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10 CFR 50
10 CFR 51
10 CFR 54

RS-14-126

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U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555-0001

Braidwood Station, Units 1 and 2
Facility Operating License Nos. NPF-72 and NPF-77
NRC Docket Nos. STN 50-456 and STN 50-457

Byron Station, Units 1 and 2
Facility Operating License Nos. NPF-37 and NPF-66
NRC Docket Nos. STN 50-454 and STN 50-455

Subject: Response to NRC Request for Additional Information, Set 20, dated April 7, 2014, related to the Braidwood Station, Units 1 and 2, and Byron Station, Units 1 and 2, License Renewal Application

References: 1. Letter from Michael P. Gallagher, Exelon Generation Company LLC (Exelon) to NRC Document Control Desk, dated May 29, 2013, "Application for Renewed Operating Licenses."

2. Letter from Lindsay R. Robinson, US NRC to Michael P. Gallagher, Exelon, dated April 7, 2014, "Request for Additional Information for the Review of the Byron Station, Units 1 and 2, and Braidwood Station, Units 1 and 2, License Renewal Application, Set 20 (TAC NOS. MF1879, MF1880, MF1881, and MF1882)"

In the Reference 1 letter, Exelon Generation Company, LLC (Exelon) submitted the License Renewal Application (LRA) for the Byron Station, Units 1 and 2, and Braidwood Station, Units 1 and 2 (BBS). In the Reference 2 letter, the NRC requested additional information to support staff review of the LRA.

Enclosure A contains the responses to these requests for additional information.

Enclosure B contains updates to sections of the LRA affected by the responses.

There are no new or revised regulatory commitments contained in this letter.

If you have any questions, please contact Mr. Al Fulvio, Manager, Exelon License Renewal, at 610-765-5936.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on 5-6-2014

Respectfully,

Michael P. Gallagher

Michael P. Gallagher
Vice President - License Renewal Projects
Exelon Generation Company, LLC

Enclosures: A. Responses to Requests for Additional Information
B. Updates to affected LRA Sections

cc: Regional Administrator – NRC Region III
NRC Project Manager (Safety Review), NRR-DLR
NRC Project Manager (Environmental Review), NRR-DLR
NRC Senior Resident Inspector, Braidwood Station
NRC Senior Resident Inspector, Byron Station
NRC Project Manager, NRR-DORL-Braidwood and Byron Stations
Illinois Emergency Management Agency - Division of Nuclear Safety

Enclosure A

Byron and Braidwood Stations (BBS), Units 1 and 2
License Renewal Application

Responses to Requests for Additional Information

RAI 3.5.2-5
RAI 4.5-1
RAI 4.5-2
RAI B.2.1.30-5

RAI 3.5.2-5

Applicability:

Byron Station (Byron) and Braidwood Station (Braidwood), all units

Background:

The Generic Aging Lessons Learned (GALL) Report age management program (AMP) XI.S4, "10 CFR Part 50, Appendix J," states that type B (local leakage rate tests – LLRTs) tests are intended to detect local leaks and to measure leakage across each pressure-containing or leakage-limiting boundary of containment penetrations. It also states

> While the calculation of leakage rates and satisfactory performance of containment leakage rate testing demonstrates the leak-tightness and structural integrity of the containment, it does not by itself provide information that would indicate that aging degradation has initiated…This would be achieved with the additional implementation of an acceptable containment inservice inspection program.

Issue:

License renewal application (LRA) Table 3.5.2-4, "Containment Structure – Summary of Aging Management Evaluation," identifies line items for stainless steel penetration sleeves (guard pipe for fuel transfer tube) and stainless steel and carbon steel penetration sleeves (guard pipe for recirculation sump effluent pipe) exposed to condensation, which will be managed for loss of material and cracking by the 10 CFR Part 50, Appendix J Program. These items are identified as notes "G,8" and "G,10," respectively.

Similarly, LRA Table 3.5.2-8, "Fuel Handling Building – Summary of Aging Management Evaluation," identifies line items for stainless steel penetration sleeves (fuel transfer tube) exposed to condensation, which will be managed for loss of material by the 10 CFR Part 50, Appendix J Program. These items are identified as "G,5" and note that the fuel transfer tube penetration sleeve and penetration bellows inside the Fuel Handling Building are tested concurrently with the fuel transfer tube penetration sleeve and penetration bellows inside the Containment Structures.

It is not clear how the proposed 10 CFR Part 50 Appendix J program, alone, will identify loss of material and cracking, when the primary role of the program for these penetrations is to perform periodic LLRTs.

Request:

1. Clarify if visual inspections are performed as part of the 10 CFR Part 50, Appendix J AMP, or explain how LLRTs will detect cracking and loss of material prior to a loss of intended function (i.e., pressure boundary, structural support, shelter, protection, water retaining boundary).

2. If an additional or alternate AMP will be used, specify the AMP(s), and revise LRA Table 3.5.2-4 to reflect such changes.

