LimerickNPEm Resource

From: Christopher.Wilson2@exeloncorp.com
Sent: Friday, April 27, 2012 2:35 PM
To: Kuntz, Robert
Subject: Advance copy of LGS letter
Attachments: 4.27.12 - LIM - Response to RAI dated 4.13 & 4.16.12 re. LGS LRA.pdf

Rob…this RAI response letter was sent to DCC today

Hearing Identifier: Limerick_LR_NonPublic
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Subject: Advance copy of LGS letter
Sent Date: 4/27/2012 2:35:04 PM
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From: Christopher.Wilson2@exeloncorp.com

Created By: Christopher.Wilson2@exeloncorp.com

Recipients:
"Kuntz, Robert" <Robert.Kuntz@nrc.gov>
Tracking Status: None

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10 CFR 50
10 CFR 51
10 CFR 54

April 27, 2012

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

Limerick Generating Station, Units 1 and 2
Facility Operating License Nos. NPF-39 and NPF-85
NRC Docket Nos. 50-352 and 50-353

Subject: Response to NRC Requests for Additional Information, dated April 13 and April 16, 2012, related to the Limerick Generating Station License Renewal Application

Reference:
1. Exelon Generation Company, LLC letter from Michael P. Gallagher to NRC Document Control Desk, "Application for Renewed Operating Licenses", dated June 22, 2011
2. Letter from Robert F. Kuntz (NRC) to Michael P. Gallagher (Exelon), "Requests for Additional Information for the review of the Limerick Generating Station, Units 1 and 2, License Renewal Application (TAC Nos. ME6555, ME6556)", dated April 13, 2012
3. Letter from Robert F. Kuntz (NRC) to Michael P. Gallagher (Exelon), "Requests for Additional Information for the review of the Limerick Generating Station, Units 1 and 2, License Renewal Application (TAC Nos. ME6555, ME6556)", dated April 16, 2012

In the Reference 1 letter, Exelon Generation Company, LLC (Exelon) submitted the License Renewal Application (LRA) for the Limerick Generating Station, Units 1 and 2 (LGS). In the Reference 2 and Reference 3 letters, the NRC requested additional information to support the staffs' review of the LRA.

Enclosed are the responses to these requests for additional information.

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 04-27-2012

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 LGS LRA sections
C: LGS License Renewal Commitment List Changes

cc: Regional Administrator – NRC Region I
NRC Project Manager (Safety Review), NRR-DLR
NRC Project Manager (Environmental Review), NRR-DLR
NRC Project Manager, NRR- DORL Limerick Generating Station
NRC Senior Resident Inspector, Limerick Generating Station
R. R. Janati, Commonwealth of Pennsylvania

Enclosure A

Responses to Requests for Additional Information related to various sections of the LGS License Renewal Application (LRA)

RAI 2.3.3.9-2.1
RAI B.2.1.28-2
RAI B.2.1.30-1.1
RAI B.2.1.30-2.1
RAI B.2.1.30-4.1

RAI 2.3.3.9-2.1

Background

The response to RAI 2.3.3.9-2, dated February 16, 2012, stated for passive components in lightning plant protection system (NFPA 78, Lightning Protection Code), that Limerick Generating Station (LGS) does not have a lightning plant protection system. Passive lightning protection components (NFPA 78) are provided for equipment and personnel protection. They are not relied upon to demonstrate compliance with 10 CFR 50.48 and as such do not perform an intended function for license renewal. Therefore, the lightning protection components are not in the scope of license renewal.

Issue

The response excluded some passive lightning protection components (NFPA 78). The response stated that the equipment passive lightning protection components have no function that supports 10 CFR 50.48 requirements; therefore, they are not within the scope of license renewal and subject to an AMR.

Request

Provide clarification on how the passive lightning protection components are required per the NFPA 78 Code but are not required for compliance with 10 CFR 50.48. If the components are required for compliance with 10 CFR 50.48 then provide information to demonstrate that the effects of aging will be adequately managed so that the intended function(s) will be maintained consistent with the current licensing basis for the period of extended operation as required by 10 CFR 54.21 (a)(3).

Exelon Response

NFPA 78, “Safety Code for the Protection of Life and Property Against Lightning”, is a general building code. The purpose of the code is the practical safeguarding of persons and property from hazards arising from exposure to lightning. Lightning protection, including passive components, provided at LGS is per NFPA 78. It is provided as implementation of a good design practice and for insurance purposes.

NFPA 78 is not one of the numerous NFPA codes referenced or cited in the NRC regulations applicable to LGS for fire protection. Lightning protection is not provided nor required to fulfill an NRC regulatory requirement. Lightning protection is not discussed in the LGS Safety Evaluation Reports and supplements, nor is it included in the LGS Technical Requirements Manual as a general design or fire protection feature. Lightning protection is not relied upon in any safety analyses or plant evaluations to perform a function that demonstrates compliance with the Commission’s regulations for Fire Protection (10 CFR 50.48), per 10 CFR 54.4(a)(3). Therefore, lightning protection components do not perform a license renewal intended function, are not in scope for license renewal and are not subject to aging management review.

RAI B.2.1.28-2

Background

The GALL Report recommends that loss of material and degradation of the neutron absorbing material capacity be determined through coupon and/or direct in situ testing.

