UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 12, 2018

Mr. Bryan C. Hanson
Senior Vice President
Exelon Generation Company, LLC
President and Chief Nuclear Officer
Exelon Nuclear
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: THREE MILE ISLAND NUCLEAR STATION, UNIT 1 – STAFF ASSESSMENT OF ACTION ITEM 7 REGARDING INSPECTION PLAN FOR REACTOR INTERNALS (EPID L-2016-LLL-0002)

Dear Mr. Hanson:

By letter dated September 16, 2016, as supplemented by letter dated April 18, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML16263A338 and ML18108A287, respectively), Exelon Generation Company, LLC, (the licensee) submitted to the U.S. Nuclear Regulatory Commission (NRC) its evaluation of applicant/licensee action (A/LAI) 7 in accordance with the safety evaluation in MRP-227-A "Pressurized Water Reactor (PWR) Internals Inspection and Evaluation Guidelines" (ADAMS Accession No. ML120170453) for Three Mile Island Nuclear Station (TMI), Unit 1.

The NRC staff has reviewed the licensee's provided evaluation and determined that the licensee adequately demonstrated that the functionality of the control rod guide tube spacer castings, in-core monitoring instrumentation guide tube spider castings, and vent valve retaining rings at TMI, Unit 1, will be maintained during the period of extended operation. Accordingly, the NRC staff determined that the licensee has adequately resolved A/LAI 7. The NRC staff's assessment is enclosed.

Enclosure 2 contains Proprietary Information. When separated from Enclosure 2, this letter is DECONTROLLED.

If you have any questions, please contact me at 301-415-2048 or via e-mail at Justin.Poole@nrc.gov.

Sincerely,

/RA/

Justin C. Poole, Project Manager
Plant Licensing Branch I
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-289

Enclosure:
1. Staff Assessment of Action Item 7 (non-proprietary version)
2. Staff Assessment of Action Item 7 (proprietary version)

cc w/o Enclosure 2: Listserv

SUBJECT: THREE MILE ISLAND NUCLEAR STATION, UNIT 1 – STAFF ASSESSMENT OF ACTION ITEM 7 REGARDING INSPECTION PLAN FOR REACTOR INTERNALS (EPID L-2016-LLL-0002) DATED JULY 12, 2018

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*by memo dated

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Enclosure 2

NONPROPRIETARY VERSION

STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

MRP-227-A APPLICANT/LICENSEE ACTION ITEM 7 EVALUATION

THREE MILE ISLAND NUCLEAR STATION, UNIT 1

EXELON GENERATION COMPANY, LLC

DOCKET NO. 50-289

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

MRP-227-A APPLICANT/LICENSEE ACTION ITEM 7 EVALUATION

THREE MILE ISLAND NUCLEAR STATION, UNIT 1

EXELON GENERATION COMPANY, LLC

DOCKET NO. 50-289

1.0 INTRODUCTION

By letter dated September 16, 2016 (Reference 1), as supplemented by letter dated April 18, 2018 (Reference 2), Exelon Generation Company, LLC (licensee), submitted to the U.S. Nuclear Regulatory Commission (NRC) its evaluation of applicant/licensee action (A/LAI) 7 for Three Mile Island Nuclear Station (TMI), Unit 1, in accordance with the safety evaluation (SE) in MRP-227-A "Pressurized Water Reactor (PWR) Internals Inspection and Evaluation Guidelines" (Reference 3). A/LAI 7 requires, in part, applicants or licensees of Babcock and Wilcox (B&W) reactor designs to develop plant-specific analysis to demonstrate that reactor vessel internals (RVI) components made of cast austenitic stainless steel (CASS) and precipitation-hardened (PH) stainless steel will maintain their functionality during the period of extended operation (PEO). By letter dated December 19, 2014 (Reference 4), the NRC staff issued its assessment of all TMI, Unit 1, RVI components and documented the licensee's commitment to submit its evaluation of the CASS and PH stainless steel RVI components in accordance with A/LAI 7 of the SE in MRP-227-A. The purpose of the September 16, 2016, submittal, as supplemented, is to fulfill this commitment. Please note that the NRC staff assessment contains licensee proprietary information and is thus marked accordingly with **[[ ]]**.