<u>Exelon Response</u>:

1. Visual inspections are not performed as part of the 10 CFR Part 50, Appendix J (B.2.1.32) aging management program. The line items identified in the *Issue* section of this RAI are associated with the inaccessible annular space between guard pipes (also called penetration sleeves) and bellows, and their associated process pipes (fuel transfer tubes and recirculation sump effluent pipes). The condensation environment represents the environment inside the annular space, which is inaccessible. These inaccessible annular spaces are normally sealed except when subjected to Appendix J testing. No visual examinations can be performed on these inaccessible component areas. Since these areas are inaccessible, no visual or other type of examination can be performed on these internal surfaces that will detect cracking, or loss of material, prior to a loss of intended function. Testing performed under the 10 CFR Part 50, Appendix J (B.2.1.32) aging management program will demonstrate the leak-tightness and structural integrity of these components. These inaccessible component areas are exempt from examination in accordance with ASME Section XI, Subsection IWE, paragraph IWE-1220.

   It should be noted that the exterior surface of the accessible portions of the guard pipes are visually examined by other programs as listed under the line items associated with the external environments for these component types. The configurations are described in UFSAR section 6.2.6.2, Containment Penetration Leakage Rate Test, LRA Section 2.4.4, Containment Structure, and LRA Section 2.4.8, Fuel Handling Building. The fuel transfer tube is also shown in UFSAR Figure 6.2-37.

2. Since the line items discussed in the NRC *Issue* section of the RAI are all associated with inaccessible component areas, no additional or alternate aging management program is specified for these components.

The LRA, Table 3.5.2-4, “Containment Structure – Summary of Aging Management Evaluation”, and Table 3.5.2-8, “Fuel Handling Building – Summary of Aging Management Evaluation”, is revised to provide additional information in the plant specific notes with regard to the components being inaccessible and exempt from examination, as shown in Enclosure B.

RAI 4.5-1

Applicability:

Byron and Braidwood

Background:

Byron and Braidwood LRA Section 4.5 addresses concrete containment tendon prestress time limited aging analyses (TLAAs). The applicant dispositioned the TLAA per 10 CFR 54.21(c)(1)(iii) because it plans to use an enhanced AMP that the applicant claims to be consistent with the GALL Report AMP X.S1, "Concrete Containment Tendon Prestress." The GALL Report AMP X.S1 recommends further evaluation of the applicant's operating experience that includes measurements, calculations, and documentation of concrete containment tendon prestress. The GALL Report AMP X.S1 states:

> The estimated and measured prestressing forces are plotted against time, and the predicted lower limit (PLL), MRV [minimum required value], and trending lines are developed for the period of extended operation.

LRA Section B.3.1.2 states that the applicant's Concrete Containment Tendon Prestress AMP, implements the American Society of Mechanical Engineers (ASME) Section XI, Subsection IWL program for the required periodic surveillances of individual tendon prestress values, supplemented with the applicable requirements of 10 CFR 50.55a(b)(2) and guidance provided by Regulatory Guide (RG) 1.35.1, "Determining Prestressing Forces for Inspection of Prestressed Concrete Containments."

LRA Section 4.5, Figures 4.5-1 through 4.5-12 contain the applicant's results of the periodic tendon lift-off force surveillances, trend lines based on the regression analyses, and the MRVs for Byron and Braidwood containment tendon groups (vertical, horizontal, and dome) over a 60-year period. ASME Section XI, Subsection IWL-2420, "Unbonded Post-Tensioning Systems," discusses requirements for frequency of tendon lift-off force measurements. RG 1.35.1 addresses the determination of prestress losses as enumerated in "Section CC-3542, "Loss of Prestress," of reference 1, "American Concrete Institute and American Society of Mechanical Engineers Subcommittee on Nuclear Power, 'Code for Concrete Reactor Vessels and Containments,' ACI-359, 1986."

The LRA Updated Final Safety Analysis Report supplement (UFSAR) for Section A.4.5, "Concrete Containment Tendon Prestress Analyses," states:

> Trend lines calculated based on the most recent tendon surveillances for all three tendons groups at Byron and Braidwood Stations, Units 1 and 2, have been extended from 40 years to 60 years.

Issue:

1. The staff reviewed LRA Figures 4.5-1 through 4.5-12 and noted that some of the reported values for control (common) tendons exhibited greater lift-off forces in later years than those recorded at earlier periodic surveillances. As indicated in RG 1.35.1, it is expected that inservice inspections and surveillances will show "expected time

dependent losses" (i.e., that tendons will lose prestress over time). The staff needs additional information regarding the increased lift-off force values to determine the effect, if any, on the slope of the regression trend line to 60 years of operation. The staff is also concerned that upward trending control (common) tendon lift-off force values could avert tendon group trend lines from intersecting the MRV line in future inservice inspections and surveillances during the period of extended operation,

2. It is not clear from LRA Figures 4.5-1 through 4.5-12, whether the frequency of lift-off data measurements follows the required frequency of measurements in ASME Section XI, Subsection IWL-2420 for the construction of the group trend lines or whether these lines are calculated based "on the most recent surveillances," as indicated in the (UFSAR) Supplement, Section A.4.5, "Concrete Containment Tendon Prestress Analyses." The staff needs this information in order to review the adequacy of the tendon prestress analysis through the period of extended operation.