The response to RAI B.2.1.28-1, provided by letter dated February 28, 2012, stated that the coupons in the Limerick Generating Station (LGS), Unit 2 spent fuel pool had experienced only two cycles of high fluence from freshly discharged fuel. The response also stated that the coupons in the LGS, Unit 1 spent fuel pool had not experienced high fluence from freshly discharged fuel since re-racking.

In order for the coupons to obtain environmental conditions bounding of all Boral spent fuel pool racks, the response to RAI B.2.1.28-1 proposes to resume an accelerated exposure configuration for the Boral coupons (i.e., surround the coupons by freshly discharged fuel assemblies) at each of the next five refueling cycles, beginning with the refueling outage in 2014 and 2013 for LGS, Units 1 and 2, respectively.

Issue

The coupons in the LGS, Units 1 and 2 spent fuel pools have not experienced long exposure to high radiation fluence from freshly discharged fuel, making the exposure time potentially non-conservative and/or not bounding of all the LGS, Unit 1 and 2 Boral spent fuel pool racks. The environmental conditions of the coupons are not bounding of all Boral racks and; therefore, may not provide acceptable testing data for monitoring loss of material and degradation of the neutron absorbing material capacity.

Request

Provide justification on how resuming a five cycle radiation exposure period will place the coupons in a bounding condition for all Boral spent fuel pool racks for the LGS, Units 1 and 2 for the period of extended operation. If there is not ample justification that the coupons will be bounding of all the Boral panels in the spent fuel pool (SFP), discuss if another method of monitoring will be used, such as in situ testing.

Exelon Response

Exelon's response to RAI B.2.1.28-1, provided by letter dated February 28, 2012, was not referring to the actual number of cycles to date in which the coupons were exposed to freshly discharged fuel. It was referring instead to a particular point in time, which was not indicative of the current coupon condition.

The original recommendation of the spent fuel storage rack manufacturer was to completely surround the coupon tree in each spent fuel pool by freshly discharged fuel assemblies following each of the first five operating cycles after rack installation. This would assure that the Boral in the coupons experiences a higher radiation dose than the Boral panels in the storage racks. Following the fifth cycle of accelerated exposure, the fuel assemblies surrounding the test coupon tree could remain in place for the remaining life of the racks. We have reviewed the plant documentation of fuel pool inventory, and have determined that the actual number of

cycles to date that the coupons were completely surrounded by freshly discharged fuel for Unit 2 is five cycles (first five cycles following rack installation), and for Unit 1 is two cycles (first two cycles following rack installation). Therefore, the original manufacturer recommendations have been attained for the Unit 2 spent fuel pool coupons.

The current spent fuel pool inventory at Limerick is governed by the requirements of the Thermal Management Guidelines of the Mitigation Strategies License Condition, which limit the number of freshly discharged fuel assemblies that surround any fuel storage cell to two, or four, after a 120-day period. The cell which contains the test coupons is not subject to these limitations. These requirements have been in place since 2005. Therefore, surrounding the test coupons by eight freshly discharged fuel bundles will ensure that the test coupons are leading indicators of other individual fuel storage cells, which will be surrounded by two or fewer freshly discharged fuel assemblies or by four or fewer of these assemblies after a 120-day period.

An analysis was performed of the spent fuel pool inventory relative to the test coupons to predict when the exposure of the coupons to freshly discharged fuel would be equal to the exposure of the limiting storage cells to freshly discharged fuel. This analysis utilized the number of freshly discharged fuel bundles adjacent to a coupon or a fuel storage cell as an indicator of radiation exposure. For simplicity, this analysis assumed that, as a worst case, a storage cell was repeatedly exposed to the maximum possible number of freshly discharged fuel assemblies. This theoretical fuel storage cell was assumed to be continuously surrounded by eight freshly discharged fuel assemblies until 2005, when the Mitigating Strategies Thermal Management Guidelines were implemented. After 2005, the analysis assumed as a worst case that this same storage cell was surrounded by four freshly discharged fuel assemblies, although this configuration could not actually occur until after a 120-day period. This analysis superimposed the actual coupon location history to date, along with the future coupon exposure cited in Exelon’s response to RAI B.2.1.28-1, which states that the coupons will be completely surrounded by freshly discharged fuel beginning with the next cycle for each unit for the next five cycles (ending in 2024 for Unit 1 and 2023 for Unit 2). The results of this analysis are displayed in Table 1 and Table 2 below.

The analysis concluded that, for this theoretical worst case condition, the coupons will be exposed to the same number of freshly discharged fuel assemblies as the theoretical worst case cell in 2020 for Unit 1, and 2021 for Unit 2, which is prior to the start of Unit 1’s PEO in 2024 and Unit 2’s PEO in 2029. After the five cycle period for completely surrounding the coupons with freshly discharged fuel assemblies, the coupons will continue to be surrounded by a greater number of freshly discharged fuel assemblies than that of any other cell location (i.e., greater than two freshly discharged fuel assemblies, or four after 120 days) to ensure that the coupon exposure remains higher than that of a theoretical worst case cell location. Additionally, the coupon tree location will be changed each cycle to ensure that the exposure of its associated cell locations remain below the coupon exposure.

