored.	Install seismically adequate anchorage. Review seismic adequacy of concrete saddles.
ATS 670-E-228	Automatic Transfer Switch, transfer between 670-E-7 and 670-E-9 (670-E-15 Backup power feed)	Inadequate anchorage of connected switchgear 670-E-9.	Upgrade 670-E-9 anchorage.
BDR1	Relays, RMS-1 backup damper actuation	Capacity does not bound demand.	Replace with seismically qualified relay and relocate Panel E.
BDR2	Relays, RMS-1 backup damper actuation	Capacity does not bound demand.	Replace with seismically qualified relay and relocate Panel E.
BDR3	Relays, RMS-1 backup damper actuation	Capacity does not bound demand.	Replace with seismically qualified relay and relocate Panel E.
C31A, B, C bays 1, 2, 3	Comparator cabinets	Unable to verify anchorage adequacy.	Search existing documentation to determine anchorage configuration or upgrade existing configuration through addition of external anchorage.
CK-6-1012	Check valve, instrument air supply	Seismic anchor motion - tubing connected to accumulator tank that is inadequately anchored.	Upgrade anchorage of accumulator.
D-13, D-15, D-51	Doors, gas-tight vertical lift	No applicable experience data equipment class.	
D-13, D-15, D-51,	Seals, gas-tight door	No applicable experience data equipment class.	
D-14, D-18, D-25	Doors, gas-tight personnel	No applicable experience data equipment class.	
D-202, D-314, D-412	Doors, gas-tight personnel	No applicable experience data equipment class.	

Table 7-1. Recommendations for Further Actions to Resolve Remaining Outliers. (15 sheets)

Equipment No	Equipment Description	Outlier Reason	Recommendation
D-30, D-54, D-35	Doors, gas-tight personnel	No applicable experience data equipment class.	
D-39, D-43, D-44	Doors, gas-tight personnel	No applicable experience data equipment class.	
D-442, D-443	Doors, gas-tight personnel	No applicable experience data equipment class.	
D-49, D-50, D-67	Doors, gas-tight personnel	No applicable experience data equipment class.	
D-52, D-441 doors	Doors, gas-tight rolling	No applicable experience data equipment class.	
D-52, D-441 seals	Seals, gas-tight door	No applicable experience data equipment class.	
E11 Spare	Battery banks, 32 Vdc PPS Channels A, B, C, D, spare Combined PPS Battery Banks	Inadequate anchorage.	Verify that existing anchors are not lead. Non-lead anchors are shown to be adequate in ARES Calculation No. 0602301.01-S-102 (Appendix N).
E11B	Battery banks, 32 Vdc PPS Channels A, B, C, D, spare Combined PPS Battery Banks	Interaction from adjacent unanchored cabinet.	Anchor or move adjacent unanchored cabinet.
E11C	Battery banks, 32 Vdc PPS Channels A, B, C, D, spare Combined PPS Battery Banks	Inadequate anchorage.	Verify that existing anchors are not lead. Non-lead anchors are shown to be adequate in ARES Calculation No. 0602301.01-S-102 (Appendix N).
E11D	Battery banks, 32 Vdc PPS Channels A, B, C, D, spare Combined PPS Battery Banks	Inadequate anchorage.	Upgrade anchorage in accordance with suggestions provided in ARES Calculation No. 0602301.01-S-102 (Appendix N).
E13C	Battery Chargers for PPS Channels A, B, C, D battery banks and 32 Vdc distribution panels	Capacity does not bound demand. Fire concern due to insufficient flex in M42/M43 lube oil lines.	Modify M42/M43 lube oil connection lines to allow for greater displacement. Consider consequences of loss of charger as being acceptable.
E13D	Battery Chargers for PPS Channels A, B, C, D battery banks and 32 Vdc distribution panels	Capacity does not bound demand. Fire concern due to insufficient flex in M42/M43 lube oil lines.	Modify M42/M43 lube oil connection lines to allow for greater displacement. Consider consequences of loss of charger as being acceptable.
E14C	Distribution panels, 32 Vdc PPS Channel C	Fire concern due to insufficient flex in M42/M43 lube oil lines.	Modify M42/M43 lube oil connection lines to allow for greater displacement.

Table 7-1. Recommendations for Further Actions to Resolve Remaining Outliers. (15 sheets)

Equipment No	Equipment Description	Outlier Reason	Recommendation
E14D	Distribution panels, 32 Vdc PPS Channel D	Fire concern due to insufficient flex in M42/M43 lube oil lines.	Modify M42/M43 lube oil connection lines to allow for greater displacement.
E15A/D	Switches and enclosures, remote, manual scram subsystem	Block wall that panel is mounted on is both inadequate in strength and an interaction source.	Strengthen wall (See ARES Calculation No. 0602301.01-S-007 [Appendix J]).
E312	Rod Clutch Coil Controller (RCCC) current adjust circuitry cabinet	Interaction potential from adjacent unanchored panel 670-E-80.	Provide positive anchorage for adjacent panel 670-E-80.
GT-6-1000	Block valve, backup nitrogen bottle	Seismic anchor motion - tubing connected to accumulator tank that is inadequately anchored.	Upgrade anchorage of accumulator.
GT-6-1001	Block valve, accumulator drain	Seismic anchor motion - tubing connected to accumulator tank that is inadequately anchored.	Upgrade anchorage of accumulator.
GT-6-1002	Block valve, PS-6-1009 and PS-6-1010	Seismic anchor motion - tubing connected to accumulator tank that is inadequately anchored.	Upgrade anchorage of accumulator.
GT-6-1003	Block valve, PS-6-1009	Seismic anchor motion - tubing connected to accumulator tank that is inadequately anchored.	Upgrade anchorage of accumulator.
GT-6-1004	Block valve, PS-6-1010	Seismic anchor motion - tubing connected to accumulator tank that is inadequately anchored.	Upgrade anchorage of accumulator.
GT-6-1005	Block valve, vent for PS-6-1009	Seismic anchor motion - tubing connected to accumulator tank that is inadequately anchored.	Upgrade anchorage of accumulator.
GT-6-1006	Block valve, vent for PS-6-1010	Seismic anchor motion - tubing connected to accumulator tank that is inadequately anchored.	Upgrade anchorage of accumulator.
GT-6-902	Boundary valves for backup Nitrogen supply to door seals	Unable to locate valve. Field walkdown indicates that line that valve is supposed to be on no longer exists.	Confirm that valve and line are no longer present.

Table 7-1. Recommendations for Further Actions to Resolve Remaining Outliers. (15 sheets)

Equipment No	Equipment Description	Outlier Reason	Recommendation
K1-IN-1	Relays, Bypass	Capacity does not bound demand.	Perform circuit analysis to determine consequences of relay chatter or replace with a seismically qualified relay.
K1-IN-4	Relays, Bypass	Capacity does not bound demand.	Perform circuit analysis to determine consequences of relay chatter or replace with a seismically qualified relay.
K1-OUT-1	Relays, Bypass	Capacity does not bound demand.	Perform circuit analysis to determine consequences of relay chatter or replace with a seismically qualified relay.
K1-OUT-4	Relays, Bypass	Capacity does not bound demand.	Perform circuit analysis to determine consequences of relay chatter or replace with a seismically qualified relay.
K2-IN-1	Relays, Trip	Capacity does not bound demand.	Perform circuit analysis to determine consequences of relay chatter or replace with a seismically qualified relay.
K2-IN-4	Relays, Trip	Capacity does not bound demand.	Perform circuit analysis to determine consequences of relay chatter or replace with a seismically qualified relay.
K2-OUT-1	Relays, Trip	Capacity does not bound demand.	Perform circuit analysis to determine consequences of relay chatter or replace with a seismically qualified relay.
K2-OUT-4	Relays, Trip	Capacity does not bound demand.	Perform circuit analysis to determine consequences of relay chatter or replace with a seismically qualified relay.
L31A, B, C, D bays 1, 2	Logic cabinets	Unable to verify anchorage adequacy.	Search existing documentation to reveal anchorage configuration or upgrade existing configuration through addition of external anchorage.
LS-19-1	Level Switch, ATR Canal Level Control	GERS caveats cannot be met. GERS needed due to high demand.	Replace with seismically qualified level switch or relocate existing switch to a low input area of the plant.
MTS 670-E-457	Manual transfer switch, transfer between feed from Panel 670-E-115 and 670-E-117	Anchorage adequacy in block wall cannot be ascertained.	Perform in-situ pull test on anchorage.

Table 7-1. Recommendations for Further Actions to Resolve Remaining Outliers. (15 sheets)

Equipment No	Equipment Description	Outlier Reason	Recommendation
None 1	Bubbler Tube, ATR Canal Level Control	No applicable experience data equipment class.	
None 16	Tubing to BDM-1-5 and BDM-1-5A downstream of instrument air supply check valve	Seismic anchor motion - tubing connected to accumulator tank that is inadequately anchored.	Upgrade anchorage of accumulator.
None 17	Pillows, Canal Impact Absorbing	No applicable experience data equipment class.	
None 18	Bellows Between Canal and Reactor Vessel	No applicable experience data equipment class.	
None 2	Viewing Window	No applicable experience data equipment class.	
None 20	Fiber Optic Cable, SER	Capacity does not bound demand. Cable tray containing cable sits atop unanchored Sequence of Events Recorder.	Provide positive anchorage for Sequence of Events Recorder. Fiber optic cable is rugged enough to withstand the high seismic demand.
None 4	Sequence of Events Recorder (SER), Units 1 and 2	Unanchored.	Provide positive anchorage.
Panel E	Radiation Monitoring and Seal Control Panel	Unanchored, interaction from adjacent 4-inch wall. Capacity does not bound demand.	Relocate relays to location in plant where seismic demand is lower.
Panel F	Radiation Monitoring and Seal Control Panel	Unanchored, interaction from adjacent 4-inch wall. Capacity does not bound demand.	Relocate relays to location in plant where seismic demand is lower.
Pri Pumps RLY-A (670-E-1)	Relays, Primary emergency coolant pump hardwired autostart logic	Capacity does not bound demand.	Perform circuit analysis to determine consequences of relay chatter or replace with a seismically qualified relay.
Pri Pumps RLY-A (670-E-2)	Relays, Primary emergency coolant pump hardwired autostart logic	Capacity does not bound demand.	Perform circuit analysis to determine consequences of relay chatter or replace with a seismically qualified relay.
R1A		Capacity does not bound demand.	Replace with seismically qualified relay and relocate Panel F.
R1B		Capacity does not bound demand.	Replace with seismically qualified relay and relocate Panel F.