2.0 REGULATORY EVALUATION

Title 10 of the *Code of Federal Regulations* (10 CFR) Part 54 addresses the requirements for managing the effects of aging components during the PEO, and MRP-227-A specifies inspection and evaluation guidelines for adequately managing aging effects in RVI components. The MRP-227-A inspection and evaluation guidelines must be followed if applicants or licensees implement them for their units. RVI include components that are made of CASS and PH stainless steel,

which are susceptible to the following aging degradation mechanisms: thermal embrittlement (TE), irradiation embrittlement (IE), or the synergistic effects of TE and IE. For TMI, Unit 1, the three RVI components that are made of CASS or PH stainless steel are the control rod guide tube (CRGT) spacer castings, the in-core monitoring instrumentation (IMI) guide tube spider castings, and the vent valve retaining rings.

The NRC staff provided the detailed regulatory evaluation of the requirements of 10 CFR Part 54 and the inspection and evaluation guidelines of MRP-227-A in the December 19, 2014, staff assessment of the TMI, Unit 1, implementation of MRP-227-A (Reference 4), in which the licensee committed to submit its evaluation of the CASS and PH stainless steel RVI components in accordance with A/LAI 7 of the SE in MRP-227-A.

3.0 TECHNICAL EVALUATION

Section 4.2.7 “Plant-Specific Evaluation of CASS Materials” of the SE in MRP-227-A, states:

> As discussed in Section 3.3.7 of this SE, the applicants/licensees of B&W, CE [Combustion Engineering], and Westinghouse reactors are required to develop plant-specific analyses to be applied for their facilities to demonstrate that B&W IMI guide tube assembly spiders and CRGT spacer castings, CE lower support columns, and Westinghouse lower support column bodies will maintain their functionality during the period of extended operation or for additional RVI components that may be fabricated from CASS, martensitic stainless steel or precipitation hardened stainless steel materials. These analyses shall also consider the possible loss of fracture toughness in these components due to thermal and irradiation embrittlement, and may also need to consider limitations on accessibility for inspection and the resolution/sensitivity of the inspection techniques. The requirement may not apply to components that were previously evaluated as not requiring aging management during development of MRP-227. That is, the requirement would apply to components fabricated from susceptible materials for which an individual licensee has determined aging management is required, for example during their review performed in accordance with Applicant/Licensee Action Item 2. The plant-specific analysis shall be consistent with the plant’s licensing basis and the need to maintain the functionality of the components being evaluated under all licensing basis conditions of operation. The applicant/licensee shall include the plant-specific analysis as part of their submittal to apply the approved version of MRP-227. **This is Applicant/Licensee Action Item 7**.

The NRC staff’s assessment of the A/LAI 7 evaluation for TMI, Unit 1, focused on the technical information in proprietary report ANP-3479P “MRP-227-A Applicant/Licensee Action Item 7 Analysis for Three Mile Island, Unit 1,” Revision 0, which the licensee included as Attachment 1 to the September 16, 2016, letter. The licensee included technical evaluations in ANP-3479P, Revision 0, to demonstrate that the CRGT spacer castings, IMI guide tube spider castings, and vent valve retaining rings will maintain their functionality during the PEO, and thus to demonstrate that loss of fracture toughness due to TE, IE, or both TE and IE, with respect to these components will be adequately managed during the PEO.

The NRC staff reviewed the methodology that the licensee used for the technical evaluations in ANP-3479P for the TMI, Unit 1, CRGT spacer castings, IMI guide tube spider castings, and vent valve retaining rings. The basic elements of this approach are identifying appropriate inputs for

evaluation, determining the likelihood of failure of the component, and determining the effect of a postulated failure on functionality of the component. The NRC staff finds the methodology the licensee used for the technical evaluations in ANP-3479P acceptable.

The following sections describe the function of each of the three subject components, summarize the licensee's technical evaluation of the component, and provide the NRC staff's assessment of the licensee's evaluation. By letter dated February 26, 2018 (Reference 5), the NRC staff issued requests for additional information (RAIs) to support its assessment.

3.1 Assessment of the CRGT Spacer Castings

3.1.1 Description and Function of the CRGT Spacer Castings

The CRGT spacer castings are part of the brazement subassembly, which includes the vertical control rod guide tubes and vertical control rod guide sectors. There are **[[ ]]** per brazement subassembly. The function of the CRGT spacer castings is to provide structural support and alignment to the vertical control rod guide tubes and vertical control rod guide sectors. The brazement subassembly guides the control rod assembly over the entire range of the vertical withdrawal or insertion path. The CRGT spacer castings do not have a core support function, but broken CGRT spacer castings could hinder the insertion of the control rods into the core within the normal anticipated time, and thus hindering shutdown capability of the reactor.