The Monitoring of Neutron-Absorbing Materials Other than Boraflex aging management program resumes coupon analysis prior to PEO. Coupon analysis will be performed beginning no earlier than 2020 for Unit 1 and 2021 for Unit 2.

Based on the analysis described above, resuming a five cycle accelerated radiation exposure period will place the coupons in a bounding condition for all Boral spent fuel pool racks for LGS Units 1 and 2 prior to the period of extended operation. Maintaining the coupons in a location which is surrounded by a greater number of freshly discharged fuel assemblies than that of any other cell location, and changing the coupon tree location each cycle will maintain

them in a bounding condition during the period of extended operation. Therefore, the coupons will provide acceptable testing data for monitoring loss of material and degradation of the neutron absorbing material capacity. The UFSAR Supplement LRA Section A.2.1.28 and LRA AMP Section B.2.1.28 are revised as shown in Enclosure B to clarify these program enhancements for the Monitoring of Neutron-Absorbing Materials Other than Boraflex program. In addition, LRA Table A.5, commitment 28 is revised as shown in Enclosure C.

Table 1
Analysis of Placing Freshly Discharged Fuel Assemblies Adjacent to Fuel Storage Cells and Coupon Cells

Unit 1 Fuel Pool

		Fuel Storage Cell		Coupon	
Year Removed from Reactor Core	Year at Completion of Cycle Exposure	Number of Freshly Discharged Fuel Assy's (for cycle)	Number of Freshly Discharged Fuel Assy's (cumulative)	Number of Freshly Discharged Fuel Assy's (for cycle)	Number of Freshly Discharged Fuel Assy's (cumulative)
1995	1997				
1996	1998				
1997	1999				
1998	2000				
1999	2001				
2000	2002				
2001	2003				
2002	2004	8	8	8	8
2003	2005				
2004	2006	8	16	8	16
2005	2007				
2006	2008	4	20	0	16
2007	2009				
2008	2010	4	24	0	16
2009	2011				
2010	2012	4	28	2	18
2011	2013				
2012	2014	4	32	2	20
2013	2015				
2014	2016	4	36	8	28
2015	2017				
2016	2018	4	40	8	36
2017	2019				
2018	2020	4	44	8	44
2019	2021				
2020	2022	4	48	8	52
2021	2023				
2022	2024	4	52	8	60

Table 2
Analysis of Placing Freshly Discharged Fuel Assemblies Adjacent to Fuel Storage Cells and Coupon Cells

Unit 2 Fuel Pool

		Fuel Storage Cell		Coupon	
Year Removed from Reactor Core	Year at Completion of Cycle Exposure	Number of Freshly Discharged Fuel Assy's (for cycle)	Number of Freshly Discharged Fuel Assy's (cumulative)	Number of Freshly Discharged Fuel Assy's (for cycle)	Number of Freshly Discharged Fuel Assy's (cumulative)
1995	1997	8	8	8	8
1996	1998				
1997	1999	8	16	8	16
1998	2000				
1999	2001	8	24	8	24
2000	2002				
2001	2003	8	32	8	32
2002	2004				
2003	2005	8	40	8	40
2004	2006				
2005	2007	4	44	0	40
2006	2008				
2007	2009	4	48	0	40
2008	2010				
2009	2011	4	52	0	40
2010	2012				
2011	2013	4	56	0	40
2012	2014				
2013	2015	4	60	8	48
2014	2016				
2015	2017	4	64	8	56
2016	2018				
2017	2019	4	68	8	64
2018	2020				
2019	2021	4	72	8	72
2020	2022				
2021	2023	4	76	8	80
2022	2024				

RAI B.2.1.30-1.1

Background

The response to RAI B.2.1.30-1, dated February 28, 2012, stated that the American Society of Mechanical Engineers (ASME) Section XI, Subsection IWE (B.2.1.30) and the 10 CFR Part 50, Appendix J (B.2.1.33) programs are credited for managing the loss of material in the steel suppression pool liner; however, inspection of the suppression pool liner coating is performed to ensure that the coatings intended function to "maintain adhesion" is maintained and to ensure that the coating continues to function as a preventive measure to corrosion. These inspection activities, in addition to suppression pool desludging, more frequent ASME Code, Section XI, Subsection, IWE examinations, and the coating maintenance plan as described in LRA Appendix A, Table A.5, Commitment 30 ensure that sufficient thickness margin of the suppression pool liner will be maintained through the period of extended operation.

Issue

Recoating of the local areas of the suppression pool with general corrosion exhibiting greater than 25 mils plate thickness loss or spot recoating in local areas with pitting greater than 50 mils deep or recoating the liner plates with greater than 25 percent coating depletion prior to the period of extended operation in 2024 for Limerick Generating Station (LGS), Unit 1 and 2029 for LGS, Unit 2 will not ensure that the coating will continue to function as a preventive measure to corrosion. The suppression pool coating has degraded substantially and is beyond its service life since 1990s, as documented in AR # 01063631.

According to Commitment 30, the coating maintenance plan will be initiated in the 2012 refueling outage for LGS, Unit 1 and the 2013 refueling outage for LGS, Unit 2, and implemented such that the areas exceeding the above criteria are recoated prior to the period of extended operation that starts in 2024 for LGS, Unit 1 and 2029 for LGS, Unit 2. To delay recoating the degraded areas of the suppression pool experiencing more than 25 percent loss by 12 to 17 years (2024 and 2029) is not acceptable especially since four of the 44 floor panels and 2 of the 30 wall panels experienced a loss of greater than 30 percent of the protective coating documented in 2010. One floor panel had a loss of 72 percent of the underwater coating. Areas of the suppression pool liner plate with 25 percent coating depletion cannot continue to function as a preventive measure for corrosion during the period of extended operation.

