NRR-PMDAPEm Resource

From: Lashley, Phil H. [phlashley@firstenergycorp.com]
Sent: Wednesday, July 22, 2015 7:58 AM
To: Wyman, Stephen; DiFrancesco, Nicholas
Cc: Lentz, Thomas A. (Licensing); Nevins, Kathleen J.
Subject: [External_Sender] FW: Perry ESEP Clarification Questions
Attachments: PNPP ESEP Clarification Question Response.pdf

Responses to the Perry ESEP clarification questions are included in the attachment to this email.

Respectfully,

Phil H. Lashley
Fleet Licensing Supervisor
Cell: (330) 696-7208
Office: (330) 315-6808
Mail Stop: A-WAC-B1

From: Lashley, Phil H.
Sent: Monday, June 22, 2015 7:17 AM
To: 'Wyman, Stephen'
Cc: DiFrancesco, Nicholas
Subject: RE: Perry ESEP Clarification Questions

Steve,

We expect to be able to provide an email response no later than July 27th.

Respectfully,

Phil H. Lashley
Fleet Licensing Supervisor
Cell: (330) 696-7208
Office: (330) 315-6808
Mail Stop: A-WAC-B1

From: Wyman, Stephen [mailto:Stephen.Wyman@nrc.gov]
Sent: Thursday, June 18, 2015 9:07 AM
To: Lashley, Phil H.
Cc: DiFrancesco, Nicholas
Subject: RE: Perry ESEP Clarification Questions

Thanks, Phil. Understand and standing by for schedule update from contractor.

Stephen M. Wyman
USNRC/NRR/JLD/HMB
Office: O-13G9 MS: O-13C5
301-415-3041 (Voice)
301-415-8333 (Fax)
Stephen.Wyman@nrc.gov

From: Lashley, Phil H. [mailto:phlashley@firstenergycorp.com]
Sent: Thursday, June 18, 2015 7:20 AM
To: Wyman, Stephen
Cc: Devlin-Gill, Stephanie; DiFrancesco, Nicholas; Nevins, Kathleen J.
Subject: RE: Perry ESEP Clarification Questions

Steve,

We believe that we understand the questions and do not require a clarification call at this time.

We will have to go through our contractor in order to provide answers to these questions. Therefore, a response date of June 30th is not going to be practicable. We are working through the schedule and will let you know when we have an expected response date.

Respectfully,

Phil H. Lashley
Fleet Licensing Supervisor
Cell: (330) 696-7208
Office: (330) 315-6808
Mail Stop: A-WAC-B1

From: Wyman, Stephen [mailto:Stephen.Wyman@nrc.gov]
Sent: Tuesday, June 16, 2015 5:04 PM
To: Lashley, Phil H.
Cc: Devlin-Gill, Stephanie; DiFrancesco, Nicholas
Subject: Perry ESEP Clarification Questions

Mr. Lashley,

In follow-up to our phone message today, as part of the NRC review of the Perry ESEP report, the staff would appreciate clarification on the following technical items:

> The following clarification questions are raised in the context of the NRC evaluation of the ESEP submittals only and licensees' responses will be reviewed by NRC staff only to the extent the use of this information affects the elements and outcomes of the ESEP evaluation. As many licensees have used information from their ongoing SPRA analyses, the current review will not evaluate methods or results as they pertain to the SPRA. They will be reviewed later at the time of SPRA review.

1. The licensee did not state whether the walkdown personnel were trained in seismic walkdown. Please confirm that the walkdowns were conducted by trained engineers that successfully completed the Seismic Qualification Utility Group (SQUG) Walkdown Screening and Seismic Evaluation Training Course in accordance with the guidance document.

2. In the equations for HCLPF presented in Section 6.5 "FUNCTIONAL EVALUATIONS OF RELAYS", C_I and D_R are used in the equations but are not defined. Also, the term F_K (= TRS knockdown factor) is defined, but is not used in the equations. Confirm or correct the equations in Section 6.5, and define all terms used in the equations.

3. ESEP Report Section 6.5 states:

"Twenty relays in the ESEL associated with the FLEX Phase 1 response required functional evaluations. The relays evaluated are housed within panels 1H13P0628, 1H13P063l, 1H13P0618, and 1H13P0621 located in the CC at EL 654."

A search of the ESEL table (Attachment A) identified 18 relays and 2 timers (Items 106 through 125 in the ESEL). Six (6) panels are identified in the ESEL as containing relays: 1H13P0628, 1H13P063l, 1H13P0618, 1H13P0621, 1H13P0625, and 1H13P0629 (Items 422, 423, 387, 421, 385, and 386, respectively, in the ESEL). From a search of the HCLPF table (Attachment B), the HCLPF value for all 6 panels is 0.86g; the "Fragility Method" is identified as "earthquake experience". All HCLPF values for the relays and timers are determined using "TRS" as the "Fragility Method": 0.35g for 16 items, and 0.27g for 4 items. Confirm that the above staff assessment is correct. Correlate the relays and timers to the panel they are housed within. Demonstrate the use of the equations in ESEP Section 6.5 in determining the HCLPF capacities for the relays, including values assumed for AF_C, if applicable.

4. ESEP Report Section 6.3.3 indicates the walkdowns identified 6 valves that did not meet the valve operator caveats necessary to use a generic approach for estimating HCLPF capacity. ESEP Report Section 6.3.1 indicates that no significant concerns were noted which could lead to an increase in sample size. Are the 6 valves representative of a larger population that do not meet the caveat, or are these the only 6 valves, within the scope of the ESEP, not meeting the caveat (i.e., 100% of the population)? What is the estimated HCLPF capacity of these valves, relative to the RLGM (GMRS)?

5. ESEP Report Section 6.6 states that "Attachment B tabulates the HCLPF values for all components on the ESEL." Attachment A, the ESEL, contains 423 items on 23 pages. Attachment B contains 14 pages of HCLPF values, with no cross reference back to the ESEL Table items. The staff cannot confirm that all ESEL items are included in Attachment B. For clarification, provide a roadmap from the ESEL Table (Attachment A) to the HCLPF Table (Attachment B).

6. Section 3.1.5 of the ESEP Reports states:

Critical indicators and recorders are typically physically located on panels/cabinets and are included as separate components; however, seismic evaluation of the instrument indication may be included in the panel/cabinet seismic evaluation (rule-of-the-box).

Section 6.1 of the ESEP Reports states:

A number of components on the ESEL are breakers and switches that are housed in a "parent" component, such as a motor control center (MCC) or switchgear. For the purpose of this evaluation, calculations are not explicitly performed for these housed components. Instead, their HCLPF is assigned based on the parent component.

The information provided in both paragraphs is not clear. Please provide a more detailed description of both approaches, how they are different, when would each approach be applied, and examples for both approaches to show how the HCLPF values of the devices were determined, including consideration of cabinet amplification, if applicable. Also, describe whether any of these devices are sensitive to vibration as are relays and other devices with contacts, and if so, how they were evaluated. Lastly, if the qualification of the devices is based on the cabinet/panel they are housed in, which have been previously qualified as part of an equipment class ("parent" component), how is it known/confirmed that the parent component normally contains the particular device.

7. Section 5.2 of the ESEP Report for Perry states the following:

> *Subsequent equipment HCLPF calculations and fragility evaluations are based on the conservative deterministic failure margin (CDFM) approach. In accordance with EPRI 1019200 [10] "Seismic Fragility Applications Guide Update," the seismic analyses are performed using BE structure stiffness, mass and damping characteristics, and the BE subsurface Vs profile compatible with the expected seismic shear strains. The resulting ISRS approximately represent the 84th percentile response suitable for use in the CDFM calculations.*

Section 4 of the Seismic Evaluation Guidance, Augmented Approach (EPRI 3002000704) allows the development of ISRS calculated from new SSI models. The guidance document indicates that: EPRI 1025287 (SPID) and the ASME/ANS PRA Standard give guidance on acceptable methods to compute both the GMRS and the associated ISRS. Table 6-5 in the SPID document, under the SFR-C6 entry, indicates that ASME/ANS PRA Standard (Addendums A and B) requires consideration of the variation of soil properties (Vs profile). Also, the SFR-C5 entry indicates that if the median-centered response analysis is performed, the evaluation should estimate the median response (i.e., structural loads and ISRS) and variability in the response using established methods.

Based on EPRI 1019200, which was referenced by the ESEP Reports, parameter variation should be incorporated into SSI analyses in order to characterize the uncertainty in the SSI demands. EPRI 1019200 indicates that the SSI analyses in ASCE 4 be followed, which require that SSI evaluations include lower bound and upper bound soil profiles to account for parameter variation in SSI. EPRI 1019200 also indicates that for the structural model, the best estimate (median) and uncertainty variation in the frequency should be considered.

Therefore, please describe how parameter variation is incorporated into the SSI analyses for the structural model and subsurface while using only the best estimate (BE) structure stiffness, mass and damping characteristics, and the BE subsurface Vs profile. Related to the above discussion, if only the BE is used for the structural model and soil profile, explain how the ISRS would approximately represent the 84th percentile response, as stated in the ESEP report.

8. Section 6.4 of the ESEP Reports states that all HCLPF calculations were performed using the CDFM methodology. Table 7-1 states that “Fragility is calculated…”. In addition, Appendix B provides information for β_C, β_R, and β_U, which would indicate that a fragility analyses has been performed.

The licensee is requested to confirm that only the CDFM methodology has been used, or to identify that fragility analysis has also been performed. If fragility analyses have been performed, then the description of the methods used to estimate HCLPF values should be updated to include a description of the fragility analyses methods used.

An email response will likely be sufficient to support the ESEP report review, however, please be aware that your email response will be made publicly available in ADAMS. A response around June 30, if practicable, would be greatly appreciated to support the planned review schedule.

Please let me or Nick DiFrancesco (at 301-415-1115) know if you would like to schedule a clarification call or have any questions and concerns.

Thanks,
Steve

Stephen M. Wyman

USNRC/NRR/JLD/HMB
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Created By: phlashley@firstenergycorp.com

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ABS Consulting
RIZZO ASSOCIATES

3552894-R-001
Revision 0

Response to Perry Nuclear Power Plant Expedited Seismic Evaluation Process Report Clarification Questions

July 8, 2015

Prepared for:

FENOC
FirstEnergy Nuclear Operating Company

ABSG Consulting Inc. • 300 Commerce Drive, Suite 200 • Irvine, California 92602

3552894-R-001
Revision 0

Response to Perry Nuclear Power Plant Expedited Seismic Evaluation Process Report Clarification Questions

July 8, 2015

Prepared by:

ABSG Consulting Inc.

Prepared for:

FirstEnergy Nuclear Operating Company
Perry Nuclear Power Plant
10 Center Road
Perry, OH 44081

APPROVALS

Report Name: Response to Perry Nuclear Power Plant Expedited Seismic Evaluation Process (ESEP) Report Clarification Questions

Date: July 8, 2015

Revision No.: 0

Approval by the responsible manager signifies that the document is complete, all required reviews are complete, and the document is released for use.

Nishikant R. Vaidya, V.P.
Advanced Engineering Projects,
RIZZO Associates

Originator: Nish Vaidya, Ph.D., P.E. — Principal — Date: 7/8/2015

Independent Technical Reviewer: Farzin R. Beigi, P.E. — Senior Consultant — Date: 7/8/2015

Approver: Thomas R. Roche, P.E. — Vice President — Date: 7/8/2015

FENOC Reviewer: Ashley Sullivan — Structural Engineer, Design Engineering — Date: 7/9/2015

FENOC Approver: Don Culler — Supervisor, Nuclear Mechanical/Structural Design Engineering — Date: 7/10/15

FENOC Approver: Ben Huck — Manager, Design Engineering — Date: 7/10/15

Table of Revisions

Revision No.	Date	Description of Revision
0	7/8/15	Original Issue

Nuclear Regulatory Commission e-mail from Stephen Wyman to Phil Lashley dated June 16, 2015.

Clarification Question #1

The licensee did not state whether the walkdown personnel were trained in seismic walkdown. Please confirm that the walkdowns were conducted by trained engineers that successfully completed the Seismic Qualification Utility Group (SQUG) Walkdown Screening and Seismic Evaluation Training Course in accordance with the guidance document.

FENOC Response

The walkdown team for ESEP components consisted of Mr. Eddie Guerra, P.E, Mr. Brian Lucarelli, and Mr. John Reddington, P.E. As discussed in Section 6.3.2 of the ESEP Report, recent SPRA walkdowns were credited for some components on the ESEL. The SPRA walkdown team consisted of Mr. Guerra, Mr. Lucarelli, Mr. Bradley Yagla, and Mr. Dom Drkulec. Additionally, Mr. Farzin Beigi, P.E. provided support and expert input to the walkdown teams throughout the full extent of the plant walkdowns as well as post-walkdown discussions.

All six of these individuals are trained engineers that have successfully completed the SQUG Walkdown Screening and Seismic Evaluation Training Course or equivalent training. Resumes and SQUG certificates for these individuals are provided in Attachment 1.

Clarification Question #2

In the equations for high confidence low probability of failure (HCLPF) presented in Section 6.5 "FUNCTIONAL EVALUATIONS OF RELAYS", C_I and D_R are used in the equations but are not defined. Also, the term F_K (= TRS knockdown factor) is defined, but is not used in the equations. Confirm or correct the equations in Section 6.5, and define all terms used in the equations.

FENOC Response

The HCLPF capacity for relays included in the expedited seismic equipment list (ESEL) is calculated following the guidelines provided in Appendix Q of Electric Power Research Institute (EPRI) 6041. The equations for relay chatter evaluation, as defined in EPRI 6041, are the following:

- For Cabinet-Based test data:

$$\text{TRSc}=\text{TRS}\cdot\frac{\text{CT}}{\text{FK}}$$

$$\text{RRSc}=\text{RRS}\cdot\text{CC}$$

- For Device-Based test data:

$$\text{TRSc}=\text{TRS}\cdot\frac{\text{CT}}{\text{FK}}$$

$$\text{RRSc}=\text{RRS}\cdot\text{CC}\cdot\frac{\text{AFC}}{\text{FMS}}$$

Where:

TRS_C = CDFM test response spectrum

RRS_C = CDFM required response spectrum

TRS = Equipment Test Response Spectrum Capacity

CT= Clipping Factor for narrow-banded TRS

FK = TRS Knockdown Factor

RRS = Required Response Spectrum

CC = Clipping Factor for narrow RRS

AFC = Cabinet Amplification Factor

FMS = Multi-axis to Single-axis conservatism factor

The formulas shown in Section 6.5 of the Perry Nuclear Power Plant Expedited Seismic Evaluation Process (ESEP) Report are applicable to the separation of variables methodology, which was not used for the relays in the Perry ESEP. The conservative deterministic failure margin (CDFM) methodology and formulas cited above are used in the relay capacity evaluations.

Clarification Question #3

Perry ESEP Report Section 6.5 states:

"Twenty relays in the ESEL associated with the FLEX Phase 1 response required functional evaluations. The relays evaluated are housed within panels 1H13P0628, 1H13P063l, 1H13P0618, and 1H13P0621 located in the CC at EL 654."

A search of the ESEL table (Attachment A) identified 18 relays and 2 timers (Items 106 through 125 in the ESEL). Six (6) panels are identified in the ESEL as containing relays: 1H13P0628, 1H13P063l, 1H13P0618, 1H13P0621, 1H13P0625, and 1H13P0629 (Items 422, 423, 387, 421, 385, and 386, respectively, in the ESEL). From a search of the HCLPF table (Attachment B), the HCLPF value for all 6 panels is 0.86g; the "Fragility Method" is identified as "earthquake experience". All HCLPF values for the relays and timers are determined using "TRS" as the "Fragility Method": 0.35g for 16 items, and 0.27g for 4 items. Confirm that the above staff assessment is correct. Correlate the relays and timers to the panel they are housed within. Demonstrate the use of the equations in ESEP Section 6.5 in determining the HCLPF capacities for the relays, including values assumed for AFC, if applicable.

FENOC Response

The twenty relays referenced in Section 6.5 of the Perry ESEP Report correspond to the 18 relays and 2 timers identified by the Staff as ESEL items 106 through 125. In this response, "relays" should be considered to encompass both relays and timers.

These twenty components are housed within the four panels listed in Section 6.5 of the Perry ESEP Report. ***Table 1*** provides a correlation between these four panels and the relays housed within them. The other two panels identified by the Staff (1H13P0625 and 1H13P0629) are relay panels, but they do not house any relays that are identified as ESEL items requiring specific functional evaluation.

Table 1. Perry Panels and Relays/Timers

Panel		Relays/Timers in Panel	
ESEL ID	**Component ID**	**ESEL ID**	**Component ID**
387	1H13P0618	109	1E51A-K101
		110	1E51Q7085
		111	1E51A-K033
		112	1E51Q7084
		115	1E51A-K086
421	1H13P0621	106	1E51A-K002
		107	1E51A-K003
		108	1E51A-K024
		113	1E51A-K015
		114	1E51A-K066
		116	1E51Q7064
		117	1E51Q7065
422	1H13P0628	118	1B21C-K007A
		120	1B21C-K008E
		122	1B21C-K051A
		124	1B21C-K051E
423	1H13P0631	119	1B21C-K007B
		121	1B21C-K008F
		123	1B21C-K051B
		125	1B21C-K051F

The panels are evaluated generically for their functional capacity using earthquake experience data to establish a capacity at the component mounting level in accordance EPRI 1019200. This process is described in Section 6.4 of the ESEP Report. The HCLPF capacity for the panels (0.86g) does not address vibration-sensitive components such as relays, as those are evaluated separately.