The CRGT spacer castings are made from CF3M grade CASS and, per Table 4-1, "B&W plants Primary components" of MRP-227-A, are susceptible to TE.

3.1.2 Licensee's Evaluation

The licensee provided a detailed evaluation of the TMI, Unit 1, CRGT spacer castings in Section 3.0 "CRGT Spacer Castings" of ANP-3479P. The evaluation is summarized below.

a) *Regarding the possibility of existing flaws:* The licensee reviewed available certified material testing reports (CMTRs) for the CRGT spacer castings and determined that the CRGT spacer castings received **[[ ]]. [[ ]]**. Therefore, given that the CRGT spacer castings received **[[ ]]**.

b) *Regarding degraded material properties:* The licensee stated that **[[ ]]** of the CRGT spacer castings are susceptible to TE. The licensee investigated the time to reach saturated material property values (such as impact energy, and, correspondingly, fracture toughness) for the CRGT spacer castings and determined that saturation **[[ ]]**.

c) *Regarding the likelihood of failure:* The licensee stated that visual testing (VT)-3 per MRP-227-A guidance of 100 percent of the accessible surfaces at each of the four screw locations of the CRGT spacer castings, performed between 2012 and 2014 at three B&W units, revealed no recordable indications. The licensee also stated that there is no known failures of CASS materials due to embrittlement that have been reported in the industry.

Finally, the licensee explained that since there is **[[**

]]. For these reasons, and considering that the material properties of the CRGT spacer castings have **[[** **]]**, the licensee concluded that failure of the CRGT spacer castings during the PEO is unlikely.

d) *Regarding the effect of failure on functionality:* The licensee evaluated the amount of distortion that will permit the control rods to freely pass through the brazement subassembly and determined that **[[**

]]. Furthermore, the licensee stated that stress analysis of the CRGT spacer castings reinforces why simultaneous failures at two screw locations are unlikely. First, the stress analysis shows that highest stresses are at the four screw locations, which implies that flaws must be **[[**

]]. Second, the stress analysis showed that **[[**

]].

The licensee stated that the brazement subassembly has two redundant features: **[[**

]]. The licensee analyzed the brazement subassembly and determined that a single failure at any screw location would be acceptable and not restrict the control rod guide path, and that multiple single failures of CRGT spacer castings in the same brazement subassembly are also acceptable. Additionally, the **[[**

]]. Also, **[[**

]].

Finally, the licensee stated control rod drop-times are tested at the beginning of each cycle per the TMI, Unit 1, technical specifications (TSs) to ensure they are within the requirements. The licensee investigates unusual drop-times when they occur. The licensee stated that to date, slow trip times have been due to unusual fuel bow or issues with the control rod drive mechanism.

For the reasons in the preceding paragraphs in item (d), the licensee concluded that **[[**

]].

3.1.3 NRC Staff's Assessment

The NRC staff reviewed the information in Section 3.0 of ANP-3479P for the CRGT spacer castings, as summarized in items (a) through (d) in Section 3.1.2 above, and provides its findings below for each corresponding item.

a) The NRC staff finds it reasonable to assume that the CRGT spacer castings received **[[ ]]** based on the licensee's review of the CMTRs. Additionally, the NRC staff verified in MRP-189, Revision 1 (Reference 6), that the CRGT spacer castings do not screen in for **[[ ]]**, mechanisms that can extend cracks. Accordingly, since the CRGT spacer castings received **[[ ]]**, the NRC staff finds the licensee's assumption that **[[ ]]** to be reasonable **[[ ]]**.

b) In the April 18, 2018, supplement, in its response to RAI-1, the licensee explained how it concluded that the CRGT spacer castings **[[ ]]**. The licensee referenced **[[ ]]**. The licensee did not specify a value of saturated fracture toughness and stated that the reduction in Charpy impact energy with time correlates with a reduction in fracture toughness.