Request:

1. State the cause for the recorded upward trending lift-off force measurement shown in Figures 4.5-1 through 4.5-12 of the LRA. Discuss if and how the higher values were considered and implemented when constructing the extended trend line to 60 years of operation.

2. Discuss what years of measurements have been selected for the construction of the trend lines in LRA Figures 4.5-1 through 4.5-12.

Exelon Response:

1. The cause of control tendons exhibiting greater lift-off forces in later years than those recorded in earlier periodic surveillances, as noted in the *Issue* section of this RAI, is consistent with factors associated with the decrease in the rate of lift-off force loss with respect to time and equipment calibration accuracy during containment tendon lift-off force measurements, as described in the following paragraphs. In addition, given that as many as ten (10) years can elapse between successive examinations of a specific tendon during later years (e.g., years 15 to 25), certain variables are introduced into the measurement of lift-off forces between surveillances due to differences in the equipment used (e.g., different jacks and pressure gauges), as well as individual equipment calibration accuracy at the time of each examination.

   As noted in the *Issue* section of this RAI, there are time-dependent losses associated with prestressing forces of containment tendons. As indicated in Regulatory Guide (RG) 1.35.1, "Determining Prestressing Forces for Inspection of Prestressed Concrete Containments", it is also acknowledged that these losses can be expected to vary linearly with the logarithm of time. That is, the majority of expected lifetime losses are realized early in plant life, resulting in relatively smaller predicted incremental losses during later years. Additionally, the IWL Code specifies requirements on the accuracy of equipment calibrations, as further discussed below. These allowable variances, however, can sometimes exceed the actual amount of prestress loss predicted from one surveillance to the next for a specific tendon. In instances such as these, where a tendon may experience little actual loss of prestress (e.g., less than 10 Kips) between any two surveillances, the IWL Code equipment calibration accuracy allowance can exceed the actual amount of prestress loss and result in the reported lift-off force values being higher during successive examinations than during earlier examinations.

ASME Section XI, Subsection IWL-2522, “Tendon Force Elongation Measurements,” specifies that the accuracy of the equipment calibration during tendon lift-off force examinations shall be within 1.5% of the specified minimum ultimate strength of the tendon. Byron and Braidwood tendons were originally specified to have 170 wires of one-quarter inch diameter with a material minimum ultimate strength of 240 ksi. Therefore, 1.5% of the specified minimum strength of a tendon is approximately 30 Kips, for a total tolerance range of 60 Kips when considering high and low-end allowances. Individual control tendon data used to develop LRA Figures 4.5-1 through 4.5-12 was reviewed to identify instances where control tendons exhibited greater lift-off force values in later years than those recorded at earlier periodic surveillances. Based on this review, for all instances where control tendon reported lift-off force values were found greater in later surveillances than earlier surveillances, the difference in the reported values were within the IWL Code allowable variance associated with equipment calibration accuracy.

All control tendon lift-off force data values were considered and implemented in the construction of the regression analysis trend lines for LRA Figures 4.5-1 through 4.5-12. A review of the individual figures that reported values for control (common) tendons exhibiting greater lift-off forces in later years than those recorded at earlier periodic surveillances was performed. Based upon this review, it is reasonable to conclude that the increased (i.e., greater) lift-off force values had no significant effect on the group regression trend line extended to 60 years of operation for the following reasons:

- The expected downward trend in control tendon lift-off force values is seen in all charts for years 0.1 to 5. The majority of the loss in prestress force occurs during these years. Therefore, these years dominate the overall loss of tendon prestress force.
- None of the tendon group trend lines are dominated by any upward lift-off force values for control tendons given the scatter in the data.
- In general, there is significant margin with respect to the point where the tendon group trend line intersects the Minimum Required Value (MRV) line and the end of the period of extended operation. At the lowest margin tendon groups, in LRA Figures 4.5-3 and 4.5-4, the last two control tendon lift-off force results show a downward trend that reinforces the downward trend line for the tendon group.

Only LRA Figure 4.5-11 exhibits an upward trending control (common) tendon lift-off force line. In this particular figure, the upward slope of the control tendon lift-off force line will not avert the tendon group trend line from intersecting the MRV in future inservice inspections and surveillances during the period of extended operation for the following reasons:

- There is significant margin between the group trend line and the MRV.
- The values for the control tendon lift-off forces are towards the bottom of the tendon group lift-off forces at the various years.
- The influence of the control tendon lift-off forces on tendon group trend lines is less significant as more data is included following future surveillances.

Therefore, based upon the above information, all control tendon lift-off force data values were considered acceptable and appropriate for implementation and inclusion into the construction of the extended 60-year trend line regression analyses shown in LRA Figures 4.5-1 through 4.5-12.