Table 7-1. Recommendations for Further Actions to Resolve Remaining Outliers. (15 sheets)

Equipment No	Equipment Description	Outlier Reason	Recommendation
R1C		Capacity does not bound demand.	Replace with seismically qualified relay and relocate Panel F.
R1A-A	Relays, RMS damper actuation	Capacity does not bound demand.	Replace with seismically qualified relay and relocate Panel E.
R1A-B	Relays, RMS damper actuation	Capacity does not bound demand.	Replace with seismically qualified relay and relocate Panel E.
R1A-C	Relays, RMS damper actuation	Capacity does not bound demand.	Replace with seismically qualified relay and relocate Panel E.
RAm-511A, B, C	Gamma level drawer with integral HVPS, fission break subsystem	Panels A and B; capacity for anchors in block walls in unknown. Panel C is missing the two bottom side anchors. Calculation showing adequate anchorage assumes missing anchors are installed and that capacity in block walls is equivalent to 3/8-inch anchors.	Install missing anchors and test anchors in block walls to ensure that capacity meets assumptions in ARES Calculation No. 0602302.01-S-103 (Appendix O).
RCR Panel R1	Control Room Panel R1	Capacity does not bound demand. Anchorage adequacy indeterminate.	Consider need for annunciator to be Seismic Category I
RCR Panel R4	Control Room Panel R4	Capacity does not bound demand. Anchorage adequacy indeterminate.	Consider need for annunciator to be Seismic Category I
RCR Panel R6	Control Room Panel R6	Capacity does not bound demand. Anchorage adequacy indeterminate.	Consider need for annunciator to be Seismic Category I
RCR Panel R8	Control Room Panel R8	Capacity does not bound demand. Anchorage adequacy indeterminate.	Consider need for annunciator to be Seismic Category I
RCR Panel R9	Control Room Panel R9	Capacity does not bound demand. Anchorage adequacy indeterminate.	Consider need for annunciator to be Seismic Category I
RE-510A-1, A-2, B-1, B-2, C-1, C-2, D (installed spare)	Ion chambers, neutron level subsystem	No applicable experience data equipment class.	
RE-511A, B, C	Gamma Ionization Chambers, fission break subsystem	No applicable experience data equipment class.	

Table 7-1. Recommendations for Further Actions to Resolve Remaining Outliers. (15 sheets)

Equipment No	Equipment Description	Outlier Reason	Recommendation
RE-512A, B, C, D (installed spared)	Detector assembly, wide range neutron subsystem	No applicable experience data equipment class.	
RE-530A/B/C	Gamma ionization chambers, ATR vent stack	No applicable experience data equipment class.	
RX-511A, B, C	Check source, shield assembly, power supply, fission break subsystem	No applicable experience data equipment class.	
Storage Locations 1,2	Transfer Station	No applicable experience data equipment class.	
TMR-IN-1	Relays, Time Delay	Capacity does not bound demand.	Perform circuit analysis to determine consequences of relay chatter or replace with a seismically qualified relay.
TMR-IN-4	Relays, Time Delay	Capacity does not bound demand.	Perform circuit analysis to determine consequences of relay chatter or replace with a seismically qualified relay.
TMR-OUT-1	Relays, Time Delay	Capacity does not bound demand.	Perform circuit analysis to determine consequences of relay chatter or replace with a seismically qualified relay.
TMR-OUT-4	Relays, Time Delay	Capacity does not bound demand.	Perform circuit analysis to determine consequences of relay chatter or replace with a seismically qualified relay.
TW-6-1029	ATR Control Valve for HVS-5 Supply Damper BDM-5-8	Capacity does not bound demand. Fire concern due to insufficient flex in M42/M43 lube oil lines.	Modify M42/M43 lube oil connection lines to allow for greater displacement.
TW-6-1030	ATR Control Valve for HVS-5 Backup Damper BDM-5-8A	Capacity does not bound demand. Fire concern due to insufficient flex in M42/M43 lube oil lines.	Modify M42/M43 lube oil connection lines to allow for greater displacement.
TW-6-1039	ATR Control Valve for HVS-5 Return Damper BDM-5-9	Capacity does not bound demand. Fire concern due to insufficient flex in M42/M43 lube oil lines.	Modify M42/M43 lube oil connection lines to allow for greater displacement.

Table 7-1. Recommendations for Further Actions to Resolve Remaining Outliers. (15 sheets)

Equipment No	Equipment Description	Outlier Reason	Recommendation
TW-6-1040	ATR Control Valve for HVS-5 Backup Damper BDM-5-9A	Capacity does not bound demand. Fire concern due to insufficient flex in M42/M43 lube oil lines.	Modify M42/M43 lube oil connection lines to allow for greater displacement.
TW-6-1049	ATR Control Valve for HVE-9 Exhaust Damper BDM-5-10	Capacity does not bound demand. Fire concern due to insufficient flex in M42/M43 lube oil lines.	Modify M42/M43 lube oil connection lines to allow for greater displacement.
TW-6-1050	ATR Control Valve for HVE-9 Backup Damper BDM-5-10A	Capacity does not bound demand. Fire concern due to insufficient flex in M42/M43 lube oil lines.	Modify M42/M43 lube oil connection lines to allow for greater displacement.
Unnumbered 11	Siphon breaker line assembly	No applicable experience data equipment class.	
Unnumbered 18	Exterior walls, sandwich panel	No applicable experience data equipment class.	
Unnumbered 19	Gas-tight equipment floor hatches	No applicable experience data equipment class.	
Unnumbered 24	Drain valve cover plates (Irradiated Fuel Storage Area)	No applicable experience data equipment class.	
Unnumbered 27	Snubber tubes	No applicable experience data equipment class.	
Unnumbered 29	Canal low-level alarm system	GERS caveats cannot be met. GERS needed due to high demand.	Replace with a seismically qualified switch or relocate switch to a low input area of the plant.
Unnumbered 3	Fuel elements	No applicable experience data equipment class.	
Unnumbered 45	Reactor console	Inadequate anchorage.	Insert missing anchor.
Unnumbered 46	Steel liners, canals (working and storage - not ATRC)	No applicable experience data equipment class.	
Unnumbered 47	Tubing to door seals, downstream of CK-6-969	No applicable experience data equipment class.	
Unnumbered 52	Concrete block, fire and isolation walls	No applicable experience data equipment class.	

Table 7-1. Recommendations for Further Actions to Resolve Remaining Outliers. (15 sheets)

Equipment No	Equipment Description	Outlier Reason	Recommendation
Unnumbered 55	Canal bulkheads, Standard and Short	No applicable experience data equipment class.	
Unnumbered 59	Concrete equipment foundations	No applicable experience data equipment class.	
Unnumbered 60	Windows, gas-tight	No applicable experience data equipment class.	
Unnumbered 61	Backup Nitrogen bottles for dampers 670-BDM-1-5 and 670-BDM-1-5A	Inadequate restraint.	Add a second chain to restrain bottles.
Unnumbered 64	Concrete, lower perimeter wall	No applicable experience data equipment class.	
Unnumbered 7	Roofing panels	No applicable experience data equipment class.	
Unnumbered 8	Support and liner, reactor vessel	No applicable experience data equipment class.	
Unnumbered 9	Steel liners, misc. gas-tight walls	No applicable experience data equipment class.	
-	Cable Tray Support 2B-C-3 (see Section 5.5)	Inadequate support anchorage	Brace cable tray support to adjacent concrete block wall.
-	Conduit to AC emergency pump motor	Conduit passes through seismically inadequate block wall.	Strengthen Wall 1B-F5-1 (See ARES Calculation No. 0602301.01-S-007 [Appendix J]).

The concrete block enclosures of TRA-650 and TRA-672 still require seismic evaluation. The Seismic Category I equipment located in these structures that are listed in Table 7-2 will be seismically qualified once the enclosures are demonstrated to be seismically qualified.

Table 7-2. Seismic Category I Equipment in TRA-650 and TRA-672.

Equipment No.	Equipment Description
650-E-1	M-3 Controller
650-E-2	M-4 Controller
650-LP-3	Lighting Panel
650-M-1	Deep Well Pump #3 and Motor
672-E-3	Lighting Panel LP-17
672-E-4	M-2 Controller
672-E-5	M-3 Controller
672-M-1	Deep Well Pump #4 and Motor
R-11	Deep Well Pump #3 Discharge Valve
R-12-CK	Deep Well Pump #3 Discharge Check Valve
R-13	Deep Well Pump #3 Siphon Isolation Valve
R-16	Deep Well Pump #4 Discharge Valve
R-17-CK	Deep Well Pump #4 Discharge Check Valve
R-18	Deep Well Pump #4 Siphon Isolation Check Valve

Equipment that still requires anchor bolt inspection to verify embedment length and tightness is listed in Table 7-3. The anchorage evaluations should be updated if any deficiencies are identified.

Table 7-3. Equipment Requiring Anchor Bolt Inspection.

Equipment No.	Equipment Description
670-E-58	Battery bank, utility UPS
670-E-59	Battery bank, instrument UPS
E11A	Battery banks, 32 Vdc PPS Channels A, B, C, D, spare Combined PPS Battery Banks
VVS Control Panel - 1B	VVS Control Panel - Main Floor 1B
674-M-10	Diesel Gen Starting Air Tank
670-E-117	Distribution panel, instrument UPS
674-E-5	Emergency Generator Feeder Breaker
674-M-20	Lube Oil Reservoir
688-M-7	688-M-1 Diesel Fuel Tank
688-M-8	688-M-2 Diesel Fuel Tank
E11 Spare	Battery banks, 32 Vdc PPS Channels A, B, C, D, spare Combined PPS Battery Banks
E11B	Battery banks, 32 Vdc PPS Channels A, B, C, D, spare Combined PPS Battery Banks
E11C	Battery banks, 32 Vdc PPS Channels A, B, C, D, spare Combined PPS Battery Banks
E11D	Battery banks, 32 Vdc PPS Channels A, B, C, D, spare Combined PPS Battery Banks
FIS-1-23 and FIS-1-24	Flow indicator switch, Primary emergency coolant pump hardwired autostart logic
LT-10-133	Level Transmitter, ATR Canal Emergency Firewater Makeup
PS-1-110	Pressure Switch Upper EFIS Supply

8.0 CONCLUSIONS AND RECOMMENDATIONS

Seismic qualification of ATR Seismic Category I equipment has been performed using the experience-based procedures of DOE/EH-0545. All ATR safety-related equipment were addressed, except for non-buried piping, equipment which is obviously not amenable to experience-based seismic qualification, and equipment with current seismic qualification documentation. Based on the reviews and evaluations summarized in Sections 5.1 to 5.6, most of the Seismic Category I equipment items included in the scope of work were determined to be seismically qualified for PC-4 seismic criteria following DOE/EH-0545 procedures.