The relays are evaluated based on TRS for the specific relay models. Relay evaluations use the equations in EPRI NP-6041, as provided in the response to Clarification Question #2 in this document. The process for relay evaluation and the basis for each term in the equation are described in more detail below.

<u>Relay Evaluation Equations</u>

Relay capacity is established based on test reports for the specific relay models. Therefore the equations for device-based test data are used.

$$TRSc = TRS \cdot \frac{CT}{FK}$$

$$RRSc = RRS \cdot CC \cdot \frac{AFC}{FMS}$$

TRS

The TRS term is obtained from the relay test report and is taken as the minimum acceleration level for the TRS in the frequency range of 4Hz – 20Hz.

Note that some relay models present different capacities for energized vs. de-energized or for normally open vs. normally closed. In these cases, all configurations for the relay are evaluated, and the lowest HCLPF is presented as the HCLPF capacity for the relay model.

CT

The CT term is a clipping factor for narrow banded TRS. Since all relay TRS for the PY ESEP are wide banded, this term is taken as unity.

FK

The TRS knockdown factor is used to obtain an approximately 99% exceedance level capacity, as described in Appendix Q of EPRI NP-6041. Table Q-2 of EPRI NP-6041 provides appropriate knockdown factors based on the type of TRS used for capacity.

RRS

The RRS term is the in-structure response spectra (ISRS) at the base of the cabinet/panel. All panels containing relays for the Perry ESEP are located in the main control room, therefore, the ISRS for EL. 654’ of the Control Complex is used.

CC

The CC term is a clipping factor for narrow banded RRS. Clipping is performed as described in Appendix Q of EPRI NP-6041.

AFC

The effective cabinet amplification factor is used to capture amplification of the response between the cabinet base and the relay mounting location. Table Q-1 of EPRI NP-6041 provides representative amplification factors based on the type of panel.

All Perry ESEP relays are mounted in control room electrical panels; and therefore an amplification factor of 4.5 is used.

FMS

As described in Section 6.5 of the ESEP Report, the multi-axis to single-axis correction factor is taken as 1.2 to remove unnecessary conservatism.

Clarification Question #4

ESEP Report Section 6.3.3 indicates the walkdowns identified 6 valves that did not meet the valve operator caveats necessary to use a generic approach for estimating HCLPF capacity. ESEP Report Section 6.3.1 indicates that no significant concerns were noted which could lead to an increase in sample size. Are the 6 valves representative of a larger population that do not meet the caveat, or are these the only 6 valves, within the scope of the ESEP, not meeting the caveat (i.e., 100% of the population)? What is the estimated HCLPF capacity of these valves, relative to the review level ground motion (RLGM) (Ground Motion Response Spectra [GMRS])?

FENOC Response

Observing valves that do not meet operator caveats for the generic approach does not constitute a significant concern. Rather, it requires a more detailed HCLPF calculation than is provided by the generic approach.

Additionally, a thorough review of plant documentation was conducted for all ESEP valves that were inaccessible or difficult to view during plant walkdowns. Between the walkdown and the documentation review, 100% of ESEP valves were evaluated for operator caveats.

After walkdowns and a review of plant documentation, a total of 15 valves on the ESEL exceeded operator caveats. For HCLPF calculations, these valves were grouped based on similar seismic characteristics (operator height, operator weight, line diameter, and seismic demand). The six valves listed in Section 6.3.3 of the ESEP Report focus on the bounding valve cases that represent the valve groups. The full list of valves that exceed operator caveats is provided in ***Table 2*** below.

The HCLPFs for these valves range from 0.29 g to 0.87g, which exceed the RLGM of 0.24g.

Table 2. Perry ESEP Valves Exceeding Operator Caveats

ESEL ID	VALVE ID
179	1E22F0012
19	1E51F0022
5	1E51F0045
152	1E12F0053A
153	1E12F0053B
138	1E12F0008
139	1E12F0009
8	1E51F0019
20	1E51F0077
21	1E51F0078
405	1P57F0015A
406	1P57F0015B
16	1E51F0076
407	1P57F0020A
408	1P57F0020B

Clarification Question #5

ESEP Report Section 6.6 states that "Attachment B tabulates the HCLPF values for all components on the ESEL." Attachment A, the ESEL, contains 423 items on 23 pages. Attachment B contains 14 pages of HCLPF values, with no cross reference back to the ESEL Table items. The staff cannot confirm that all ESEL items are included in Attachment B. For clarification, provide a roadmap from the ESEL Table (Attachment A) to the HCLPF Table (Attachment B).

FENOC Response

Attachment A of the ESEP report contains the ESEL with a total of 423 components with their description, position, location and current seismic class. Attachment B of the ESEP report contains the Tabulated HCLPF values with the same 423 components, reordered according to their defined component groups, with the fragility results (HCLPF, β_C, β_R and β_U, A_m), the failure mode and fragility method used. For clarification, an additional column identifying the ESEL item number is added to Attachment B, and presented in Attachment 2 of this response.

Clarification Question #6

Section 3.1.5 of the ESEP Reports states:

Critical indicators and recorders are typically physically located on panels/cabinets and are included as separate components; however, seismic evaluation of the instrument indication may be included in the panel/cabinet seismic evaluation (rule-of-the-box).

Section 6.1 of the ESEP Reports states:

A number of components on the ESEL are breakers and switches that are housed in a "parent" component, such as a motor control center (MCC) or switchgear. For the purpose of this evaluation, calculations are not explicitly performed for these housed components. Instead, their HCLPF is assigned based on the parent component.

The information provided in both paragraphs is not clear. Please provide a more detailed description of both approaches, how they are different, when would each approach be applied, and examples for both approaches to show how the HCLPF values of the devices were determined, including consideration of cabinet amplification, if applicable. Also, describe whether any of these devices are sensitive to vibration as are relays and other devices with contacts, and if so, how they were evaluated. Lastly, if the qualification of the devices is based on the cabinet/panel they are housed in, which have been previously qualified as part of an equipment class ("parent" component), how is it known/confirmed that the parent component normally contains the particular device.

FENOC Response

The above referenced sections of the ESEP Report describe the approach to the rule-of-the-box. Section 3.1.5 states that indicators and recorders are listed on the ESEL as distinct items, but that their seismic evaluation is based on the evaluation of the "parent" component. Section 6.1 reiterates that when an ESEL item is identified to be mounted on a parent component, the HCLPF of the parent component is assigned to the item.

Twenty relays in the ESEL associated with the FLEX Phase 1 response required functional evaluations. The relays evaluated are housed within panels 1H13P0628, 1H13P0631, 1H13P0618, and 1H13P0621 located in the CC at EL 654. The seismic fragility for the relay chatter mode is developed based on the applicable TRS and including cabinet amplification. For the relay chatter evaluation, the CDFM methodology is followed as described in EPRI NP-6041.

All other housed items on the ESEL are addressed on the basis of the "rule-of-the-box". The HCLPF calculations are based on the guidance provided in EPRI TR-1002988, in which a generic capacity of 1.8g or use of GERS is endorsed for functional capacity. The anchorage capacity for the parent component is also evaluated. The HCLPF developed for the parent component is assigned as the HCLPF value to all ESEL components housed therein, as documented in Attachment B of the ESEP report.

For example, transmitter 1G43N0060B was walked down to confirm its location and mounting on rack 1H51P1111. This component is therefore assigned the HCLPF of 1H51P1111. Similarly, a walkdown confirmed that the Lube Oil Cooler 1E51B0002 and the Reactor Core

Isolation Cooling (RCIC) Turbine Governor Valve 1E51F0511 are mounted on the RCIC Turbine 1E51C0002. As the generic HCLPF calculation for 1E51C0002 considers everything within the boundary of the skid, 1E51B0002 and 1E51F0511 are assigned the HCLPF of 1E51C0002.

Clarification Question #7

Section 5.2 of the ESEP Report for Perry states the following:

> *Subsequent equipment HCLPF calculations and fragility evaluations are based on the conservative deterministic failure margin (CDFM) approach. In accordance with EPRI 1019200 [10] "Seismic Fragility Applications Guide Update," the seismic analyses are performed using BE structure stiffness, mass and damping characteristics, and the BE subsurface Vs profile compatible with the expected seismic shear strains. The resulting ISRS approximately represent the 84th percentile response suitable for use in the CDFM calculations.*

Section 4 of the Seismic Evaluation Guidance, Augmented Approach (EPRI 3002000704) allows the development of ISRS calculated from new soil structure interaction (SSI) models. The guidance document indicates that: EPRI 1025287 (screening, prioritization and implementation details [SPID]) and the ASME/ANS PRA Standard give guidance on acceptable methods to compute both the GMRS and the associated ISRS. Table 6-5 in the SPID document, under the SFR-C6 entry, indicates that ASME/ANS PRA Standard (Addendums A and B) requires consideration of the variation of soil properties (Vs profile). Also, the SFR-C5 entry indicates that if the median-centered response analysis is performed, the evaluation should estimate the median response (i.e., structural loads and ISRS) and variability in the response using established methods.

Based on EPRI 1019200, which was referenced by the ESEP Reports, parameter variation should be incorporated into SSI analyses in order to characterize the uncertainty in the SSI demands. EPRI 1019200 indicates that the SSI analyses in ASCE 4 be followed, which require that SSI evaluations include lower bound and upper bound soil profiles to account for parameter variation in SSI. EPRI 1019200 also indicates that for the structural model, the best estimate (median) and uncertainty variation in the frequency should be considered.

Therefore, please describe how parameter variation is incorporated into the SSI analyses for the structural model and subsurface while using only the best estimate (BE) structure stiffness, mass and damping characteristics, and the BE subsurface Vs profile. Related to the above discussion, if only the BE is used for the structural model and soil profile, explain how the ISRS would approximately represent the 84th percentile response, as stated in the ESEP report.

FENOC Response

The recommended guidelines (EPRI 1019200) are used to obtain a deterministic response for the given shape of the foundation input response spectrum (FIRS), and using best estimate structure and soil stiffness and conservative estimate of median damping. This response approximates the 84th percentile relative to the statistical distribution that would result from say a set of 30 calculations randomly varying stiffness and damping parameters and using a set of 30 time histories. The deterministic response is suitable for use in the CDFM calculation of fragilities of plant SSCs.

EPRI 1019200 further states that the SSI analysis should address best estimate + parameter variation, and that the peak shifting should be used instead of peak broadening recommended in ASCE 4-98. However, the reported analysis uses only the result from the BE soil column

(stiffness and damping), and median structure stiffness and damping. The effects of variability of the soil column stiffness and damping are considered using the approach in EPRI NP-6041. This approach estimates the upper and lower bound SSI frequencies based on the fixed base frequency, the best estimate SSI frequency and a CV factor in the soil column stiffness. Considering the depth to rock and the overlying basal gravel and engineered fill, the upper and lower bound SSI frequencies are estimated to be in the range of ± 15% of the best estimate SSI frequency.

Therefore, the upper and lower bound seismic responses are not expected to be significantly different from the best estimate response. Nevertheless, the variability in the SSI stiffness is accommodated in the CDFM method for calculating fragilities by peak shifting of at least ± 20%.

Clarification Question #8

Section 6.4 of the ESEP Reports states that all HCLPF calculations were performed using the CDFM methodology. Table 7-1 states that "Fragility is calculated…". In addition, Appendix B provides information for β_C, β_R and β_U, which would indicate that a fragility analyses has been performed.

The licensee is requested to confirm that only the CDFM methodology has been used, or to identify that fragility analysis has also been performed. If fragility analyses have been performed, then the description of the methods used to estimate HCLPF values should be updated to include a description of the fragility analyses methods used.

FENOC Response

CDFM methodology has been used for all calculations as stated in Section 6.4 of the ESEP Report. The use of the word "fragility" in this context refers to the hybrid approach for fragilities where the HCLPF capacity is calculated first using CDFM methodology and the median capacity is then determined with an assumed composite variability (β_C). The hybrid approach to fragilities and the associated variabilities are described in Section 6.4.1 of EPRI 1025287. It is noted that reporting the median capacity is not required for the ESEP, and are only provided as additional information.

Attachment 1.
Walkdown Team Member Resumes

ABS Consulting

FARZIN R. BEIGI, P.E.

PROFESSIONAL HISTORY

ABSG Consulting Inc., Oakland, California, Senior Consultant, 2004–Present
Technical Manager, 2001–2004

EQE International, Inc., California, Principal Engineer, 1990–2001

TENERA L.P., Berkeley, California, Project Manager, 1982–1990

PROFESSIONAL EXPERIENCE

Mr. Beigi has more than 32 years of professional structural and civil engineering experience. As a Senior Consultant for ABS Consulting, Mr. Beigi provides project management and structural engineering services, primarily for seismic evaluation projects. He has extensive experience in the areas of seismic evaluation of structures, equipment, piping, seismic criteria development, and structural analysis and design. Selected project accomplishments include the following:

- Currently Mr. Beigi is managing the seismic portion of the seismic PRA project for FirstEnergy Nuclear Operating Company's four nuclear reactors at Davis-Besse Nuclear Power Station, Perry Nuclear Power Plant, and Beaver Valley Power Station Units 1 and 2. This project involves modelling of structures, generation of response spectra within those structures, walkdowns of all components on the PRA list and performing seismic fragility evaluations for selected equipment and structures.
- Most recently, Mr. Beigi has been involved in performing seismic and wind fragility analyses of equipment and structures at Gösgen Nuclear Power Plant in Switzerland, Lungmen Nuclear Power Plant in Taiwan, Oconee Nuclear Station in U.S., Point Lepreau Nuclear Plant in Canada, Beznau Nuclear Power Plant in Switzerland, Olkiluoto Nuclear Power Plant in Finland, and Neckarwestheim Nuclear Power Station in Germany.
- Provided new MOV seismic qualification (weak link) reports, for North Anna, Surry, and Kewaunee nuclear plants to maximize the valve structural thrust capacity by eliminating conservatisms found in existing qualification reports and previously used criteria.
- At Salem Nuclear Power Plant, Mr. Beigi developed design verification criteria for seismic adequacy of heating, ventilation, and air conditioning (HVAC) duct systems. He also performed field verification of as-installed HVAC systems and provided engineering evaluations documenting seismic adequacy of these systems, which included dynamic analyses of selected worst-case bounding samples.

- Mr. Beigi has participated in several piping adequacy verification programs for nuclear power plants. At Watts Bar and Bellefonte Nuclear Plants, he was involved in the development of walkdown and evaluation criteria for seismic evaluation of small bore piping and participated in plant walkdowns and performed piping stress analyses. At Oconee Nuclear Station, Mr. Beigi was involved in developing screening and evaluation criteria for seismic adequacy verification of service water piping system and performed walkdown evaluations as well as piping stress analyses. At Browns Ferry Nuclear Plant, Mr. Beigi was involved in the assessment of seismic interaction evaluation program for large and small bore piping systems.
- Mr. Beigi performed a study for the structural adequacy of bridge cranes at Department of Energy's (DOE) Paducah Gaseous Diffusion Plant utilizing Drain-2DX non-linear structural program. The study focused on the vulnerabilities of these cranes as demonstrated in the past earthquakes.
- Mr. Beigi has generated simplified models of structures for facilities at Los Alamos National Lab and Cooper Nuclear Station for use in development of building response spectra considering the effects of soil-structure-interactions.
- Mr. Beigi has participated as a Seismic Capability Engineer in resolution of the U.S. Nuclear Regulatory Commission's Unresolved Safety Issue A-46 (i.e., Seismic Qualification of Equipment) and has performed Seismic Margin Assessment at the Browns Ferry Nuclear Power Plant (Tennessee Valley Authority [TVA]), Oconee Nuclear Plant (Duke Power Co.), Duane Arnold Energy Center (Iowa Electric Company), Calvert Cliffs Nuclear Power Plant (Baltimore Gas and Electric), Robinson Nuclear Power Plant (Carolina Power & Light), and Bruce Power Plant (British Energy – Ontario, Canada). He has performed extensive fragility studies of the equipment and components in the switchyard at the Oconee Nuclear Power Plant.
- Mr. Beigi has developed standards for design of distributive systems to be utilized in the new generation of light water reactor power plants. These standards are based on the seismic experience database, testing results, and analytical methods.
- Mr. Beigi managed EQE's on-site office at the Tennessee Valley Authority Watts Bar Nuclear Power Plant. His responsibilities included staff supervision and technical oversight for closure of seismic systems interaction issues in support of the Watts Bar start-up schedule. Interaction issues that related to qualification for Category I piping systems and other plant features included seismic and thermal proximity issues, structural failure and falling of non-seismic Category I commodities, flexibility of piping systems crossing between adjacent building structures, and seismic-induced spray and flooding concerns. Mr. Beigi utilized seismic experience data coupled with analytical methods to address these seismic issues.
- As a principal engineer, Mr. Beigi conducted the seismic qualification of electrical raceway supports at the Watts Bar Plant. The qualification method involved in-plant walkdown screening evaluations and bounding analysis of critical case samples. The acceptance criteria for the bounding analyses utilized ductility-based criteria to ensure consistent design margins. Mr. Beigi also provided conceptual design

modifications and assisted in the assessment of the constructability of these modifications. Mr. Beigi utilized similar methods for qualification of HVAC ducts and supports at Watts Bar, and assisted criteria and procedures development for HVAC ducting, cable trays, conduit and supports at the TVA Bellefonte nuclear power plant.