2. LRA Figures 4.5-1 through 4.5-12 contain individual tendon force measurements associated with surveillances years that are consistent with the schedules prescribed in IWL-2421, “Sites with Multiple Plants”, and Regulatory Position 1.5 of RG 1.35, “Inservice Inspection of Ungrouted Tendons in Prestressed Concrete Containments”, as described below.

   Prior to the 15th year Containment In-Service Inspection (CISI) examinations, the CISI examination frequency was in accordance with the modified frequency for multi-unit sites specified in RG 1.35. Beginning with the 15th year examinations, the examination frequency has been in accordance with the modified ISI interval allowed in IWL-2421 for multi-unit sites, rather than the interval specified in IWL-2420 for single unit sites. Based upon this examination frequency, prestressing tendon force measurements for each selected tendon group sample have been performed on both Byron Unit 1 and Braidwood Unit 1 at 1, 5, 10, and 20 years after the initial Structural Integrity Test (SIT). Prestressing tendon force measurements have been performed on both Byron Unit 2 and Braidwood Unit 2 at 1, 5, 15, and 25 years after the initial SIT.

   All tendon force measurement values associated with examinations performed in accordance with the RG 1.35 and IWL-2421 prescribed schedules, as described above, have been selected for the construction of the trend lines in LRA Figures 4.5-1 through 4.5-12. Additional tendon force measurements beyond those required by RG 1.35 and IWL-2421 have also been documented for Braidwood, Units 1 and 2, and included in the trend line calculations for LRA Figures 4.5-7 through 4.5-10. Specifically, this includes tendon lift-off measurements for Unit 1 vertical and horizontal tendons during the 15th year surveillance, Unit 2 horizontal tendons during the 3rd year surveillance, and Unit 2 vertical and horizontal tendons during the 10th year surveillance. These additional measurements have been associated with augmented and follow-up examinations of tendons, i.e., tendons affected by steam generator replacement related activities, tendons where free water inspection results did not meet acceptance criteria, tendons where the number of ineffective wires exceeded the original specified limit during construction, and tendons with excessive gaps in shim stacks.

   In conclusion, the trend lines included in the regression analyses shown in LRA Figures 4.5-1 through 4.5-12 are based on all tendon surveillances and include the most recent tendon surveillances (e.g., 20th year for Byron and Braidwood Unit 1, and 25th year for Byron and Braidwood Unit 2). These trend lines have been constructed using tendon lift-off force data values obtained during surveillances scheduled in accordance with the required frequencies of measurement specified in IWL-2421 and RG 1.35, as well as additional tendon lift-off force data values when available for individual tendons.

RAI 4.5-2

Applicability:

Byron Unit 2

Background:

LRA Section 4.5 addresses concrete containment tendon prestress TLAAs. The applicant dispositioned the TLAA per 10 CFR 54.21(c)(1)(iii) because it plans to use an enhanced AMP that the applicant claims to be consistent with the GALL Report AMP X.S1. The GALL Report AMP X.S1 recommends further evaluation of applicant's operating experience that includes measurements, calculations, and documentation of concrete containment tendon prestress. A review of the LRA Section 4.5, Figures 4.5-2, 4.5-4, and 4.5-6, indicates that the figures include tendon lift-off force data points, regression analyses-based trend lines, and the tendon force MRVs for each tendon group (vertical, horizontal, dome) of Byron Unit 2. The LRA states that the ASME Section XI, Subsection IWL program performs the required ASME Section XI, Subsection IWL periodic surveillances of individual tendon prestress values, supplemented with the applicable requirements of 10 CFR 50.55a(b)(2).

Issue:

During its onsite audit, the staff compared the analyses in LRA Figures 4.5-2, 4.5-4, and 4.5-6 with the Byron Unit 2 regression analyses contained in the most recent ASME Section XI, Subsection IWL report titled, "Final Report for Exelon Byron Station U1 and U2 25th year Containment Building Tendon Surveillance," (IWL report) and a document titled, "Regression Analysis to Predict Post-Tensioning Forces for Byron Unit 2 Containment Tendons in Support of License Renewal" (license renewal analysis report) and noted the following:

- LRA Figures 4.5-2, 4.5-4, and 4.5-6 indicate that first measurements of lift-off forces for Byron Unit 2 occurred at year one. The IWL report that contains the 60 year tendon lift-off force predictions, however, start at year five instead of year one.
- The IWL report and the license renewal analysis report appear to differ in the number of reported tendon lift-off force data points for the examined tendon groups at certain periodic surveillances.

The staff is unclear as to why the data in the IWL report appears to differ from the data used in the license renewal analysis report. Additionally, it is also not clear which of the two analyses was used to develop LRA Figures 4.5-2, 4.5-4, and 4.5-6.

Request:

Clarify whether there is a difference between the data in the IWL report and the data used for the license renewal analysis report; and if so, (1) provide explanation for the difference, and (2) discuss which of the two reports' data sets were used to develop LRA Figures 4.5-2, 4.5-4, and 4.5-6 and the resulting tendon prestress trend lines extending to 60 year of operation.