Equipment components not satisfying the DOE/EH-0545 screening procedures were designated outliers. Many of the outliers were seismically qualified for PC-4 seismic criteria by implementing other methods besides the experience-based procedures of DOE/EH-0545, including further review of earthquake experience data beyond that implicit in DOE/EH-0545, additional seismic analysis, and engineering judgment.

Outliers that remain unresolved are listed in Table 7-1 above. This listing also provides recommendations for further actions that may be taken to resolve these remaining outliers. Once these (or similar) actions are implemented, the outliers will be seismically qualified.

Equipment that still requires anchor bolt inspection to verify embedment length and tightness is listed in Table 7-2. The anchorage evaluations should be updated if any deficiencies are identified.

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APPENDIX A

SEISMIC CATEGORY I EQUIPMENT INCLUDED IN THE SCOPE OF WORK

Equipment ID	Individual Component ID	Description	PC-4 Criteria Not Satisfied	Subcomponent	Parent Component	Basis for Outlier
Emergency Firewater Injection System						
ABu-534A, 534B, 534C	ABu-534A	Buffer unit, FIS pressure	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
	ABu-534B		X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
	ABu-534C		X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
ABu-535A, 535B, 535C	ABu-535A	Buffer unit, FIS level	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
	ABu-535B		X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
	ABu-535C		X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
ACu-534A-LL, 534B-LL, 534C-LL	ACu-534A-LL	Analog comparator unit, FIS pressure	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
	ACu-534B-LL		X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
	ACu-534C-LL		X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
ACu-535A-LL, 535B-LL, 535C-LL bottom	ACu-535A-LL bottom	Analog comparator unit, FIS Bottom Head Actuation	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
	ACu-535B-LL bottom		X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
	ACu-535C-LL bottom		X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
ACu-535A-LL, 535B-LL, 535C-LL upper	ACu-535A-LL upper	Analog comparator unit, FIS Upper Vessel Actuation	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
	ACu-535B-LL upper		X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
	ACu-535C-LL upper		X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
C-12 thru C-16	A-12 thru A-16	Instrument valves for FIS pressure channels A, B, and C. Valves C-15 and C-16 shared with level channels.		X	None 15A	
	B-12 thru B-16			X	None 15B	
	C-12 thru C-16			X	None 15C	
CK-1-617, -618	CK-1-617	Check valves, upper reactor vessel EFIS injection lines				
	CK-1-618					
CK-1-77 thru -80	CK-1-77	Check valves, firewater lines to Rx bottom head				
	CK-1-78					
	CK-1-79					
	CK-1-80					
CK-C-1-50		Check valve in line from primary gland seal pumps				

Equipment ID	Individual Component ID	Description	PC 4 Criteria Not Satisfied	Subcomponent	Parent Component	Basis for Outlier
C-VENT, C-1 thru C-11, C-15, C-16	A-VENT, A-1 thru A-11, A-15, A-16	Instrument valves for FIS level channels A, B, and C. Valves C-15 and C-16 shared with pressure channels.		X	None 15A	
	B-VENT, B-1 thru B-11, B-15, B-16			X	None 15B	
	C-VENT, C-1 thru C-11, C-15, C-16			X	None 15C	
FBHA, FBHB, FBHC, FBHD	FBHA	FIS Relay Logic Panel, Bottom Head Actuation		X	SW-1A	
	FBHB			X	SW-1B	
	FBHC			X	SW-1C	
	FBHD			X	SW-1D	
FISBHMTS		FIS Bottom head, manual trip sensor unit		X	P11	
FISUVMTS		FIS Upper vessel, manual trip sensor unit		X	P11	
FUVA, FUVB, FUVC, FUVD	FUVA	FIS Relay Logic Panel, Upper Vessel Actuation		X	Panel FIS Bottom Head A	
	FUVB			X	Panel FIS Bottom Head B	
	FUVC			X	Panel FIS Bottom Head C	
	FUVD			X	Panel FIS Bottom Head D	
GB-P-1-49		Globe valve in line from primary gland seal pumps				
GT-1-150 thru -153	GT-1-150	Block valves, firewater lines to Rx bottom head				
	GT-1-151					
	GT-1-152					
	GT-1-153					
GT-1-619, -620	GT-1-619	Isolation valves, upper vessel firewater injection lines				
	GT-1-620					
GT-1-622, GT-1-628	GT-1-622	Upper Vessel EFIS LDW Discharge Block	X			Capacity does not bound demand.
	GT-1-628		X			Capacity does not bound demand.
GT-1-630, GT-1-631, GT-1-634, GT-1-639, GT-L-1-98, GB-1-874	GB-1-874	Bottom Head EFIS Boundary valves				
	GT-1-630					
	GT-1-631					
	GT-1-634					
	GT-1-639					
	GT-L-1-98					
GT-F-1-242		Boundary gate valve				

Equipment ID	Individual Component ID	Description	PC-4 Criteria Not Satisfied	Subcomponent	Parent Component	Basis for outlier
GT-F-1-97		Gate valve from demineralized water supply				
LCV-1-615, -616	LCV-1-615	Control valves, upper reactor vessel firewater injection				
	LCV-1-616					
LCV-1-7A, -7B	LCV-1-7A	Control valves, firewater injection to Rx bottom head				
	LCV-1-7B					
Lm-535-1-LL, 535-2-LL, 535-3-LL, 535-4-LL upper	Lm-535-1-LL upper	2/3 Logic Module, FIS upper vessel actuation	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
	Lm-535-2-LL upper		X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
	Lm-535-3-LL upper		X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
	Lm-535-4-LL upper		X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
Lm-535-1-LL, 535-2-LL,535-3LL, 535-4-LL bottom	Lm-535-1-LL bottom	2/3 Logic Module, FIS bottom head actuation	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
	Lm-535-2-LL bottom		X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
	Lm-535-3-LL bottom		X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
	Lm-535-4-LL bottom		X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
LT-535A, 535B, 535C		Level Transmitter, FIS Upper Vessel and Bottom Head		X	None 15A	
LT-535A, 535B, 535C		Level Transmitter, FIS Upper Vessel and Bottom Head		X	None 15B	
LT-535A, 535B, 535C		Level Transmitter, FIS Upper Vessel and Bottom Head		X	None 15C	
MTBH-1, MTBH-2	MTBH-1	FIS Bottom head, manual trip switches		X	P11	
	MTBH-2			X	P11	
MTUV-1, MTUV-2	MTUV-1	FIS Upper vessel, manual trip switches		X	P11	
	MTUV-2			X	P11	
Panel FIS Bottom Head A		Panel FIS Bottom Head A				
Panel FIS Bottom Head B		Panel FIS Bottom Head B				
Panel FIS Bottom Head C		Panel FIS Bottom Head C				
Panel FIS Bottom Head D		Panel FIS Bottom Head D				
None	None 15A	FIS Transmitter Cabinet A				
None	None 15B	FIS Transmitter Cabinet B				
None	None 15C	FIS Transmitter Cabinet C				

Equipment ID	Individual Component ID	Description	PC 4 Criteria Not Satisfied	Subcomponent	Parent Component	Basis for Outlier
PLm-534-1-LL, 534-2-LL, 534-3-LL, 534-4-LL	PLm-534-1-LL	2/3 Logic Module, FIS pressure actuation	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
	PLm-534-2-LL		X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
	PLm-534-3-LL		X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
	PLm-534-4-LL		X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
PT-10-6 (EFIS)		Pressure Indication Lower EFIS Supply				
PT-534A, 534B, 534C	PT-534A	Pressure Transmitter, FIS pressure		X	None 15A	
	PT-534B			X	None 15B	
	PT-534C			X	None 15C	
SV-1-624, -625	SV-1-624	Pilot Valves, air control to LCV-1-7A, -7B		X	LCV-1-7A	
	SV-1-625			X	LCV-1-7B	
SV-1-626, -627	SV-1-626	Pilot valves, air control for LCV-1-615, -616				
	SV-1-627					
SW-1A, SW-1B, SW-1C, SW-1D	SW-1A	FIS Pressure Bypass Switches				
	SW-1B					
	SW-1C					
	SW-1D					
PCS Overpressure Relief System						
SF-A-1-71, -72		Safety relief valves, lower reactor vessel drain line				
Radiation Monitoring and Seal System						
670-E-313		Relay panel	X			Capacity does not bound demand.
Panel E		Radiation Monitoring and Seal Control Panel	X			Unanchored, interaction from adjacent 4-inch wall. Capacity does not bound demand. Contains low capacity relay.
Panel F		Radiation Monitoring and Seal Control Panel	X			Unanchored, interaction from adjacent 4-inch wall. Capacity does not bound demand. Contains low capacity relay.
670-BDM-1		Butterfly damper, supply air from HVA-2	X			Capacity does not bound demand.
670-BDM-1-1		Butterfly damper, HVS-1 supply to reactor area	X			Capacity does not bound demand.
670-BDM-1-1A		670-BDM-1-1 Backup damper	X			Capacity does not bound demand.

Equipment ID	Individual Component ID	Description	PC 4 Criteria Not Satisfied	Subcomponent	Parent Component	Basis for Outlier
670-BDM-1-2		Butterfly damper, HVS-1 supply to basements	X			Capacity does not bound demand.
670-BDM-1-2A		670-BDM-1-2 Backup damper	X			Capacity does not bound demand.
670-BDM-1-3		Butterfly damper, return air to HVS-1 plenum	X			Capacity does not bound demand.
670-BDM-1-3A		670-BDM-1-3 Backup damper	X			Capacity does not bound demand.
670-BDM-1-5		Butterfly damper, HVE-17A, -17B discharge to stack				
670-BDM-1-5A		670-BDM-1-5 Backup damper				
670-BDM-1A		670-BDM-1 Backup damper	X			Capacity does not bound demand.
670-BDM-2		Butterfly damper, return air to HVA-2	X			Capacity does not bound demand.
670-BDM-2A		670-BDM-2 Backup damper	X			Capacity does not bound demand.
670-BDM-4-8		Butterfly damper, RDAS room return to HVS-4	X			Capacity does not bound demand.
670-BDM-4-8A		670-BDM-4-8 Backup damper	X			Capacity does not bound demand.
670-BDM-5-10		Butterfly damper, HVE-9A & B exhaust from battery room	X			Capacity does not bound demand and fire concern due to insufficient flex in M42/M43 lube oil lines.
670-BDM-5-10A		670-BDM-5-10 Backup damper	X			Capacity does not bound demand and fire concern due to insufficient flex in M42/M43 lube oil lines.
670-BDM-5-8		Butterfly damper, HVS-5 basement air supply	X			Capacity does not bound demand and fire concern due to insufficient flex in M42/M43 lube oil lines.
670-BDM-5-8A		670-BDM-5-8 Backup damper	X			Capacity does not bound demand and fire concern due to insufficient flex in M42/M43 lube oil lines.
670-BDM-5-9		Butterfly damper, HVS-5 basement area return	X			Capacity does not bound demand and fire concern due to insufficient flex in M42/M43 lube oil lines.