- Mr. Beigi also has extensive experience utilizing finite element computer codes in performing design and analysis of heavy industrial structures, systems, and components. At the Texas Utility Comanche Peak Nuclear Power Plant, Mr. Beigi administered and scheduled individuals to execute design reviews of cable tray supports; evaluated generic design criteria for the design and construction of nuclear power plant systems and components and authored engineering evaluations documenting these reviews.

Mr. Beigi has also been involved in a number of seismic risk assessment and equipment strengthening programs for high tech industry, biotech industry, petrochemical plants, refineries, and other industrial facilities. Selected project accomplishments include:

- Most recently performed Seismic Qualification of Critical Equipment for the Standby Diesel Power Plants Serving Fort Greely, and Clear Air Force Station, Alaska. Projects also included design of seismic restraints for the equipment and design of seismic supports for conduit, cable tray, duct, and piping systems. Both facilities are designated by the Department of Defense as a Seismic User Group Four (SUG-IV) facility. Seismic qualification of equipment and interconnections (conduit, duct and piping) involved a combination of stress computations, compilation of shake table data and the application of experience data from past earthquakes. Substantial cost savings were achieved by maximum application of the experience data procedures for seismic qualification.
- Assessment of earthquake risk for Genentech, Inc., in South San Francisco, California. The risk assessments included damage to building structures and their contents, damage to regional utilities required for Genentech operation, and estimates of the period of business interruption following a major earthquake. Provided recommendations for building or equipment upgrades or emergency procedures, with comparisons of the cost benefit of the risk reduction versus the cost of implementing the upgrade. Project included identification of equipment and piping systems that were vulnerable under seismic loading and design of retrofit for those components as well as providing construction management for installation phase of the project.
- Fault-tree model and analysis of critical utility systems serving Space Systems/Loral, a satellite production facility, in Palo Alto, California.
- Seismic evaluation and design of retrofits for equipment, tools and process piping as well as clean room ceilings and raised floors at UMC FABs in Taiwan.
- For LDS Church headquartered in Utah, performed seismic vulnerability assessment and ranked over 1,200 buildings of miscellaneous construction types for the purpose of retrofit prioritization.

- Seismic evaluation and design of retrofits for clean room ceilings at Intel facilities in Hillsborough, Oregon.
- Assessment of programmable logic controls as part of year 2000 (Y2K) turn over evaluation at an automatic canning facility in Stanislaus, California.
- Seismic evaluation and design of retrofits for equipment and steel storage tanks at the Colgate-Palmolive plant in Cali, Colombia.
- Design of seismic anchorage for equipment and fiberglass tanks at the AMP facilities in Shizouka, Japan.
- Evaluation and design of seismic retrofits for heavy equipment, and piping systems at Raychem facilities in Redwood City and Menlo Park, California.
- Assessment of the seismic adequacy of equipment, structures and storage tanks at the Borden Chemical Plant in Fremont, California.
- Design of seismic bracing for fire protection and chilled water piping systems at the Goldman Sachs facilities in Tokyo, Japan.
- Design of seismic retrofits for low rise concrete and steel buildings and design of equipment strengthening schemes at AVON Products Co. in Japan.
- Managed the design and construction of seismic retrofits for production equipment and storage tanks at Coca Cola Co. in Japan.
- Seismic evaluation and design of retrofit for equipment, piping and structures at the UDS AVON Refinery located in Richmond, California.
- Seismic assessment and peer review of the IBM Plaza Building, a 31-story high rise building located in the Philippines.
- Seismic evaluation and conceptual retrofit design for the headquarters building of the San Francisco Fire Department.
- Equipment strengthening and detailed retrofit design for the Bank of America Building in San Francisco.
- Equipment strengthening and detailed retrofit design for Sutro Tower in San Francisco.
- Equipment strengthening and detailed retrofit design for Pacific Gas & Electric substations in the San Francisco, California, area.
- Seismic evaluations and loss estimates (damage and business interruption) for numerous facilities in Japan, including Baxter Pharmaceuticals, NCR Japan Ltd., and Somar Corporation.
- Seismic evaluation of concrete and steel buildings at St. Joseph Hospital in Stockton, California, in accordance with the guidelines provided in FEMA 178.

EDUCATION

B.S., Civil Engineering, San Francisco State University, San Francisco, California, 1982

REGISTRATION

Professional Engineer: California
Seismic Qualification Utilities Group Certified Seismic Capability Engineer
Training on Near-Term Task Force Recommendation 2.3 – Plant Seismic Walkdowns

AFFILIATIONS

American Society of Civil Engineers, Professional Member

SELECTED PUBLICATIONS

Wakefield, D., F. Beigi, and R. Fine, "An Approach to Seismic PRA SSC Screening," 2015 International Topical Meeting on Probabilistic Safety Assessment and Analysis (PSA 2015), Sun Valley, Idaho, 2015.

Richner, M. Sener Tinic, M. Ravindra, R. Campbell, F. Beigi, and A. Asfura, "Insights Gained from the Beznau Seismic PSA Including Level 2 Considerations," 2008 International Topical Meeting on Probabilistic Safety Assessment and Analysis (PSA 2008), Knoxville, Tennessee, 2008.

Klapp, U., F. R. Beigi, W. Tong, A. Strohm, and W. Schwarz, "Seismic PSA of Neckarwestheim 1 Nuclear Power Plant," 19th International Conference on Structural Mechanics in Reactor Technology (SMiRT 19), Toronto, Canada, August 12–17, 2007.

Asfura, A. P., F. R. Beigi, and B. N. Sumodobila, "Dynamic Analysis of Large Steel Tanks," 17th International Conference on Structural Mechanics in Reactor Technology (SMiRT 17), Prague, Czech Republic, August 17–22, 2003.

"Seismic Evaluation Guidelines for HVAC Duct and Damper Systems," EPRI Technical Report 1007896, published by the Electric Power Research Institute, April 2003.

Arros, J., and F. Beigi, "Seismic Design of HVAC Ducts based on Experienced Data," Current Issues Related to Nuclear Plant Structures, Equipment and Piping, proceedings of the 6th Symposium, published by North Carolina State University, Florida, December 1996.

Beigi, F. R., and J. O. Dizon, "Application of Seismic Experience Based Criteria for Safety Related HVAC Duct System Evaluation," Fifth DOE Natural Phenomenon Hazards Mitigation Symposium, Denver, Colorado, November 13–14, 1995.

Beigi, F. R., and D. R. Denton, "Evaluation of Bridge Cranes Using Earthquake Experience Data," presented at Fifth DOE Natural Phenomenon Hazards Mitigation Symposium, Denver, Colorado, November 13–14, 1995.

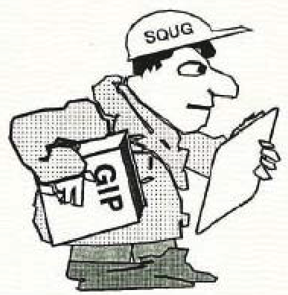
SQUG

Certificate of Achievement

This is to Certify that

Farzin R. Beigi

has Completed the SQUG Walkdown Screening
and Seismic Evaluation Training Course
Held May 3–7, 1993



Neil P. Smith, Commonwealth Edison
SQUG Chairman

David A. Freed, MPR Associates
SQUG Training Coordinator

Robert P. Kassawara, EPRI
SQUG Program Manager

279 Dorchester Rd, Akron Ohio 44313
Phone 234-678-8262
E-mail jreddman@aol.com

JOHN E. REDDINGTON

Work experience

January 2007 to present:

Principal Consultant, Probabilistic Risk Analysis: Lead fire PRA for the Davis-Besse fire PRA, including contractor oversight and coordination; specialization in HRA, including operations interface, model integration, dependency analysis and PWROG HRA Subcommittee; fire PRA peer reviews; currently technical lead for seismic PRA for FENOC fleet; mentor to junior and co-op engineers.

August 2004- January 2007:

Principal Programs Engineer, Fleet office Akron, OH: responsible for the fire protection program for the FENOC fleet

August 2003 to August 2004: Davis-Besse Nuclear Station Oak Harbor, OH

Training Manager: Responsible for direction and implementation of site's accredited training programs. Heavily involved with high intensity training required to get Davis-Besse back on line following a two year outage replacing the reactor head.

January 2001 to August 2003 : Davis-Besse Nuclear Station Oak Harbor, OH

Supervisor Quality Assurance Oversight for Maintenance:

Responsible for value added assessments based on performance as well as compliance. Ensure industry best practices are used as standards for performance in maintenance, outage planning, and scheduling.

1996 to January 2001,

Superintendent Mechanical Maintenance

Manage the short and long term direction of the Mechanical and Services Maintenance Departments. Responsible for 80 to 90 person department with a budget between 7 and 15 million dollars a year. Direct the planning, engineering, and field maintenance activities. Direct oversight of outage preparations and implementation. One year assignment working with Technical Skills Training preparing for accreditation.

1993 – 1996

Shift Manager

Act as the on-shift representative of the Plant Manager. Responsible for providing continuous management support for all Station activities to ensure safe and efficient plant operation. Establish short term objectives for plant control and provide recommendations to the Shift Supervisor. Monitor core reactivity and thermal hydraulic performance, containment isolation capability, and plant radiological conditions during transients and advise the operating crew on the actions required to maintain adequate shutdown margin, core cooling capability, and minimize radiological releases.

1991 – 1993

Senior System and Maintenance Engineer

Provide Operations with system specific technical expertise. Responsible for maintaining and optimizing the extraction steam and feedwater heaters, the fuel handling equipment and all station cranes.

Acted as **Fuel Handling Director** during refueling outages. Responsibilities Included maintaining the safe and analyzed core configuration, directing operation personnel on fuel moves, directing maintenance personnel on equipment repair and preventative maintenance.

1986 – 1991

Senior Design Engineer and Senior Reactor Operator student

Activities included modification design work and plant representative on the Seismic Qualification Utilities Group and the Seismic Issues subcommittee. Licensed as a Senior Reactor Operator following extensive classroom, simulator, shift training, and Nuclear Regulatory Commission examination.

1984 – 1986 Sargent & Lundy Engineers Chicago, IL

Senior Structural Engineer

Responsible for a design team of engineers for the steel design and layout to support the addition of three baghouses on a coal fired plant in Texas. Investigated and prepared both remedial and long term solutions to structural problems associated with a hot side precipitator.

1980 – 1984

Structural Engineer

Responsible for steel and concrete design and analysis for LaSalle and Fermi Nuclear Power plants. Performed vibrational load and stability analysis for numerous piping systems. Member of the on-site team of engineers responsible for timely in-place modifications to the plant structure at LaSalle.

1979 – 1980 Wagner Martin Mechanical Contractors Richmond, IN

Engineer/Project Manager

Responsible for sprinkler system design through approval by appropriate underwriter. Estimator and Project Manager on numerous mechanical projects up to 1.8 million dollars.

Education	1975 - 1979	Purdue University	West Lafayette, IN
	Bachelor of Science in Civil Engineering		
	1990- 1995	University of Cincinnati	Cincinnati, OH
	Master of Science in Nuclear Engineering		

Professional memberships

Professional Engineer, State of Illinois, 1984

Professional Engineer, State of Ohio, 1986

Senior Reactor Operator, Davis-Besse Nuclear Power Plant, 1990

Qualified Lead Auditor, 2003

SQUG qualified 1987

Other

Committee Chairman, Young Life Toledo Southside, Lake Erie West Region

Sunday School Teacher- College age young people.

EPRI

Certificate of Achievement

This is to Certify that

John E. Reddington

has Completed the Trial SQUG A46 Walkdown Screening and Seismic Evaluation Training Course Held November 20-25, 1987

Richard G. Starck II

Richard G. Starck[II], MPR Associates, Inc.
Training Coordinator

R.P. Kassawara

Robert P. Kassawara, EPRI
Program Manager

Eddie M. Guerra, P.E.

Senior Structural Engineer

Years Experience
5

Level
6

Education
M. Eng., Structural Engineering, Lehigh University, Bethlehem, PA – May 2010

B.S., Civil Engineering, University of Puerto Rico, Mayaguez, PR – Dec. 2008

Professional Registrations
Professional Engineer: Puerto Rico – 2013 (PE24153)

SQUG Certified Seismic Capability Engineer

Professional Affiliations
American Society of Civil Engineers (ASCE)

American Society of Mechanical Engineers (ASME)

Network for Earthquake and Engineering Simulation (NEES)

Society of Hispanic Professional Engineers (SHPE) (Vice-President, Western Pennsylvania Region)

Honors and Awards
2010 Recipient of the Thornton Tomasetti Foundation Scholarship

Golden Key International Honor Society

Tau Beta Pi Engineering Honor Society

Dean's List University of Puerto Rico

Academic Activities
Adjunct Professor, Department of Mathematics, Community College of Allegheny County

Guest Speaker - "Challenges for a New Generation of Structural Engineers," Department of Civil and Environmental Engineering, Lehigh University.

Skill Areas:

- Seismic Engineering
- Seismic PRA
- Ductile Steel Design
- Soil-Structure Interaction
- Reinforced Concrete Design
- Wind Aerodynamics
- Seismic Walkdowns
- Fragility Analysis
- Finite Element Analysis
- Advanced Structural Analysis
- Project Management
- Structural Steel Design
- Impact Engineering
- Nuclear Safety Systems

Mr. Ed M. Guerra has served as a Senior Structural Engineer for RIZZO Associates (RIZZO) in the fields of seismic engineering, wind dynamics, impact engineering, and design of steel and concrete structures. Mr. Guerra has been involved in several Seismic, Wind and Aircraft Impact Risk Assessments for nuclear plants, both in the US and international. As part of his Seismic PRA experience, Mr. Guerra has been involved in all supporting aspects of the project, including SEL development, Seismic Walkdowns, Building Dynamic Analysis, SSI Analysis, Fragility Analysis of Equipment, Relays and Structures and External Peer Reviews. Mr. Guerra has also worked closely with systems modelers and PRA analysts especially throughout the iterative process of identifying and reevaluating top contributors to the plant risk level.

Mr. Guerra has performed fragility evaluations and seismic walkdowns in support of 2.3 and 2.1 NTTF Programs for several NPPs in the US. Recently, Mr. Guerra has been appointed to the Joint Committee on Nuclear Risk Management (JCNRM) as a contributor for part 5 "Requirements for Seismic Events At-Power PRA" of the ASME/ANS PRA Standard. His main areas of interest in Seismic PRA are the effects of structural and soil non-linearity on components, wave-propagation effects on structures, the correlation of PRA failure modes and structural failure mechanisms, and smart data management and logistics. Mr. Guerra is SQUG-certified and has completed the EPRI-sponsored Seismic PRA training. He is an active participant of EPRI Workshops currently held to provide lessons learned to US utilities currently undergoing Seismic PRAs.

Watts Bar NPP Seismic PRA

Tennessee Valley Authority|
Rhea County, Tennessee
12/2014 – 01/2015

Mr. Guerra performed seismic fragility evaluations for Air Handling Units, Condensers and Cooler Units in support of Watts Bar Seismic PRA. In reference to EPRI 103959 and EPRI 6041, Mr. Guerra developed fragility parameters for functional and structural failure modes based on available test data and seismic qualifications for each of the aforementioned groups of equipment. The resulting fragility parameters, including potential spatial interactions, were used as input to the PRA model for subsequent risk quantification.

Computer Skills

STAAD Pro, SASSI, PC-SPEC, ANSYS, AutoCAD, SAP2000, RAM, Mathcad, and Microsoft Project

Publications

Guerra, Eddie M., Impact Analysis of a Self-Centered Steel Concentrically Braced Frame," NEES Consortium, May-July 2007

Languages

English, Spanish

Tornado Screening Walkdowns for Genkai Units 3 & 4

Scientech | Kyushu Electric Power Company | Genkai, Japan

07/2014 – 08/2014

Mr. Guerra performed tornado walkdowns for Genkai Units 3 and 4 in order to identify and assess the effect of tornado-borne missiles against safety-related structures. During the 3-day walkdown period, the walkdown team focused on three main aspects: confirming that a sample of previously identified missiles comply with the findings documented in previous inspection reports, identifying and record detailed information for vulnerable critical targets, and recording detailed design characteristics and dimensions of critical potential missiles. The information collected by the team of walkdown engineers was subsequently used to reduce the number of potential missiles within the specified radius for Units 3 and 4. In addition, the walkdown team assessed the condition of existing counter measures as well as provided expert opinion on alternate countermeasures to sustain tornado effects.

Perry NPP Seismic PRA

ABS Consulting | FirstEnergy Nuclear Operating Company | Perry, Ohio

08/2012 – Present

Mr. Guerra serves as the Senior Project Engineer for the calculation of Seismic Fragilities for mechanical and electrical equipment in support of the Seismic PRA for the plant. In his role as a structural analyst, Mr. Guerra has implemented both FA and CDFM methodologies in order to develop fragility curves for components to be credited in the plant logic model. In addition to mechanical and electrical equipment as defined in the EPRI 21 Classes, Mr. Guerra is performing fragility analyses for NSSS components and plant distributions systems. Parameters necessary for the development of fragility curves are being calculated following EPRI guidelines including EPRI 103959, EPRI 6041, EPRI 1002988 and the EPRI Update 1019200. Results from the Seismic PRA will comply with the ASME ANS RA-Sa-2009 Standard and the NTTF 2.1 Recommendation.

As Senior Project Engineer he engaged in performing seismic fragilities for reinforced concrete shear walls in support of the Seismic PRA for the plant. Mr. Guerra has implemented the use of SAP2000 models and Mathcad calculations in order to evaluate the shear walls seismic capacity and their associated building structural responses. Fragility curves for shear walls were developed based on median, HCLPF and variability parameters estimated from EPRI guidelines. Shear wall fragilities associated with the plant's safety-related buildings have been incorporated into the plant logic model for quantification of CDF contribution.

