


Fukushima Near-Term Task Force (NTTF) Recommendation 2.3:
NRC Submittal report for Seismic Walk-downs
McGuire Unit 1

ATTACHMENT 6

PEER Review Summary Report

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| | Location: | North Carolina, USA |

NTTF 2.3 SEISMIC PEER REVIEW REPORT
MCGUIRE NUCLEAR STATION UNITS 1 AND 2


Prepared for:

Duke Energy Carolinas, LLC

Prepared by: Shaw North Carolina, Inc. and ARES Corporation


November 15, 2012

QA CATEGORY III



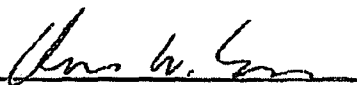
Peer Reviewer: Paul D. Baughman, P.E.
ARES Corporation

11/15/2012
Date



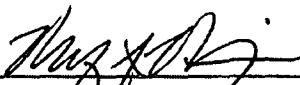
Peer Reviewer: George Bushnell, P.E.
Shaw Power

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Date



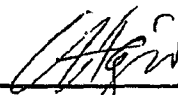
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11/15/2012
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Acronyms

| | |
|-------|---|
| ARES | ARES Corporation |
| AWC | Area Walk-By Checklist |
| CAP | Corrective Action Program |
| EPRI | Electric Power Research Institute |
| IPEEE | Individual Plant Examination of External Events |
| MNS | McGuire Nuclear Station |
| NEI | Nuclear Energy Institute |
| NRC | U.S. Nuclear Regulatory Commission |
| NTTF | Near-Term Task Force |
| PIP | Problem Investigation Process |
| SCE | Seismic Capability Engineer |
| SQUG | Seismic Qualification Utility Group |
| SSC | Structure, System and Component |
| SWC | Seismic Walkdown Checklist |
| SWE | Seismic Walkdown Engineer |
| SWEL | Seismic Walkdown Equipment List |

1.0 INTRODUCTION

Electric Power Research Institute (EPRI) Report 1025286, *Seismic Walkdown Guidance for Resolution of Fukushima Near-Term Task Force Recommendation 2.3: Seismic*, was issued in June 2012. This document provides guidance and procedures to perform seismic walkdowns as required by the U.S. Nuclear Regulatory Commission's (NRC's) 50.54(f) letter regarding Near-Term Task Force (NTTF) Recommendation 2.3: Seismic. The EPRI guidance covers selection of personnel; selection of a sample of structures, systems, and components (SSCs) that represent diversity of component types and ensures inclusion of components from critical systems/functions; conduct of the walkdowns; evaluation of potentially adverse conditions against the plant seismic licensing basis; peer review; Individual Plant Examination of External Events (IPEEE) vulnerabilities; and reporting requirements. It was intended that all U.S. nuclear power plants utilize this guidance document in meeting the requirements of the NRC 50.54(f) letter.

Duke Energy (Duke) contracted with the Shaw Group (Shaw) / ARES Corporation (ARES) Team to perform the NTTF 2.3 peer review at the McGuire Nuclear Station (MNS). This report documents that peer review.

2.0 SCOPE

The scope of this effort was to perform the NTTF 2.3 Seismic Peer Review at MNS, in accordance with the guidelines in Section 6, *Peer Review*, of EPRI 1025286. The peer review is to be documented in a submittal report as discussed in Section 8, *Submittal Report*, of EPRI 1025286. It is intended that the information contained herein will be utilized by Duke as part of its overall NTTF 2.3 submittal report to be delivered to the NRC in November 2012.

Per Section 6 of EPRI 1025286, the peer review should cover the following:

- Review the selection of the SSCs included on the Seismic Walkdown Equipment List (SWEL).
- Review a sample of the checklists prepared for the seismic walkdowns and area walk-bys.
- Review the licensing basis evaluations.
- Review the decisions for entering the potentially adverse conditions in the Corrective Action Program (CAP) process.
- Review the submittal report.
- Summarize the results of the peer review process.

3.0 METHODOLOGY

The Shaw/ARES methodology conforms to the guidance in Section 6 of EPRI 1025286. The Peer Review Team consisted of three individuals, all of whom have seismic engineering experience as it



applies to nuclear power plants. These individuals participated in the peer review of each of the activities.

The peer review process for the SWEL development and the seismic walkdowns consisted of the following:

- Reviewing the activity guidance in EPRI 1025286, the NEI Q&A bulletins, the NEI first-mover reports, and NRC Temporary Instruction 2515/188.
- Conducting an in-process review at the plant site, including interviews with the personnel performing the activity and reviewing in-process documentation.
- Performing an in-plant surveillance (for the walkdown activity) of a seismic walkdown and an area walk-by.
- Providing in-process observations and comments to the personnel performing the activities.
- Conducting a final review of a sample of the completed documentation.

The peer review process for the licensing basis evaluations and the decisions for entering potentially adverse conditions into the CAP consisted of reviewing the overall review process and the licensing basis reviews. The peer review process for the submittal report consisted of reviewing the draft submittal prepared by McGuire Design Engineering for licensing review.

4.0 PERSONNEL

The Peer Review Team consisted of the following individuals:

- **Paul Baughman**, P.E., ARES Corporation, Team Leader. Mr. Baughman is a licensed structural engineer with over 40 years of experience in seismic engineering for nuclear power stations. Mr. Baughman is a subject matter expert and trainer for the Seismic Qualification Utility Group (SQUG). Mr. Baughman has performed seismic assessment activities for MNS and is familiar with the MNS seismic licensing basis. Mr. Baughman has performed many seismic margin assessments and seismic probabilistic risk assessments, and is familiar with systems modeling and development of safe shutdown equipment lists.
- **George Bushnell**, P.E., Shaw Power Group. Mr. Bushnell is a licensed mechanical engineer with over 40 years of experience in engineering qualification of electrical and mechanical equipment for nuclear power stations. Mr. Bushnell is a qualified SQUG Seismic Capability Engineer (SCE) and company specialist for design and qualification of ASME III components.
- **Robert Keiser**, P.E., Duke Energy. Mr. Keiser is a licensed professional engineer in North and South Carolina with over 20 years of experience in the seismic qualification of electrical equipment for Duke Energy's McGuire, Catawba, and Oconee Nuclear Stations. Mr. Keiser

received training as a SQUG SCE and was involved with the SQUG effort at Oconee and the IPEEE efforts at all three stations.