Equipment ID	Individual Component ID	Description	PC 4 Criteria Not Satisfied	Subcomponent	Parent Component	Basis for Outlier
670-BDM-5-9A		670-BDM-5-9 Backup damper	X			Capacity does not bound demand and fire concern due to insufficient flex in M42/M43 lube oil lines.
BDR1, BDR2, BDR3, BDR4	BDR1	Relays, RMS-1 backup damper actuation	X	X	Panel E	Capacity does not bound demand.
	BDR2		X	X	Panel E	Capacity does not bound demand.
	BDR3		X	X	Panel E	Capacity does not bound demand.
	BDR4			X	670-E-313	
BF-29-1		Argon Delay Line Supply				
BF-29-12		Argon Delay Line Condensate Return				
BF-29-2		Argon Delay Line Supply				
BF-29-5		Argon Delay Line Return				
BF-29-6		Argon Delay Line Return				
CK-6-1012		Check valve, instrument air supply	X			Seismic anchor motion - tubing connected to accumulator tank that is inadequately anchored.
CSSA		Switch, manual containment isolation	X	X	RCR Panel R9	Reference Parent Component
GT-6-1000		Block valve, backup nitrogen bottle	X			Seismic anchor motion - tubing connected to accumulator tank that is inadequately anchored.
GT-6-1001		Block valve, accumulator drain	X			Seismic anchor motion - tubing connected to accumulator tank that is inadequately anchored.
GT-6-1002		Block valve, PS-6-1009 and PS-6-1010	X			Seismic anchor motion - tubing connected to accumulator tank that is inadequately anchored.
GT-6-1003		Block valve, PS-6-1009	X			Seismic anchor motion - tubing connected to accumulator tank that is inadequately anchored.
GT-6-1004		Block valve, PS-6-1010	X			Seismic anchor motion - tubing connected to accumulator tank that is inadequately anchored.
GT-6-1005		Block valve, vent for PS-6-1009	X			Seismic anchor motion - tubing connected to accumulator tank that is inadequately anchored.

Equipment ID	Individual Component ID	Description	PC 4 Criteria Not Satisfied	Subcom-ponent	Parent Component	Basis for Outlier
GT-6-1006		Block valve, vent for PS-6-1010	X			Seismic anchor motion - tubing connected to accumulator tank that is inadequately anchored.
LM530-1, LM530-2, LM530-3, LM530-4		2/3 logic modules, vent stack high gamma	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
None	None 16	Tubing to BDM-1-5 and BDM-1-5A downstream of instrument air supply check valve	X			Seismic anchor motion - tubing connected to accumulator tank that is inadequately anchored.
PRV-6-1011		Pressure regulating valve for backup nitrogen bottle				
PS-6-1009		Pressure switch				
PS-6-1010		Pressure switch				
R1-A, R1-B, R1-C, R1A-A, R1A-B, R1A-C	R1-A, R1-B, R1-C	Relays, RMS damper actuation	X	X	Panel F	Reference Parent Component
	R1A-A, R1A-B, R1A-C		X	X	Panel E	Reference Parent Component
R1AX2B, R1AX1B, R1A1B, R1A2B, R1AX2, R1AX1, R1A1, R1A2	R1A2B, R1AX2, R1AX1, R1A1, R1A2	Relays, RMS-1 shutdown signals from logic modules		X	Panel F	
	R1AX2B, R1AX1B, R1A1B, R1A2B			X	Panel E	
RABU-530A/B/C		Buffer units, vent stack gamma level	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
RACU-530-A/B/C		Analog comparator units, vent stack gamma level	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
RAM-530A/B/C		Amplifier, RMS System	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
RE-530A/B/C		Gamma ionization chambers, ATR vent stack	X			No applicable experience data equipment class.
SV-6-1007		4-way solenoid valve for BDM-1-5				
SV-6-1008		4-way solenoid valve for BDM-1-5A				
TW-6-1029		ATR Control Valve for HVS-5 Supply Damper BDM-5-8	X			Capacity does not bound demand. Fire concern due to insufficient flex in M42/M43 lube oil lines.
TW-6-1030		ATR Control Valve for HVS-5 Backup Damper BDM-5-8A	X			Capacity does not bound demand. Fire concern due to insufficient flex in M42/M43 lube oil lines.

Equipment ID	Individual Component ID	Description	EC 4 Criteria Not Satisfied	Subcomponent	Parent Component	Basis for outlier
TW-6-1039		ATR Control Valve for HVS-5 Return Damper BDM-5-9	X			Capacity does not bound demand. Fire concern due to insufficient flex in M42/M43 lube oil lines.
TW-6-1040		ATR Control Valve for HVS-5 Backup Damper BDM-5-9A	X			Capacity does not bound demand. Fire concern due to insufficient flex in M42/M43 lube oil lines.
TW-6-1049		ATR Control Valve for HVE-9 Exhaust Damper BDM-5-10	X			Capacity does not bound demand. Fire concern due to insufficient flex in M42/M43 lube oil lines.
TW-6-1050		ATR Control Valve for HVE-9 Backup Damper BDM-5-10A	X			Capacity does not bound demand. Fire concern due to insufficient flex in M42/M43 lube oil lines.
TW-6-1058		ATR Control Valve for HVS-1 Supply Damper BDM-1-1	X			Capacity does not bound demand.
TW-6-1067		ATR Control Valve for HVS-1 Supply Damper BDM-1-2	X			Capacity does not bound demand.
TW-6-1068		ATR Control Valve for HVS-1 Backup Damper BDM-1-2A	X			Capacity does not bound demand.
TW-6-1077		ATR Control Valve for HVS-1 Return Damper BDM-1-3	X			Capacity does not bound demand.
TW-6-1078		ATR Control Valve for HVS-1 Backup Damper BDM-1-3A	X			Capacity does not bound demand.
TW-6-1087		ATR Control Valve for HVR-1 reactor operating area exhaust BDM-1-4	X			Capacity does not bound demand.
TW-6-1088		ATR Control Valve for HVS-1 Backup Damper BDM-1-1A	X			Capacity does not bound demand.
TW-6-1097		ATR Control Valve for HVA-2 Return Damper BDM-1	X			Capacity does not bound demand.
TW-6-1098		ATR Control Valve for HVA-2 Backup Damper BDM-1A	X			Capacity does not bound demand.
TW-6-1208		ATR Control Valve for HVA-2 Supply Damper BDM-2	X			Capacity does not bound demand.
TW-6-1209		ATR Control Valve for HVA-2 Backup Damper BDM-2A	X			Capacity does not bound demand.
TW-6-1218		ATR Control Vale for HVS-4 Return Damper BDM-4-8	X			Capacity does not bound demand.

Equipment ID	Individual Component ID	Description	PC 4 Criteria Not Satisfied	Subcomponent	Parent Component	Basis for Outlier
TW-6-1219		ATR Control Valve for HVS-4 Backup Damper BDM-4-8A	X			Capacity does not bound demand.
Unnumbered	Unnumbered 39	High voltage power supply, RMS System				
Unnumbered	Unnumbered 61	Backup Nitrogen bottles for dampers 670-BDM-1-5 and 670-BDM-1-5A	X			Inadequate restraint.
Unnumbered	Unnumbered 62	Preamplifier, RMS System				
Vessel Vent System						
670-VV-RLY-B, 670-VV-RLY-C	670-VV-RLY-B	Panel, Vessel Vent Relay Control Cabinets	X			Capacity does not bound demand.
	670-VV-RLY-C		X			Capacity does not bound demand.
BK-23- 31, 32, 35, 36	BK-23- 31	Boundary block valves		X	VVS Control Panel - Main Floor	
	BK-23- 32			X	VVS Control Panel - 1B	
	BK-23- 35			X	VVS Control Panel - Main Floor	
	BK-23- 36			X	VVS Control Panel - 1B	
BK-23-17, 18	BK-23-17	Isolation valves, gas to PRV-23-14		X	VVS Control Panel - 1B	
	BK-23-18			X	VVS Control Panel - 1B	
BK-23-7, 8	BK-23-7	Isolation valves, gas to PRV-23-4		X	VVS Control Panel - Main Floor	
	BK-23-8			X	VVS Control Panel - Main Floor	
CK-23-15, 16	CK-23-15	Check valves air/gas to SV-23-11		X	VVS Control Panel - 1B	
	CK-23-16			X	VVS Control Panel - 1B	
CK-23-5, 6	CK-23-5	Check valves, air/gas to SV-23-10				
	CK-23-6					
CPS-2-2B and CPS-2-2C	CPS-2-2B	32 to 24 Vdc Regulator	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
	CPS-2-2C		X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
F-23-21, -22	F-23-21	Filter, air to GB-23-1, -2			VVS Control Panel - 1B	
	F-23-22			X	VVS Control Panel - 1B	
GB-23-1, -2	GB-23-1	Control valves, vessel vent system				
	GB-23-2					
VVS Control Panel - 1B		VVS Control Panel - Main Floor 1B				

Equipment ID	Individual Component ID	Description	PC-4 Criteria Not Satisfied	Subcomponent	Parent Component	Basis for Outlier
VVS Control Panel - Main Floor		VVS Control Panel - Main Floor 1F				
ND-23-23, -24	ND-23-23	Valve, adjustment of air flow to GB-23-1, -2			VVS Control Panel - 1B	
	ND-23-24			X	VVS Control Panel - 1B	
PRV-23-14		Pressure regulator, gas to SV-23-11		X	VVS Control Panel - 1B	
PRV-23-4		Pressure regulator, gas to SV-23-10		X	VVS Control Panel - Main Floor	
SF-23-19		Safety Relief Valve to PRV-23-14		X	VVS Control Panel - 1B	
SF-23-9		Safety Relief Valve to PRV-23-4		X	VVS Control Panel - Main Floor	
SV-23-10, -11	SV-23-10	Pilot valves, air control to GB-23-1, -2		X	VVS Control Panel - Main Floor	
	SV-23-11			X	VVS Control Panel - Main Floor	
SW-23-1, 2, 11, 12	SW-23-1	Switches, manual actuation of Vessel Vent Valves		X	P11	
	SW-23-11					
	SW-23-12					
	SW-23-2			X	P11	
Unnumbered	Backup N2 bottles for VVS valves - Floor 1F	Backup Nitrogen bottles for Vessel Vent Valves - Floor 1F				
VV-R1B, -R2B, -R1C, -R2C	VV-R1B	Relays, Indication of manual actuation of vessel vent valves		X	670-VV-RLY-B	
	VV-R1C			X	670-VV-RLY-B	
	VV-R2B			X	670-VV-RLY-C	
	VV-R2C			X	670-VV-RLY-C	
LOCA Primary Coolant Pump Shutoff System						
K1-IN-1, K1-IN-4, K1-OUT-1, K1-OUT-4	K1-IN-1	Relays, Bypass	X	X	TMR-LOCA-ESF-1	Capacity does not bound demand.
	K1-IN-4		X	X	TMR-LOCA-ESF-4	Capacity does not bound demand.
	K1-OUT-1		X	X	TMR-LOCA-ESF-1	Capacity does not bound demand.
	K1-OUT-4		X	X	TMR-LOCA-ESF-4	Capacity does not bound demand.
K2-IN-1, K2-IN-4, K2-OUT-1, K2-OUT-4	K2-IN-1	Relays, Trip	X	X	TMR-LOCA-ESF-1	Capacity does not bound demand.