Mr. Guerra served as the Project Engineering Associate for the Seismic Walkdowns of the Perry Nuclear Power Plant in support of its Seismic PRA and 2.1 NTTF Fukushima Resolution. Mr. Guerra was part of the team of Seismic Walkdown Engineers responsible for the walkdown of electrical and mechanical components as well as piping and electrical distribution systems. Mr. Guerra implemented the use of computer tablets to expedite the data management process prior, during and after the walkdowns. Inclusion rules, or caveats, as depicted in EPRI 6041 and EPRI 5223, were implemented when performing the walkdowns in order to reduce the level of detailed fragility calculations to be subsequently performed. Successful completion of plant walkdowns led to the reduction in the number of systems and components to be evaluated as part of the fragility calculation effort.

Mr. Guerra also served as the Project Engineering Associate for the Seismic Walkdowns of the Perry Nuclear Power Plant in support of the 2.3 NTTF Fukushima Resolution. As part of the 2.3 Walkdowns, Mr. Guerra performed visual inspections in order to identify un-analyzed, non-conforming, and degraded conditions related to Systems, Structures, and Components. Mr. Guerra implemented the use of computer tablets to expedite the data management process prior, during and after the walkdowns. The Seismic Walkdown Team adhered to the EPRI 2.3 NTTF Guidance in order to identify Potentially Adverse Seismic Conditions and efficiently implement the plant's Licensing Basis Evaluation and Corrective Action Program.

Mr. Guerra has served as the point of contact between systems modelers and PRA analysts especially throughout the iterative process of identifying and refining top contributors to the plant risk level. The objective of

this iterative process was to refine seismic fragilities to assess unintended conservatism in the fragility parameters to subsequently achieve an acceptable risk level quantified in terms of CDF or LERF.

Mr. Guerra participated in the Peer Review of the PNPP Seismic PRA in support of the work related to walkdowns, building evaluations and equipment fragilities. As part of the PNPP Peer Review, Mr. Guerra engaged in the direct response of comments from peer reviewers as well as technical discussions regarding compliance with the ASME Standard.

Beaver Valley Unit 1 NPP Seismic PRA

ABS Consulting | FirstEnergy Nuclear Operating Company | Shippingport, Pennsylvania

09/2012 – Present

Mr. Guerra serves as the Senior Project Engineer for the calculation of Seismic Fragilities for mechanical and electrical equipment in support of the Seismic PRA for the plant. In his role as a structural analyst, Mr. Guerra has implemented both FA and CDFM methodologies in order to develop fragility curves for components to be credited in the plant logic model. In addition to mechanical and electrical equipment as defined in the EPRI 21 Classes, Mr. Guerra is performing fragility analyses for NSSS components and plant distributions systems. Parameters necessary for the development of fragility curves are being calculated following EPRI guidelines including EPRI 103959, EPRI 6041, EPRI 1002988, and the EPRI Update 1019200. Results from the Seismic PRA will comply with the ASME ANS RA-Sa-2009 Standard and the NTTF 2.1 Recommendation.

As Project Engineer he engaged in performing seismic fragilities for reinforced concrete shear walls in support of the Seismic PRA for the plant. Mr. Guerra has implemented the use of SAP2000 models and Mathcad calculations in order to evaluate the shear walls seismic capacity and their associated building structural responses. Fragility curves for shear walls were developed based on median, HCLPF and variability parameters estimated from EPRI guidelines. Shear wall fragilities associated with the plant's safety-related buildings have been incorporated into the plant logic model for quantification of CDF contribution.

Mr. Guerra served as the Project Engineering Associate for the Seismic Walkdowns of the Beaver Valley Unit 1 Nuclear Power Station in support of its Seismic PRA and 2.1 NTTF Fukushima Resolution. He was part of the team of Seismic Walkdown Engineers responsible for the walkdown of electrical and mechanical components as well as piping and electrical distribution systems. Mr. Guerra implemented the use of computer tablets to expedite the data management process prior, during and after the walkdowns. Inclusion rules, or caveats, as depicted in EPRI 6041 and EPRI 5223, were implemented when performing the walkdowns in order to reduce the level of detailed fragility calculations to be subsequently performed. Successful completion of plant walkdowns led to the reduction in the number of systems and components to be evaluated as part of the fragility calculation effort.

He also served as the Project Engineering Associate for the Seismic Walkdowns of the Beaver Valley Unit 1 Nuclear Power Station in support of the 2.3 NTTF Fukushima Resolution. As part of the 2.3 Walkdowns, Mr. Guerra performed visual inspections in order to identify un-analyzed, non-conforming, and degraded conditions related to Systems, Structures, and Components. Mr. Guerra implemented the use of computer tablets to expedite the data management process prior, during and after the walkdowns. The Seismic Walkdown Team adhered to the EPRI 2.3 NTTF Guidance in order to identify Potentially Adverse Seismic Conditions and efficiently implement the plant's Licensing Basis Evaluation and Corrective Action Program.

Mr. Guerra has served as the point of contact between systems modelers and PRA analysts especially throughout the iterative process of identifying and refining top contributors to the plant risk level. The objective of this iterative process was to refine seismic fragilities to assess unintended conservatism in the fragility parameters to subsequently achieve an acceptable risk level quantified in terms of CDF or LERF.

Mr. Guerra participated in the Peer Review of the BVPS-1 Seismic PRA in support of the work related to walkdowns, building evaluations and equipment fragilities. As part of the BVPS-1 Peer Review, Mr. Guerra engaged in the direct response of comments from peer reviewers as well as technical discussions regarding compliance with the ASME Standard.

Beaver Valley Unit 2 NPP Seismic PRA

ABS Consulting | FirstEnergy Nuclear Operating Company | Shippingport, Pennsylvania

09/2012 – Present

Mr. Guerra serves as the Senior Project Engineer for the calculation of Seismic Fragilities for mechanical and electrical equipment in support of the Seismic PRA for the plant. In his role as a structural analyst, Mr. Guerra has implemented both FA and CDFM methodologies in order to develop fragility curves for components to be credited in the plant logic model. In addition to mechanical and electrical equipment as defined in the EPRI 21 Classes, Mr. Guerra is performing fragility analyses for NSSS components and plant distributions systems. Parameters necessary for the development of fragility curves are being calculated following EPRI guidelines including EPRI 103959, EPRI 6041, EPRI 1002988, and the EPRI Update 1019200. Results from the Seismic PRA will comply with the ASME ANS RA-Sa-2009 Standard and the NTTF 2.1 Recommendation.

As Project Engineer he engaged in performing seismic fragilities for reinforced concrete shear walls in support of the Seismic PRA for the plant. Mr. Guerra has implemented the use of SAP2000 models and Mathcad calculations in order to evaluate the shear walls seismic capacity and their associated building structural responses. Fragility curves for shear walls were developed based on median, HCLPF and variability parameters estimated from EPRI guidelines. Shear wall fragilities associated with the plant's safety-related buildings have been incorporated into the plant logic model for quantification of CDF contribution.

In addition, Mr. Guerra served as the Project Engineer Associate for the Seismic Walkdowns of the Beaver Valley Unit 2 Nuclear Power Station in support of its Seismic PRA and 2.1 NTTF Fukushima Resolution. He was part of the team of Seismic Walkdown Engineers responsible for the walkdown of electrical and mechanical components as well as piping and electrical distribution systems. Mr. Guerra implemented the use of computer tablets to expedite the data management process prior, during and after the walkdowns. Inclusion rules, or caveats, as depicted in EPRI 6041 and EPRI 5223, were implemented when performing the walkdowns in order to reduce the level of detailed fragility calculations to be subsequently performed. Successful completion of plant walkdowns led to the reduction in the number of systems and components to be evaluated as part of the fragility calculation effort.

Mr. Guerra also served as the Project Engineer Associate for the Seismic Walkdowns of the Beaver Valley Unit 2 Nuclear Power Station in support of the 2.3 NTTF Fukushima Resolution. As part of the 2.3 Walkdowns, Mr. Guerra performed visual inspections in order to identify un-analyzed, non-conforming, and degraded conditions related to Systems, Structures, and Components. Mr. Guerra implemented the use of computer tablets to expedite the data management process prior, during and after the walkdowns. The Seismic Walkdown Team adhered to the EPRI 2.3 NTTF Guidance in order to identify Potentially Adverse Seismic Conditions and efficiently implement the plant's Licensing Basis Evaluation and Corrective Action Program.

Mr. Guerra has served as the point of contact between systems modelers and PRA analysts especially throughout the iterative process of identifying and refining top contributors to the plant risk level. The objective of this iterative process was to refine seismic fragilities to assess unintended conservatism in the fragility parameters to subsequently achieve an acceptable risk level quantified in terms of CDF or LERF.

Mr. Guerra participated in the Peer Review of the BVPS-2 Seismic PRA in support of the work related to walkdowns, building evaluations and equipment fragilities. As part of the BVPS-2 Peer Review, Mr. Guerra engaged in the direct response of comments from peer reviewers as well as technical discussions regarding compliance with the ASME Standard.

Davis-Besse NPP Seismic PRA

ABS Consulting | FirstEnergy Nuclear Operating Company | Oak Harbor, Ohio

03/2012 – Present

Mr. Guerra serves as the Senior Project Engineer for the calculation of Seismic Fragilities for mechanical and electrical equipment in support of the Seismic PRA for the plant. In his role as a structural analyst, Mr. Guerra has implemented both FA and CDFM methodologies in order to develop fragility curves for components to be credited in the plant logic model. In addition to mechanical and electrical equipment as defined in the EPRI 21 Classes, Mr. Guerra is performing fragility analyses for NSSS components and plant distributions systems. Parameters necessary for the development of fragility curves are being calculated following EPRI guidelines

including EPRI 103959, EPRI 6041, EPRI 1002988, and the EPRI Update 1019200. Results from the Seismic PRA will comply with the ASME ANS RA-Sa-2009 Standard and the NTTF 2.1 Recommendation.

As Project Engineer he engaged in performing seismic fragilities for reinforced concrete shear walls in support of the Seismic PRA for the plant. Mr. Guerra has implemented the use of SAP2000 models and Mathcad calculations in order to evaluate the shear walls seismic capacity and their associated building structural responses. Fragility curves for shear walls were developed based on median, HCLPF and variability parameters estimated from EPRI guidelines. Shear wall fragilities associated with the plant's safety-related buildings have been incorporated into the plant logic model for quantification of CDF contribution.

Mr. Guerra served as the Project Engineering Associate for the Seismic Walkdowns of the Davis-Besse Nuclear Power Station in support of its Seismic PRA and 2.1 NTTF Fukushima Resolution. He was part of the team of Seismic Walkdown Engineers responsible for the walkdown of electrical and mechanical components as well as piping and electrical distribution systems. Mr. Guerra implemented the use of computer tablets to expedite the data management process prior, during and after the walkdowns. Inclusion rules, or caveats, as depicted in EPRI 6041 and EPRI 5223, were implemented when performing the walkdowns in order to reduce the level of detailed fragility calculations to be subsequently performed. Successful completion of plant walkdowns led to the reduction in the number of systems and components to be evaluated as part of the fragility calculation effort.

In addition, he served as the Project Engineering Associate for the Seismic Walkdowns of the Davis-Besse Nuclear Power Station in support of the 2.3 NTTF Fukushima Resolution. As part of the 2.3 Walkdowns, Mr. Guerra performed visual inspections in order to identify un-analyzed, non-conforming, and degraded conditions related to Systems, Structures, and Components. Mr. Guerra implemented the use of computer tablets to expedite the data management process prior, during and after the walkdowns. The Seismic Walkdown Team adhered to the EPRI 2.3 NTTF Guidance in order to identify Potentially Adverse Seismic Conditions and efficiently implement the plant's Licensing Basis Evaluation and Corrective Action Program.

Mr. Guerra, as a Project Engineering Associate, engaged in the Soil-Structure Interaction Analysis for the Davis-Besse Auxiliary Building. Mr. Guerra developed FE computer models for the Auxiliary Building using AutoCAD, ANSYS, and SAP2000. Mr. Guerra then performed both fixed-base and Soil-Structure Interaction Analyses of the Auxiliary Building using SAP2000 and SASSI programs. Input ground motion was derived from the Site-Specific Seismic-Hazard Analysis performed in support of the Seismic PRA. Seismic input was defined at the Reactor Foundation Level and subsequently, In-Structure Response Spectra, or ISRS, were developed at several floor elevations of the Auxiliary Building. The final plots for ISRS at varying locations in the structure were used as the median-centered seismic demand for the fragility analysis of structures and equipment in the Auxiliary Building.

He also served as the Project Engineering Associate engaged in a seismic analysis of the Auxiliary Building-Area 7 of the Davis Besse Nuclear Power Station. As part the analysis, Mr. Guerra was responsible for developing Finite Element and Stick Models using ANSYS and SAP2000. Mr. Guerra developed graphical In-Structure Response Spectra comparisons denoting the dynamic responses arising from both Stick and FE models subjected to the same ground input motion. Results of the analysis provided the basis for validating the use of existing IPEEE stick models for the seismic re-evaluation of plant structures to support the SPRA and the NTTF 2.1 submittals.

Mr. Guerra has served as the point of contact between systems modelers and PRA analysts especially throughout the iterative process of identifying and refining top contributors to the plant risk level. The objective of this iterative process was to refine seismic fragilities to assess unintended conservatism in the fragility parameters to subsequently achieve an acceptable risk level quantified in terms of CDF or LERF.

Mr. Guerra participated in the Peer Review of the DBNPS Seismic PRA in support of the work related to walkdowns, building evaluations and equipment fragilities. As part of the DBNPS Peer Review, Mr. Guerra engaged in the direct response of comments from peer reviewers as well as technical discussions regarding compliance with the ASME Standard.

Duane Arnold NPP – Seismic & Wind Qualification of Louvered Panel Modules

Duane Arnold | Cedar Rapids, Iowa

01/2012 – 03/2012

Mr. Guerra, Project Engineer Associate, assisted with the qualification of a tornado Louvered Panel Module assembly for a Chiller Unit Enclosure to be erected for the Duane Arnold Nuclear Power Plant. The extent of the qualification included the assessment of tornado wind loading effects, impact effects of air-borne missiles, seismic loading and inner-structure ventilation criteria. In addition to the performed linear elastic analyses, the qualification process included the application of plastic design and energy balance concepts in order to assess impact effects and inner-structure ventilation criteria respectively.

Y-Loop Testing Facility Inspection of Shenyang Turbo Machinery

Shenyang Turbo Machinery | Shenyang, P. R. of China

11/2011 – 12/2011

Mr. Guerra, Engineer Associate II, was part of the team in charge of performing the inspection of the Y-Loop Testing Facility for the Cooling System of the AP1000 Nuclear Power Plant. The inspection procedures focused primarily on welded connections, steel structural members and bolted connections. Final recommendations were provided which led to the approval of the design and installation of the Y-Loop Testing Facility Steel Structure.

Koeberg NPP Seismic Evaluation

ESKOM | Cape Town, South Africa

09/2011 – 11/2011

Mr. Guerra, Engineer Associate II, performed the structural assessment of reinforced concrete shear walls in the Koeberg NPP subjected to the effects from Aircraft Impact Loading. Semi-empirical relations associated to perfectly plastic collisions were implemented for the evaluation of local, global and secondary effects resulting from a missile impact on concrete walls. Results from the analysis provided the basis for risk informed assessments in relation to Aircraft Impact on Koeberg's Safety-Related Structures.

Mr. Guerra served as the Engineer Associate II for the calculation of Seismic Fragilities for mechanical and structural components in support of the Seismic Margin Assessment of the Koeberg Nuclear Power Plant. In his role as a structural analyst, Mr. Guerra implemented CDFM methodologies in order to determine seismic fragilities for components falling within the Review Level Earthquake screening threshold. Parameters necessary for the development of seismic fragilities were calculated following EPRI guidelines including EPRI 103959, EPRI 6041, and EPRI 1002988. Results from the seismic evaluation of screened-in components were implemented as the basis for more detailed analyses and minor modifications.

Mr. Guerra, Engineer Associate II, was part of the Seismic Walkdown Team responsible for the walkdown of electrical and mechanical components as well as piping and electrical distribution systems in support of the SMA for the Koeberg NPP. Mr. Guerra followed GIP walkdown guidelines in order to determine if components and systems were below the Review Level Earthquake margin level. Successful completion of plant walkdowns led to the reduction in the number of systems and components to be evaluated as part of the fragility calculation effort.

Santa Isabel Wind Turbine Tower Analysis and Design Revision

Siemens | Santa Isabel, Puerto Rico

10/2010 – 09/2011

Mr. Guerra, Engineer Associate I, was in charge of the analysis and design revision of a wind turbine tower to be constructed in Santa Isabel, Puerto Rico. He developed design criteria based on local building code requirements and the International Electro technical Commission (IEC) provisions for wind turbine design. The analysis encompassed the suitability of the tower against regional extreme seismic and wind demands.

General Electric Peer Review for Mechanical Equipment Qualification

General Electric | Chilca, Peru

06/2010 – 09/2011

Mr. Guerra, Engineer Associate I, provided structural revision services for General Electric Power and Water Division regarding the seismic qualification of electrical equipment to be installed in the Fenix Power Plant located in Chilca, Peru. Equipment and surrounding structures were verified following Peruvian structural standards.