Request

Protective coatings help in long term aging management of the suppression pool liner plate by preventing and inhibiting general and pitting corrosion. Therefore, provide additional information on how selectively recoating of the suppression pool carbon steel liner plate, in areas where existing coating has depleted more than 25 percent, will ensure that the coating will continue to function as a preventive measure to corrosion during the period of extended operation.

Exelon Response

We agree that protective coatings help in long term aging management of the suppression pool liner by preventing and inhibiting the loss of material due to corrosion. However, the Service Level I coating does not have a license renewal intended function for long term aging management of the suppression pool liner plate for preventing and inhibiting the loss of material

due to corrosion. As identified in LRA Table 3.5.2-11, "Primary Containment Summary of Aging Management Evaluation," the ASME Section XI, Subsection IWE (B.2.1.30) and the 10 CFR Part 50, Appendix J (B.2.1.33) programs are credited for managing the loss of material due to corrosion in the steel suppression pool liner. The Service Level I coating intended function for license renewal is to "maintain adhesion" so as to not adversely affect the operability of ECCS by clogging the ECCS suction strainers. This intended function is maintained through the implementation of GALL Report AMP XI.S8, Protective Coating Monitoring and Maintenance Program which is described in LRA Appendix B, section B.2.1.37.

LGS is a Mark II concrete containment where containment strength is derived from the concrete rather than the steel liner. The steel liner ensures a high degree of leak tightness during operating and accident conditions. There is a substantial margin available for liner corrosion. The containment liner plate is constructed of 1/4-inch thick carbon steel and includes a calculated margin of 1/8-inch. The Service Level I coating is a feature to protect the liner from material loss; however, this function is not a license renewal intended function. The 25 percent coating loss recoat criterion is a reasonable criterion upon which to minimize material loss based on the low corrosion rate on suppression pool liner uncoated surfaces. As discussed in Exelon’s response to RAI B.2.1.30-4, LGS specific suppression pool water chemistry and operating temperatures result in an expected rate of corrosion in the suppression pool liner of less than 2 mils per year.

The coating maintenance plan described in LRA Appendix A.5, Commitment 30 is one of several enhancements to suppression pool liner activities that will be implemented prior to the period of extended operation. The coating maintenance plan corrects deficiencies in coating to allow the coating to continue to perform its non-license renewal function to protect the suppression pool liner from corrosion. The implementation of the coating maintenance plan does not delay recoating the degraded areas of the suppression pool experiencing more than 25 percent coating loss by 12 to 17 years (2024 for Unit 1 and 2029 for Unit 2). The coating maintenance plan provides for the systematic restoration of the coating on floor and wall plates such that no submerged plate will have coating depletion in excess of 25 percent when entering the period of extended operation. The coating maintenance plan also includes activities to arrest corrosion when the criteria for a total plate recoat are not met. Area recoating will be done when general corrosion exceeds 25 mils plate thickness loss and spot recoating will be done when localized corrosion exceeds 50 mils plate thickness loss. The coating maintenance plan has been initiated in the 2012 refueling outage for Unit 1 and will be initiated in the 2013 refueling outage for Unit 2. The plan will be implemented such that the areas exceeding the recoat criteria are prioritized and corrected in a phased approach to ensure that these areas are recoated prior to the period of extended operation.

RAI B.2.1.30-2.1

Background

The response to RAI B.2.1.30-2, dated February 28, 2012, stated:

1. The acceptance criterion used for the initial visual examination of the LGS, Unit 1 downcomers in the 1R13 outage, as reported in AR 1063631, is less than or equal to 60 mils. The technical basis of this owner-established criterion is the design analyses for the downcomers. These analyses conclude that surface defects of less than or equal to 0.0625 inches are acceptable to meet design requirements. The corrosion found on the downcomers during 1R13 outage affected less than 13 percent of the cumulative surface area examined. Loss of metal in the exposed substrate was generally less than 15 mils.

2. Small areas of minimal general corrosion identified on the 1.25-inch thick columns do not affect load bearing capacity or visibly reduce the cross sectional area, and are therefore acceptable.

3. The acceptance criterion used for inspections of the submerged portion of the suppression pool liner for general corrosion is less than or equal to 0.125 inch metal loss. In addition, spot corrosion less than or equal to 2.5 inches in diameter may be 0.1875 inches in depth. The specification and analysis contain acceptance criteria which consider variations in plate thickness due to corrosion in the submerged portion of the suppression pool liner plate. The acceptance criteria varies based on the size of corrosion sites and the surrounding wall thickness. For a plate which is 4 percent under the theoretical thickness, the lower plate stiffness could create a slight increase in loading on the anchor.