<u>Exelon Response</u>:

Background

In 2009, Byron Station performed the 25th year IWL examinations, including tendon lift-off force measurements for Unit 2. The results of these examinations, including prepared regression analyses for each tendon group, were documented in a vendor report titled, "Final Report for Exelon Byron Station Unit 1 and Unit 2 25th Year Containment Building Tendon Surveillance." For the purposes of this response, this document will be referred to as the "25th year IWL report." New regression analyses were developed to support the Byron and Braidwood License Renewal Application (LRA), which included extending the regression analyses' trend lines out to 60 years. These new regression analyses for Byron Unit 2 were contained in a calculation titled, "Regression Analysis to Predict Post-Tensioning Forces for Byron Unit 2 Containment Tendons in Support of License Renewal." For the purposes of this response, this document will be referred to as the "license renewal analysis report." A review of these documents reveals certain differences do exist in both the content and the presentation of the tendon lift-off force data, as noted in the *Issue* section of this RAI. Although there are differences between the two sets of data, it has been confirmed that there is no impact on the LRA. A discussion of these identified differences is provided below. 'Response (1)' and 'Response (2)', below, address the numbered items '(1)' and '(2)', respectively, identified in the Staff's *Request*, above.

Response (1)

As noted in the first bulleted item in the *Issue* section of this RAI, the presentation of the surveillance year number (e.g., 1, 5, 10, etc.) differs between the two aforementioned documents. The reason for the difference in the identified surveillance year numbers is related to a difference in the initial date from when each report begins counting the number of elapsed years for each scheduled surveillance. The vendor-supplied 25th year IWL report identified and presented the surveillance year numbers with respect to the number of years since the tendon was originally tensioned during construction. The license renewal analysis report identified and presented the surveillance year numbers with respect to the completion of the initial Structural Integrity Test (SIT). This is consistent with the direction that, "The first inservice inspection needs to be performed one year after the Initial Structural Integrity Testing (ISIT)", as contained in NRC Regulatory Guide 1.35.1, "Determining Prestressing Forces for Inspection of Prestressed Concrete Containments", Section 4. Given that the SIT was performed approximately four (4) years after the tendons were originally tensioned, the surveillance year numbers documented in the two reports are different. Specifically, since the first tendon lift-off force surveillance was performed one year after the completion of the SIT, the license renewal analysis report documents the first surveillance as Year 1, while the 25th year IWL report documents the first surveillance as Year 5. Differences in how the surveillance year numbers are identified and presented between the two documents do not impact the slope of the trend lines since the slope of the lines is a factor of the actual individual data point values and their relative relationship to one another, starting with the first surveillance (i.e., Year 1) and all subsequent surveillances, and not in how the surveillance year numbers are simply presented between the two documents.

As noted in the second bulleted item in the *Issue* section of this RAI, the two aforementioned documents do contain differences in the number of tendon lift-off force data points. Based on a review of the data sets from the two documents, there are no differences in the number of tendon lift-off force data points reported for dome and horizontal tendons. However, a discrepancy was identified between the two documents with respect to the number of tendon lift-off force data points reported for the vertical tendons during the first two tendon lift-off surveillances (e.g., years 1 and 5 after SIT). Specifically, lift-off force values for five (5) vertical tendons during the first year surveillance and two (2) vertical tendons during the fifth year surveillance are contained in the license renewal analysis report, but were inadvertently not included in the 25th year IWL report. As a result, this condition has been entered into the corrective action programs of both Exelon and the vendor. An updated 25th year surveillance graph to include these additional lift-off values for the Unit 2 vertical tendon group was reviewed and found to have no appreciable impact on the trend line. Since the data points that were missing from the 25th year IWL report were early in plant life (i.e., years 1 and 5), and of the same approximate force values as other data points in those surveillance years, there was no appreciable impact at later years, especially years 40 to 60. Furthermore, based on the 60-year regression analysis developed for the LRA, which included these additional lift-off values, the trend line for the vertical tendon group has been shown to remain above the group minimum required value (MRV) for the 60-year period.

Response (2)

The data set contained in the license renewal analysis report titled, “Regression Analysis to Predict Post-Tensioning Forces for the Byron Unit 2 Containment Tendons in Support of License Renewal” was used to develop LRA Figures 4.5-2, 4.5-4, and 4.5-6. This data set content was appropriate for the development of the LRA figures since presenting the surveillance year numbers with respect to the SIT is consistent with IWL-2400, which also prescribes the examination frequency years relative to the completion of the SIT. Furthermore, although a minor impact, the additional tendon lift-off force data points contained in the license renewal analysis report results in a more informed and accurate trend line that is more representative of the loss of prestress phenomenon associated with the overall tendon group. Therefore, the data set contained in the license renewal analysis report was appropriate for inclusion in LRA Figures 4.5-2, 4.5-4, and 4.5-6.