Potash Fertilizer Plant Seismic Analysis

Rivers Consulting | Province of Mendoza, Argentina

06/2010 – 08/2011

Mr. Guerra, Engineer Associate I, assisted in the analysis and design revision of a Potash Fertilizer Plant to be constructed in the Mendoza Province, Argentina. He performed dynamic analysis and structural design revision of the main steel structure by complying with Local Argentinean Structural Codes.

Structural Analysis of Steel Floor Framing System

Curtiss-Wright | Cheswick, Pennsylvania

05/2011 – 06/2011

Mr. Guerra, Engineer Associate I, performed a structural analysis addressing the structural adequacy of a steel floor framing system in order to sustain heavy equipment weights. Structural revision included computer modeling of the steel framing and revision of code criteria involving both Chinese and American steel shape properties.

AP1000 HVAC Duct System Seismic Qualification

SSM | Westinghouse Electric Company, LLC | Pittsburgh, Pennsylvania

10/2010 – 05/2011

Mr. Guerra, Engineer Associate I, was part of the team responsible for the seismic qualification of the AP1000 HVAC Duct System project. He performed structural dynamic analysis of all mayor steel platforms inside steel containment vessel; investigated the interaction of steel vessel and HVAC system displacements due to normal operational and severe thermal effects; and performed finite element modeling of HVAC access doors under static equivalent seismic loads. Mr. Guerra followed AISC, ASCE and SMACNA standards for the qualification of steel duct supports.

SQUG

Certificate of Achievement

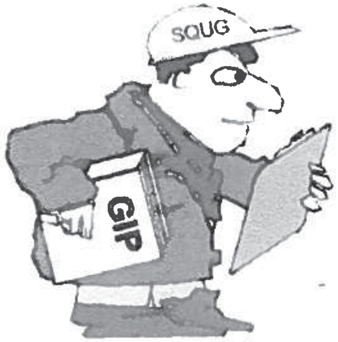
This is to Certify that

Eddie M. Guerra

has Completed the SQUG Walkdown Screening and Seismic Evaluation Training Course

June 11-15, 2012

Glen Allen, Virginia



Paul D. Baughman, ARES Corporation
SQUG Instructor

Divakar Bhargava, Dominion Generation
SQUG Chairman

Brian A. Lucarelli, E.I.T.

Engineering Associate

Years Experience
5

Level
5

Education
B.S., Civil Engineering, University of Pittsburgh, Pittsburgh, PA – December 2009

B.S., Mathematics, Waynesburg University, Waynesburg, PA - December 2009

Professional Certifications
Engineer-in-Training – PA
ET013562

Continuing Education
SQUG Walkdown Screening and Seismic Evaluation Training Course, August 2012

Short Course on Computational Geotechnics and Dynamics, August 2011.

ASDSO Estimating Permeability Webinar, December 2010.

Computer Skills
SAP2000, PLAXIS, SEEP/W, SLOPE/W, THERM, AutoCAD, ArcGIS, $Phase^2$, Slide, MathCAD

Professional Affiliations
American Concrete Institute (ACI)

ACI Committee 207 (Mass Concrete) – Associate Member

American Society of Civil Engineers (ASCE)

Engineers Without Borders (EWB)

Skill Areas:

- Seismic Fragility Evaluations
- Seismic Walkdown Inspection
- Soil Mechanics
- Roller Compacted Concrete
- Construction Materials Testing
- Quality Assurance

Mr. Lucarelli has experience in seismic walkdown inspections of operating nuclear plants and seismic fragility evaluations of structures, systems, and components. He has attended the 5-day SQUG Walkdown Screening and Seismic Evaluation Training Course and has also provided support during peer reviews to the ASME/ANS PRA Standard.

Mr. Lucarelli also has experience in geotechnical modeling, structural modeling, and quality control in support of applications for proposed nuclear plants.

Watts Barr NPP Seismic Scoping Study
URS Consulting | TVA | Rhea County, Tennessee
3/2014 – 01/2015

As an Engineering Associate, Mr. Lucarelli has been engaged in performing seismic evaluations of plant structures and components in support of developing seismic fragilities for the seismic PRA. As part of this effort, Mr. Lucarelli was part of the Seismic Walkdown Team. He was responsible to perform the NTTF 2.1 Seismic Walkdown and Equipment Screening and to perform walkdowns in support of the Expedited Seismic Evaluation Process (ESEP). Mr. Lucarelli also developed seismic fragilities for miscellaneous components such as the Polar Crane, Steel Containment Vessel Penetrations, and Control Room Ceiling.

Perry NPP Seismic PRA
ABS Consulting | FirstEnergy Nuclear Operating Company | Perry, Ohio
6/2012 – Present

As an Engineering Associate, Mr. Lucarelli has been engaged in performing seismic evaluations of plant structures and components in support of developing seismic fragilities for the seismic PRA. As part of this effort, Mr. Lucarelli was part of the Seismic Walkdown Team. He was responsible to perform the NTTF 2.1 Seismic Walkdown and Equipment Screening. He was also responsible to perform the NTTF 2.3 Seismic Walkdown and walkdowns in support of the Expedited Seismic Evaluation Process (ESEP). Mr. Lucarelli managed the development of equipment fragilities for PNPP and acted as the point of contact between the team of fragility analysts and the PRA analyst developing the logic model.

Mr. Lucarelli participated in the Peer Review of the PNPP Seismic PRA in support of the work related to walkdowns and equipment fragilities. As part of the PNPP Peer Review, Mr. Lucarelli engaged in the direct response of comments from peer reviewers as well as technical discussions regarding compliance with the ASME Standard.

Beaver Valley Unit 1 NPP Seismic PRA

ABS Consulting | FirstEnergy Nuclear Operating Company | Shippingport, Pennsylvania

6/2012 – Present

As an Engineering Associate, Mr. Lucarelli has been engaged in performing seismic evaluations of plant structures and components in support of developing seismic fragilities for the seismic PRA. As part of this effort, Mr. Lucarelli was part of the Seismic Walkdown Team and was responsible to perform the NTTF 2.1 Seismic Walkdown and Equipment Screening. Mr. Lucarelli performed walkdowns in support of the Expedited Seismic Evaluation Process (ESEP).

Beaver Valley Unit 2 NPP Seismic PRA

ABS Consulting | FirstEnergy Nuclear Operating Company | Shippingport, Pennsylvania

6/2012 – Present

As an Engineering Associate, Mr. Lucarelli has been engaged in performing seismic evaluations of plant structures and components in support of developing seismic fragilities for the seismic PRA. As part of this effort, Mr. Lucarelli was part of the Seismic Walkdown Team. He was responsible to perform the NTTF 2.1 Seismic Walkdown and Equipment Screening. He was also responsible to perform the NTTF 2.3 Seismic Walkdown. Mr. Lucarelli performed walkdowns in support of the Expedited Seismic Evaluation Process (ESEP).

Davis-Besse NPP Seismic PRA

ABS Consulting | FirstEnergy Nuclear Operating Company | Oak Harbor, Ohio

6/2012 – Present

As an Engineering Associate, Mr. Lucarelli has been engaged in performing seismic evaluations of plant structures and components in support of developing seismic fragilities for the seismic PRA. As part of this effort, Mr. Lucarelli was part of the Seismic Walkdown Team. He was responsible to perform the NTTF 2.1 Seismic Walkdown and Equipment Screening. He was also responsible to perform the NTTF 2.3 Seismic Walkdown. Mr. Lucarelli performed walkdowns in support of the Expedited Seismic Evaluation Process (ESEP).

Visaginas NPP Units 3 and 4

Visagino Atomine Elektrine UAB | Villnius, Lithuania

10/2012 – 12/2012

As an Engineering Associate, Mr. Lucarelli Evaluated cone penetration test (CPT) data to evaluate site uniformity, provide recommended elastic modulus values for geologic layers, and evaluate dissipation test results to determine the coefficient of consolidation for geologic layers.

Vogtle NPP Geotechnical Investigation

Westinghouse Electric Company | Burke County, Georgia

2/2012 – 7/2012

RIZZO conducted a settlement analysis to predict the total and differential settlements expected during construction of the Vogtle Units. Mr. Lucarelli was responsible for reviewing on-site heave and settlement data and the excavation sequence to calibrate the material properties in the settlement model. He was also responsible for creating a settlement model that implemented the expected AP1000 construction sequence and presenting the results in a report.

Levy County NPP Foundation Considerations

Sargent & Lundy/Progress Energy | Crystal River, Florida

1/2010 – 6/2012

Mr. Lucarelli has been extensively involved in the design and specification of the Roller Compacted Concrete (RCC) Bridging Mat that will support the Nuclear Island foundation. He authored numerous calculations and reports related to the work for this project, including responding to Requests for Additional Information from the NRC. He performed finite element analyses of the stresses within the Bridging Mat under static and dynamic loading conditions, evaluation of whether the stresses in the Bridging Mat met the applicable requirements of ACI 349 and ACI 318, and the determination of long-term settlement. As part of laboratory testing program for RCC, Mr. Lucarelli assisted in the evaluation, selection, and testing specification for the concrete materials to ensure they met the applicable ASTM material standards. He also authored the Work Plan and served as on-

site quality control during laboratory testing of RCC block samples in direct tension and biaxial direct shear. His responsibilities included inspection of the testing being performed, control of documentation related to testing activities, and ensuring subcontractors fulfilled the requirements of RIZZO's NQA-1 Quality Assurance Program.

Blue Ridge Dam Rehab

Tennessee Valley Authority | Fannin County, Georgia

3/2012 – 4/2012

RIZZO conducted a deformation analysis of the downstream side of the Blue Ridge Dam to assess the observed movement in the Mechanically Stabilized Earth (MSE) wall. Mr. Lucarelli prepared a two dimensional finite element model of the dam, which included reviewing construction documentation and instrument readings to determine cross sectional dimensions and material properties.

Akkuyu NPP Site Investigation

WorleyParsons | Mersin Province, Turkey

9/2011 – 3/2012

RIZZO conducted a geotechnical and hydrogeological investigation of the proposed site for four Russian VVER-1200 reactors. This investigation entailed geotechnical and hydrogeological drilling and sampling, geophysical testing, and geologic mapping. Mr. Lucarelli served as on-site quality control for this project. His responsibilities included controlling all records generated on site, interfacing with TAEK (Turkish Regulatory Agency) auditors, and tracking nonconformance observed during the field investigation in accordance with RIZZO's NQA-1 Quality Assurance Program. Mr. Lucarelli also assisted in the preparation of the report summarizing the findings of the field investigation.

Calvert Cliffs NPP Unit 3

Unistar | Calvert County, Maryland

7/2011 – 1/2012

5/2010 – 11/2010

RIZZO completed a COLA-level design of the Ultimate Heat Sink Makeup Water Intake Structure at the Calvert Cliffs site. Mr. Lucarelli authored and checked calculations to determine the design loads, as prescribed by ASCE 7, to be used in a Finite Element model of the structure. Mr. Lucarelli was also responsible for ensuring that the design met the requirements of the Design Control Document.

Mr. Lucarelli also performed a settlement analysis for the Makeup Water Intake Structure.

Areva RAI Support Services for U.S. EPR Design Certification

AREVA

8/2011 – 9/2011 (10-4435)

Mr. Lucarelli assisted in the calculation of the subgrade modulus distribution for the foundation of the Nuclear Auxiliary Building (NAB) for the U.S. Evolutionary Power Reactor (U.S. EPR). This iterative process included modeling subsurface profiles in DAPSET to obtain a soil spring distribution under the basemat. The soil spring distribution was then modeled in GTSTRUDL as the basemat support.

C.W. Bill Young Regional Reservoir Forensic Investigation

Confidential Client | Tampa, Florida

2/2010 – 3/2010

RIZZO conducted a forensic investigation into the cause of soil-cement cracking on the reservoir's upstream slope. This investigation involved a thorough review of construction testing results and documentation to determine inputs for seepage and slope stability analyses. Mr. Lucarelli reviewed construction documentation and conducted quality control checks on the data used for the analyses. Mr. Lucarelli also prepared a number of drawings and figures that presented the results of the forensic investigation.

PREVIOUS EXPERIENCE

Aquaculture Development

Makili | Mali, Africa

9/2007 – 12/2009

As the project coordinator, his primary responsibilities included maintaining a project schedule, developing a budget for project implementation, and coordinating technical reviews of project documentation with a Technical Advisory Committee.

The University Of Pittsburgh Chapter Of Engineers Without Borders designed and constructed an aquaculture pond in rural Mali, Africa with a capacity of 3.6 million gallons. This pond is designed to maintain enough water through a prolonged dry season to allow for year-round cultivation of tilapia. As the project technical lead, Mr. Lucarelli was involved in developing conceptual design alternatives and planning two site assessment trips. These scope of these site assessment trips included topographic surveying, the installation of climate monitoring instrumentation, soil sampling and characterization, and laboratory soils testing.

Southwestern Pennsylvania Commission

Pittsburgh, Pennsylvania

05/2008 – 08/2008

As a transportation intern, Mr. Lucarelli analyzed data in support of various studies dealing with traffic forecasting, transit use, and highway use. He also completed fieldwork to assess the utilization of regional park-and-ride facilities.

SQUG

Presents this

Certificate of Achievement

To Certify That

Brian A. Lucarelli

has Completed the SQUG Walkdown Screening and Seismic Evaluation Training Course

Held August 20-24, 2012

Richard G. Starck II

Richard G. Starck II, MPR Associates, Inc.
SQUG Instructor

Paul D. Baughman, ARES Corporation
SQUG Instructor

Bradley T. Yagla, E.I.T.

Engineering Associate

Years Experience
2

Level
3

Education
B.S. Civil & Environmental Engineering, University of Pittsburgh – Pittsburgh, Pennsylvania – 2012

Professional Certifications
Engineer-in-Training (EIT) – Pennsylvania

Computer Skills
STAAD.Pro, AutoCAD, Revit, RISA-3D, SAP2000, SASSI, MathCad

Skill Areas:

Structural Modeling	Structural Analysis
Nuclear Power Plants	Structures
Modular Construction	Pipe Supports
Embedment Plates	Seismic Walkdowns
Seismic Fragilities	SSI Dynamic Analysis

Mr. Yagla is an Engineering Associate with RIZZO Associates (RIZZO). Mr. Yagla has been involved primarily in the structural analysis of power generation structures.

RIZZO's senior staff have recently completed the Seismic 2-Day NTTF 2.3 Seismic Walkdown Training. This training is being disseminated to others on RIZZO's staff, including Mr. Yagla.

Perry NPP Seismic PRA

ABS Consulting | FirstEnergy Nuclear Operating Company | Perry, Ohio

06/2012 – Present

Mr. Yagla, as an Engineering Associate, performed the following tasks in support of the Seismic Probabilistic Risk Assessment (SPRA) for the plant:

- Assessed existing seismic analyses of plant structures, systems, and components (SSCs).
- Developed Finite Element (FE) and Stick Models of plant structures for seismic analysis.
- Validated and verified FE models using 1-g push and modal analyses.
- Analyzed structure FE models for soil-structure interaction.
- Conducted in-plant seismic walkdowns of SSCs to identify potential failure modes.
- Performed fragility calculations for SSCs using probabilistic and deterministic approaches.
- Originated and checked calculations and reports pertaining to seismic walkdowns and fragilities.

Beaver Valley Unit 1 NPP Seismic PRA

ABS Consulting | FirstEnergy Nuclear Operating Company | Shippingport, Pennsylvania

06/2012 – Present

Mr. Yagla, as an Engineering Associate, performed the following tasks in support of the Seismic Probabilistic Risk Assessment (SPRA) for the plant:

- Assessed existing seismic analyses of plant structures, systems, and components (SSCs).
- Developed Finite Element (FE) and Stick Models of plant structures for seismic analysis.
- Validated and verified FE models using 1-g push and modal analyses.
- Analyzed structure FE models for soil-structure interaction.
- Conducted in-plant seismic walkdowns of SSCs to identify potential failure modes.
- Performed fragility calculations for SSCs using probabilistic and deterministic approaches.
- Originated and checked calculations and reports pertaining to seismic walkdowns and fragilities.

Beaver Valley Unit 2 NPP Seismic PRA

ABS Consulting | FirstEnergy Nuclear Operating Company | Shippingport, Pennsylvania

06/2012 – Present

Mr. Yagla, as an Engineering Associate, performed the following tasks in support of the Seismic Probabilistic Risk Assessment (SPRA) for the plant:

- Assessed existing seismic analyses of plant structures, systems, and components (SSCs).
- Developed Finite Element (FE) and Stick Models of plant structures for seismic analysis.
- Validated and verified FE models using 1-g push and modal analyses.
- Analyzed structure FE models for soil-structure interaction.
- Conducted in-plant seismic walkdowns of SSCs to identify potential failure modes.
- Performed fragility calculations for SSCs using probabilistic and deterministic approaches.
- Originated and checked calculations and reports pertaining to seismic walkdowns and fragilities.

Davis-Besse NPP Seismic PRA

ABS Consulting | FirstEnergy Nuclear Operating Company | Oak Harbor, Ohio

06/2012 – Present

Mr. Yagla, as an Engineering Associate, performed the following tasks in support of the Seismic Probabilistic Risk Assessment (SPRA) for the plant:

- Assessed existing seismic analyses of plant structures, systems, and components (SSCs).
- Developed Finite Element (FE) and Stick Models of plant structures for seismic analysis.
- Validated and verified FE models using 1-g push and modal analyses.
- Analyzed structure FE models for soil-structure interaction.
- Conducted in-plant seismic walkdowns of SSCs to identify potential failure modes.
- Performed fragility calculations for SSCs using probabilistic and deterministic approaches.
- Originated and checked calculations and reports pertaining to seismic walkdowns and fragilities.