   The NRC staff reviewed **[[ ]]** which includes a discussion of the correlation between Charpy impact energy and fracture toughness for CASS. Based on this review, the NRC staff finds acceptable that a reduction in Charpy impact energy with time correlates with a reduction in fracture toughness with time. The staff reviewed the information in **[[ ]]**, which shows Charpy impact energy plotted against aging time for heats of CF3 grade CASS. The staff noted that **[[ ]]**. The guidance for TE screening of CASS (Reference 8, "Grimes letter"), which shows CASS having high molybdenum content being more susceptible to TE, supports this conclusion. Therefore, the NRC staff finds the licensee's conclusion that the CRGT spacer castings have **[[ ]]** acceptable.

c) The NRC staff finds that the operating experience (OE) for the three B&W units and the industry-wide OE for CASS materials are favorable with regards to cracking of CRGT spacer castings. As previously mentioned, the NRC staff verified in MRP-189, Revision 1, that the CRGT spacer castings do not screen in for **[[ ]]**. Therefore, the NRC staff finds that the assumption that **[[ ]]** is reasonable. The NRC staff noted that TMI, Unit 1, entered the PEO on April 19, 2014. Therefore, considering that the CRGT spacer casting material **[[ ]]**

]], the favorable OE, **[[**

]], the staff finds acceptable the licensee's conclusion that failure of the CRGT spacer castings during the PEO is unlikely. The staff also notes that its findings on the stress analysis of the CRGT spacer castings discussed in item d below support the conclusion that failure of the CRGT spacer castings during the PEO is unlikely.

d) The NRC staff reviewed the distortion discussion and determined that **[[**

]], as discussed in the next paragraph. The staff also reviewed the licensee's stress analysis and finds that it corroborates the conclusion that **[[** **]]**. In the April 18, 2018, supplement, in its response to RAI-2, the licensee stated that **[[**

]]. The NRC staff, therefore, finds the licensee's conclusion that **[[**

]] to be acceptable.

The NRC staff reviewed and confirmed the two redundant features of the brazement subassembly of which the CRGT spacer castings are a part. The staff reviewed the information in Section 2.3.4 "Control Rod Guide Tube Assembly" of MRP-189, Revision 1, and determined that **[[**

]].

The NRC staff noted that control rod drop-time testing per the TMI, Unit 1, TSs would detect unusual drop-times, whether the cause is related to the degraded CRGT spacer castings or not. This technical specification requirement provides the staff reasonable assurance that the licensee would take the proper action to correct unusual control rod drop-times should they occur.

Based on the preceding paragraphs in item (d), the NRC staff finds that the licensee adequately considered the effect of postulated CRGT spacer castings failures on the component's functionality.

Based on the discussion in items (a) through (d) above, the NRC staff determined that the licensee adequately demonstrated that it will maintain the functionality of the CRGT spacer castings during the PEO. Accordingly, the staff determined that the licensee will adequately manage the aging effects of the CRGT spacer castings during the PEO.

3.2 Assessment of the IMI Guide Tube Spider Castings

3.2.1 Description and Function of the IMI Guide Tube Spider Castings

The IMI guide tube spider castings resemble a four-leafed butterfly nut, with each leaf or "leg" welded to one of four walls of a "cubbyhole" of the lower grid rib section. The center hub of an IMI guide tube spider casting slides over, **[[** **]]**, the upper tip of the IMI guide tube. The function of the IMI guide tube spider casting is to provide lateral restraint for the IMI guide tube and the function of the spider fillet welds is to hold the IMI guide tube spider casting in place. The IMI guide tube provides a continuous protected guide path for the IMI from their entry

into the reactor pressure vessel (RPV), through the RPV instrumentation nozzles, to the entrance into the fuel assembly instrument guide tube. **[[**

]], but broken IMI guide tube spider castings (including their welds) could impair entry of IMI. Impaired entry of IMI could adversely affect monitoring of core parameters critical to ensuring reactor safety.

The IMI guide tube spider castings are made from CF8 grade CASS and, per Table 4-1 of MRP-227-A, are susceptible to both TE and IE.