RAI B.2.1.30-5

Applicability:

Byron

Background:

LRA Section B.2.1.30 states that the ASME Section XI, Subsection IWL AMP is an existing program that, following enhancements, will be consistent with the GALL Report AMP XI.S2, "ASME Section XI, Subsection IWL." During Byron and Braidwood onsite AMP audits, the staff reviewed operating experience regarding a crack found on the Braidwood Unit 1 primary containment. The crack was found in 2006 during the 25th ASME Section XI, Subsection IWL visual inspection of the containment concrete. Based on the description in the applicant's action request, the crack is diagonal and located on the upper right corner of the concrete patch placed after the Unit 1 containment concrete was cut out for the steam generator (SG) replacement in 1998. Grease leakage was also observed through the crack. During the Braidwood onsite audit, the staff performed a walkdown to look at the condition of the concrete where the crack was located and noted that there was also a similar crack on the upper left corner of the SG replacement patch in Unit 1's primary containment. Also during the audit, the applicant stated that a similar condition exists for the Byron Unit 1 primary containment concrete at the SG replacement patch.

Issue:

The GALL Report states that "[o]perating experience involving the AMP, including past corrective actions resulting in program enhancements or additional programs, should provide objective evidence to support a determination that the effects of aging will be adequately managed so that the structure and component intended functions will be maintained during the period of extended operation." The GALL Report AMP XI.S2 states that the frequency and scope of examinations specified in 10 CFR 50.55a and ASME Section XI, Subsection IWL, should ensure that aging effects would be detected before they would compromise the design-basis requirements. The GALL Report also states that areas that indicate suspect conditions receive a more rigorous detailed visual examination (as defined by the ASME Code). The staff reviewed a letter dated February 26, 2008 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML080570644) that was submitted to the NRC by the applicant, which stated that the condition was evaluated for Braidwood, Unit 1, and was determined to be acceptable because the amount of grease leakage was small. The letter also stated that the grease leakage is being monitored on an annual basis, during the summer months when the sheathing filler viscosity results in the worst-case condition for leakage. Noting that the applicant stated this indication was also found at the Byron, Unit 1, primary containment, the staff needs additional information on if and how the IWL program will be used to manage this aging effect through the period of extended operation for Byron, Unit 1. For Byron, Unit 1, the staff is unclear as to (1) whether more rigorous detailed visual examinations were required or performed, (2) whether the cracking indicates an adverse condition has occurred with the prestressed tendons in that location, and (3) if grease leakage from the cracks is evaluated per the IWL program.

Request:

Describe the actions taken to assess the condition of the cracks, type and frequency of inspections performed (if any), and corrective actions (if any) in accordance with the ASME Section XI, Subsection IWL Program. Also state whether there has been an evaluation per the IWL Code to assess the amount of grease leakage coming through the cracks and to determine if the leakage has any adverse effect on the ability of the affected tendons to perform their intended function.

Exelon Response:

The ASME Section XI, Subsection IWL (B.2.1.30) aging management program (IWL aging management program) is used to manage the aging effects of the ASME Boiler and Pressure Vessel Code, Class CC Concrete Components, as mandated by 10 CFR 50.55a. The primary inspection method is a visual examination, supplemented by testing. Inspection methods, inspected parameters, and acceptance criteria are in accordance with ASME Section XI, Subsection IWL as approved by 10 CFR 50.55a. Accessible concrete surfaces are subject to periodic general visual examinations to detect deterioration and distress such as defined in ACI 201.1R, “Guide for Making a Condition Survey of Concrete in Service”, and ACI 349.3R, “Evaluation of Existing Nuclear Safety-Related Concrete Structures”, as well as grease leakage. The cracks and grease leakage deposits identified in this RAI have been examined and evaluated on four separate occasions. The cracks and grease leakage deposits identified in this RAI will be examined and evaluated in the future in accordance with the ASME Section XI, Subsection IWL-2400 and ACI 349.3R.

At Byron, actions have been taken to assess the condition of the cracks described in the *Background and Issue* sections of this RAI. The type and frequency of examinations, evaluations, and corrective actions met the requirements of the ASME Section XI, Subsection IWL. Evaluations of the cracks and grease leakage deposits have been performed in accordance with the ASME Section XI, Subsection IWL requirements. The examinations and evaluations of the cracks and grease leakage deposits identified in this RAI are described below in the following sections of the RAI response.

- *Initial Examination and Evaluation*
- *IWL Program Implementation*
- *Follow-up IWL Program Examinations*
- *Current and Future IWL Program Implementation*
- *Condition Assessment and Acceptance Criteria*
- *Conclusions*

Initial Examination and Evaluation:

The cracks mentioned in the *Background* and *Issue* sections of this RAI were identified during the examinations of the Byron Unit 1 containment in 1998 following the replacement of the steam generators. The cracks are in the patch used to repair the hole created for the steam generator replacement in the Byron Unit 1 containment. These cracks are about 0.01” wide, and are generally diagonal at the corners of the patch, as are typical shrinkage cracks at a square patch. The grease leakage deposits that are mentioned consist of very small areas and amount to only a few ounces of grease. These imperfections are not unusual and do not indicate that an adverse condition has occurred with the prestressed tendons at the patch.