PREVIOUS EXPERIENCE

Intern – Piping and Supports Integration

Westinghouse Electric Company | Cranberry Township, Pennsylvania

05/2011 – 08/2011

- Coordinated pipe support and embedment plate issue resolution for Embedment Project Team.
- Created and maintained a spreadsheet that tracked 800 issues from detection to resolution.
- Verified embedment plate issues were rectified in the AP1000 computer model using NavisWorks.
- Provided vital embedment information to critical China AP1000 Projects in Weekly deliverables.
- Presented qualitative and statistical issue – related data to management on a daily basis.

Intern – Modules and Construction Interface

Westinghouse Electric Company | Cranberry Township, Pennsylvania

05/2010 – 08/2010

- Provided input during formal design review for modular AP1000 Nuclear Power Plant Units.
- Developed process flowcharts for piping isometric drawing classification.
- Verified stress calculations for pipe hangers in mechanical modules.
- Located and documented discrepancies between AP1000 computer model and technical drawings.
- Participated in weekly Nuclear Technical and Human Performance training sessions.

Certificate of Attendance

This certifies that

Bradley Yagla

Attended the following Training Course:

"SQUG Walkdown Screening and Seismic Evaluation"

Presented by

Eddie M. Guerra

on

Thursday, November 29, 2012

PCR ENGINEERS/CONSULTANTS/CM

Eddie M. Guerra
Project Engineer

November 29, 2012

Dom Drkulec, E.I.T.

Project Engineering Associate

Years Experience
2

Level
4

Education
M.S., Civil & Environmental Engineering, Drexel University, Philadelphia, PA – 2011

B.S., Civil Engineering, University of Zagreb, Zagreb, Croatia - 2004

Professional Registrations
Engineer-In-Training (E.I.T.)

Computer Skills
SAP2000, ANSYS, ABAQUS, AutoCAD, MATLAB, Maple, MS Office Suite

Languages
English & Croatian

Skill Areas:

- Structural Concrete Design
- Steel & Masonry Design
- Structural Behavior
- Pre-stressed Concrete Design
- Seismic Response Analysis

Mr. Dom Drkulec is a Project Engineering Associate with RIZZO Associates (RIZZO). Mr. Drkulec has been involved primarily in the structural analysis of power generation structures and has also experience in research, material testing, and building inspections.

RIZZO's senior staff have recently completed the Seismic 2-Day NTTF 2.3 Seismic Walkdown Training. This training is being disseminated to others on RIZZO's staff, including Mr. Drkulec.

Perry NPP Seismic PRA

ABS Consulting | FirstEnergy Nuclear Operating Company | Perry, Ohio

03/2013 – Present

Mr. Drkulec, as a Project Engineering Associate, was a member of the seismic walkdown team in support of the seismic probabilistic risk assessment (SPRA) being performed at the plant. Walkdown procedures were in accordance with 2.1 NTTF Recommendation and EPRI NP-6041 guidelines. Walkdown data was recorded using digital photographs and Screening Evaluation Work Sheets (SEWS). Focus of the walkdown was on the evaluation of existing condition, agreement with screening caveats, anchorage, and possible seismic spatial systems interactions of selected mechanical and electrical components.

He is also participating in development of seismic fragility curves of structures and components for the plant. Defined failure modes for selected Structures, Systems, and Components are associated with fragility curves for a given level of seismic ground motion. Seismic fragility calculations are being performed in accordance with EPRI 103959, EPRI 1002988, and EPRI 1019200 documents.

Beaver Valley Unit 1 NPP Seismic PRA

ABS Consulting | FirstEnergy Operating Company | Shippingport, Pennsylvania

02/2013 – Present

Mr. Drkulec, as a Project Engineering Associate, was a member of the seismic walkdown team in support of the seismic probabilistic risk assessment (SPRA) being performed at the plant. Walkdown procedures were in accordance with 2.1 NTTF Recommendation and EPRI NP-6041 guidelines. Walkdown data was recorded using digital photographs and Screening Evaluation Work Sheets (SEWS). Focus of the walkdown was on the evaluation of existing condition, agreement with screening caveats, anchorage, and possible seismic spatial systems interactions of selected mechanical and electrical components.

He is also participating in development of seismic fragility curves of structures and components for the plant. Defined failure modes for selected Structures, Systems, and Components are associated with fragility curves for a given level of seismic ground motion. Seismic fragility calculations are being performed in accordance with EPRI 103959, EPRI 1002988, and EPRI 1019200 documents.

Beaver Valley Unit 2 NPP Seismic PRA

ABS Consulting | FirstEnergy Operating Company | Shippingport, Pennsylvania

01/2013 – Present

Mr. Drkulec, as a Project Engineering Associate, was a member of the seismic walkdown team in support of the seismic probabilistic risk assessment (SPRA) being performed at the plant. Walkdown procedures were in accordance with 2.1 NTTF Recommendation and EPRI NP-6041 guidelines. Walkdown data was recorded using digital photographs and Screening Evaluation Work Sheets (SEWS). Focus of the walkdown was on the evaluation of existing condition, agreement with screening caveats, anchorage, and possible seismic spatial systems interactions of selected mechanical and electrical components.

He is also participating in development of seismic fragility curves of structures and components for the plant. Defined failure modes for selected Structures, Systems, and Components are associated with fragility curves for a given level of seismic ground motion. Seismic fragility calculations are being performed in accordance with EPRI 103959, EPRI 1002988, and EPRI 1019200 documents.

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Davis-Besse NPP Seismic PRA

ABS Consulting | FirstEnergy Operating Company | Oak Harbor, Ohio

12/2012 – Present

Mr. Drkulec, as a Project Engineering Associate, was involved in development of in-structure response spectra and other structural response parameters utilizing SAP2000 for the plant's Auxiliary 6 Building and Intake Structure. Seismic modeling was done by seismic design criteria of ASCE 43-05 and ASCE 4-98 for Structures, Systems, and Components in Nuclear facilities. The program ANSYS was used to define model properties and for automatic meshing of the overall mode. The program SASSI was employed for modeling soil-structure interaction.

He was also involved in Seismic Analysis Report preparation for both of the above mentioned buildings. The goal of the analyses is to obtain Floor Response Spectra and other structural response parameters for the Seismic Probabilistic Risk Assessment of the plant.

PREVIOUS EXPERIENCE

Site Engineer

Industrogradnja d.d. | Zagreb, Croatia

01/2005 – 12/2005

- Supervised the construction of residential buildings
- Arranged work and deliveries on the site, and verified plans compatibility with the design
- Interpreted contract design documents for subcontractors and monitored their work
- Worked with local authorities to ensure compatibility of the design with local construction regulations

RESEARCH/TEACHING EXPERIENCE

Teaching Assistant

Drexel University | Philadelphia, Pennsylvania

12/2008 – 01/2012

- Partnered with structural engineers in investigations and studies related to reconstruction of steel structures, and in modeling, analysis and design of bridges and industrial buildings
- Led project in which reinforced masonry walls were tested to predict structural seismic response and to evaluate current code strength expressions
- Prepared weekly reports, plans and schedule for ongoing projects
- Created user manual for SAP 2000 software as instructor of structural design and structural analysis courses
- Organized land survey and construction materials labs

Certificate of Attendance

This certifies that

Dom Drkulec

Attended the following Training Course:

"SQUG Walkdown Screening and Seismic Evaluation"

Presented by

Eddie M. Guerra

on

Thursday, November 29, 2012

PCR
ENGINEERS CONSULTANTS CM

Eddie M. Guerra
Project Engineer

November 29, 2012

Attachment 2.
Tabulated HCLPF Values
with ESEL ID

Tabulated HCLPF Values with ESEL ID

Equipment ID	HCLPF	β_C	β_R	β_U	A_m	Failure Mode	Fragility Method	ESEL Item #
0P49D0001A	0.40	0.35	0.24	0.26	0.91	Anchorage	New Analysis	196
0P49D0001B	0.40	0.35	0.24	0.26	0.91	Anchorage	New Analysis	197
1M56S0001	0.50	0.40	0.24	0.32	1.27	Functional	Earthquake Experience Data	233
1M56S0002	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	234
1M56S0003	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	235
1M56S0009	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	236
1M56S0010	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	237
1M56S0011	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	238
1M56S0012	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	239
1M56S0013	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	240
1M56S0014	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	241
1M56S0015	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	242
1M56S0016	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	243
1M56S0017	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	244
1M56S0018	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	245
1M56S0019	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	246
1M56S0020	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	247
1M56S0021	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	248
1M56S0022	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	249
1M56S0023	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	250
1M56S0024	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	251

Tabulated HCLPF Values with ESEL ID

Equipment ID	HCLPF	β_C	β_R	β_U	A_m	Failure Mode	Fragility Method	ESEL Item #
1M56S0025	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	252
1M56S0026	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	253
1M56S0027	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	254
1M56S0028	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	255
1M56S0029	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	256
1M56S0030	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	257
1M56S0031	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	258
1M56S0032	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	259
1M56S0033	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	260
1M56S0034	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	261
1M56S0035	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	262
1M56S0036	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	263
1M56S0037	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	264
1M56S0038	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	265
1M56S0039	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	266
1M56S0040	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	267
1M56S0041	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	268
1M56S0042	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	269
1M56S0043	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	270
1M56S0044	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	271
1M56S0045	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	272

Tabulated HCLPF Values with ESEL ID

Equipment ID	HCLPF	β_C	β_R	β_U	A_m	Failure Mode	Fragility Method	ESEL Item #
1M56S0046	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	273
1M56S0047	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	274
1M56S0048	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	275
1M56S0049	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	276
1M56S0050	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	277
1M56S0051	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	278
1M56S0052	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	279
1M56S0053	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	280
1M56S0054	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	281
1M56S0055	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	282
1M56S0056	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	283
1M56S0057	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	284
1M56S0058	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	285
1M56S0059	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	286
1M56S0060	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	287
1M56S0061	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	288
1M56S0062	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	289
1M56S0063	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	290
1M56S0064	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	291
1M56S0065	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	292
1M56S0066	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	293

Tabulated HCLPF Values with ESEL ID

Equipment ID	HCLPF	β_C	β_R	β_U	A_m	Failure Mode	Fragility Method	ESEL Item #
1M56S0067	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	294
1M56S0068	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	295
1M56S0069	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	296
1M56S0070	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	297
1M56S0071	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	298
1M56S0072	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	299
1M56S0073	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	300
1M56S0074	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	301
1M56S0075	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	302
1M56S0076	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	303
1M56S0077	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	304
1M56S0078	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	305
1M56S0079	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	306
1M56S0080	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	307
1M56S0081	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	308
1M56S0082	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	309
1M56S0083	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	310
1M56S0084	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	311
1M56S0085	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	312
1M56S0086	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	313
1M56S0087	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	314

Tabulated HCLPF Values with ESEL ID

Equipment ID	HCLPF	β_C	β_R	β_U	A_m	Failure Mode	Fragility Method	ESEL Item #
1M56S0088	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	315
1M56S0089	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	316
1M56S0090	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	317
1M56S0091	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	318
1M56S0092	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	319
1M56S0093	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	320
1M56S0094	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	321
1M56S0095	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	322
1M56S0096	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	323
1M56S0097	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	324
1M56S0098	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	325
1M56S0099	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	326
1M56S0100	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	327
1M56S0101	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	328
1M56S0102	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	329
1M56S0102-CNTR	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	330
1M56S0102-H2 IGNT	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	331
1M56S0103	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	332
1M56S0103-CNTR	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	333
1M56S0103-H2 IGNT	0.72	0.45	0.24	0.38	2.04	Functional	Earthquake Experience Data	334

Tabulated HCLPF Values with ESEL ID

Equipment ID	HCLPF	β_C	β_R	β_U	A_m	Failure Mode	Fragility Method	ESEL Item #
0R24S0020	0.47	0.40	0.24	0.32	1.20	Anchorage	New Analysis	211
0R24S0025	0.47	0.40	0.24	0.32	1.20	Anchorage	New Analysis	218
0R24S0035	0.47	0.40	0.24	0.32	1.20	Anchorage	New Analysis	216
0R24S0036	0.47	0.40	0.24	0.32	1.20	Anchorage	New Analysis	222
1R24S0018	0.47	0.40	0.24	0.32	1.20	Anchorage	New Analysis	210
1R24S0019	0.47	0.40	0.24	0.32	1.20	Anchorage	New Analysis	343
1R24S0021	0.47	0.40	0.24	0.32	1.20	Anchorage	New Analysis	214
1R24S0022	0.47	0.40	0.24	0.32	1.20	Anchorage	New Analysis	215
1R24S0023	0.47	0.40	0.24	0.32	1.20	Anchorage	New Analysis	217
1R24S0024	0.47	0.40	0.24	0.32	1.20	Anchorage	New Analysis	344
1R24S0026	0.47	0.40	0.24	0.32	1.20	Anchorage	New Analysis	220
1R24S0028	0.47	0.40	0.24	0.32	1.20	Anchorage	New Analysis	221
1R24S0029	0.47	0.40	0.24	0.32	1.20	Anchorage	New Analysis	402
1R24S0030	0.25	0.40	0.24	0.32	0.63	Anchorage	New Analysis	223
1R24S0031	0.25	0.40	0.24	0.32	0.63	Anchorage	New Analysis	212
1R24S0032	0.25	0.40	0.24	0.32	0.63	Anchorage	New Analysis	219
1E12C0002B	2.75	0.40	0.24	0.32	6.97	Anchorage	Scaling based on Design Criteria	412
1B21F0041A	1.50	0.40	0.24	0.32	3.80	Functional	Test Response Spectra (TRS)	46
1B21F0041F	1.50	0.40	0.24	0.32	3.80	Functional	Test Response Spectra (TRS)	49
1B21F0410A	1.50	0.40	0.24	0.32	3.80	Functional	Test Response Spectra (TRS)	72
1B21F0410B	1.50	0.40	0.24	0.32	3.80	Functional	Test Response Spectra (TRS)	81

Tabulated HCLPF Values with ESEL ID

Equipment ID	HCLPF	β_C	β_R	β_U	A_m	Failure Mode	Fragility Method	ESEL Item #
1B21F0415A	1.50	0.40	0.24	0.32	3.80	Functional	Test Response Spectra (TRS)	74
1B21F0415B	1.50	0.40	0.24	0.32	3.80	Functional	Test Response Spectra (TRS)	83
1B21F0041B	1.50	0.40	0.24	0.32	3.80	Functional	Test Response Spectra (TRS)	47
1B21F0041E	1.50	0.40	0.24	0.32	3.80	Functional	Test Response Spectra (TRS)	48
1B21F0047D	1.50	0.40	0.24	0.32	3.80	Functional	Test Response Spectra (TRS)	50
1B21F0047H	1.50	0.40	0.24	0.32	3.80	Functional	Test Response Spectra (TRS)	51
1B21F0051C	1.50	0.40	0.24	0.32	3.80	Functional	Test Response Spectra (TRS)	52
1B21F0051D	1.50	0.40	0.24	0.32	3.80	Functional	Test Response Spectra (TRS)	53
1B21F0051G	1.50	0.40	0.24	0.32	3.80	Functional	Test Response Spectra (TRS)	54
1B21F0411A	1.50	0.40	0.24	0.32	3.80	Functional	Test Response Spectra (TRS)	79
1B21F0411B	1.50	0.40	0.24	0.32	3.80	Functional	Test Response Spectra (TRS)	88
1B21F0414A	1.50	0.40	0.24	0.32	3.80	Functional	Test Response Spectra (TRS)	73
1B21F0414B	1.50	0.40	0.24	0.32	3.80	Functional	Test Response Spectra (TRS)	82
1B21F0422A	1.50	0.40	0.24	0.32	3.80	Functional	Test Response Spectra (TRS)	76
1B21F0422B	1.50	0.40	0.24	0.32	3.80	Functional	Test Response Spectra (TRS)	85
1B21F0425A	1.50	0.40	0.24	0.32	3.80	Functional	Test Response Spectra (TRS)	75
1B21F0425B	1.50	0.40	0.24	0.32	3.80	Functional	Test Response Spectra (TRS)	84
1B21F0442A	1.50	0.40	0.24	0.32	3.80	Functional	Test Response Spectra (TRS)	78
1B21F0442B	1.50	0.40	0.24	0.32	3.80	Functional	Test Response Spectra (TRS)	87
1B21F0443A	1.50	0.40	0.24	0.32	3.80	Functional	Test Response Spectra (TRS)	80
1B21F0443B	1.50	0.40	0.24	0.32	3.80	Functional	Test Response Spectra (TRS)	89