5.0 SELECTION OF THE SSCs INCLUDED ON THE SWEL

Guidance on development of the SWEL is provided in Section 3 of EPRI 1025286. Two SWELs are prepared: SWEL 1, a sample of items to safely shut down the reactor and maintain containment integrity; and SWEL 2, spent fuel pool related items. SWEL 1 is expected to contain 90-120 items for each unit. The MNS SWEL 1 for each unit contains 99 items, which satisfies the expectation from the EPRI guidance.

The development of the MNS SWEL is documented in a McGuire calculation package, MCC-1612.00-00-0001, *10CFR50.54(f) Recommendation 2.3 Fukushima Near-Term Task Force (NTTF) Seismic Walkdown Inspections*. The calculation discusses the development of the seismic walkdown equipment list (SWEL 1) and the seismic walkdown spent fuel pool equipment list (SWEL 2). An in-process draft of the calculation was provided to the peer reviewers at the MNS site visit August 28-30, 2012. Revision 0 of the calculation and SWEL lists for each unit were provided to the peer reviewers on October 15, 2012.

The SWEL was originated by Mr. Bryan Meyer, Principal Engineer, MNS Design Engineering, and checked by Mr. Harry Vanpelt, Senior Engineer, MNS Design Engineering. Messrs. Meyer and Vanpelt have extensive knowledge of MNS design, licensing and operation, as well as extensive system engineering experience. Mr. Philip Thompson reviewed the SWEL for operations. Mr. Thompson is a former Senior Reactor Operator at MNS and is familiar with plant operations and the site-specific probabilistic risk assessment. Mr. Thompson's input to the SWEL has been documented in an email attached to the calculation (Attachment 10).

MNS started with the IPEEE Equipment List as the base list. This list is documented in Attachment 23 of the Duke Energy IPEEE Calculation, MCC 1535.00-00-0004, *Seismic PRA/IPEEE Backup Calculation*. It is included as Attachment 2 of MCC-1612.00-00-0001. Using this list is intended to satisfy Screens 1-3 of the EPRI guidance document.

The IPEEE Equipment List Report describes the primary and secondary success path systems for reactivity control, pressure and inventory control, and decay heat removal. It also describes equipment added for containment performance. There follow individual lists of mechanical, electrical, and containment performance equipment, organized by system. Equipment which is non-safety is so noted in the lists.

SWEL 1 was developed by selecting a sample of equipment from the base list. SWEL 2 was developed separately as described in Calculation MCC-1612.00-00-0001. The calculation includes separate attachments for MNS Unit 1 and 2 SWEL 1 and SWEL 2 lists.

The SWEL 1 lists comply with the four screens in the EPRI guidance:

- Screen 1: Seismic Category I. Because the non-safety (therefore, non-Category I) equipment is identified, this screen was satisfied in the sample by not including the non-safety equipment.

- Screen 2: Equipment or Systems Only. The IPEEE lists contain equipment only, so structures, penetrations, and piping systems have already been taken out of the sample.
- Screen 3: Support for the Five Safety Functions. The IPEEE equipment list contains equipment for all of the safety functions. It specifies the safety functions on a system basis, rather than for each equipment item. In the SWEL spreadsheet, Duke system engineers with operations input specified the safety functions for the equipment items. A pivot table was created for each unit to summarize the number of items for each safety function. This table shows all safety functions are represented (a significant number of SWEL items support all functions and are denoted "various.")
- Screen 4, Sample Considerations, involves the following:
 - Variety of Types of Systems. The system is specified for each item of the SWEL 1. There is a table that summarizes the number of items in each system. For each unit, of 99 items there are 22 systems represented. The maximum number from a single system is 12, while the minimum number is one. The SWEL 1 meets the requirement for a variety of types of systems.
 - Major New and Replacement Equipment. The SWEL preparers identified items on the SWEL that were modified based on their knowledge of major station modifications. For each item, the modification package is referenced. Of the 99 items in each unit, 47 have had modifications (25 in Unit 1, 22 in Unit 2). This is more than 20% of the items in each unit. Other items also have been modified (not as part of major station modifications), so the actual sample size of modified items is probably larger. It is concluded that the sample contains a sufficient number of modified components.
 - Variety of Types of Equipment. The equipment category of each item is listed. All categories are represented, except Compressors and Motor-Generators. This is because there are no safety-related compressors or motor-generators at McGuire. The distribution among the equipment classes is similar to what one would expect the distribution in the IPEEE equipment list would be. It is concluded the distribution is good.
 - Variety of Environments. The SWEL gives the building, elevation, and room number for each item. A table summarizes the number of items in each building and each elevation/room within that building. Six items are inside containment. The items are distributed fairly evenly throughout the plant, rather than being clustered in just a few areas. While the specific environment of the building/elevation/room is not given, so the numbers corresponding to the environments listed in the EPRI document are not specified, it is clear that all areas with safety-related equipment are represented. Therefore, it is concluded that all environments are represented.
 - Equipment Enhanced from the IPEEE. The IPEEE did not identify any vulnerabilities requiring modification; however, there were a number of enhancements made. Attachment 3 of the SWEL calculation lists the nine enhancements. Five are on the SWEL. Of the ones not on the SWEL, two are no longer safety-related and one is

seismic housekeeping not associated with a specific equipment item (however, it would be included indirectly in the area walk-by). The one remaining item was securing arc barriers in the main control board. Duke considered the sample to be sufficient without including the item in the main control board. The peer reviewers concur with this.

- Consideration of Contribution to Risk. Initially, risk insights were included by the SWEL preparers specifying items they knew to be risk-significant based on their long experience with risk evaluations at the plant. Subsequently, the Probabilistic Risk Assessment group has done a risk categorization of all plant items (and events) using the seismic Probabilistic Risk Assessment model and the IPEEE seismic hazard curves. A table of items having a contribution to risk of 1% or more, in order of risk significance, was provided in an email that is Attachment 9 of the SWEL calculation. The top item is not Seismic Category I so is not applicable to the SWEL. The next item is the surrogate representing screened out components. Of 25 screened out components, two thirds are on the SWEL (many of these are multiple components so the proportion is actually larger). Of the remaining seven components, three are not applicable to the SWEL, two are on the SWEL, and two are not on the SWEL. It is concluded that risk insights were properly considered.