3.2.2 Licensee's Evaluation

The licensee provided a detailed evaluation of the TMI, Unit 1, IMI guide tube spider castings in Section 4.0 "IMI Guide Tube Spider Castings" of ANP-3479P. The evaluation is summarized below.

a) *Regarding the possibility of existing flaws:* The licensee reviewed available **[[**

]], are limited to ASME (American Society of Mechanical Engineers) Code allowable sizes in castings for pressure boundary components.

b) *Regarding degraded material properties:* The licensee stated that there is, generally, lack of fracture toughness data, especially in the neutron fluence range relevant to the TMI, Unit 1, IMI guide tube spacer castings. This neutron fluence range is **[[**

]]. The licensee explained that at this fluence level, the IMI guide tube spider castings retain enough fracture toughness such that the **[[**

]] based on the fracture toughness categorization defined in NUREG/CR-7027 (Reference 9). Additionally, to address the effect of IE, the licensee referenced an NRC evaluation included in the Grimes letter (Reference 8) and the results of a joint effort on the effect of neutron fluence on fracture toughness by the Boiling Water Reactors Vessel and Internals Program and Materials Reliability Program (BWRVIP/MRP). Specifically, the licensee determined that **[[**

]] the fracture toughness criterion in the Grimes letter, and, thereby, concluded that the fracture toughness reduction due to IE is not significant. The licensee stated that the IMI guide tube spider castings are not **[[** **]]**.

c) *Regarding the likelihood of failure:* The licensee concluded that the IMI guide tube spider castings are unlikely to fail due to IE for three reasons: (1) **[[**

]] for the reasons summarized in item (a); (2) the dominant crack driving force is **[[**

]]; and (3) the IMI guide tube spider castings **[[**

]] for the reasons summarized in item (b).

d) *Regarding the effect of failure on functionality:* The licensee's structural analysis demonstrated that stresses due to **[[ ]]**, safe shutdown earthquake (SSE), and LOCA **[[ ]]** and that **[[ ]]**. The structural analysis also shows that **[[ ]]**. Additionally, the flow induced vibration analysis shows that **[[ ]]**. For these reasons, the licensee concluded that **[[ ]]** in a IMI guide tube spider casting **[[ ]]** in the same casting. Having established that **[[ ]]**, the licensee further reasoned that **[[ ]]**.

3.2.3 NRC Staff's Assessment

The NRC staff reviewed the information in Section 4.0 of ANP-3479P for the IMI guide tube spider castings, as summarized in items (a) through (d) in Section 3.2.2 above, and provides its findings below for each corresponding item.

a) The NRC staff finds it reasonable to assume that the IMI guide tube spider castings received **[[ ]]**. The NRC staff verified in MRP-189, Revision 1, that the IMI guide tube spider castings do not screen in for **[[ ]]**. Since the IMI guide tube spider castings received **[[ ]]** and cracking mechanisms are not present, NRC staff finds it reasonable that **[[ ]]**.

b) The NRC staff established its position on loss of fracture toughness for CF3 and CF8 grade CASS (with less than 20 percent ferrite) due to IE and TE in its SE of BWRVIP-234 (Reference 10). The licensee stated that the IMI guide tube spider castings (made of CF8 grade CASS) have **[[ ]]**, but did not specify a value. The pressurized water reactors owners group (PWROG) issued report PWROG-15032-NP (Reference 11) to evaluate loss of fracture toughness for CF8 grade CASS due to TE. In its assessment (Reference 12), of PWROG-15032-NP, the NRC staff stated that static-cast CF8 grade CASS can be shown to have a high probability of ferrite content below 20 percent. Therefore, the NRC staff determined that **[[ ]]** likely means **[[ ]]** and that, accordingly, the SE of BWRVIP-234 is applicable for evaluating the effects of IE and TE on the spider castings. The bottom curve in Figure A1 of the SE of BWRVIP-234 shows that at a fluence of **[[ ]]**, the fracture toughness is a little below 200 kJ/m^2 (kilojoule/square meter and megajoule/square meter). The value of 200 kJ/m^2 is the fracture toughness acceptance criterion established in Section 3.3.8 of the SE of BWRVIP-234. The NRC staff noted that this fracture toughness criterion is less than 255 kJ/m^2 from the Grimes letter that the licensee referenced, but also that the Grimes letter criterion was established for pressure boundary components. As the staff noted in in Section 3.3.8 of the SE of BWRVIP-234, RVI components do not need the same level of toughness as pressure boundary components. Therefore, the NRC staff determined that the reduction of fracture toughness of the IMI guide tube spider castings due to IE and TE would not be significant.

c) The NRC staff finds that assuming **[[ ]]** in the IMI guide tube spider castings is reasonable for the reasons discussed in item (a). The staff finds that due to the **[[ ]]**, is reasonable. The NRC staff cannot verify that the IMI guide tube spider castings **[[ ]]** for the reasons discussed in item (b).

d) The NRC staff finds it reasonable that **[[ ]]** because weld residual stresses are well-known to cause cracking in component joints. The staff finds it appropriate that the licensee considered design basis loads in the structural analysis in addition to **[[ ]]**. In the April 18, 2018, supplement, in its response to RAI-3, the licensee stated that **[[ ]]**. For these reasons, the NRC staff determined that **[[ ]]**.