Detailed visual examinations of the cracks were performed in 1998. The examinations were performed before, at peak pressure, and at the conclusion of the integrated leak rate test that pressurized the containment following the steam generator replacement and repair of the containment. The extent, width, location, and lengths of the cracks were noted, mapped, and followed during the progress of the pressurization and resulting expansion of the containment during performance of the integrated leak rate test. The cracks were evaluated as part of the review of the integrated leak rate test results and determined to be insignificant.

<u>IWL Program Implementation</u>:

In accordance with IWL-2510, the IWL aging management program specifies general visual examination of all accessible concrete surfaces for evidence of conditions indicative of damage or degradation, such as cracking, spalling, scaling, leaching of calcium hydroxide, rebar corrosion, loss of material, increase in porosity and permeability, loss of bond, and other indications of potential distress as described in ACI 201.1 R and ACI 349.3R, as well as grease leakage. Selected areas, such as those that indicate suspect areas, are subject to detailed visual examinations, by an examiner qualified to perform detailed visual examinations, in accordance with IWL-2500-1 to determine the magnitude and extent of deterioration and distress, in accordance with IWL 2310(b).

The cracks and some small volumes of grease leakage deposits were recorded as part of the initial general visual examinations associated with implementation of the IWL program in 2001. Detailed examinations of these cracks had previously been performed as a result of the steam generator replacement as described above. Corrective actions included performance of follow-up examinations of the cracks and grease leaks, evaluation by the Responsible Engineer (RE), and entering the condition into the IWL aging management program records for follow-up examinations. The RE evaluated the cracks and grease leakage deposits, determined that the conditions were not structurally significant, and accepted the conditions without requiring any repair or replacement.

<u>Follow-up IWL Program Examinations</u>:

Monitoring of the cracks and the grease leakage deposits consisted of follow-up general visual examinations of the containment in 2006 and 2011 as part of the IWL program. No significant changes to the cracks or grease leakage deposits were noted. The shape and size of the grease leakage deposits were described as unchanged in 2006 and 2011. The results of the visual examinations were evaluated by the RE and the recordable indications determined to be insignificant with respect to containment structural integrity.

In 2004, as part of the 20th year examination of the containment tendons, two hoop tendons and one vertical tendon that had been affected by the Steam Generator Replacement were selected for physical examination. All acceptance criteria were met and there were no indications of degradation detrimental to containment structural integrity associated with the cracks or grease leaks described in this RAI.

<u>Current and Future IWL Program Implementation</u>:

The next general examination of the containment concrete surface is scheduled in 2015, which will include re-examination of these cracks and grease deposits. The next examination of tendons at Byron is scheduled for 2014, and current plans are to include tendons in the area affected by the patch in the containment wall.

The frequency and the scope of examinations, specified in BBS ASME Section XI, Subsection IWL (B.2.1.30) aging management program, are in accordance with 10 CFR 50.55a and ASME Section XI, Subsection IWL-2400. In accordance with ASME Section XI, Subsection IWL-2310, all accessible concrete surface areas of each unit, including coated surfaces, are monitored regularly (i.e., every 5 years) to identify corrosion protection medium (grease) leakage and areas of concrete deterioration and distress, as defined in ACI 201.1R and ACI 349.3R. The RE reviews and evaluates indication data which exceed acceptance criteria and determines the need for further corrective actions, including trending.

Condition Assessment and Acceptance Criteria:

Acceptance criteria are in accordance with ASME Section XI, Subsection IWL-3000. The condition of concrete surfaces is acceptable if the RE determines that there is no evidence of damage or degradation sufficient to warrant further evaluation or repair. ACI 201.1R and ACI 349.3R are used as a reference for identification of concrete damage or degradation. The RE is a registered professional engineer that meets the requirements of ASME Section XI, Subsection IWL-2320, which requires that the RE be experienced in evaluating the inservice condition of structural concrete and knowledgeable of the design and construction codes and other criteria used in design and construction of concrete containments.

The ASME Section XI, Subsection IWL (B.2.1.30) aging management program requires that an engineering evaluation be performed in accordance with ASME Section XI, Subsection IWL-3300 if the examination results exceed acceptance standards. The program requires that the engineering evaluation report include the following: a) the cause of the condition that does not meet the acceptance criteria; b) the applicability of the condition to the other unit at the same site; c) the acceptability of the concrete containment without repair of the item; d) whether or not repair or replacement is required and, if required, the extent, method, and completion date for the repair or replacement; and e) the extent, nature, and frequency of additional examinations.