Calculation MCC-1612.00-00-0001 contains a section on the development of the SWEL 2. There are two base lists developed for each unit: one for spent fuel cooling system components, the other for components that could cause rapid drain down. The rationale for identifying the components for each list is provided, and it has been reviewed by Mr. Philip Thompson for operations. There are 12 spent fuel cooling components and ten rapid drain down components identified for each unit. The SWEL 2 for each unit consists of five components from the spent fuel cooling base list and three components from the rapid drain down list. The section contains a discussion for each item not included in SWEL 2. It is concluded that the SWEL 2 conforms to the EPRI guidance.

A preliminary peer review checklist was developed with specific comments to be addressed. This checklist is included as Appendix A to this report. The checklist and comments were discussed with Mr. Bryan Meyer at the site exit meeting. The final calculation was reviewed to see if the comments were resolved. All of the comments are considered resolved. The final checklist is included as Appendix B of this report.

6.0 SEISMIC WALKDOWNS AND AREA WALK-BYS

The equipment items and areas to be walked down were specified in the SWEL provided by Duke (MCC-1612.00-00-0001). The walkdowns consist of two parts: equipment-specific seismic walkdowns and area walk-bys. The specific instructions for each part are delineated in EPRI 1025286.

Seismic walkdowns of specific items on the SWEL (SWEL 1 plus SWEL 2) focused on identifying adverse anchorage conditions, adverse seismic interactions, and other adverse seismic conditions that could challenge the seismic adequacy of a SWEL item.

Anchorage was examined for degraded, nonconforming or unanalyzed conditions. This included visual inspection of the anchorage and verification of anchorage condition. The visual inspections looked for bent, broken, missing or loose hardware; corrosion that is more than mild surface oxidation; visible cracks in the concrete near anchors; and other potentially adverse seismic conditions. This did not apply to line-mounted items.

Anchorage configuration was verified to be consistent with the existing plant documentation for a portion of the equipment with anchorage. The anchorage configuration verification must be done for at least 50% of the non-line-mounted SWEL items. The percentages for MNS were 57% and 61% for Unit 1 and Unit 2, respectively. This exceeds the EPRI 1025286 requirement.

The area adjacent to and surrounding the SWEL item was inspected for nearby SSCs that could be seismic interaction hazards due to proximity, failure, and falling, or insufficient flexibility of attached lines and cables. Detailed guidance on seismic spatial interactions is given in Appendix D of EPRI 1025286.

The SWEL item was also examined to see if there were any other potentially adverse seismic conditions besides anchorage and seismic interaction. These could include other degraded conditions, loose or missing subcomponent fasteners, unusual large or heavy subcomponents, doors or panels not latched or fastened, or any other condition which might be seismically adverse. Where possible, cabinets and enclosures were opened for examination of internals.

Area walk-bys consisted of examining the general area surrounding the specific SWEL items for potentially adverse seismic conditions. The area examined included either the entire room enclosing the SWEL item or at least 35 feet in any direction. The examination looked for degraded anchorage conditions of equipment in the area; significantly degraded equipment; poorly supported cable/conduit raceways, HVAC ducting, or piping; and unsecured temporary equipment that could cause seismic interactions (seismic housekeeping concerns). The area walk-by included looking for potential seismic interactions from flooding, spray, or fire. These potential seismic interactions are described in Section 4 of EPRI 1025286.

The Peer Review Team reviewed the qualifications of the engineers performing the walkdowns and verified that they meet the requirements for Seismic Walkdown Engineer in EPRI 1025286. The Peer Review Team also conducted interviews with the walkdown teams to confirm that they had a good understanding of the guidance in EPRI 1025286.

The individuals interviewed were:

- Bryan Hanna – ARES, Walkdown Team Lead
- Tom Tonden – Shaw, Walkdown Team Member
- Mark Eli – ARES, Walkdown Team Lead
- Karen Kuhn – Shaw, Walkdown Team Member

- Kevin Rubright – ARES, Walkdown Team Lead
- George Hermann – Shaw, Walkdown Team Member
- Harpreet Ghuman – ARES, Walkdown Support

Mr. Charles Conselman, ARES, also performed walkdowns, as a Walkdown Team Lead. He was not on site during the peer review site visit, but was interviewed by the Peer Review Team at Oconee Nuclear Station at a later date.

Interviews of walkdown personnel were jointly performed by the Duke, ARES, and Shaw members of the Peer Review Team. Personnel were interviewed as teams (two at a time) to assess their working synergy as well as individual capabilities/knowledge. Walkdown team members were verified to have either directly received the EPRI Seismic Walkdown Training Course, or to have received the Training Course as taught by an individual who had taken the EPRI course in person. Discussion provided positive indication that the walkdown personnel had adequate experience and training to perform walkdown and walk-by activities in compliance with the EPRI Seismic Walkdown Guidance. As teams, they displayed knowledge of the primary objectives of the walkdowns, appropriate levels of dialog between themselves to reach common agreement without excessive discussion, and adequate objectivity in identification of significant discrepancies between as-designed and as-found conditions. Team member qualifications are included in the unit-specific walkdown results reports.

Review of the walkdown documentation packages verified sufficient information included to allow ready identification and location of in-situ SWEL components. Appropriate vendor drawings, anchorage details, calculations and/or license definitions or IPEEE documentation were included for the 50% population of floor-mounted components specified for detailed inspection of anchorage provisions. A few inconsistencies were noted between document identifiers in the checklist entries and the package contents; however, these were easily resolved.

The Peer Review Team reviewed a sample of in-process Seismic Walkdown Checklist (SWCs) and Area Walk-By Checklist (AWCs). The review verified adequacy regarding level of completion and presence of explanatory notes/identification of discrepancies where appropriate. However, a common trait was frequent absence of explanation for items that were not intuitively obvious from reference to the documentation package or where engineering judgment was used by the team. Much of this was attributed to an incomplete reference to photographs taken during the walkdown, due to the in-process nature of the majority of packages reviewed. Walkdown engineers were advised to maintain consideration of clarity in the documentation of the walkdowns.