The NRC staff reviewed the description of **[[ ]]**. Although the licensee did not calculate a **[[ ]]** as the licensee stated in the April 18, 2018, supplement, the NRC staff finds that **[[ ]]**.

The NRC staff also determined that the licensee's flow induced vibration analysis that **[[ ]]** further supports that **[[ ]]** is not a concern. Accordingly, the NRC staff determined that the licensee provided reasonable assurance that it will maintain functionality of the IMI guide tube spider castings during the PEO.

Based on the discussion in items (a) through (d) above, the NRC staff determined that the licensee adequately demonstrated that it will maintain the functionality of the IMI guide tube spider castings during the PEO. Accordingly, the NRC staff determined that the licensee will adequately manage the aging effects of the IMI guide tube spider castings during the PEO.

3.3 Assessment the Vent Valve Retaining Rings

3.3.1 Description and Function of the Vent Valve Retaining Rings

The vent valve retaining rings are part of the vent valve assembly within the core support shield assembly. There are eight vent valve assemblies in the core support shield assembly. Each vent valve assembly includes a top retaining ring and a bottom retaining ring. The function of the retaining rings is to retain the vent valve body in the vent valve nozzle. In the event of a pipe rupture in the RPV inlet pipe, the vent valve opens to permit steam generated in the core to flow

directly to the break. This permits the core to be flooded and adequately cooled when emergency core coolant is supplied to the RPV. A secondary function of the vent valve is to **[[ ]]**. Failure of a retaining ring or portion of a retaining ring results in loss of support function for the vent valve body **[[ ]]** and **[[**

]].

The vent valve retaining rings are made from Type 15-5 PH stainless steel and, per Table 4-1 of MRP-227-A, are susceptible to TE.

3.3.2 Licensee's Evaluation

The licensee provided a detailed evaluation of the TMI, Unit 1, vent valve retaining rings in Section 5.0 "Vent Valve Retaining Rings" of ANP-3479P. The evaluation is summarized below.

a) *Regarding the possibility of existing flaws:* The licensee reviewed available CMTRs for the vent valve retaining rings, and determined that the TMI, Unit 1, vent valve rings **[[ ]]**. The licensee stated that information on **[[ ]]**. Therefore, given that the vent valve rings received **[[**

]].

b) *Regarding degraded material properties:* **[[**

]]. Additionally, the licensee stated that a reasonable lower bound fracture toughness for the vent valve retaining rings is **[[ ]]**.

c) *Regarding the likelihood of failure:* The licensee stated that given the vent valve retaining rings **[[ ]]**, the **[[**

]]. The licensee stated that having no known cracking or failures of vent valve retaining rings confirms this conclusion. Because of this, the conclusion in item (a) regarding the **[[**

]], and the expected fracture toughness of the vent valve retaining rings to be **[[**

]], the licensee concluded that failure of the vent valve retaining rings is not expected during the PEO.

d) *Regarding the effect of failure on functionality:* The licensee stated that if vent valve retaining rings break, **[[**

]], but it would not **[[**

]] during a large cold leg break LOCA. The licensee also stated that with broken vent valve retaining rings, **[[**

]].

3.3.3 NRC Staff's Assessment

The NRC staff reviewed the information in Section 5.0 of ANP-3479P for the vent valve retaining rings, as summarized in items (a) through (d) in Section 3.3.2 above, and provides its findings below for each corresponding item.

a) The NRC staff finds it reasonable to assume that the vent valve rings received **[[ ]]** based on the licensee's review of the CMTRs. Additionally, the NRC staff verified in MRP-189, Revision 1, that the vent valve retaining rings do not screen in for **[[ ]]**, mechanisms that can extend cracks. Accordingly, the NRC staff finds the licensee's assumption that the vent valve retaining rings are **[[ ]]** to be reasonable even though information on **[[ ]]**.

b) The licensee stated that **[[**

]]. The NRC staff requested clarification on how the licensee reached this conclusion. In the April 18, 2018, supplement, in its response to RAI-4, the licensee clarified that, **[[**