Tabulated HCLPF Values with ESEL ID

Equipment ID	HCLPF	β_C	β_R	β_U	A_m	Failure Mode	Fragility Method	ESEL Item #
1B21F0444A	1.50	0.40	0.24	0.32	3.80	Functional	Test Response Spectra (TRS)	77
1B21F0444B	1.50	0.40	0.24	0.32	3.80	Functional	Test Response Spectra (TRS)	86
1E51F0017	0.65	0.40	0.24	0.32	1.66	Functional	Earthquake Experience Data	10
1E51F0015	0.65	0.40	0.24	0.32	1.66	Functional	Earthquake Experience Data	15
1R42S0015	0.46	0.40	0.24	0.32	1.17	Functional	GERS	231
1R42S0024	0.35	0.40	0.24	0.32	0.89	Anchorage	Test Response Spectra (TRS)	103
1R23S0009	0.29	0.40	0.24	0.32	0.73	Functional	Test Response Spectra (TRS)	209
1R23S0010	0.29	0.40	0.24	0.32	0.73	Functional	Test Response Spectra (TRS)	213
1R23S0011	0.29	0.40	0.24	0.32	0.73	Functional	Test Response Spectra (TRS)	404
1R23S0012	0.29	0.40	0.24	0.32	0.73	Functional	Test Response Spectra (TRS)	403
2R23S0009	0.29	0.40	0.24	0.32	0.73	Functional	Test Response Spectra (TRS)	195
2R23S0010	0.29	0.40	0.24	0.32	0.73	Functional	Test Response Spectra (TRS)	199
1R22S0006	0.61	0.40	0.24	0.32	1.55	Functional	Test Response Spectra (TRS)	399
1R22S0007	0.61	0.40	0.24	0.32	1.55	Functional	Test Response Spectra (TRS)	400
1R22S0009	0.61	0.40	0.24	0.32	1.55	Functional	Test Response Spectra (TRS)	401
2R22S0007	0.61	0.40	0.24	0.32	1.55	Functional	Test Response Spectra (TRS)	198
0R71S0083	0.60	0.40	0.24	0.32	1.52	Functional	Earthquake Experience Data	204
1M56S0201	0.63	0.40	0.24	0.32	1.60	Anchorage	New Analysis	335
1M56S0202	0.63	0.40	0.24	0.32	1.60	Anchorage	New Analysis	336
1R23S0015	0.95	0.40	0.24	0.32	2.41	Anchorage	New Analysis	208
1E51C0001	0.50	0.40	0.24	0.32	1.27	Functional	Earthquake Experience Data	1

Tabulated HCLPF Values with ESEL ID

Equipment ID	HCLPF	β_C	β_R	β_U	A_m	Failure Mode	Fragility Method	ESEL Item #
1E51C0002	0.50	0.40	0.24	0.32	1.27	Functional	Earthquake Experience Data	2
1G40C0005	0.50	0.40	0.24	0.32	1.27	Functional	Earthquake Experience Data	180
1G42C0001	0.50	0.40	0.24	0.32	1.27	Functional	Earthquake Experience Data	169
1E51B0002	0.50	0.40	0.24	0.32	1.27	Functional	Assigned based on rule of the box. Parent component: 1E51C0002	4
1E51C0004	0.50	0.40	0.24	0.32	1.27	Functional	Assigned based on rule of the box. Parent component: 1E51C0002	3
1E51F0511	0.50	0.40	0.24	0.32	1.27	Functional	Assigned based on rule of the box. Parent component: 1E51C0002	12
1R45C0001A	0.38	0.40	0.24	0.32	0.96	Functional	Earthquake Experience Data	190
1R45C0001B	0.38	0.40	0.24	0.32	0.96	Functional	Earthquake Experience Data	192
1R45C0001C	0.38	0.40	0.24	0.32	0.96	Functional	Earthquake Experience Data	194
1R45C0002A	0.38	0.40	0.24	0.32	0.96	Functional	Earthquake Experience Data	189
1R45C0002B	0.38	0.40	0.24	0.32	0.96	Functional	Earthquake Experience Data	191
1R45C0002C	0.38	0.40	0.24	0.32	0.96	Functional	Earthquake Experience Data	193
1E12C0002A	2.75	0.40	0.24	0.32	6.97	Anchorage	Scaling based on Design Criteria	411
1E22F0012	0.49	0.40	0.24	0.32	1.24	Functional	Test Response Spectra (TRS)	179
1E51F0022	0.49	0.40	0.24	0.32	1.24	Functional	Test Response Spectra (TRS)	19
1E51F0045	0.49	0.40	0.24	0.32	1.24	Functional	Test Response Spectra (TRS)	5
1E12F0053A	0.29	0.40	0.24	0.32	0.73	Functional	Test Response Spectra (TRS)	152

Tabulated HCLPF Values with ESEL ID

Equipment ID	HCLPF	β_C	β_R	β_U	A_m	Failure Mode	Fragility Method	ESEL Item #
1E12F0053B	0.29	0.40	0.24	0.32	0.73	Functional	Test Response Spectra (TRS)	153
1E12F0009	0.29	0.40	0.24	0.32	0.73	Functional	Test Response Spectra (TRS)	139
1E12F0008	0.29	0.40	0.24	0.32	0.73	Functional	Test Response Spectra (TRS)	138
1E51F0019	0.87	0.40	0.24	0.32	2.21	Functional	Component-specific Seismic Qualification	8
1E51F0077	0.87	0.40	0.24	0.32	2.21	Functional	Component-specific Seismic Qualification	20
1E51F0078	0.87	0.40	0.24	0.32	2.21	Functional	Component-specific Seismic Qualification	21
1E51F0076	0.47	0.40	0.24	0.32	1.20	Functional	Test Response Spectra (TRS)	16
1E12F0042A	0.46	0.40	0.24	0.32	1.16	Functional	Earthquake Experience Data	146
1E12F0042B	0.46	0.40	0.24	0.32	1.16	Functional	Earthquake Experience Data	147
1E51F0063	0.46	0.40	0.24	0.32	1.16	Functional	Earthquake Experience Data	13
1G41F0140	0.46	0.40	0.24	0.32	1.16	Functional	Earthquake Experience Data	155
1E12F0028A	0.40	0.40	0.24	0.32	1.00	Functional	Test Response Spectra (TRS)	142
1E12F0028B	0.40	0.40	0.24	0.32	1.00	Functional	Test Response Spectra (TRS)	143
1E12F0537A	0.26	0.45	0.24	0.38	0.75	Functional	Earthquake Experience Data	144
1E12F0537B	0.26	0.45	0.24	0.38	0.75	Functional	Earthquake Experience Data	145
1P45F0130A	0.38	0.40	0.24	0.32	0.96	Functional	Test Response Spectra (TRS)	187
1P45F0130B	0.38	0.40	0.24	0.32	0.96	Functional	Test Response Spectra (TRS)	188
1E12F0064A	0.66	0.40	0.24	0.32	1.69	Functional	Earthquake Experience Data	149
1E12F0064B	0.66	0.40	0.24	0.32	1.69	Functional	Earthquake Experience Data	148

Tabulated HCLPF Values with ESEL ID

Equipment ID	HCLPF	β_C	β_R	β_U	A_m	Failure Mode	Fragility Method	ESEL Item #
1E51F0010	0.66	0.40	0.24	0.32	1.69	Functional	Earthquake Experience Data	7
1E51F0031	0.66	0.40	0.24	0.32	1.69	Functional	Earthquake Experience Data	9
1E51F0059	0.66	0.40	0.24	0.32	1.69	Functional	Earthquake Experience Data	18
1E51F0510	0.66	0.40	0.24	0.32	1.69	Functional	Earthquake Experience Data	11
1E22F0010	0.67	0.40	0.24	0.32	1.71	Functional	Earthquake Experience Data	177
1E22F0011	0.67	0.40	0.24	0.32	1.71	Functional	Earthquake Experience Data	178
1G42F0010	0.67	0.40	0.24	0.32	1.71	Functional	Earthquake Experience Data	170
1G42F0020	0.67	0.40	0.24	0.32	1.71	Functional	Earthquake Experience Data	171
1G42F0060	0.67	0.40	0.24	0.32	1.71	Functional	Earthquake Experience Data	173
1E12F0004A	0.66	0.40	1.66	0.32	1.71	Functional	Earthquake Experience Data	133
1E12F0004B	0.66	0.40	1.66	0.32	1.71	Functional	Earthquake Experience Data	136
1E21F0001	0.66	0.40	1.66	0.32	1.71	Functional	Earthquake Experience Data	184
1E22F0001	0.66	0.40	1.66	0.32	1.71	Functional	Earthquake Experience Data	175
1E22F0015	0.66	0.40	1.66	0.32	1.71	Functional	Earthquake Experience Data	174
1E12F0006A	0.66	0.40	1.66	0.32	1.71	Functional	Earthquake Experience Data	134
1E12F0006B	0.67	0.40	0.24	0.32	1.71	Functional	Earthquake Experience Data	137
1E21F0011	0.44	0.40	0.24	0.32	1.11	Functional	Earthquake Experience Data	186
1E21F0012	0.44	0.40	0.24	0.32	1.11	Functional	Earthquake Experience Data	185
1E51F0068	0.44	0.40	0.24	0.32	1.11	Functional	Earthquake Experience Data	17
1G42F0080	0.44	0.40	0.24	0.32	1.11	Functional	Earthquake Experience Data	172
1E12F0024A	0.46	0.40	0.24	0.32	1.16	Functional	Earthquake Experience Data	140

Tabulated HCLPF Values with ESEL ID

Equipment ID	HCLPF	β_C	β_R	β_U	A_m	Failure Mode	Fragility Method	ESEL Item #
1E12F0024B	0.46	0.40	0.24	0.32	1.16	Functional	Earthquake Experience Data	141
1E12F0048A	0.46	0.40	0.24	0.32	1.16	Functional	Earthquake Experience Data	132
1E12F0048B	0.46	0.40	0.24	0.32	1.16	Functional	Earthquake Experience Data	135
1E51F0013	0.32	0.40	0.24	0.32	0.82	Functional	Earthquake Experience Data	6
1E12F0027A	0.30	0.40	0.24	0.32	0.77	Functional	Earthquake Experience Data	150
1E12F0027B	0.30	0.40	0.24	0.32	0.77	Functional	Earthquake Experience Data	151
1E21F0005	0.30	0.40	0.24	0.32	0.77	Functional	Earthquake Experience Data	126
1E22F0023	0.30	0.40	0.24	0.32	0.77	Functional	Earthquake Experience Data	176
1E51F0064	0.30	0.40	0.24	0.32	0.77	Functional	Earthquake Experience Data	14
1G41F0145	0.30	0.40	0.24	0.32	0.77	Functional	Earthquake Experience Data	154
1E22F0004	0.31	0.40	0.24	0.32	0.79	Functional	Earthquake Experience Data	127
0M23C0001A	0.70	0.45	0.24	0.38	2.01	Anchorage	New Analysis	200
0M23C0001B	0.70	0.45	0.24	0.38	2.01	Anchorage	New Analysis	201
1R42S0012	0.32	0.40	0.24	0.32	0.80	Anchorage	New Analysis	228
1R42S0013	0.32	0.40	0.24	0.32	0.80	Anchorage	New Analysis	229
1R42S0014	0.32	0.40	0.24	0.32	0.80	Anchorage	New Analysis	230
0R71P0083	0.86	0.45	0.24	0.38	2.47	Functional	Earthquake Experience Data	205
1R25S0170	0.74	0.40	0.24	0.32	1.89	Functional	Earthquake Experience Data	182
1R42S0002	0.41	0.40	0.24	0.32	1.03	Functional	GERS	232
1R42S0003	0.41	0.40	0.24	0.32	1.03	Functional	GERS	227
0R42S0011	0.70	0.40	0.24	0.32	1.79	Functional	Test Response Spectra (TRS)	225

Tabulated HCLPF Values with ESEL ID

Equipment ID	HCLPF	β_C	β_R	β_U	A_m	Failure Mode	Fragility Method	ESEL Item #
1E22S0006	0.70	0.40	0.24	0.32	1.79	Functional	Test Response Spectra (TRS)	224
1R42S0005	0.29	0.40	0.24	0.32	0.73	Anchorage	New Analysis	226
0R42S0007	0.41	0.40	0.24	0.32	1.01	Anchorage	New Analysis	202
0R42S0009	0.41	0.40	0.24	0.32	1.01	Anchorage	New Analysis	206
1R42S0006	0.41	0.40	0.24	0.32	1.01	Anchorage	New Analysis	203
1R42S0008	0.41	0.40	0.24	0.32	1.01	Anchorage	New Analysis	207
1H22P0004A	0.37	0.40	0.24	0.32	0.95	Anchorage	New Analysis	104
1H22P0027	0.37	0.40	0.24	0.32	0.95	Anchorage	New Analysis	105
1B21N0068A	0.37	0.40	0.24	0.32	0.95	Anchorage	Assigned based on rule of the box. Parent component: 1H22P0004A	93
1B21N0068B	0.37	0.40	0.24	0.32	0.95	Anchorage	Assigned based on rule of the box. Parent component: 1H22P0027	94
1B21N0068E	0.37	0.40	0.24	0.32	0.95	Anchorage	Assigned based on rule of the box. Parent component: 1H22P0004A	95
1B21N0068F	0.37	0.40	0.24	0.32	0.95	Anchorage	Assigned based on rule of the box. Parent component: 1H22P00027	96
1B21N0081A	0.37	0.40	0.24	0.32	0.95	Anchorage	Assigned based on rule of the box. Parent component: 1H22P0004A	90
1B21N0091A	0.37	0.40	0.24	0.32	0.95	Anchorage	Assigned based on rule of the box. Parent component: 1H22P0004A	97

Tabulated HCLPF Values with ESEL ID

Equipment ID	HCLPF	β_C	β_R	β_U	A_m	Failure Mode	Fragility Method	ESEL Item #
1B21N0091B	0.37	0.40	0.24	0.32	0.95	Anchorage	Assigned based on rule of the box. Parent component: 1H22P00027	98
1B21N0091E	0.37	0.40	0.24	0.32	0.95	Anchorage	Assigned based on rule of the box. Parent component: 1H22P0004A	99
1B21N0091F	0.37	0.40	0.24	0.32	0.95	Anchorage	Assigned based on rule of the box. Parent component: 1H22P00027	100
1B21N0095A	0.37	0.40	0.24	0.32	0.95	Anchorage	Assigned based on rule of the box. Parent component: 1H22P0004A	101
1B21N0095B	0.37	0.40	0.24	0.32	0.95	Anchorage	Assigned based on rule of the box. Parent component: 1H22P00027	102
1H51P0134B	0.54	0.45	0.24	0.38	1.55	Functional	GERS	413
1H51P0134A	0.54	0.45	0.24	0.38	1.55	Functional	GERS	415
1H22P0017	0.54	0.45	0.24	0.38	1.55	Functional	GERS	416
1D23N0022A	0.54	0.45	0.24	0.38	1.55	Functional	Assigned based on rule of the box. Parent component: 1H51P0134A	388
1D23N0022B	0.54	0.45	0.24	0.38	1.55	Functional	Assigned based on rule of the box. Parent component: 1H51P0134B	389
1D23N0032A	0.54	0.45	0.24	0.38	1.55	Functional	Assigned based on rule of the box. Parent component: 1H51P0134A	390

Tabulated HCLPF Values with ESEL ID

Equipment ID	HCLPF	β_C	β_R	β_U	A_m	Failure Mode	Fragility Method	ESEL Item #
1D23N0032B	0.54	0.45	0.24	0.38	1.55	Functional	Assigned based on rule of the box. Parent component: 1H51P0134B	391
1D23N0042A	0.54	0.45	0.24	0.38	1.55	Functional	Assigned based on rule of the box. Parent component: 1H51P0134A	392
1D23N0042B	0.54	0.45	0.24	0.38	1.55	Functional	Assigned based on rule of the box. Parent component: 1H51P0134B	393
1D23N0043A	0.54	0.45	0.24	0.38	1.55	Functional	Assigned based on rule of the box. Parent component: 1H51P0134A	394
1D23N0043B	0.54	0.45	0.24	0.38	1.55	Functional	Assigned based on rule of the box. Parent component: 1H51P0134B	395
1D23N0230	0.54	0.45	0.24	0.38	1.55	Functional	Assigned based on rule of the box. Parent component: 1H51P0134A	396
1E51N0003	0.54	0.45	0.24	0.38	1.55	Functional	Assigned based on rule of the box. Parent component: 1H22P0017	22
1E51N0007	0.54	0.45	0.24	0.38	1.55	Functional	Assigned based on rule of the box. Parent component: 1H22P0017	23
1E51N0050	0.54	0.45	0.24	0.38	1.55	Functional	Assigned based on rule of the box. Parent component: 1H22P0017	41

Tabulated HCLPF Values with ESEL ID

Equipment ID	HCLPF	β_C	β_R	β_U	A_m	Failure Mode	Fragility Method	ESEL Item #
1E51N0051	0.54	0.45	0.24	0.38	1.55	Functional	Assigned based on rule of the box. Parent component: 1H22P0017	36
1E51N0052	0.54	0.45	0.24	0.38	1.55	Functional	Assigned based on rule of the box. Parent component: 1H22P0017	43
1E51N0053	0.54	0.45	0.24	0.38	1.55	Functional	Assigned based on rule of the box. Parent component: 1H22P0017	39
1E51N0055A	0.54	0.45	0.24	0.38	1.55	Functional	Assigned based on rule of the box. Parent component: 1H22P0017	34
1E51N0056A	0.54	0.45	0.24	0.38	1.55	Functional	Assigned based on rule of the box. Parent component: 1H22P0017	32
1H51P1046	0.38	0.45	0.24	0.38	1.08	Functional	Earthquake Experience Data	166
1H51P1111	0.38	0.45	0.24	0.38	1.08	Functional	Earthquake Experience Data	167
1D23N0270A	0.38	0.45	0.24	0.38	1.08	Functional	Assigned based on rule of the box. Parent component: 1H51P1344	397
1D23N0270B	0.38	0.45	0.24	0.38	1.08	Functional	Assigned based on rule of the box. Parent component: 1H51P1345	398
1G43N0020A	0.38	0.45	0.24	0.38	1.08	Functional	Assigned based on rule of the box. Parent component: 1H51P1045	160