The following SWCs and AWCs were reviewed:

- 1VGTK0062: 1A1 Diesel Generator Start Air Tank
- 2A EDG: Unit 2 Emergency Diesel Generator Set A
- 2VGCP0059: Unit 2 EDG Starting Air Compressor
- 2VGTK0062: Unit 2 EDG Starting Air Tank
- 2EVDB: Unit 2 125 volt Breaker Panel

EVAB Area Walk-by
2CAPU0002: Unit 2 Motor Driven Aux Feedwater Pump
2NV-238: Unit 2 Charging Flow Valve
Aux Building El 716: PD Pump Room Area Walk-by
1NPVU00015: 1A High Head Reactor Volume Pump
1ANV Pump Room Walk-By
2NI-136B: RHR Supply Valve to Med-Hi NI Pump (Safety Injection)
2BNI Pump Room Walk-by
2NV-221A: Hi-Head NV Pump FWST Isolation Valve (CVCS/Safety Injection)
1NI-147A: NI Pump Min-Flow Isolation Valve
Aux Building El 716 Room 615 Area Walk-by
2NVPU00016 2B: Hi-Head NV Pump (including Area Walk-by)
2EMXH: 600 VAC Essential Motor Control Center (including Area Walk-by)
2EPG-B1-EV1B: Vital Battery Charger/Inverter
1EPG-B1-EV1B: Vital Battery Charger/Inverter
Vital Battery Room Area Walk-by

The Peer Review Team also performed an in-plant surveillance of the walkdown activities. This consisted of two parts: 1) independently reviewing a completed SWC and AWC, and 2) observing a walkdown team during a walkdown. The independent assessment was a seismic walkdown of Emergency Diesel Generator Battery Rack 1EPQ-BC-EDGB and a seismic walk-by of the 1A Emergency Diesel Generator Room. The observed walkdown covered the equipment-specific assessment of the 1A1 Diesel Generator Start Tank 1VGTK0062.

The Peer Review Team reviewed the following entries into the MNS PIP:

- M-12-06096 dated 8/21/12: potential foreign material exclusion issue; discarded bolts and three metal plates under cabinet bottom.
- M-12-06099 dated 8/22/2012: miscellaneous minor issue on several emergency power generator components; missing fasteners on power panel covers; loose support mounting bolt.
- M-12-06176 dated 8/23/12: potential operability concern with missing anchor bolts on DG control panel, resolved by Duke Engineering review/analysis.
- M-12-06272 dated 8/28/12: several perceived close/insufficient clearances between commodities, resolved by Duke Engineering evaluation.

The PIPs were determined to accurately reflect the walkdown team findings.

The Peer Review Team concluded that the walkdowns were being conducted in accordance with the EPRI guidance.

The Peer Review Team has reviewed the final walkdown reports (Shaw Technical Report 1457690101-R-M-00001-1, *Seismic Walkdown Report for Duke Energy's McGuire Nuclear Station Unit 1*, and Shaw Technical Report 1457690101-R-M-00002-1, *Seismic Walkdown Report for Duke Energy's McGuire Nuclear Station Unit 2*). The reports describe the walkdowns and summarize the results. The reports contain all of the information required by the EPRI guidance.

The Unit 1 report summarizes results for Unit 1 as 101 equipment items (93 from SWEL 1 and eight from SWEL 2) and 50 areas (48 from SWEL 1 and two from SWEL 2). Six additional items were deferred to the Unit 1 outage. Of the 101 walked down, 69 were anchored. Of these 69, 40 had their anchorage configuration verified (57%). This exceeds the EPRI guidance requirement of 50%. A total of 30 potentially adverse seismic conditions were noted (i.e., a box on the SWC or AWC was marked U or N). 11 additional items were marked Unknown due to anchorage being wholly or partially concealed. These 10 were dispositioned by Duke MNS Design Engineering as acceptable (the evaluations are documented in the NRC submittal). One was deferred to the Unit 1 outage. The 30 potentially adverse seismic conditions were entered into the CAP for resolution. Each condition was entered into a PIP document for tracking and resolution. The PIP number for each item is listed in the table in Appendix B of the walkdown report.

The Unit 2 report summarizes results for Unit 2 as 107 equipment items (99 SWEL 1 and eight SWEL 2) and 56 areas (54 SWEL 1 and two SWEL 2). No items were deferred (inaccessible items were walked down by Duke engineers during the Unit 2 outage and are included in the walkdown report). Of the 107 walked down, 68 were anchored. Of these 68, 42 had their anchorage configuration verified (61%). This exceeds the EPRI guidance requirement of 50%. A total of 27 potentially adverse seismic conditions were noted (i.e., a box on the SWC or AWC was marked U or N). Six additional items were marked Unknown due to anchorage being wholly or partially concealed. These six were dispositioned by Duke MNS Design Engineering as acceptable (the evaluations are documented in the NRC submittal). The 27 potentially adverse seismic conditions were entered into the CAP for resolution. Each condition was entered into a PIP document for tracking and resolution. The PIP number for each item is listed in the table in Appendix B of the walkdown report.

As noted above, subsequent to completion of the Shaw/ARES walkdowns, Duke Energy engineers performed walkdowns of Unit 2 inaccessible items (seven equipment items and five areas). The Duke personnel and their qualifications as Seismic Walkdown Engineers are given in Table 4-2 of the walkdown report. The Peer Review Team did not interview these personnel.

The Peer Review Team reviewed a sample of the final SWCs and AWCs listed in Appendix C of this report. The sample consisted of 38 SWCs and 18 AWCs. This is 18% of the total. The EPRI guidance requires that 10-25% of the final checklists be reviewed. The sample satisfies the EPRI guidance.

7.0 LICENSING BASIS REVIEWS

All potentially adverse conditions require a licensing basis review in accordance with the EPRI guidance. For MNS, the licensing basis reviews were performed by Duke Design Engineering personnel. Messrs. Bryan Meyer, Mike Langel, Charles Cunningham, and Drew Lyerly performed licensing basis reviews. These individuals meet the personnel requirements in EPRI 1025286.

Each potentially adverse condition identified by the walkdown team was entered into the CAP via PIP. Several items may be entered into a single PIP, but they are listed separately. Each PIP has a unique identification number. This enables the problem to be tracked to closure. The Duke Licensing Basis Reviewer stated that the licensing basis reviews were documented in the PIPs associated with the potentially adverse conditions. No conditions were found to violate the MNS seismic licensing basis.

As noted in Section 6 above, the PIPs associated with the potentially adverse seismic conditions are listed in Appendix B of the walkdown reports. The Peer Review Team reviewed the licensing basis evaluations for all of the potentially adverse seismic conditions. The review of PIP M-12-06083 is described below.