4. The Generic Aging Lessons Learned (GALL) Report does not recommend augmented examinations (Examination Category E-C) of areas with material loss in excess of 10 percent of the nominal containment wall thickness. ASME Code, Section XI, Subsection IWE, specifically IWE-1240, also does not recommend augmented examinations (Examination Category E-C) of areas with material loss in excess of 10 percent of the nominal containment wall thickness. To accept a component for continued service by examination in accordance with IWE-3122.1, the acceptance standards of IWE-3500 must be met. No mention is made in these paragraphs of a 10 percent wall loss criterion. For E-A examinations, the examinations must meet the standards of ASME Code, Section XI, Subsection IWE, specifically IWE-3510.1 and IWE-3510.2, which indicate that the Owner shall define the acceptance criteria.

Issue

1. The response to the RAI B.2.1.30-2 states that the owner-established criteria for recoating of downcomers is based on the analysis that surface defects of less than or equal to 0.0625 inches are acceptable to meet design requirements. However, it is not clear if the surface defects considered were for local pitting degradation or for general corrosion. In addition, the staff cannot find any reference to this analysis in the Updated Final Safety Analysis Report (UFSAR).

2. The staff finds the response to RAI B.2.1.30-2 concerning the current condition of the suppression pool support columns acceptable because general corrosion loss of 20 mils

is equivalent to less than 2 percent of the 1.25-inch thick columns, and will not affect the load carrying capacity of the columns. However, the staff is not clear how the aging and trending of corrosion of the support columns will be managed in the future since the support columns are ASME Code, Section XI, Subsection IWF Class MC components and are inspected on a 10 year interval. Commitment 30 requires an ASME Code, Section XI, Subsection IWE, examination of the submerged portion of the suppression pool each ISI period.

3. General corrosion in some of the liner plates in LGS, Units 1 and 2 suppression pools is up to 35 mils or 14 percent of the nominal thickness of the liner plate. The response stated that a plate which is 4 percent under the theoretical thickness, the lower plate stiffness would create a slight increase in loading on the anchor; however the response has not addressed the effect of this loss in thickness of 14 percent on the capacity liner anchors, including the welds between the liner plate and the anchor.

4. ASME Code, Section XI, Subsection IWE, IWE-1241, "Examination Surface Areas," states that surface areas likely to experience accelerated degradation and aging require the augmented examinations identified in Table IWE-2500-1, Examination Category E-C. Such areas include the interior and exterior containment surface areas that are subject to accelerated corrosion with no or minimal corrosion allowance or areas where the absence or repeated loss of protective coatings has resulted in substantial corrosion and pitting. Typical locations of such areas are those exposed to standing water. The carbon steel liner plate in the suppression pool has standing water and is subject to accelerated corrosion and pitting with substantial loss of protective coating. In addition the coating is beyond its designed life. Therefore, the liner plate surfaces in the suppression pool that is exposed to standing water require augmented inspection in accordance with ASME Code, Section XI, Subsection IWE, IWE-1241.

Request

1. Provide additional details about the assumption used for developing owner-established criteria for recoating of down comers. Did the analysis consider surface defects of less than or equal to 0.0625 inches as due to local degradation or as a general corrosion allowance? In addition, provide reference to any design basis document in which the analysis is documented.

2. Clarify if the support columns in the suppression pool will be inspected every ISI period or every ISI interval.

3. Confirm that the effect of the loss in thickness of 35 mils (14 percent) in one liner plate located adjacent to another plate without any loss and up to 16 percent over nominal thickness on the capacity of liner anchors has been considered in the analysis.

4. Explain why suppression pool liner plates at LGS, Units 1 and 2 that are subject to accelerated corrosion and loss of protective coatings are not selected for augmented inspection as specified in ASME Code, Section XI, Subsection IWE, specifically IWE-1241.

Exelon Response

1. The acceptance criterion for the downcomers of 0.0625 inches for surface defects is applied to local degradation of less than or equal to 5.5 inches in any direction. An area of localized corrosion of 0.040 inches (or more) metal loss will be recoated. The criterion for acceptable general corrosion is less than or equal to 0.044 inches metal loss. An area greater than 5.5 inches in any direction with a depth of 0.030 inches (or more) metal loss will be recoated. Four original design calculations were used as the basis for Engineering Evaluations AR 1300201-02 and AR 1300201-03 which address the criteria for localized surface defects, general corrosion, and recoating.

2. The examination frequency for the suppression pool columns is each inspection interval which is in accordance with ASME Section XI, Subsection IWF, Table IWF-2500-1 for item F1.40. The examination frequency is appropriate for the 1.25-inch thick columns since the general corrosion loss of less than 2 percent of column material thickness is not significant and does not affect the load carrying capacity of the columns.

3. Buckling of the liner and the carrying capacity of the anchor system are considered in the design analysis. The maximum strain developed in a vertical wall section of the liner is controlling with respect to acceptance criteria, and as such is the more limiting condition. Since the plate in question is a floor plate, and the thinned portion in question is limited to 5.54% of that plate's surface area, the acceptance criteria from the design analysis remain valid for Unit 2 floor plate 2-FP-07D-4. The effects of plate curvature, anchor spacing, and variation in overall plate thicknesses between adjacent wall plates due to rolling tolerances on loading of the wall anchor system (including welds) is discussed in Item 4 of Exelon's response to RAI B.2.1.30-2.