Tabulated HCLPF Values with ESEL ID

Equipment ID	HCLPF	β_C	β_R	β_U	A_m	Failure Mode	Fragility Method	ESEL Item #
1G43N0020B	0.38	0.45	0.24	0.38	1.08	Functional	Assigned based on rule of the box. Parent component: 1H51P1043	161
1G43N0060A	0.38	0.45	0.24	0.38	1.08	Functional	Assigned based on rule of the box. Parent component: 1H51P1046	162
1G43N0060B	0.38	0.45	0.24	0.38	1.08	Functional	Assigned based on rule of the box. Parent component: 1H51P1111	163
1H51P1043	0.38	0.45	0.24	0.38	1.08	Functional	Earthquake Experience Data	165
1H51P1344	0.38	0.45	0.24	0.38	1.08	Functional	Earthquake Experience Data	417
1H51P1345	0.38	0.45	0.24	0.38	1.08	Functional	Earthquake Experience Data	418
1H51P1045	0.38	0.45	0.24	0.38	1.08	Functional	Earthquake Experience Data	164
1D23N0050A	0.53	0.35	0.24	0.26	1.20	Functional	Earthquake Experience Data	345
1D23N0050B	0.53	0.35	0.24	0.26	1.20	Functional	Earthquake Experience Data	346
1D23N0060A	0.53	0.35	0.24	0.26	1.20	Functional	Earthquake Experience Data	347
1D23N0060B	0.53	0.35	0.24	0.26	1.20	Functional	Earthquake Experience Data	348
1D23N0070A	0.53	0.35	0.24	0.26	1.20	Functional	Earthquake Experience Data	349
1D23N0070B	0.53	0.35	0.24	0.26	1.20	Functional	Earthquake Experience Data	350
1D23N0080A	0.53	0.35	0.24	0.26	1.20	Functional	Earthquake Experience Data	351
1D23N0080B	0.53	0.35	0.24	0.26	1.20	Functional	Earthquake Experience Data	352
1D23N0170A	0.53	0.35	0.24	0.26	1.20	Functional	Earthquake Experience Data	353
1D23N0170B	0.53	0.35	0.24	0.26	1.20	Functional	Earthquake Experience Data	354
1D23N0180A	0.53	0.35	0.24	0.26	1.20	Functional	Earthquake Experience Data	355

Tabulated HCLPF Values with ESEL ID

Equipment ID	HCLPF	β_C	β_R	β_U	A_m	Failure Mode	Fragility Method	ESEL Item #
1D23N0180B	0.53	0.35	0.24	0.26	1.20	Functional	Earthquake Experience Data	356
1D23N0190A	0.53	0.35	0.24	0.26	1.20	Functional	Earthquake Experience Data	357
1D23N0190B	0.53	0.35	0.24	0.26	1.20	Functional	Earthquake Experience Data	358
1D23N0200A	0.53	0.35	0.24	0.26	1.20	Functional	Earthquake Experience Data	359
1D23N0200B	0.53	0.35	0.24	0.26	1.20	Functional	Earthquake Experience Data	360
1D23N0220	0.53	0.35	0.24	0.26	1.20	Functional	Earthquake Experience Data	361
1D23N0221	0.39	0.40	0.24	0.32	0.99	Functional	Earthquake Experience Data	378
1H13P0740	0.86	0.45	0.24	0.38	2.47	Functional	Earthquake Experience Data	383
1H13P0741	0.86	0.45	0.24	0.38	2.47	Functional	Earthquake Experience Data	380
1H13P0601	0.65	0.45	0.24	0.38	1.87	Functional	Earthquake Experience Data	414
1E51K0601	0.65	0.45	0.24	0.38	1.87	Functional	Assigned based on rule of the box. Parent component: 1H13P0601	24
1E51R0600	0.65	0.45	0.24	0.38	1.87	Functional	Assigned based on rule of the box. Parent component: 1H13P0601	25
1E51R0601	0.65	0.45	0.24	0.38	1.87	Functional	Assigned based on rule of the box. Parent component: 1H13P0601	29
1E51R0602	0.65	0.45	0.24	0.38	1.87	Functional	Assigned based on rule of the box. Parent component: 1H13P0601	26
1E51R0603	0.65	0.45	0.24	0.38	1.87	Functional	Assigned based on rule of the box. Parent component: 1H13P0601	30

Tabulated HCLPF Values with ESEL ID

Equipment ID	HCLPF	β_C	β_R	β_U	A_m	Failure Mode	Fragility Method	ESEL Item #
1E51R0606	0.65	0.45	0.24	0.38	1.87	Functional	Assigned based on rule of the box. Parent component: 1H13P0601	31
1E51R0607	0.65	0.45	0.24	0.38	1.87	Functional	Assigned based on rule of the box. Parent component: 1H13P0601	28
1G43R0022A	0.65	0.45	0.24	0.38	1.87	Functional	Assigned based on rule of the box. Parent component: 1H13P0601	156
1G43R0022B	0.65	0.45	0.24	0.38	1.87	Functional	Assigned based on rule of the box. Parent component: 1H13P0601	157
1G43R0062A	0.65	0.45	0.24	0.38	1.87	Functional	Assigned based on rule of the box. Parent component: 1H13P0601	158
1G43R0062B	0.65	0.45	0.24	0.38	1.87	Functional	Assigned based on rule of the box. Parent component: 1H13P0601	159
1H13P0618	0.86	0.45	0.24	0.38	2.47	Functional	Earthquake Experience Data	387
1H13P0625	0.86	0.45	0.24	0.38	2.47	Functional	Earthquake Experience Data	385
1H13P0629	0.86	0.45	0.24	0.38	2.47	Functional	Earthquake Experience Data	386
1H13P0691	0.86	0.45	0.24	0.38	2.47	Functional	Earthquake Experience Data	419
1H13P0868	0.86	0.45	0.24	0.38	2.47	Functional	Earthquake Experience Data	384
1H13P0869	0.86	0.45	0.24	0.38	2.47	Functional	Earthquake Experience Data	379
1B21N0681A	0.86	0.45	0.24	0.38	2.47	Functional	Assigned based on rule of the box. Parent component: 1H13P0691	91

Tabulated HCLPF Values with ESEL ID

Equipment ID	HCLPF	β_C	β_R	β_U	A_m	Failure Mode	Fragility Method	ESEL Item #
1B21N0682A	0.86	0.45	0.24	0.38	2.47	Functional	Assigned based on rule of the box. Parent component: 1H13P0691	92
1E51N0650	0.86	0.45	0.24	0.38	2.47	Functional	Assigned based on rule of the box. Parent component: 1H13P0629	42
1E51N0651	0.86	0.45	0.24	0.38	2.47	Functional	Assigned based on rule of the box. Parent component: 1H13P0629	37
1E51N0652	0.86	0.45	0.24	0.38	2.47	Functional	Assigned based on rule of the box. Parent component: 1H13P0629	44
1E51N0653	0.86	0.45	0.24	0.38	2.47	Functional	Assigned based on rule of the box. Parent component: 1H13P0629	40
1E51N0654	0.86	0.45	0.24	0.38	2.47	Functional	Assigned based on rule of the box. Parent component: 1H13P0629	45
1E51N0655A	0.86	0.45	0.24	0.38	2.47	Functional	Assigned based on rule of the box. Parent component: 1H13P0629	35
1E51N0656A	0.86	0.45	0.24	0.38	2.47	Functional	Assigned based on rule of the box. Parent component: 1H13P0629	33
1E51N0659	0.86	0.45	0.24	0.38	2.47	Functional	Assigned based on rule of the box. Parent component: 1H13P0629	38
1H13P0883	0.86	0.45	0.24	0.38	2.47	Functional	Earthquake Experience Data	168

Tabulated HCLPF Values with ESEL ID

Equipment ID	HCLPF	β_C	β_R	β_U	A_m	Failure Mode	Fragility Method	ESEL Item #
1D23N0051A	0.38	0.45	0.24	0.38	1.08	Functional	Assigned based on rule of the box. Parent component: 1H51P0142	362
1D23N0051B	0.38	0.45	0.24	0.38	1.08	Functional	Assigned based on rule of the box. Parent component: 1H51P0143	364
1D23N0061A	0.38	0.45	0.24	0.38	1.08	Functional	Assigned based on rule of the box. Parent component: 1H51P0142	363
1D23N0061B	0.38	0.45	0.24	0.38	1.08	Functional	Assigned based on rule of the box. Parent component: 1H51P0143	365
1D23N0071A	0.38	0.45	0.24	0.38	1.08	Functional	Assigned based on rule of the box. Parent component: 1H51P0142	366
1D23N0071B	0.38	0.45	0.24	0.38	1.08	Functional	Assigned based on rule of the box. Parent component: 1H51P0143	368
1D23N0081A	0.38	0.45	0.24	0.38	1.08	Functional	Assigned based on rule of the box. Parent component: 1H51P0142	367
1D23N0081B	0.38	0.45	0.24	0.38	1.08	Functional	Assigned based on rule of the box. Parent component: 1H51P0143	369
1D23N0171A	0.38	0.45	0.24	0.38	1.08	Functional	Assigned based on rule of the box. Parent component: 1H51P0142	370

Tabulated HCLPF Values with ESEL ID

Equipment ID	HCLPF	β_C	β_R	β_U	A_m	Failure Mode	Fragility Method	ESEL Item #
1D23N0171B	0.38	0.45	0.24	0.38	1.08	Functional	Assigned based on rule of the box. Parent component: 1H51P0143	372
1D23N0181A	0.38	0.45	0.24	0.38	1.08	Functional	Assigned based on rule of the box. Parent component: 1H51P0142	371
1D23N0181B	0.38	0.45	0.24	0.38	1.08	Functional	Assigned based on rule of the box. Parent component: 1H51P0143	373
1D23N0191A	0.38	0.45	0.24	0.38	1.08	Functional	Assigned based on rule of the box. Parent component: 1H51P0142	374
1D23N0191B	0.38	0.45	0.24	0.38	1.08	Functional	Assigned based on rule of the box. Parent component: 1H51P0143	376
1D23N0201A	0.38	0.45	0.24	0.38	1.08	Functional	Assigned based on rule of the box. Parent component: 1H51P0142	375
1D23N0201B	0.38	0.45	0.24	0.38	1.08	Functional	Assigned based on rule of the box. Parent component: 1H51P0143	377
1E51K0702	0.38	0.45	0.24	0.38	1.08	Functional	Assigned based on rule of the box. Parent component: 1H51P0973	27
1H51P0142	0.38	0.45	0.24	0.38	1.08	Functional	Earthquake Experience Data	381
1H51P0143	0.38	0.45	0.24	0.38	1.08	Functional	Earthquake Experience Data	382
1M56P0003	0.38	0.45	0.24	0.38	1.08	Functional	Earthquake Experience Data	337

Tabulated HCLPF Values with ESEL ID

Equipment ID	HCLPF	β_C	β_R	β_U	A_m	Failure Mode	Fragility Method	ESEL Item #
1M56P0004	0.38	0.45	0.24	0.38	1.08	Functional	Earthquake Experience Data	338
1M56P0005	0.38	0.45	0.24	0.38	1.08	Functional	Earthquake Experience Data	339
1M56P0006	0.38	0.45	0.24	0.38	1.08	Functional	Earthquake Experience Data	340
1H51P0973	0.38	0.45	0.24	0.38	1.08	Functional	Earthquake Experience Data	420
1M56P0007	0.38	0.45	0.24	0.38	1.08	Functional	Earthquake Experience Data	341
1M56P0008	0.38	0.45	0.24	0.38	1.08	Functional	Earthquake Experience Data	342
1R25S0174	0.44	0.40	0.24	0.32	1.11	Functional	Earthquake Experience Data	181
1R74S0070	0.74	0.40	0.24	0.32	1.89	Functional	Earthquake Experience Data	183
1E12B0001A	0.77	0.40	0.24	0.32	1.95	Anchorage	New Analysis	128
1E12B0001B	0.77	0.40	0.24	0.32	1.95	Anchorage	New Analysis	130
1E12B0001C	0.77	0.40	0.24	0.32	1.95	Anchorage	New Analysis	129
1E12B0001D	0.77	0.40	0.24	0.32	1.95	Anchorage	New Analysis	131
1B21A0003A	1.46	0.40	0.24	0.32	3.70	Anchorage	New Analysis	55
1B21A0004F	1.46	0.40	0.24	0.32	3.70	Anchorage	New Analysis	67
1B21A0003B	1.46	0.40	0.24	0.32	3.70	Anchorage	New Analysis	56
1B21A0003E	1.46	0.40	0.24	0.32	3.70	Anchorage	New Analysis	57
1B21A0003F	1.46	0.40	0.24	0.32	3.70	Anchorage	New Analysis	58
1B21A0003L	1.46	0.40	0.24	0.32	3.70	Anchorage	New Analysis	59
1B21A0003P	1.46	0.40	0.24	0.32	3.70	Anchorage	New Analysis	60
1B21A0003T	1.46	0.40	0.24	0.32	3.70	Anchorage	New Analysis	61
1B21A0003V	1.46	0.40	0.24	0.32	3.70	Anchorage	New Analysis	62

Tabulated HCLPF Values with ESEL ID

Equipment ID	HCLPF	β_C	β_R	β_U	A_m	Failure Mode	Fragility Method	ESEL Item #
1B21A0004A	1.46	0.40	0.24	0.32	3.70	Anchorage	New Analysis	64
1B21A0004B	1.46	0.40	0.24	0.32	3.70	Anchorage	New Analysis	65
1B21A0004E	1.46	0.40	0.24	0.32	3.70	Anchorage	New Analysis	66
1B21A0004L	1.46	0.40	0.24	0.32	3.70	Anchorage	New Analysis	68
1B21A0004P	1.46	0.40	0.24	0.32	3.70	Anchorage	New Analysis	69
1B21A0004T	1.46	0.40	0.24	0.32	3.70	Anchorage	New Analysis	70
1B21A0004V	1.46	0.40	0.24	0.32	3.70	Anchorage	New Analysis	71
1B21A0005U	1.46	0.40	0.24	0.32	3.70	Anchorage	New Analysis	63
1P57F0015A	0.87	0.40	0.24	0.32	2.21	Functional	Component-specific Seismic Qualification	405
1P57F0015B	0.87	0.40	0.24	0.32	2.21	Functional	Component-specific Seismic Qualification	406
1P57F0020A	0.47	0.40	0.24	0.32	1.20	Functional	Test Response Spectra (TRS)	407
1P57F0020B	0.47	0.40	0.24	0.32	1.20	Functional	Test Response Spectra (TRS)	408
1P57A0003A	0.56	0.40	0.24	0.32	1.42	Anchorage	New Analysis	409
1P57A0003B	0.56	0.40	0.24	0.32	1.42	Anchorage	New Analysis	410
1E51A-K002	0.35	0.45	0.24	0.38	0.99	Functional	Test Response Spectra (TRS)	106
1E51A-K003	0.35	0.45	0.24	0.38	0.99	Functional	Test Response Spectra (TRS)	107
1E51A-K024	0.35	0.45	0.24	0.38	0.99	Functional	Test Response Spectra (TRS)	108
1E51A-K101	0.35	0.45	0.24	0.38	0.99	Functional	Test Response Spectra (TRS)	109
1E51Q7085	0.27	0.45	0.24	0.38	0.77	Functional	Test Response Spectra (TRS)	110
1E51A-K033	0.35	0.45	0.24	0.38	0.99	Functional	Test Response Spectra (TRS)	111

Tabulated HCLPF Values with ESEL ID

Equipment ID	HCLPF	β_C	β_R	β_U	A_m	Failure Mode	Fragility Method	ESEL Item #
1E51Q7084	0.27	0.45	0.24	0.38	0.77	Functional	Test Response Spectra (TRS)	112
1E51A-K015	0.35	0.45	0.24	0.38	0.99	Functional	Test Response Spectra (TRS)	113
1E51A-K066	0.35	0.45	0.24	0.38	0.99	Functional	Test Response Spectra (TRS)	114
1E51A-K086	0.35	0.45	0.24	0.38	0.99	Functional	Test Response Spectra (TRS)	115
1E51Q7064	0.27	0.45	0.24	0.38	0.77	Functional	Test Response Spectra (TRS)	116
1E51Q7065	0.27	0.45	0.24	0.38	0.77	Functional	Test Response Spectra (TRS)	117
1H13P0621	0.86	0.45	0.24	0.38	2.47	Functional	Earthquake Experience Data	421
1B21C-K007A	0.35	0.45	0.24	0.38	0.99	Functional	Test Response Spectra (TRS)	118
1B21C-K007B	0.35	0.45	0.24	0.38	0.99	Functional	Test Response Spectra (TRS)	119
1B21C-K008E	0.35	0.45	0.24	0.38	0.99	Functional	Test Response Spectra (TRS)	120
1B21C-K008F	0.35	0.45	0.24	0.38	0.99	Functional	Test Response Spectra (TRS)	121
1B21C-K051A	0.35	0.45	0.24	0.38	0.99	Functional	Test Response Spectra (TRS)	122
1B21C-K051B	0.35	0.45	0.24	0.38	0.99	Functional	Test Response Spectra (TRS)	123
1B21C-K051E	0.35	0.45	0.24	0.38	0.99	Functional	Test Response Spectra (TRS)	124
1B21C-K051F	0.35	0.45	0.24	0.38	0.99	Functional	Test Response Spectra (TRS)	125
1H13P0628	0.86	0.45	0.24	0.38	2.47	Functional	Earthquake Experience Data	422
1H13P0631	0.86	0.45	0.24	0.38	2.47	Functional	Earthquake Experience Data	423

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