PIP M-12-6083 contained nine items from Appendix B of the Unit 1 walkdown report (Items 1, 4, 6, 7, 16, 17, 18, 24, and 27) and several from Unit 2. These items are also listed in Table 4-1 of the Unit 1 submittal report. All are listed as meeting the licensing basis. The bases for the conclusions were described in the resolution for each item. The peer reviewers agree with the resolutions. It was noted that some of the determinations relied on engineer judgment. The individuals who made the judgments are identified in the PIP. The reviews of the other licensing basis evaluations in the PIPs were similar.

The peer reviewers checked that all of the potentially adverse seismic conditions listed in Appendix B of the walkdown reports had licensing basis reviews documented in the referenced PIPs. The following comments have been noted and forwarded to MNS for resolution. MNS is in the process of incorporating these comments into the PIPs.

The following items were in the referenced PIPs, but did not have licensing basis reviews documented:

- Unit 1, SWEL 1 Item 27, in PIP M-12-06678 did not have a licensing basis determination.
- Unit 2, SWEL 1 Item 14, in PIP M-12-06803 did not have a licensing basis determination.
- Unit 2, SWEL 1 Item 1, in PIP M-12-06803 did not have a licensing basis determination.

These are minor items that have been identified for correction. It appears these items would not compromise the equipment seismic capacity, but the basis for this should be stated in the PIP in order to meet the EPRI guidelines. MNS has stated that the PIPs will be updated to contain a licensing basis review resolution.

The following did not appear to have licensing basis evaluations documented in the referenced PIPs:

- In the Unit 1 walkdown report Appendix B, SWEL 1 Item 24 references PIP M-12-06803. We could not find this item in PIP M-12-06803. PIP M-12-07071 (Group 2, Item 13) appears to be for this item, which is described in the PIP as Unit 1 MDCA Pump Room, rather than Unit 2 MDCA Pump Room as described in the walkdown report (this is assumed to be a typo in the walkdown report).
- In the Unit 1 walkdown report Appendix B, SWEL 2 Item 3 references PIP M-12-06678. We could not find it in this PIP, or in the PIPs provided.

- In the Unit 2 walkdown report Appendix B, SWEL 1 Item 17 references PIP M-12-08603. We could not find it in this PIP, or in the PIPs provided.
- In the Unit 2 walkdown report Appendix B, SWEL 1 Item 26 references PIP M-12-06803. We could not find it in this PIP, or in the PIPs provided.

The peer reviewers would not expect these items would compromise the equipment seismic capacity. However, the licensing basis reviews should be documented and retrievable.

The Peer Review Team concludes that the licensing basis reviews, subject to closure of the open items above, were conducted in accordance with the EPRI guidance.

8.0 DECISIONS ON ENTERING POTENTIALLY ADVERSE SEISMIC CONDITIONS INTO THE CAP PROCESS

All of the potentially adverse seismic conditions identified by the seismic walkdown teams were entered in the CAP for further evaluation. The Peer Review Team review of the seismic walkdowns determined that the identifications of adverse seismic conditions were conservatively made. Thus, the decision to enter all of them into the CAP was likewise conservative.

The licensing basis reviews determined none of the potentially adverse seismic conditions violated the MNS licensing basis. Therefore, it was not necessary to perform any extent of condition evaluations.

There were a number of enhancements identified as a result of the walkdowns, which were determined to improve the seismic condition of the plant. Work orders were assigned for implementation of the enhancements.

The Peer Review Team concludes that the decisions on entering potentially adverse conditions in the CAP process were in accordance with the EPRI guidance.

9.0 SUBMITTAL REPORT

The Peer Review Team reviewed a draft of the submittal report for MNS Unit 1 provided by Mr. Bryan Meyer on November 1, 2012. The report contains the required sections and discussions. Several comments on the submittal were provided to Mr. Meyer in a preliminary peer review report on November 6, 2012. An updated submittal draft was provided to the Peer Review Team on November 7, 2012. The comments on the previous draft were resolved to the satisfaction of the peer reviewers.

Table 4-1 of the submittal report lists the potentially adverse seismic conditions and gives the CAP disposition (i.e., the results of the licensing basis review). The peer reviewers confirmed that the resolutions given in the table agree with the resolutions in the PIPs, except for those that are listed as open items in Section 7 above.

The Peer Review Team concludes that the submittal report is in accordance with the EPRI guidance, subject to closure of the open items in Section 7.

10.0 CONCLUSIONS

The conclusion of the peer review is that the MNS NTTF 2.3 seismic walkdown effort has been conducted in accordance with the guidance in EPRI 1025286. Comments made during the in-process review of the SWEL development and the Walkdowns have been addressed satisfactorily. Comments on the final walkdown reports, the licensing basis reviews, and the NRC submittal have been noted above. These comments relate to details of the execution and do not affect the overall conclusion.

11.0 REFERENCES

Duke Energy Calculation MCC 1535.00-00-0004, *Seismic PRA/IPEEE Backup Calculations*, May 1994.

Duke Energy Calculation MCC-1612.00-00-0001, *10CFR50.54(f) Recommendation 2.3 Fukushima Near-Term Task Force (NTTF) Seismic Walkdown Inspections*, October 15, 2012.

Duke Energy, *Fukushima Near-Term Task Force (NTTF) Recommendation 2.3: NRC Submittal Report for Seismic Walkdowns, McGuire Unit 1*, DRAFT, November 1, 2012.

EPRI 1025286, *Seismic Walkdown Guidance for Resolution of Fukushima Near-Term Task Force Recommendation 2.3: Seismic*, June 2012, Electric Power Research Institute, Palo Alto, CA.

Letter, E. Leeds and M. Johnson (NRC) to All Power Reactor Licensees et al., "Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," Enclosure 2.3, "Recommendation 2.3: Seismic," dated March 12, 2012.

Shaw Technical Report 1457690101-R-M-00001-1, *Seismic Walkdown Report for Duke Energy's McGuire Nuclear Station Unit 1*, Revision 1, November 5, 2012.

Shaw Technical Report 1457690101-R-M-00002-1, *Seismic Walkdown Report for Duke Energy's McGuire Nuclear Station Unit 2*, Revision 1, November 5, 2012.

APPENDIX A

PEER REVIEW CHECKLIST FOR IN-PROCESS SWEL



Peer Review Checklist for SWEL

Instructions for Completing Checklist

This peer review checklist may be used to document the review of the Seismic Walkdown Equipment List (SWEL) in accordance with Section 6: Peer Review. The space below each question in this checklist should be used to describe any findings identified during the peer review process and how the SWEL may have changed to address those findings. Additional space is provided at the end of this checklist for documenting other comments.