The ASME Section XI, Subsection IWL (B.2.1.30) aging management program is already being revised in Enhancement #4, to explicitly require that areas of concrete deterioration and distress be recorded in accordance with the guidance provided in ACI 349.3R; and in Enhancement #5, to include quantitative acceptance criteria, based on the "Evaluation Criteria" provided in Chapter 5 of ACI 349.3R that will be used to augment the qualitative assessment of the RE. ACI 349.3R, section 5.1, “Acceptance without further evaluation”, provides the first tier for findings that are acceptable without further evaluation, which includes passive cracks less than 0.015” in width, measured below any surface-enhanced widening. Passive cracks are defined as those having an absence of recent growth and absence of other degradation mechanisms at the crack. The cracks described in this RAI meet the tier 1 criteria in ACI 349.3R.

To date, only small volumes of deposits from grease leakage have been identified, these have been quantified and do not appear to be increasing over time. The grease deposits are trended so that any change or increase will be noted during examinations and evaluated by the RE to determine if there is any indication of degradation that would be detrimental to containment structural integrity. The grease leakage is no longer active and the volume of the grease leakage deposits were estimated to be only a few ounces, which is insignificant compared to the net volume inside the tendon sheath of approximately 100 gallons. These conditions are considered to meet the acceptance criteria in ASME Section XI, Subsection IWL-3221.4, “Corrosion Protection Medium”, which states that protection medium is acceptable when the absolute difference between the amount removed and the amount replaced shall not exceed 10% of the tendon net duct volume.

Based on industry-related documentation (e.g., ORNL/CP-102334, “An Investigation of Tendon Corrosion-Inhibitor Leakage into Concrete”, by Naus, Oland, and Costello), any tendon grease leakage onto the concrete does not damage the concrete.

Conclusions:

The examination results discussed above demonstrate that the conditions described in the RAI related to containment concrete cracks and grease leakage deposits are being adequately monitored, managed, and maintained by the ASME Section XI, Subsection IWL (B.2.1.30) aging management program. These aging effects will be managed through periodic monitoring to ensure that any changes to the conditions are detected and evaluated by the RE.

Based upon the above discussion, the aging effects associated with the cracks and grease leakage deposits described in this RAI will be adequately managed by the ASME Section XI, Subsection IWL (B.2.1.30) aging management program so that the structure and component intended functions will be maintained throughout the period of extended operation.

Enclosure B

Byron and Braidwood Stations, Units 1 and 2
License Renewal Application (LRA) updates resulting from the response to the following RAI:

RAI 3.5.2-5

Note: To facilitate understanding, portions of the original LRA have been repeated in this Enclosure, with revisions indicated. Existing LRA text is shown in normal font. Changes are highlighted with ***bolded italics*** for inserted text.

As a result of the response to RAI 3.5.2-5 provided in Enclosure A of this letter, LRA Table 3.5.2-4, Containment Structure, page 3.5-168, Plant Specific Notes 8 and 10 are revised as shown below. Additions are highlighted with ***bolded italics.***

Table 3.5.2-4 Containment Structure

Plant Specific Notes:

8. The 10 CFR Part 50, Appendix J (B.2.1.32) program is used to manage the aging effect(s) applicable to this component type, material, and environment combination in the gap ***(inaccessible annular space)*** between the guard pipe and the fuel transfer tube***. These areas are normally sealed except when subjected to Appendix J testing. No visual examinations can be performed on these inaccessible component areas; they are exempt from examination in accordance with ASME Section XI, Subsection IWE, paragraph IWE-1220*****.**

9. The ASME Section XI, Subsection IWE (B.2.1.29) program is also used to manage the aging effect(s) applicable to this component type, material, and environment combination where the guard pipe for the fuel transfer tube is exposed inside of the refueling cavity. The penetration sleeves in the refueling cavity are normally exposed to air except when the refueling cavity is filled with water during outages.

10. The 10 CFR Part 50, Appendix J (B.2.1.32) program is used to manage the aging effect(s) applicable to this component type, material, and environment combination in the gap ***(inaccessible annular space)*** between the guard pipe and the recirculation sump effluent pipe. ***These areas are normally sealed except when subjected to Appendix J testing. No visual examinations can be performed on these inaccessible component areas; they are exempt from examination in accordance with ASME Section XI, Subsection IWE, paragraph IWE-1220.***

As a result of the response to RAI 3.5.2-5 provided in Enclosure A of this letter, LRA Table 3.5.2-8, Fuel Handling Building, page 3.5-200, Plant Specific Note 5 is revised as shown below. Additions are highlighted with ***bolded italics***.

Table 3.5.2-8 Fuel Handling Building

Plant Specific Notes:

5. The fuel transfer tube penetration sleeve and penetration bellows inside the Fuel Handling Building are tested concurrently with the fuel transfer tube penetration sleeve and penetration bellows inside the Containment Structure, which are tested in accordance with 10 CFR Part 50, Appendix J (B.2.1.32) program. ***These specific line items are associated with inaccessible component areas, including the inaccessible annular space between the fuel transfer tube penetration sleeve and penetration bellows, and the fuel transfer tube. These areas are normally sealed except when subjected to Appendix J testing. No visual examinations can be performed on these inaccessible component areas; they are exempt from examination in accordance with ASME Section XI, Subsection IWE, paragraph IWE-1220.***