]]. The licensee also clarified that **[[**

]]. The NRC staff finds it reasonable to cite saturation information for **[[ ]]**, considering **[[**

]]. Accordingly, the NRC staff finds acceptable the licensee's conclusion that the vent valve retaining rings have **[[ ]]**.

c) The NRC staff finds that because the vent valve retaining rings are: (1) **[[ ]]**; (2) **[[ ]]**; and (3) there has been no cracking or failures of vent valve retaining rings B&W-designed PWRs, the failure of the vent valve retaining rings is unlikely during the PEO.

d) The NRC staff finds the information the licensee provided regarding **[[ ]]** and the capability of the vent valve to **[[**relieve pressure during LOCA with failed retaining rings**]]** provides reasonable assurance of functionality of the vent valve retaining rings during the PEO.

Based on the discussion in items (a) through (d) above, the NRC staff determined that the licensee adequately demonstrated that it will maintain the functionality of the vent valve retaining rings during the PEO. Accordingly, the NRC staff determined that the licensee will adequately manage the aging effects of the vent valve retaining rings during the PEO.

4.0 CONCLUSION

The NRC staff has reviewed the licensee's TMI, Unit 1, evaluation of A/LAI 7 of the SE in the MRP-227-A. Based on the discussions in Section 3.0 of this assessment, the staff determined

that the licensee adequately demonstrated that the functionality of the CRGT spacer castings, IMI guide tube spider castings, and vent valve retaining rings at TMI, Unit 1, will be maintained during the PEO. Accordingly, the NRC staff determined that the licensee has adequately resolved A/LAI 7.

5.0 REFERENCES

1. Letter from Edward W. Callan (Exelon) to NRC, "Submittal of Inspection Plan for Reactor Internals, A/LAI #7 Component Evaluation," September 16, 2016 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16263A338).

2. Letter from David P. Helker (Exelon) to NRC, "Response to Request for Additional Information — Three Mile Island Nuclear Station, Unit 1 – Request for Additional Information Regarding Inspection Plan for Reactor Internals Action Item 7 (EPID L-2016-LLL-0002)," April 18, 2018 (ADAMS Accession No. ML18108A287).

3. *Materials Reliability Program: Pressurized Water Reactor Internals Inspection and Evaluation Guidelines (MRP-227-A)*. EPRI, Palo Alto, CA: 2011. 1022863 (ADAMS Accession Nos. ML120170453).

4. Letter from NRC to Michael J. Pacilio (Exelon), "Three Mile Island Nuclear Station, Unit 1 – Staff Assessment of the Reactor Vessel Internals Inspection Plan (TAC No. MF1459)," December 19, 2014 (ADAMS Accession No. ML14297A411).

5. Letter from Justin C. Poole (NRC) to Bryan C. Hanson (Exelon), "Three Mile Island Nuclear Station, Unit 1 – Request for Additional Information Regarding Inspection Plan for Reactor Internals Action Item 7 (EPID L-2016-LLL-0002)," February 26, 2018 (ADAMS Accession No. ML18043B142).

6. *Materials Reliability Program:* Screening, *Categorization, and Ranking of B&W-Designed PWR Internals Component Items (MRP-189-Rev. 1)*. EPRI, Palo Alto, CA: 2009. 1018292 (PROPRIETARY).

7. NUREG/CR-4513, Revision 1, "Estimation of Fracture Toughness of Cast Stainless Steels During Thermal Aging in LWR Systems," August 1994 (ADAMS Accession No. ML052360554).

8. Letter from NRC to Douglas J. Walters (Nuclear Energy Institute), "License Renewal Issue No. 98-0030, Thermal Aging Embrittlement of Cast Austenitic Stainless Steel Components," May 19, 2000 (ADAMS Accession No. ML003717179).

9. NUREG/CR-7027, "Degradation of LWR Core Internal Materials due to Neutron Irradiation," December 2010 (ADAMS Accession No. ML102790482).

10. Letter from NRC to Tim Hanley (Chairman, BWR Vessel and Internals Project), "Final Safety Evaluation of the BWRVIP-234: Thermal Aging and Neutron Embrittlement Evaluation of Cast Austenitic Stainless Steel for BWR Internals (TAC NO. ME5060)," June 22, 2016 (ADAMS Accession No. ML16096A002).

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