1. Were the five safety functions adequately represented in the SWEL 1 selection? Y N

The IPEEE equipment lists contain equipment for all of the safety functions. However, the safety functions applying to the individual items of equipment are not specified. One would need to use the item's system to tie back to the safety function. In addition, the IPEEE Report combined the pressure control and inventory control functions as a single function.

Need to enhance SWEL report to give number of items corresponding to each of the 5 safety functions.

2. Does SWEL 1 include an appropriate representation of items having the following sample selection attributes:

- a. Various types of systems? Y N

Each item of the SWEL 1 contains the system. There is a pivot table that summarizes the number of items in each system. Of 100 items, there are 22 systems represented. The maximum number from a single system is 13, while the minimum number is 1.

- b. Major new and replacement equipment? Y N

For each item, if there has been a modification the modification package is referenced. Of the 100 items, 23 have had modifications. It is not stated how many of the base list items were modified, so the sample size of modified items is not known. However, we concluded that having 23 items represents a conservative sample size.

- c. Various types of equipment? Y N

The equipment category of each item is listed. A pivot table tabulates the number in each category. Two categories (AOV and MOV/SOV) have 14 and 20 items, respectively. The remaining categories have between 1 and 8 items apiece, except for Motor-Generators which had none. This is because there are no Seismic Category I motor-generations at McGuire. The distribution among the equipment classes is similar to what we would expect the distributio in the IPEEE equipment list would be.

- d. Various environments? Y N

The SWEL gives the building, elevation and room number for each item. A table summarizes the number of items in each building and each elevation/room within that building. The items are evenly distributed throughout the plant. However, the specific environment of the building/elevation/room is not given, so the numbers corresponding to the environments listed in the EPRI document are not known. Six items are inside containment

Need to identify the environments and the number in each environment..

Peer Review Checklist for SWEL

- e. Equipment enhanced based on the findings of the IPEEE (or equivalent) program? Y N
The IPEEE did not identify any vulnerabilities requiring modification. However, there were a number of enhancements made. Attachment 4 of the SWEL report lists the nine enhancements. Only four are on the SWEL. Of the ones not on the SWEL, two are no longer safety-related, one is not associated with a specific equipment item (however, it would be included indirectly in the area walk-by) and ??(are last two connected with items on the SWEL?) Report needs explanation for items not included
- Need to address the items not included in the SWEL 1.*
- f. Were risk insights considered in the development of SWEL 1? Y N
This is not addressed in the draft SWEL report. Need to address this.

3. For SWEL 2:

- a. Were spent fuel pool related items considered, and if applicable included in SWEL 2? Y N
The draft report contains a section on the development of the SWEL-2. It provides the criteria for selecting the equipment, in terms of causing pool draining. It contains the basis for each thing that meets the criteria that is not included on SWEL-2. However, the section is not yet complete
- Need to complete this section to address EPRI guidelines.*
- b. Was an appropriate justification documented for spent fuel pool related items not included in SWEL 2? Y N
Section contains a discussion for each item not included in SWEL 2.

4. Provide any other comments related to the peer review of the SWELs.

1. A section needs to be added that describes the participation of operations in development of SWEL 1 and SWEL 2
2. Each person that contributed needs to be identified and their area of expertise described. This is in addition to the originator and checker of the calculation. Need to cover knowledge of IPEEE program.

5. Have all peer review comments been adequately addressed in the final SWEL? Y N

Sheet 3 of 3

Peer Reviewer #1: _____ Date: _____

Peer Reviewer #2: _____ Date: _____



APPENDIX B

PEER REVIEW CHECKLIST FOR FINAL SWEL



Peer Review Checklist for SWEL

Instructions for Completing Checklist

This peer review checklist may be used to document the review of the Seismic Walkdown Equipment List (SWEL) in accordance with Section 6: Peer Review. The space below each question in this checklist should be used to describe any findings identified during the peer review process and how the SWEL may have changed to address those findings. Additional space is provided at the end of this checklist for documenting other comments.

1. Were the five safety functions adequately represented in the SWEL 1 selection? Y N

The IPEEE equipment list contains equipment for all of the safety functions. It specifies the safety functions on a system basis, rather than for each equipment item. In the SWEL spreadsheet, Duke systems engineers with operations input specified the safety functions for the equipment items. A pivot table was created for each unit to summarize the number of items for each safety function. This table shows all safety functions are represented (a significant number of SWEL items support all functions and are denoted "various").

The comment from the in-process checklist is satisfactorily resolved.

2. Does SWEL 1 include an appropriate representation of items having the following sample selection attributes:

- a. Various types of systems? Y N

Each item of the SWEL 1 contains the system. There is a pivot table that summarizes the number of items in each system. Of 99 for each unit, there are 22 systems represented. The maximum number from a single system is 12, while the minimum number is 1.

- b. Major new and replacement equipment? Y N

The SWEL preparers identified items on the SWEL that were modified based on their knowledge of major station modifications. For each item, the modification package is referenced. Of the 99 items in each unit, 47 have modification packages referenced (25 in Unit 1, 22 in Unit 2). This is greater than 20% of the items. Other items probably also have been modified (not part of major modifications), so the actual sample size of modified items is probably larger. We conclude that the sample contains a sufficient number of modified components.

- c. Various types of equipment? Y N

The equipment category of each item is listed. A pivot table tabulates the number in each category. All categories are represented, except Compressors and Motor-Generators. This is because there are no safety-related compressors or motor-generators at McGuire. The distribution among the equipment classes is similar to what we would expect the distribution in the IPEEE equipment list would be. We conclude the distribution is good.

Peer Review Checklist for SWEL

- d. Various environments? Y N

The SWEL gives the building, elevation and room number for each item. A pivot table summarizes the number of items in each building and each elevation/room within that building. Six items are inside containment. The items are distributed fairly evenly throughout the plant, rather than being clustered in just a few areas. While the specific environment of the building/elevation/room is not given, so the numbers corresponding to the environments listed in the EPRI document are not specified, it is clear that all areas with safety-related equipment are represented. Therefore, we conclude that all environments are represented.

The comment from the in-process checklist is satisfactorily resolved.