4. Submerged suppression pool liner plates at LGS have been selected for augmented inspection as specified in ASME Code Section XI, Subsection IWE. Criteria for augmented inspections which are aligned with the coating action levels from LRA Appendix A.5, Commitment 30 were initiated starting in 2012. LGS Unit 1 submerged suppression pool liner plates have been selected for augmented inspection based on this new criteria. LGS Unit 2 suppression pool liner plates are scheduled for inspection in accordance with the new criteria starting in 2013. ASME Section XI, Subsection IWE, IWE-1241(a) and IWE 1241(b) contain examples of areas that should be considered for examination in accordance with Table IWE-2500-1, Examination Category E-C. IWE-1241(a) identifies areas with no or minimal corrosion allowance as an example of an area to be considered for examination in accordance with Table IWE-2500-1, Examination Category E-C. As stated in Item 5 of Exelon's response to RAI B.2.1.30-2; "… *a design analysis demonstrates that the carbon steel suppression pool liner is twice the necessary thickness.*" Therefore, the LGS Suppression Pool liner has a substantial corrosion margin which was considered in developing the owners acceptance criteria including the criteria for Examination Category E-C.

RAI B.2.1.30-4.1

Background

The response to RAI B.2.1.30-2, dated February 28, 2012, stated that the LGS ASME Section XI, Subsection IWE program as described in LRA Section B.2.1.30 is consistent with GALL Report AMP XI.S1 and ASME Section XI requirements for monitoring and trending. The corrosion of the submerged portion of the suppression pool liner is being trended and is between 1 to 2 mils per year based on data collected during several ASME Code, Section XI, Subsection IWE, inspections performed since 1996 in both LGS, Units 1 and 2. The response further stated that this rate compares well with the corrosion rate of 1.8 mils determined by an engineering analysis for uncoated carbon steel components in the suppression pool for the LGS specific suppression pool water chemistry and operating temperature. The response has also determined that the expected general corrosion rate, if applied to uncoated steel areas for 60 years, will result in a containment liner thickness that meets the liner engineering acceptance criteria for structural integrity.

Issue

The staff finds the response concerning the general corrosion rate of about 2 mils per year for carbon steel liner plate exposed to standing water in the suppression pool acceptable because it is based on actual measured data over several refueling outages since 1996. However, the pitting corrosion rate is unpredictable and usually 2-10 times more than general corrosion rate (See; J.A. Gonzales, "Comparison of Rates of General Corrosion and maximum Pitting Penetration of Concrete Embedded Steel Reinforcement," Cement of Concrete Research, Vol. 25, No.2. pp257-264, Fraser King, "Overview of a Carbon Steel Container Corrosion model for a deep Geological Repository in Sedimentary Rock," Nuclear Waste Management Organization Report TR-2007-01, March 2007, and Xiaodong Sun and Lietai Yang, "Real Time Monitoring of Localized and General Corrosion Rates in Drinking Water Systems Utilizing Coupled Multielectrode Array Sensors," Paper No. 060904, 61 First Annual NACE Conference and Exhibition, 2006). This is evident at the LGS suppression pool liner plate where pitting corrosion of 122 mils has been observed in 2006, about 25 years after the plant started operation. This loss could not have started immediately after plant operation because it takes time for the protective coating to degrade.

Request

Explain how containment liner thickness will meet the engineering acceptance criteria for structural integrity, in areas of degraded coating, where pitting corrosion continues at the rate of 4 to 20 mils per year for 60 years or even until the period of extended operation starting in 2024 in LGS, Unit 1 and 2029 in LGS, Unit 2 as described in Commitment 30.

Exelon Response

As described in LRA Commitment 30, an ASME IWE examination of the submerged portion of the suppression pool liner will be performed each ISI period beginning in 2012 for Unit 1 and in 2013 for Unit 2. This inspection frequency results in an inspection every two to four years on each unit. Commitment 30 also includes spot recoating of areas with localized corrosion greater than 50 mils deep and local recoating of areas with general corrosion greater than 25 mils plate thickness loss. These actions to inspect and recoat degraded areas prevent material loss due

to corrosion from exceeding the engineering acceptance criteria for structural integrity of the suppression pool liner.

Pitting corrosion is not anticipated to be a major degradation mechanism for the LGS carbon steel suppression pool liner. Pitting corrosion occurs on alloys that form protective passive films in the suppression pool environment, and carbon steel does not typically form passive films in low temperature water. Also, the primary pitting corrosion promoting anion, chloride, in the LGS suppression pool water is only present at very low levels of a few parts per billion. Therefore, the carbon steel liner exposed to the suppression pool environment is anticipated to experience general corrosion, not pitting corrosion.

A review of the references cited in the "Issue" discussion of this RAI concludes that they are not representative of the material and water chemistry conditions for the LGS suppression pool liner, and the conclusions regarding pitting corrosion are not directly applicable to LGS.

- The paper by J. A. Gonzalez, et al., discusses the localized attack on carbon steel reinforcement embedded in chloride contaminated high pH (e. g., 12-14) concrete. This study concludes that the maximum penetration of localized attack is equivalent to about four to eight times the average general penetration. The LGS configuration consists of purified water at neutral pH with only trace amounts of chlorides in contact with the carbon steel liner plate. Therefore, the localized corrosion rates in the chloride contaminated high pH concrete are not considered applicable to the LGS suppression pool liner.