Equipment ID	Individual Component ID	Description	PC/4 Criteria Not Satisfied	Subcomponent	Parent Component	Basis for Outlier
	K2-IN-4		X	X	TMR-LOCA-ESF-4	Capacity does not bound demand.
	K2-OUT-1		X	X	TMR-LOCA-ESF-1	Capacity does not bound demand.
	K2-OUT-4		X	X	TMR-LOCA-ESF-4	Capacity does not bound demand.
KM6-IN1-1, KM6-IN1-2, KM6-IN4-1, KM6-IN4-2, KM6-OUT1-1, KM6-OUT1-2, KM6-OUT4-1, KM6-OUT4-2	KM6-IN1-1	Relays, Pump Shutoff 2:4 relay logic circuits for Primary Pump 670-M-6		X	RLY-LOCA-ESF-M6	
	KM6-IN1-2			X	RLY-LOCA-ESF-M6	
	KM6-IN4-1			X	RLY-LOCA-ESF-M6	
	KM6-IN4-2			X	RLY-LOCA-ESF-M6	
	KM6-OUT1-1			X	RLY-LOCA-ESF-M6	
	KM6-OUT1-2			X	RLY-LOCA-ESF-M6	
	KM6-OUT4-1			X	RLY-LOCA-ESF-M6	
	KM6-OUT4-2			X	RLY-LOCA-ESF-M6	
KM7-IN1-1, KM7-IN1-2, KM7-IN4-1, KM7-IN4-2, KM7-OUT1-1, KM7-OUT1-2, KM7-OUT4-1, KM7-OUT4-2	KM7-IN1-1	Relays, Pump Shutoff 2:4 relay logic circuits for Primary Pump 670-M-7		X	RLY-LOCA-ESF-M7	
	KM7-IN1-2			X	RLY-LOCA-ESF-M7	
	KM7-IN4-1			X	RLY-LOCA-ESF-M7	
	KM7-IN4-2			X	RLY-LOCA-ESF-M7	
	KM7-OUT1-1			X	RLY-LOCA-ESF-M7	
	KM7-OUT1-2			X	RLY-LOCA-ESF-M7	
	KM7-OUT4-1			X	RLY-LOCA-ESF-M7	
	KM7-OUT4-2			X	RLY-LOCA-ESF-M7	
KM8-IN1-1, KM8-IN1-2, KM8-IN4-1, KM8-IN4-2, KM8-OUT1-1, KM8-OUT1-2, KM8-OUT4-1, KM8-OUT4-2	KM8-IN1-1	Relays, Pump Shutoff 2:4 relay logic circuits for Primary Pump 670-M-8		X	RLY-LOCA-ESF-M8	
	KM8-IN1-2			X	RLY-LOCA-ESF-M8	
	KM8-IN4-1			X	RLY-LOCA-ESF-M8	
	KM8-IN4-2			X	RLY-LOCA-ESF-M8	
	KM8-OUT1-1			X	RLY-LOCA-ESF-M8	
	KM8-OUT1-2			X	RLY-LOCA-ESF-M8	
	KM8-OUT4-1			X	RLY-LOCA-ESF-M8	
	KM8-OUT4-2			X	RLY-LOCA-ESF-M8	
KM9-IN1-1, KM9-IN1-2, KM9-IN4-1, KM9-IN4-2, KM9-OUT1-1, KM9-OUT1-2, KM9-OUT4-1, KM9-OUT4-2	KM9-IN1-1	Relays, Pump Shutoff 2:4 relay logic circuits for Primary Pump 670-M-9		X	RLY-LOCA-ESF-M9	
	KM9-IN1-2			X	RLY-LOCA-ESF-M9	
	KM9-IN4-1			X	RLY-LOCA-ESF-M9	
	KM9-IN4-2			X	RLY-LOCA-ESF-M9	
	KM9-OUT1-1			X	RLY-LOCA-ESF-M9	

Equipment ID	Individual Component ID	Description	PC 4 Criteria Not Satisfied	Subcomponent	Parent Component	Basis for Outlier
	KM9-OUT1-2			X	RLY-LOCA-ESF-M9	
	KM9-OUT4-1			X	RLY-LOCA-ESF-M9	
	KM9-OUT4-2			X	RLY-LOCA-ESF-M9	
PLm501-1-L-ESF, PLm501-4-L-ESF		2:3 ESF Logic Modules, vessel outlet pressure subsystem, LOW	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
PLm502-1-LL-ESF, PLm502-4-LL-ESF		2:3 ESF Logic Modules, vessel inlet pressure subsystem, LOW	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
RLY-LOCA-ESF-M6, RLY-LOCA-ESF-M7, RLY-LOCA-ESF-M8, RLY-LOCA-ESF-M9	RLY-LOCA-ESF-M6	Enclosures, Primary Pump LOCA ESF Primary Pump Trip Relay				
	RLY-LOCA-ESF-M7					
	RLY-LOCA-ESF-M8					
	RLY-LOCA-ESF-M9					
S1-1, S1-5, S4-1, S4-5	S1-1	Switches, Reset (mounted on P11)		X	TMR-LOCA-ESF-1	
	S1-5			X	TMR-LOCA-ESF-1	
	S4-1			X	TMR-LOCA-ESF-4	
	S4-5			X	TMR-LOCA-ESF-4	
S1-2, S1-6, S4-2, S4-6	S1-2	Switches, Normal/Bypass (local mounted)		X	TMR-LOCA-ESF-1	
	S1-6			X	TMR-LOCA-ESF-1	
	S4-2			X	TMR-LOCA-ESF-4	
	S4-6			X	TMR-LOCA-ESF-4	
S1-3, S1-7, S4-3, S4-7	S1-3	Switches, Reset (local mounted)		X	TMR-LOCA-ESF-1	
	S1-7			X	TMR-LOCA-ESF-1	
	S4-3			X	TMR-LOCA-ESF-4	
	S4-7			X	TMR-LOCA-ESF-4	
S1-4, S1-8, S4-4, S4-8	S1-4	Switches, Normal/Bypass (mounted on P11)		X	TMR-LOCA-ESF-1	
	S1-8			X	TMR-LOCA-ESF-1	
	S4-4			X	TMR-LOCA-ESF-4	
	S4-8			X	TMR-LOCA-ESF-4	
S-M6, S-M7, S-M8, S-M9	S-M6	Switches, Normal/Test		X	RLY-LOCA-ESF-M6	
	S-M7			X	RLY-LOCA-ESF-M7	
	S-M8			X	RLY-LOCA-ESF-M8	
	S-M9			X	RLY-LOCA-ESF-M9	

Equipment ID	Individual Component ID	Description	RC-4 Criteria Not Satisfied	Subcomponent	Parent Component	Basis for Outlier
TMR-IN-1, TMR-IN-4, TMR-OUT-1, TMR-OUT-4	TMR-IN-1	Relays, Time Delay	X	X	TMR-LOCA-ESF-1	Capacity does not bound demand.
	TMR-IN-4		X	X	TMR-LOCA-ESF-4	Capacity does not bound demand.
	TMR-OUT-1		X	X	TMR-LOCA-ESF-1	Capacity does not bound demand.
	TMR-OUT-4		X	X	TMR-LOCA-ESF-4	Capacity does not bound demand.
TMR-LOCA-ESF-1, TMR-LOCA-ESF-4	TMR-LOCA-ESF-1	Enclosures, Timer Relay	X			Contains low capacity relays.
	TMR-LOCA-ESF-4		X			Contains low capacity relays.
Reactor Shutdown System (RSS)						
GT-F-1-504A-H		Isolation valves, emergency pump recirculating flow subsystem				
62-1, 62-4	62-1	Relays, Time Delay		X	E311A	
	62-4			X	E311D	
670-E-510		Control Panel, ATR Canal Emergency Firewater Makeup				
74-500/1X, 74-500/4X	74-500/1X	Relays, Loss of Power (32 Vdc)		X	E311A	
	74-500/4X			X	E311D	
74-500/ESF-1, 74-500/ESF-4	74-500/ESF-1	Relays, Loss of Power (120 Vac)		X	E311A	
	74-500/ESF-4			X	E311D	
C31A, B, C bays 1, 2, 3		Comparator cabinets	X			Unable to verify anchorage adequacy.
CLLC-513A, B, C		Contact logic level converters, Seismic subsystem	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
CLLC-516A, B, C		Contact logic level converters, manual scram subsystem	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
CLLC-523A, B, C		CLLC modules for Experiment Loops 1CW, 2E, 2D, 2B, and 1D	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
CLLC-525A, B, C		CLLC modules for Experiment Loops 1CW, 2E, 2D, 2B, and 1D	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
CLLC-528A, B, C		CLLC modules for Experiment Loops 1CW, 2E, 2D, 2B, and 1D	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
CLLC-529A, B, C		CLLC modules for Experiment Loops 1CW, 2E, 2D, 2B, and 1D	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
CLLC-532A, B, C		CLLC modules for Experiment Loops 1CW, 2E, 2D, 2B, and 1D	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component