- e. Equipment enhanced based on the findings of the IPEEE (or equivalent) program? Y N

The IPEEE did not identify any vulnerabilities requiring modification. However, there were a number of enhancements made. Attachment 3 of the SWEL calculation lists the nine enhancements. Five are on the SWEL. Of the ones not on the SWEL, two are no longer safety-related and one is seismic housekeeping not associated with a specific equipment item (however, it would be included indirectly in the area walk-by). The one remaining item was securing arc barriers in the main control board. Duke considered the sample to be sufficient without including the item in the main control board. We concur with this.

The comment from the in-process checklist is satisfactorily resolved.

- f. Were risk insights considered in the development of SWEL 1? Y N

Initially, risk insights were included by the SWEL preparers specifying items they knew to be risk-significant based on their long experience with risk evaluations at the plant. Subsequently, the PRA group has done a risk categorization of all plant items (and events) using the seismic PRA model and the IPEEE seismic hazard curves. A table of items having a contribution to risk of 1% or more, in order of risk significance, was provided in an email that is Attachment 9 of the SWEL calculation. The top item is not Seismic Category I so is not applicable to the SWEL. The next item is the surrogate representing screened out components. Of 25 screened out components, approximately 2/3 are on the SWEL (many of these are multiple components so the proportion is actually larger). Of the remaining seven components, three are not applicable to the SWEL, two are on the SWEL and two are not on the SWEL. It is concluded that risk insights were properly considered.

The comment from the in-process checklist is satisfactorily resolved.

3. For SWEL 2:

- a. Were spent fuel pool related items considered, and if applicable included in SWEL 2? Y N

There are two base lists developed for each unit: one for spent fuel cooling system components, the other for components that could cause rapid drain down. The rationale for identifying the components for each list is provided, and it has been reviewed by Philip Thompson for operations. There are 12 spent fuel cooling components and 10 rapid drain down components identified for each unit. The SWEL-2 for each unit consists of 5 components from the spent fuel cooling base list and 3 components from the rapid drain down list. The section is now complete, and we conclude it meets the EPRI guidance.

The comment from the in-process checklist is satisfactorily resolved.

Peer Review Checklist for SWEL

b. Was an appropriate justification documented for spent fuel pool related items not included in SWEL 2? Y N

The section contains a discussion for each item not included in SWEL 2.

4. Provide any other comments related to the peer review of the SWELs.

The following comments were in this section of the in-process checklist:

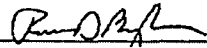
1. A section needs to be added that describes the participation of operations in development of SWEL 1 and SWEL 2


This material has been added. The email documenting the operations review has been added to the calculation. This comment has been satisfactorily resolved.

2. Each person that contributed needs to be identified and their area of expertise described. This is in addition to the originator and checker of the calculation. Need to cover knowledge of IPEEE program.

This has been added to the SWEL calculation. This comment has been satisfactorily resolved.

5. Have all peer review comments been adequately addressed in the final SWEL? Y N

Peer Reviewer #1: Paul D. Baughman, P.E., ARES  Date: 11/15/2012

Peer Reviewer #2: George Bushnell, P.E., SHAW  Date: 11/15/2012

Peer Reviewer #3: Robert L. Keiser, P.E., Duke  Date: 11/15/2012



APPENDIX C

SUMMARY OF PEER REVIEW OF FINAL SWCs AND AWCs



Walkdown Team Members: Charles Conselman, Tom Tonden, Mark Eli, Kevin Rubright, George Hermann, Bryan Hanna, Karen Kuhn, Harpreet Ghuman

Summary of Peer Review of Final SWCs and AWCs

| EDB ID | Equipment Class | 50% Anchorage | Non 50% Anchorage | Line Mounted | Overall Status | Team | Comments |
|-------------------------|-----------------|---------------|-------------------|--------------|----------------|-------|---|
| EDG Bldg 1A EDG Room | | | | | Y | CC/GH | Area Walkdown (1A EDG Room - EL 736.5) 1. Identifies seven separate components assessed in area 2. No additional notes/photographs |
| 1EPE-MX-EMXE | 01 | | X | | U | TT/BH | Obstructed view 2/16 anchor bolts and connection details to building structure; no other conditions noted; no photographs |
| 1EPQ-BA-EDGA | 15 | X | | | U | GH/CC | Obstructed view 2/12 fasteners; no other conditions noted Reference documents cited; no photographs |
| 1EPQ-BC-EDGA | 16 | X | | | N | CC/GH | Inconsistent with plant documentation: shim pack thickness in excess of SQUG review guideline; no other conditions noted Reference documents cited; photographs of unacceptable characteristic |
| 1VG-61 | 08 | | | X | Y | GH/CC | No conditions noted; no photographs |
| 1VGCP0058 | 12 | X | | | Y | GH/CC | No conditions noted; no photographs |
| 1VGTK0062 | 21 | | X | | N | CC/GH | Potential identified for seismic interaction Photo included; references cited |
| 1VGTK0063 | 21 | X | | | N | CC/GH | Potential identified for seismic interaction No photograph included; references cited |
| Unit 1 Diesel Bldg | | | | | Y | CC/GH | Area Walkdown (1B EDG Room - EL 736.5) 1. Identifies seven separate components assessed in area 2. Temporary scaffolding noted (no interaction); no photographs |
| 1B EDG | 17 | | X | | Y | CC/GH | No conditions noted; no photographs |
| 1EPQ-BA-EDGB | 15 | | X | | Y | CC/GH | No conditions noted; no photographs |
| 1EPQ-BC-EDBG | 16 | | X | | Y | CC/GH | Block wall noted; determined as "type D" (seismically qualified) by referenced documentation |
| 1VG-66 | 8 | | | X | Y | CC/GH | No conditions noted; no photographs |
| 1VGCP0060 | 12 | X | | | Y | CC/GH | No conditions noted; no photographs References cited |
| 1VGTK0064 | 21 | | X | | Y | CC/GH | No conditions noted; no photographs |
| 1VGTK0065 | 21 | X | | | Y | CC/GH | No conditions noted; no photographs References cited |