- The paper by F. King discusses the potential corrosion of carbon steel spent fuel containers stored in a deep geological repository where the carbon steel containers are placed in contact with compacted bentonite clay. Over long periods of time the bentonite is assumed to become saturated with water containing contaminates at levels not present in the LGS suppression pool water. The study concludes that the pH of the environments plays a key role, with uniform corrosion observed below a critical pH and localized corrosion at higher pH values. The value of this critical pH depends on temperature and the concentration of ions in solution and has been reported to range from 8 to 10.5. This critical pH value is up to four orders of magnitude higher than the LGS suppression pool water pH which is in the average range of 6.5 to 6.8. Therefore, since the environment (bentonite) and water chemistry from the study are not representative of the LGS conditions, the conclusions regarding localized corrosion are not applicable.

- The paper by X. Sun, et al., discusses the viability of a coupled multi-electrode sensor array to provide real-time monitoring of corrosion in air-saturated (and not nitrogen blanketed) drinking water systems. The electrochemical testing was conducted over a very short time period (e. g., three hours and eight days) in both distilled water and spring water. The short duration of the test does not provide results that are representative of long term operating conditions for the LGS suppression pool liner. However, if one considers the test results for distilled water, which is more representative of the LGS suppression pool water than spring water, the test indicates that the maximum localized corrosion rate was eight times higher than the average corrosion rate for carbon steel, and the maximum localized corrosion rate for carbon steel was 3.5 mil/year. Thus, the average corrosion rate for carbon steel for the test conditions was 3.5 divided by 8 or 0.44 mil/year and is not representative of LGS. The LGS liner general corrosion rate is approximately 2 mil/year based on years of field

exposure to the suppression pool environment. Therefore, these electrochemical test results do not appear to be directly applicable to LGS.

As discussed above, the studies cited in this RAI do not represent the material-environment combination for the LGS suppression pool liner. A study more representative of the LGS suppression pool liner material-environment combination was performed by A. D. Mercer, et al., "Comparative Study of Factors Influencing the Action of Corrosion Inhibitors for Mild Steel in Neutral Solution," Part III, Sodium Nitrite, British Corrosion Journal, Vol. 3, May 1968. In this study, carbon steel was immersed for 100 days in high purity water similar in conductivity to the LGS suppression pool plus water containing various aggressive anions such as sulfate, nitrate, and chloride. This test also quantitatively determined the general corrosion rates of carbon steel, and this information was used for the LGS carbon steel corrosion evaluation. While general corrosion of carbon steel was observed in this high purity water control test environment, there was no evidence of pitting corrosion, which is consistent with what is expected for carbon steel in this environment that closely represents the LGS suppression pool liner environment.

Inspections of the suppression pool liner have identified isolated locations where material loss has been identified that are greater than expected for general corrosion. The area with the greatest metal loss, 122 mil, is on a floor plate, was identified during the Unit 1 inspection performed in 2006 and was immediately recoated. The 2006 inspection was the first quantitative inspection of the floor plate. A previous general visual inspection of this area in 1996 identified locations of mechanical damage (nicks, dings, scrapes, etc.) that exposed the liner plate to the suppression pool water. Therefore, it is not known when the corrosion at this location initiated or if some of the wall thickness loss is due to mechanical damage in addition to corrosion. The small number of these locations is indicative of mechanical damage as the initiator of the corrosion. Otherwise, the number of areas that exhibit metal loss greater than expected from general corrosion would be significantly higher and be prevalent in many of the liner plates that have experienced a loss of coating.

The inspection scope and frequency described in Commitment 30 provides for the identification of any areas where localized corrosion is occurring at a rate higher than the general corrosion rate, and the recoating criteria will arrest the material loss at these localized corrosion areas prior to reaching the structural integrity acceptance criteria. Exelon's response to RAI B.2.1.30-2 identifies the acceptance criteria for the submerged portion of the suppression pool liner for general corrosion and localized corrosion. Using the general corrosion recoat criterion of 25 mils and a general corrosion rate of 2 mils per year, an uncoated area could experience a reduction in wall thickness of 33 mils ((25 mils) + (2 mils/yr x 4 yr)) due to general corrosion at the next inspection when the degraded area would be recoated. This is well below the 125 mils general corrosion allowance. Even though the X. Sun testing referenced above is not applicable to the LGS environment; if a localized corrosion rate as high as a factor of eight times the general corrosion rate were to occur at LGS, the maintenance plan would arrest the material loss. Using a localized corrosion recoat criterion of 50 mils and a localized corrosion rate as high as 8 times the general corrosion rate, the depth of the localized corroded area would be 114 mils ((50 mils) + (2 mils/yr x 4 yr x 8)) at the next inspection when the degraded area would be recoated or repaired. This is below the 125 mils general corrosion allowance and well below the structural integrity acceptance criterion for metal loss of 187.5 mils for localized corrosion. Therefore, the maintenance plan as described in LRA Commitment 30 adequately addresses both general corrosion and localized corrosion to avoid significant material loss and maintain the suppression pool liner integrity. The containment liner thickness will continue to meet the engineering acceptance criteria for structural integrity in areas of degraded coating.

The maintenance plan described in Commitment 30 has already been initiated on Unit 1 and will be initiated on Unit 2 in 2013 such that general and localized corrosion will not result in significant material loss both during the current license period as well as through the period of extended operation.