Equipment ID	Individual Component ID	Description	PC 4 Criteria Not Satisfied	Subcomponent	Parent Component	Basis for Outlier
CPS1-1A, -1B, -1C, CPS2-2A, -2B, -2C, CPS3-1A, -1B, -1C, CPS3-2A, -2B, -2C, CPS3-3A, -3B, -3C		24/12 Vdc power supply bins, RSS comparator/ CLLC/2/3 logic module cabinets A, B, C	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
CPS2-1A, -1B, 1C		12 Vdc power supply bins, RSS CLLC logics	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
dPaBu-500A-1, 500A-2, 500B-1, 500B-2, 500C-1, 500C-2		Buffer units, vessel differential pressure subsystem	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
dPaCu-500A-HH, 500B-HH, 500C-HH		Analog comparator unit, vessel differential pressure subsystem, HIGH	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
dPaCu-500A-LL, 500B-LL, 500C-LL		Analog comparator unit, vessel differential pressure subsystem, LOW	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
dPLm-500-1-HH, 500-2-HH, 500-3-HH, 500-4-HH		2/3 Logic modules, vessel differential pressure subsystem, HIGH	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
dPLm-500-1-LL, 500-2-LL, 500-3-LL, 500-4-LL		2/3 Logic modules, vessel differential pressure subsystem, LOW	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
dPT-1-21, -22, -23, -24		Transmitter, Quadrant Differential Pressure 1, 2, 3, and 4				
dPT-500A, B, C	dPT-500A	Differential pressure transmitter, vessel differential pressure subsystem		X	I51A	
	dPT-500B			X	I51B	
	dPT-500C			X	I51C	
dTaBu-505A, B, C		Buffer units, quadrant differential temperature subsystem Quadrant 1	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
dTaBu-506A, B, C		Buffer units, quadrant differential temperature subsystem Quadrant 2	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
dTaBu-507A, B, C		Buffer units, quadrant differential temperature subsystem Quadrant 3	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
dTaBu-508A, B, C		Buffer units, quadrant differential temperature subsystem Quadrant 4	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
dTaCu-505A, B, C		Analog comparator units, quadrant differential temperature subsystem Quadrant 1	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component

Equipment ID	Individual Component ID	Description	PC-4 Criteria Not Satisfied	Subcomponent	Parent Component	Basis for Outlier
dTaCu-506A, B, C		Analog comparator units, quadrant differential temperature subsystem Quadrant 2	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
dTaCu-507A, B, C		Analog comparator units, quadrant differential temperature subsystem Quadrant 3	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
dTaCu-508A, B, C		Analog comparator units, quadrant differential temperature subsystem Quadrant 4	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
dTLm-505-1, 2, 3, 4		2/3 logic modules, quadrant differential temperature subsystem Quadrant 1	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
dTLm-506-1, 2, 3, 4		2/3 logic modules, quadrant differential temperature subsystem Quadrant 2	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
dTLm-507-1, 2, 3, 4		2/3 logic modules, quadrant differential temperature subsystem Quadrant 3	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
dTLm-508-1, 2, 3, 4		2/3 logic modules, quadrant differential temperature subsystem Quadrant 4	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
dTT-505A, B, C	dTT-505A	Differential temperature transmitter, quadrant differential temperature subsystem Quadrant 1		X	I51A	
	dTT-505B			X	I51B	
	dTT-505C			X	I51C	
dTT-506A, B, C	dTT-506A	Differential temperature transmitter, quadrant differential temperature subsystem Quadrant 2		X	I51A	
	dTT-506B			X	I51B	
	dTT-506C			X	I51C	
dTT-507A, B, C	dTT-507A	Differential temperature transmitter, quadrant differential temperature subsystem Quadrant 3		X	I51A	
	dTT-507B			X	I51B	
	dTT-507C			X	I51C	
dTT-508A, B, C	dTT-508A	Differential temperature transmitter, quadrant differential temperature subsystem Quadrant 4		X	I51A	
	dTT-508B			X	I51B	
	dTT-508C			X	I51C	
E15A/D		Switches and enclosures, remote, manual scram subsystem	X			Block wall that panel is mounted on is both inadequate in strength and an interaction source.

Equipment ID	Individual Component ID	Description	PC 4 criteria Not Satisfied	Subcomponent	Parent Component	Basis for Outlier
E310A, B, C	E310A	Relay cabinets				
	E310B					
	E310C					
E311A, D	E311A	Relay cabinets, ESF	X			Contains low capacity relays.
	E311D		X			Contains low capacity relays.
E312		Rod Clutch Coil Controller (RCCC) Current adjust circuitry cabinet	X			Interaction potential from adjacent unanchored panel 670-E-80.
E32A, D		RCCC power supply cabinet - power supplies				
E34A, B, C, D		RCCC cabinets, RCCC modules A1 thru A8				
FaBu-503A, B, C		Buffer units, emergency flow subsystem	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
FaBu-504A, B, C		Buffer units, emergency pump recirculating flow subsystem	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
FaBu-515A, B, C		Buffer units, emergency pump recirculating flow subsystem	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
FaCu-503A, 503B, 503C		Analog comparator unit, emergency flow subsystem	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
FaCu-504A, 504B, 504C		Analog comparator unit, emergency pump recirculating flow subsystem	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
FaCu-515A, 515B, 515C		Analog comparator unit, emergency pump recirculating flow subsystem	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
FE-503A, B, C	FE-503A	Flow elements, emergency flow subsystem				
	FE-503B					
	FE-503C					
FE-504A, B, C	FE-504A	Flow elements, emergency pump recirc flow subsystem				
	FE-504B					
	FE-504C					
FE-515A, B, C	FE-515A	Flow elements, emergency pump recirc subsystem				
	FE-515B					
	FE-515C					
FLm-503-1, -2, -3, -4		2/3 Logic modules, emergency flow subsystem	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component

Equipment ID	Individual Component ID	Description	RC-4 Criteria Not Satisfied	Subcomponent	Parent Component	Basis for Outlier
FLm-504-1, -2, -3, -4		2/3 Logic modules, emergency pump recirculating flow subsystem	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
FLm-504A-SPL, FLm-504B-SPL, FLm-504C-SPL		Special Logic, emergency pump recirculating flow subsystem	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
FT-503A, B, C	FT-503A	Flow transmitters, emergency flow subsystem		X	I52A	
	FT-503B			X	I52B	
	FT-503C			X	I52C	
FT-504A, B, C	FT-504A	Flow transmitters, emergency pump recirculating flow subsystem		X	I52A	
	FT-504B			X	I52B	
	FT-504C			X	I52C	
FT-515A, B, C	FT-515A	Flow transmitters, emergency pump recirculating flow subsystem		X	I52A	
	FT-515B			X	I52B	
	FT-515C			X	I52C	
GB-U-1-500A, B, C	GB-U-1-500A	Isolation valves, vessel differential pressure subsystem				
	GB-U-1-500B					
	GB-U-1-500C					
GB-U-1-503B-L, GB-U-1-503B-H, GB-U-1-503C-L, GB-U-1-503C-H	GB-U-1-503B-H	Isolation valves, emergency flow subsystem				
	GB-U-1-503B-L					
	GB-U-1-503C-H			X	I52C	
	GB-U-1-503C-L			X	I52C	
GB-U-1-504B-L, GB-U-1-504B-H, GB-U-1-504C-L, GB-U-1-504C-H	GB-U-1-504B-H	Isolation valves, emergency pump recirculating flow subsystem				
	GB-U-1-504B-L					
	GB-U-1-504C-H					
	GB-U-1-504C-L					
GB-U-1-514A-L, GB-U-1-514A-H, GB-U-1-514B-L, GB-U-1-514B-H, GT-F-1-514C-L, GT-F-1-514C-H	GB-U-1-514A-H	Isolation valves, Vessel level subsystem				
	GB-U-1-514A-L					
	GB-U-1-514B-H					
	GB-U-1-514B-L					
	GT-F-1-514C-H					
	GT-F-1-514C-L					
GB-U-1-515B-L, GB-U-1-515B-H, GB-U-1-515C-L, GB-U-1-515C-H	GB-U-1-515B-H	Isolation valves, emergency pump recirculating flow subsystem				
	GB-U-1-515B-L					
	GB-U-1-515C-H					
	GB-U-1-515C-L					

Equipment ID	Individual Component ID	Description	PC 4 Criteria Not Satisfied	Subcomponent	Parent Component	Basis for Outlier
GC-510A, B, C		Gain controls, neutron level subsystem	X	X	Unnumbered 45	Reference Parent Component
GC-512A, B, C		Gain controls, wide range neutron subsystem	X	X	Unnumbered 45	Reference Parent Component
GT-F-127, 128, 129	GT-F-127	Isolation valves, outlet pressure subsystem				
	GT-F-128					
	GT-F-129					
GT-F-1-503A-L, GT-F-1-503A-H	GT-F-1-503A-H	Isolation valves, emergency flow subsystem		X	I52C	
	GT-F-1-503A-L			X	I52C	
GT-F-1-504A-L, GT-F-1-504A-H		Isolation valves, emergency pump recirculating flow subsystem				
GT-F-1-515A-L, GT-F-1-515A-H	GT-F-1-515A-H	Isolation valves, emergency pump recirculating flow subsystem				
	GT-F-1-515A-L					
HS-516A, B, C		Switches, manual scram subsystem	X	X	Unnumbered 45	Reference Parent Component
HS-540A, B, C		Switches, Mode select	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
HV100, HV200, HV500A/B/C-LPV, -LPS, -PE, -HPV, -HPS, -HPC, -LPC, -HPD, -LPD	HV100, HV200, HV500A-LPV, -LPS, -PE, -HPV, -HPS, -HPC, -LPC, -HPD, -LPD	Instrument valves, vessel differential pressure subsystem		X	I51A	
	HV100, HV200, HV500B-LPV, -LPS, -PE, -HPV, -HPS, -HPC, -LPC, -HPD, -LPD			X	I51B	
	HV100, HV200, HV500C-LPV, -LPS, -PE, -HPV, -HPS, -HPC, -LPC, -HPD, -LPD			X	I51C	

Equipment ID	Individual Component ID	Description	PC 4 Criteria Not Satisfied	Subcom-ponent	Parent Component	Basis for Outlier
HV100, HV514A/B/C-LPV, -LPS, -PE, -HPV, -HPS, -HPC, -LPC, -HPD, -LPD	HV100, HV514A-LPV, -LPS, -PE, -HPV, -HPS, -HPC, -LPC, -HPD, -LPD	Instrument valves, Vessel level subsystem		X	I51A	
	HV100, HV514B-LPV, -LPS, -PE, -HPV, -HPS, -HPC, -LPC, -HPD, -LPD			X	I51B	
	HV100, HV514C-LPV, -LPS, -PE, -HPV, -HPS, -HPC, -LPC, -HPD, -LPD			X	I51C	
HV501A/B/C-S, -D, -C, -V	HV501A-S, -D, -C, -V	Instrument valves, outlet pressure subsystem		X	I51A	
	HV501B-S, -D, -C, -V			X	I51B	
	HV501C-S, -D, -C, -V			X	I51C	
HV502A/B/C-S, -C, -D, -V	HV502A-S, -C, -D, -V	Instrument valves, vessel inlet pressure		X	I51A	
	HV502B-S, -C, -D, -V			X	I51B	
	HV502C-S, -C, -D, -V			X	I51C	
HV503A/B/C-H, -L, -LPV, -LPS, -PE, -HPV, -HPS, -HPC, -LPC, -HPD, -LPD	HV503A-H, -L, -LPV, -LPS, -PE, -HPV, -HPS, -HPC, -LPC, -HPD, -LPD	Instrument valves, emergency flow subsystem		X	I52A	
	HV503B-H, -L, -LPV, -LPS, -PE, -HPV, -HPS, -HPC, -LPC, -HPD, -LPD			X	I52B	
	HV503C-H, -L, -LPV, -LPS, -PE, -HPV, -HPS, -HPC, -LPC, -HPD, -LPD			X	I52C	