Summary of Peer Review of Final SWCs and AWCs

| EDB ID | Equipment Class | 50% Anchorage | Non 50% Anchorage | Line Mounted | Overall Status | Team | Comments |
|---------------------------------|-----------------|---------------|-------------------|--------------|----------------|-------|---|
| A Control Room Ventilation Area | | | | | Y | KR/KK | Area Walkdown (A Control Room Ventilation Area) 1. Identifies 2 separate components assessed in area 2. No additional notes/photographs |
| 0VCD0001 | 07 | | | X | Y | KR/KK | No conditions noted; no photographs |
| 0VCFL0011 | 09 | X | | | Y | KR/KK | No conditions noted; no photographs References cited |
| Reactor Bldg Annulus | | | | | Y | ME/GH | Area Walkdown (Reactor Bldg Annulus – Unit 1) 3. Identifies 3 SWEL components in area 4. Potential housekeeping issue cited (wiring) |
| INV-B42AC | 08 | | | X | Y | ME/GH | Shim detail noted: within SQUG evaluation criteria |
| INVAC0048 | 00 | | X | | Y | ME/GH | No conditions noted; no photographs |
| INVP0046 | 05 | X | | | N | ME/GH | Anchorage detail verified against reference documents Potential seismic interaction with piping identified |
| Control Room AHU Area | | | | | Y | KR/KK | Area Walkdown (Control Room AHU Area) 1. 1 SWEL component in area 2. No conditions noted; no photographs |
| 0VCAH0001 | 10 | X | | | Y | KR/KK | Anchorage detail verified against reference documents No conditions noted; no photographs |
| Control Room Chiller Area | | | | | Y | KR/KK | Area Walkdown (Control Room Chiller Area) 1. Identifies 2 separate components assessed in 2. No conditions noted; no photographs |
| 0YC-CH-0005 | 11 | X | | | Y | KR/KK | No conditions noted; no photographs References cited |
| Aux Bldg | | | | | Y | KR/KK | Area Walkdown (KC Surge Tank Area) 1. Identifies 2 separate components assessed in 2. No conditions noted; no photographs |
| IKCTK0009 | 21 | X | | | Y | KR/KK | Anchorage verified against reference documents Potential event-caused flooding detail cited Photo included |
| Aux Bldg | | | | | Y | ME/GH | Area Walkdown (Aux Bldg Pipechase – EL 695) 1. 1 SWEL component in area 2. No conditions noted; no photographs |
| IND-4B | 08 | | | X | N | ME/GH | Unrelated to SWEL component: degraded cable tray support configuration noted |

Summary of Peer Review of Final SWCs and AWCs

| EDB ID | Equipment Class | 50% Anchorage | Non 50% Anchorage | Line Mounted | Overall Status | Team | Comments |
|-----------------------|-----------------|---------------|-------------------|--------------|----------------|-------|--|
| Aux Bldg Room 500 | | | | | Y | KR/KK | Area Walkdown (ND Pump Room) 1. 1 SWEL component in area 2. No conditions noted; no photographs |
| INDPU0002 | 06 | X | | | Y | KR/KK | Anchorage detail verified against reference documents No conditions noted; no photographs |
| Aux Bldg Room 5001 | | | | | Y | KR/KK | Area Walkdown (ND Pump Room) 1. 1 SWEL component in area 2. No conditions noted; no photographs |
| INDPU0001 | 06 | | X | | Y | KR/KK | No conditions noted; no photographs |
| Aux Bldg Room 5002 | | | | | Y | KR/KK | Area Walkdown (ND Pump Room) 1. 1 SWEL component in area 2. No conditions noted; no photographs |
| INSPU0001 | 06 | | X | | Y | KR/KK | No conditions noted; no photographs |
| Aux Bldg Room 600 B/C | | | | | Y | KR/KK | Area Walkdown (RN Strainer Room) 1. Identifies 4 separate components assessed in area 2. No additional notes/photographs |
| IRN-21A | 07 | | | X | Y | KR/KK | No conditions noted; no photographs |
| IRNPU0007 | 05 | | X | | Y | KR/KK | No conditions noted; no photographs Temporary scaffolding noted in area: no interaction |
| IRNST0001 | 00 | Y | | | Y | KR/KK | Anchorage detail verified against reference documents No conditions noted; no photographs |
| Aux Bldg Room 600 | | | | | N | KR/KK | Area Walkdown (MDCAP Room) 1. 1 SWEL component in area 2. Potential seismic interaction noted; photographs included |
| ICA-56A | 07 | | | X | N | KR/KK | Potential seismic interactions identified; photographs included 1. Cable drop from tray contacting valve operator 2. Lack of flexibility in attached lines |
| Aux Bldg Room 600 | | | | | N | TT/BH | Area Walkdown (Unit 1 MDCA Pump Room) Several potential seismic interaction details noted: photographs included; close clearance and zero clearance cited |
| ICAPNAFPA | 20 | Y | | | U | BH/TT | Obstructed view 4/12 fasteners; no other conditions noted Reference documents cited; no photographs |
| ICAPU0001 | 05 | X | | | Y | BH/TT | Anchorage detail verified against reference documents No conditions noted; no photographs |

Summary of Peer Review of Final SWCs and AWCs

| EDB ID | Equipment Class | 50% Anchorage | Non 50% Anchorage | Line Mounted | Overall Status | Team | Comments |
|-------------------|-----------------|---------------|-------------------|--------------|----------------|----------------|--|
| 1WL322B | 08 | | | X | Y | BH/TT | No conditions noted; no photographs |
| Aux Bldg Room 600 | | | | | Y | TT/BH | Area Walkdown (Unit 1 TDCA Pump Room) Potential housekeeping item noted; no interaction |
| 1CAPNAFTP | 20 | | X | | U | ME/KK | Obstructed view of anchorage; no other conditions noted Reference documents cited; no photographs |
| 1CAPU0003 | 05 | X | | | Y | BH/TT | Anchorage detail verified against reference documents No conditions noted; no photographs |
| 1CAXH0003 | 21 | | X | | U | BH/TT | Potential edge distance concern with anchorage bolts No photographs; no references cited |
| Aux Bldg Room 601 | | | | | N | TT/KK BH/ME | Area Walkdown (Unit 2 MDCA Pump Room) Combined teams performed walkdown 1. Identified potential adverse seismic interaction 2. Photographs included; references cited |
| 0RN7A | 08 | | | X | Y | ME/TT | No conditions noted; no photographs |
| Aux Bldg Room 722 | | | | | Y | TT/ME | Area Walkdown (Essential MCC Room) No conditions noted; no photographs |
| 1EMXB | 01 | | X | | U | TT/ME | Obstructed view of "some anchor bolts" Verified IPEEE enhancement implemented |
| 1EMXB1 | 01 | X | | | U | TT/ME | Obstructed view of "some anchor bolts" Verified IPEEE enhancement implemented References cited. |