Equipment ID	Individual Component ID	Description	PC 4 Criteria Not Satisfied	Subcomponent	Parent Component	Basis for Outlier
HV504A/B/C-H, -L, -LPV, -LPS, -PE, -HPV, -HPS, -HPC, -LPC, -HPD, -LPD	HV504A-H, -L, -LPV, -LPS, -PE, -HPV, -HPS, -HPC, -LPC, -HPD, -LPD	Instrument valves, emergency pump recirculating flow subsystem		X	I52A	
	HV504B-H, -L, -LPV, -LPS, -PE, -HPV, -HPS, -HPC, -LPC, -HPD, -LPD			X	I52B	
	HV504C-H, -L, -LPV, -LPS, -PE, -HPV, -HPS, -HPC, -LPC, -HPD, -LPD			X	I52C	
HV515A/B/C-H, -L, -LPV, -LPS, -PE, -HPV, -HPS, -HPC, -LPC, -HPD, -LPD	HV515A-H, -L, -LPV, -LPS, -PE, -HPV, -HPS, -HPC, -LPC, -HPD, -LPD	Instrument valves, emergency pump recirculating flow subsystem		X	I52A	
	HV515B-H, -L, -LPV, -LPS, -PE, -HPV, -HPS, -HPC, -LPC, -HPD, -LPD			X	I52B	
	HV515C-H, -L, -LPV, -LPS, -PE, -HPV, -HPS, -HPC, -LPC, -HPD, -LPD			X	I52C	
I51A, B, C I52A, B, C	I51A	Vessel Pressure and Temperature Transmitter Instrument Rack				
	I51B					
	I51C					
	I52A					
	I52B					
	I52C					
L31A, B, C, D bays 1, 2		Logic cabinets	X			Unable to verify anchorage adequacy.
LaBu-514A, B, C		Buffer units, Vessel level subsystem	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
LaCu-514A, B, C		Analog comparator units, Vessel level subsystem	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
LLm-514-1, -2, -3, -4		2/3 logic modules, Vessel level subsystem	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
Lm-Div-1, -2, -3, -4		1/40 division logic modules	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component

Equipment ID	Individual Component ID	Description	PC 4 Criteria Not Satisfied	Subcom-ponent	Parent Component	Basis for Outlier
LPS1-1A, -1B, -1C, LPS2-1A, -1B, -1C		12 Vdc power supply bins, 2/3 logics, division logic	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
LT-514A, B, C	LT-514A	Level transmitter, Vessel level subsystem				
	LT-514B					
	LT-514C					
MSLm-516-1, -2, -3, -4		2/3 logic modules, manual scram subsystem	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
504XA (E310A)		Relay, panel E310A		X	E310A	
504XA (E310B)		Relay, panel E310A		X	E310B	
504XA (E310C)		Relay, panel E310A		X	E310C	
515XA (E310A)		Relay, panel E310A		X	E310A	
515XA (E310B)		Relay, panel E310A		X	E310B	
515XA (E310C)		Relay, panel E310A		X	E310C	
62/A (E310A)		Relay, panel E310A		X	E310A	
62/A (E310B)		Relay, panel E310A		X	E310B	
62/A (E310C)		Relay, panel E310A		X	E310C	
NLPA 31 A, B, C		Neutron Level Pre-Amp Cabinets				
None	None 12	Pre-amplifiers, for RE-510A-1, A-2, B-1, B-2, C-1, C-2, neutron level subsystem		X	NLPA 31 A, B, C	
None	None 6	RTD thermal wells, quadrant differential temperature subsystem Quadrant 1, 2, 3, 4				
None	None 7	Temperature element well for TE-517 A, B, C, Outlet temperature subsystem				
None	None 8	SATS amplifiers, channel A, B, C, fission break subsystem	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
None	None 9	RTD thermal wells, vessel inlet temperature subsystem				
PaBu-501A-1, 501A-2, 501B-1, 501B-2, 501C-1, 501C-2		Buffer units, outlet pressure subsystem	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
PaBu-502A-1, 502A-2, 502B-1, 502B-2, 502C-1, 502C-2		Buffer units, vessel inlet pressure subsystem	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
PaCu-501A-H, 501B-H, 501C-H		Analog comparator units, outlet pressure subsystem, HIGH	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component

Equipment ID	Individual Component ID	Description	EC4 Criteria Not Satisfied	Subcomponent	Parent Component	Basis for Outlier
PaCu-501A-L, 501B-L, 501C-L		Analog comparator units, outlet pressure subsystem, LOW	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
PaCu-502A-H, 502B-H, 502C-H		Analog comparator units, vessel inlet pressure subsystem, HIGH	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
PaCu-502A-L, 502B-L, 502C-L		Analog comparator units, vessel inlet pressure subsystem, LOW	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
PLm-501-1-H, 501-2-H, 501-3-H, 501-4-H		2/3 Logic modules, outlet pressure subsystem, HIGH	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
PLm-501-1-L, 501-2-L, 501-3-L, 501-4-L		2/3 Logic modules, outlet pressure subsystem, LOW	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
PLm-502-1-H, 502-2-H, 502-3-H, 502-4-H		2/3 Logic modules, vessel inlet pressure subsystem, HIGH	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
PLm-502-1-L, 502-2-L, 502-3-L, 502-4-L		2/3 Logic modules, vessel inlet pressure subsystem, LOW	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
PT-501A, B, C	PT-501A	Pressure transmitter, outlet pressure subsystem		X	I51A	
	PT-501B			X	I51B	
	PT-501C			X	I51C	
PT-502A, B, C	PT-502A	Pressure transmitters, vessel inlet pressure subsystem		X	I51A	
	PT-502B			X	I51B	
	PT-502C			X	I51C	
RA-512A, B, C, D (installed spare)		Pre-amplifiers, for RE-512A, B, C, D, wide range neutron subsystem		X	NLPA 31 A, B, C	
RaBu-510A, B, C		Buffer units, neutron level subsystem	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
RaBu-511A, B, C		Buffer units, fission break subsystem	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
RaBu-512A, B, C		Buffer units, wide range neutron subsystem	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
RaCu-510A, B, C		Analog comparator units, neutron level subsystem	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
RaCu-511A, B, C		Analog comparator units, fission break subsystem	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
RaCu-512A, B, C		Analog comparator units, wide range neutron subsystem	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
RAm-510A, B, C		Neutron level drawer with integrated HVPS, neutron level subsystem	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component

Equipment ID	Individual Component ID	Description	PC 4 Criteria Not Satisfied	Subcomponent	Parent Component	Basis for Outlier
RAm-511A, B, C		Gamma level drawer with integral HVPS, fission break subsystem	X			Panels A and B; capacity for anchors in block walls in unknown. Panel C is missing the two bottom side anchors. Calculation showing adequate anchorage assumes missing anchors are installed and that capacity in block walls is equivalent to 3/8-inch anchor
RAm-512A, B, C		Wide range drawer with integral HVPS, wide range neutron subsystem	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
RE-510A-1, A-2, B-1, B-2, C-1, C-2, D (installed spare)		Ion chambers, neutron level subsystem	X			No applicable experience data equipment class.
RE-511A, B, C		Gamma Ionization Chambers, fission break subsystem	X			No applicable experience data equipment class.
RE-512A, B, C, D (installed spared)		Detector assembly, wide range neutron subsystem	X			No applicable experience data equipment class.
RI-512A, B, C		Remote drawer range indication, wide range neutron subsystem	X	X	RCR Panel R4	Reference Parent Component
RLm-510-1, 2, 3, 4		2/3 logic modules, neutron level subsystem	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
RLm-511-1, 2, 3, 4		2/3 logic modules, fission break subsystem	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
RLm-512-1, -2, -3, -4		2/3 logic modules, wide range neutron subsystem	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
RX-511A, B, C		Check source, shield assembly, power supply, fission break subsystem	X			No applicable experience data equipment class.
TaBu-509A, B, C		Buffer units, vessel inlet temperature subsystem	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
TaBu-517A, B, C		Buffer units, Outlet temperature subsystem	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
TaCu-509A, B, C		Analog comparator units, vessel inlet temperature subsystem	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
TaCu-517A, B, C		Analog comparator units, Outlet temperature subsystem	X	X	C31A, B, C bays 1, 2, 3	Reference Parent Component
TE-505A, B, C		RTD elements, quadrant differential temperature subsystem Quadrant 1				

Equipment ID	Individual Component ID	Description	PC 4 Criteria Not Satisfied	Subcomponent	Parent Component	Basis for Outlier
TE-506A, B, C		RTD elements, quadrant differential temperature subsystem Quadrant 2				
TE-507A, B, C		RTD elements, quadrant differential temperature subsystem Quadrant 3				
TE-508A, B, C		RTD elements, quadrant differential temperature subsystem Quadrant 4				
TE-509A, B, C		RTD elements, vessel inlet temperature subsystem				
TE-517A, B, C		Temperature elements, Outlet temperature subsystem				
TE-518A, B, C		RTD elements, quadrant differential temperature subsystem Quadrant 1				
TE-519A, B, C		RTD elements, quadrant differential temperature subsystem Quadrant 2				
TE-520A, B, C		RTD elements, quadrant differential temperature subsystem Quadrant 3				
TE-521A, B, C		RTD elements, quadrant differential temperature subsystem Quadrant 4				
TLm-509-1, -2, -3, -4		2/3 logic modules, vessel inlet temperature subsystem	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
TLm-517-1, -2, -3, -4		2/3 logic modules, Outlet temperature subsystem	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
TT-509A, B, C	TT-509A	Temperature transmitter, vessel inlet temperature subsystem		X	I51A	
	TT-509B			X	I51B	
	TT-509C			X	I51C	
TT-517A, B, C	TT-517A	Temperature transmitters, Outlet temperature subsystem		X	I51A	
	TT-517B			X	I51B	
	TT-517C			X	I51C	
VbLm-513-1, -2, -3, -4		2/3 logic modules, Seismic subsystem	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
VbS-513A, B, C		Tri-axial seismic triggers, Seismic subsystem				

Equipment ID	Individual Component ID	Description	FC 4 Criteria Not Satisfied	Subcomponent	Parent Component	Basis for Outlier
ESF/RESET-1 (Primary Pump Shutoff system)		Switches, Reset (Local)		X	E311A	
ESF/RESET-4 local (Primary Pump Shutoff system)		Switches, Reset (Local)		X	E311D	
500/1X, 500/ESF-1	500/1X	Relays, Primary Pump Shutoff ESF Logic		X	E311A	
	500/ESF-1		X	X	E311A	Capacity does not bound demand.
500/4X, 500/ESF-4	500/4X	Relays, Primary Pump Shutoff ESF Logic		X	E311D	
	500/ESF-4		X	X	E311D	Capacity does not bound demand.
dPLm-500-1-HH-ESF, dPLm-500-4-HH-ESF		2/3 ESF Logic Modules, vessel differential pressure subsystem HIGH	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
ESF/RESET-1, ESF/RESET-4 control room primary pump		Switches, Reset (Reactor Control Room)		X	P11	
Pressurizing and Gland Seal Pump Shutoff System						
ESF/RESET-1 (Pressurizing and Gland Seal Pump Shutoff system)		Switches, Reset (Local)		X	E311A	
ESF/RESET-4 local (Pressurizing and Gland Seal Pump Shutoff system)		Switches, Reset (Local)		X	E311D	
502/11X, 502/44X, 502/ESF-4, 502/ESF-4B	502/11X	Relays, Pressurizing and Gland Seal Pump Shutoff ESF Logic		X	E311D	
	502/44X			X	E311D	
	502/ESF-4		X	X	E311D	Capacity does not bound demand.
	502/ESF-4B		X	X	E311D	Capacity does not bound demand.
502/1X, 502/4X, 502/ESF-1, 502/ESF-1B	502/1X	Relays, Pressurizing and Gland Seal Pump Shutoff ESF Logic		X	E311A	
	502/4X			X	E311A	
	502/ESF-1		X	X	E311A	Capacity does not bound demand.
	502/ESF-1B		X	X	E311A	Reference Parent Component
74-502/1X, 74-502/4X, 74-502/11X, 74-502/44X	74-502/11X, 74-502/44X	Relays, Loss of Power (32 Vdc)		X	E311D	
	74-502/1X, 74-502/4X			X	E311A	

Equipment ID	Individual Component ID	Description	RC 4 Criteria Not Satisfied	Subcomponent	Parent Component	Basis for Outlier
74-502/ESF-1, 74-502/ESF-4	74-502/ESF-1	Relays, Loss of Power (120 Vac)		X	E311A	
	74-502/ESF-4			X	E311D	
ESF/RESET-1, ESF/RESET-4 control room gland seal		Switches, Reset (Reactor Control Room)		X	P11	
PLm-502-1-H-ESF, PLm-502-4-H-ESF		2/3 ESF Logic Modules, vessel inlet pressure subsystem HIGH	X	X	L31A, B, C, D bays 1, 2	Reference Parent Component
Safety Rod System						
405815		Flux trap fillers (N, E, SE, S, SW, and W)	X			No applicable experience data equipment class.
405904		Hafnium absorber plate assembly, safety rod (N, E, SE, S, SW, and W)	X			No applicable experience data equipment class.
404695-1		Guide tube, safety rod (N, E, SE, S, SW, and W)	X			No applicable experience data equipment class.
417977-2		Latch assembly, safety rod hafnium absorber plate (N, E, SE, S, SW, and W)	X			No applicable experience data equipment class.
670-M-459 120557		Rack tube assembly (N, E, SE, S, SW, and W)	X			Reference Parent Component
Buildings, Misc. Structures and Components						
670-GBM-470		Backup Nitrogen bottle for D-441 door seal		X	670-E-496	
BK-6-641, BK-6-642		Block valves for backup Nitrogen bottles to door seals		X	Nitrogen Backup Station for Doors D-411 and D-15	
CK-6-890		Air/Nitrogen supply to D-441		X	670-E-496	
CK-6-969		Check valve, supply to door seals	X			Capacity does not bound demand.
D-13, D-15, D-51		Doors, gas-tight vertical lift	X			No applicable experience data equipment class.
D-13, D-15, D-51,		Seals, gas-tight door	X			No applicable experience data equipment class.
D-14, D-18, D-25		Doors, gas-tight personnel	X			No applicable experience data equipment class.
D-202, D-314, D-412		Doors, gas-tight personnel	X			No applicable experience data equipment class.
D-30, D-54, D-35		Doors, gas-tight personnel	X			No applicable experience data equipment class.

Equipment ID	Individual Component ID	Description	PC-4 Criteria Not Satisfied	Subcomponent	Parent Component	Basis for Outlier
D-39, D-43, D-44		Doors, gas-tight personnel	X			No applicable experience data equipment class.
D-442, D-443		Doors, gas-tight personnel	X			No applicable experience data equipment class.
D-49, D-50, D-67		Doors, gas-tight personnel	X			No applicable experience data equipment class.
D-52, D-441 doors		Doors, gas-tight rolling	X			No applicable experience data equipment class.
D-52, D-441 seals		Seals, gas-tight door	X			No applicable experience data equipment class.
GT-6-625, CK-6-626,		Air/Nitrogen supply to D-51	X			Capacity does not bound demand.
GT-6-629, CK-6-630,		Air/Nitrogen supply to D-52	X			Capacity does not bound demand.
GT-6-633, CK-6-634,		Air/Nitrogen supply to D-13	X			Capacity does not bound demand.
GT-6-637, CK-6-638,		Air/Nitrogen supply to D-15	X			Capacity does not bound demand.
GT-6-834, CK-6-858,		Air/Nitrogen supply to D-441		X	670-E-496	
		Air/Nitrogen supply to D-441				
GT-6-860, PCV-6-991,		Air/Nitrogen supply to D-441				
670-E-496		Air/Nitrogen Supply to D-441 Enclosure				
Nitrogen Backup Station for Doors D-411 and D-15		Nitrogen Backup Station for Doors D-411 and D-15				
PCV-6-990, SV-6-861,		Air/Nitrogen supply to D-441		X	670-E-496	
PI-6-127, PI-6-134		Air/ Nitrogen pressure to D-441 door seal	X			Capacity does not bound demand.
PI-6-646		Air/Nitrogen pressure to D-51 door seal				
PI-6-647		Air/Nitrogen pressure to D-52 door seal	X			Capacity does not bound demand.
PI-6-648		Air/Nitrogen pressure to D-13 door seal	X			Capacity does not bound demand.
PI-6-649		Air/Nitrogen pressure to D-15 door seal	X			Capacity does not bound demand.
PRV-6-627, SOV-6-628		Air/Nitrogen supply to D-51				
PRV-6-631, SOV-6-632		Air/Nitrogen supply to D-52	X			Capacity does not bound demand.

Equipment ID	Individual Component ID	Description	PC 4 Criteria Not Satisfied	Subcomponent	Parent Component	Basis for Outlier
PRV-6-635, SOV-6-636		Air/Nitrogen supply to D-13	X			Capacity does not bound demand.
PRV-6-639, SOV-6-640		Air/Nitrogen supply to D-15	X			Capacity does not bound demand.
PRV-6-643 CK-6-645		Backup Nitrogen supply to door seals		X	Nitrogen Backup Station for Doors D-411 and D-15	
PV-6-857, GT-6-902	GT-6-902	Boundary valves for backup Nitrogen supply to door seals	X			Unable to locate valve. Field walkdown indicates that line that valve is supposed to be on no longer exists.
	PV-6-857			X	670-E-496	
SF-6-644, BL-6-970,		Boundary valves for backup Nitrogen supply to door seals		X	Nitrogen Backup Station for Doors D-411 and D-15	
Unnumbered	Unnumbered 18	Exterior walls, sandwich panel	X			No applicable experience data equipment class.
Unnumbered	Unnumbered 19	Gas-tight equipment floor hatches	X			No applicable experience data equipment class.
Unnumbered	Unnumbered 4	Backup Nitrogen bottles for door seals		X	Nitrogen Backup Station for Doors D-411 and D-15	
Unnumbered	Unnumbered 47	Tubing to door seals, downstream of CK-6-969	X			No applicable experience data equipment class.
Unnumbered	Unnumbered 52	Concrete block, fire and isolation walls	X			No applicable experience data equipment class.
Unnumbered	Unnumbered 59	Concrete equipment foundations	X			No applicable experience data equipment class.
Unnumbered	Unnumbered 60	Windows, gas-tight	X			No applicable experience data equipment class.
Unnumbered	Unnumbered 64	Concrete, lower perimeter wall	X			No applicable experience data equipment class.
Unnumbered	Unnumbered 7	Roofing panels	X			No applicable experience data equipment class.
Unnumbered	Unnumbered 8	Support and liner, reactor vessel	X			No applicable experience data equipment class.
Unnumbered	Unnumbered 9	Steel liners, misc. gas-tight walls	X			No applicable experience data equipment class.

Equipment ID	Individual Component ID	Description	FC 4 Criteria Not Satisfied	Subcomponent	Parent Component	Basis for Outlier
Control Complex						
A10		Annunciator Panel, RCR Panel R6	X	X	RCR Panel R6	Reference Parent Component
A13		Annunciator Panel, RCR Panel R8	X	X	RCR Panel R8	Reference Parent Component
A7		Annunciator Panel, RCR Panel R1	X	X	RCR Panel R1	Reference Parent Component
A8		Annunciator Panel, RCR Panel R9	X	X	RCR Panel R9	Reference Parent Component
A9		Annunciator Panel, RCR Panel R4	X	X	RCR Panel R4	Reference Parent Component
RCR Panel R1		Control Room Panel R1	X			Capacity does not bound demand. Anchorage adequacy indeterminate.
RCR Panel R4		Control Room Panel R4	X			Capacity does not bound demand. Anchorage adequacy indeterminate. Block wall interaction
RCR Panel R6		Control Room Panel R6	X			Capacity does not bound demand. Anchorage adequacy indeterminate. Block wall interaction
RCR Panel R8		Control Room Panel R8	X			Capacity does not bound demand. Anchorage adequacy indeterminate. Block wall interaction
RCR Panel R9		Control Room Panel R9	X			Capacity does not bound demand. Anchorage adequacy indeterminate. Block wall interaction
None	None 10	Horn, Annunciator, RCR Panel R9	X	X	RCR Panel R9	Reference Parent Component
None	None 20	Fiber Optic Cable, SER	X			Capacity does not bound demand. Cable tray containing cable sits atop unanchored Sequence of Events Recorder. Block wall interaction.
None	None 4	Sequence of Events Recorder, (SER), Units 1 and 2	X			Unanchored. Block wall interaction.