Enclosure B
LGS License Renewal Application Updates

Notes:

- To facilitate understanding, portions of the original LRA have been repeated in this Enclosure, with revisions indicated.
- Text from the original LRA or previous RAI responses is shown in normal font. Changes are highlighted with ***bold italics*** for inserted text and strikethroughs for deleted text.

As a result of the response to RAI B.2.1.28-2 provided in Enclosure A of this letter, LRA Section A.2.1.28 and the Enhancements sub-section of LRA Section B.2.1.28 are revised as follows:

A.2.1.28 Monitoring of Neutron-Absorbing Materials Other than Boraflex

The Monitoring of Neutron-Absorbing Materials Other Than Boraflex program is an existing condition monitoring program that periodically analyzes test coupons of the Boral material in the Unit 1 and Unit 2 spent fuel racks to determine if the neutron-absorbing capability of the material has degraded. This program ensures that a 5 percent sub-criticality margin is maintained in the spent fuel pool.

The Monitoring of Neutron-Absorbing Materials Other Than Boraflex aging management program will be enhanced to:

1. Perform test coupon analysis on a ten-year frequency***, beginning no earlier than 2020 for Unit 1 and 2021 for Unit 2***.
2. Initiate corrective action if coupon test result data indicates that acceptance criteria will be exceeded prior to the next scheduled test coupon analysis.
3. Resume the accelerated exposure configuration for the Boral coupons (surrounded by freshly discharged fuel assemblies) at each of five ***additional*** refueling cycles, beginning with the next refueling for each unit (2013 for Unit 2, 2014 for Unit 1).
4. Maintain the coupon exposure such that it is bounding for the Boral material in all spent fuel racks***, by relocating the coupon tree to a different spent fuel rack cell location each cycle and by surrounding the coupons with a greater number of freshly discharged fuel assemblies than that of any other cell location***.

These enhancements will be implemented prior to the period of extended operation.

B.2.1.28 Monitoring of Neutron-Absorbing Materials Other than Boraflex

Enhancements

Prior to the period of extended operation, the following enhancements will be implemented in the following program elements:

1. Perform test coupon analysis on a ten-year frequency***, beginning no earlier than 2020 for Unit 1 and 2021 for Unit 2***. **Program Element Affected: Detection of Aging Effects (Element 4)**

2. Initiate corrective action if coupon test result data indicates that acceptance criteria will be exceeded prior to the next scheduled test coupon analysis. **Program Element Affected: Corrective Actions (Element 7)**

3. Resume the accelerated exposure configuration for the Boral coupons (surrounded by freshly discharged fuel assemblies) at each of five ***additional*** refueling cycles, beginning with the next refueling for each unit (2013 for Unit 2, 2014 for Unit 1). **Program Element Affected: Monitoring and Trending (Element 5)**

4. Maintain the coupon exposure such that it is bounding for the Boral material in all spent fuel racks***, by relocating the coupon tree to a different spent fuel rack cell location each cycle and by surrounding the coupons with a greater number of freshly discharged fuel assemblies than that of any other cell location***. **Program Element Affected: Monitoring and Trending (Element 5)**

Enclosure C

LGS
License Renewal Commitment List Changes

This Enclosure identifies commitments made in this document and is an update to the LGS LRA Appendix A, Table A.5 License Renewal Commitment List. Any other actions discussed in the submittal represent intended or planned actions and are described to the NRC for the NRC's information and are not regulatory commitments. Changes to the LGS LRA Appendix A, Table A.5 License Renewal Commitment List are as a result of the Exelon response to the following RAI:

RAI B.2.1.28-2

Notes:
- Updated LRA Sections and Tables are provided in the same order as the RAI responses contained in Enclosure A.
- To facilitate understanding, portions of the original LRA have been repeated in this Enclosure, with revisions indicated.
- Text from the original LRA or previous RAI responses is shown in normal font. Changes are highlighted with ***bold italics*** for inserted text and strikethroughs for deleted text.

As a result of the response to RAI B.2.1.28-2 provided in Enclosure A of this letter, LRA, Appendix A, Table A.5, pages A-54 and A-55, is revised as follows:

NO.	PROGRAM OR TOPIC	COMMITMENT	IMPLEMENTATION SCHEDULE	SOURCE
28	Monitoring of Neutron-Absorbing Materials Other than Boraflex	Monitoring of Neutron-Absorbing Materials Other than Boraflex is an existing program that will be enhanced to: 1. Perform test coupon analysis on a ten-year frequency***, beginning no earlier than 2020 for Unit 1 and 2021 for Unit 2***. 2. Initiate corrective action if coupon test result data indicates that acceptance criteria will be exceeded prior to the next scheduled test coupon analysis. 3. Resume the accelerated exposure configuration for the Boral coupons (surrounded by freshly discharged fuel assemblies) at each of five ***additional*** refueling cycles, beginning with the next refueling for each unit (2013 for Unit 2, 2014 for Unit 1). 4. Maintain the coupon exposure such that it is bounding for the Boral material in all spent fuel racks***, by relocating the coupon tree to a different spent fuel rack cell location each cycle and by surrounding the coupons with a greater number of freshly discharged fuel assemblies than that of any other cell location***.	Program to be enhanced prior to the period of extended operation. Inspection schedule identified in commitment.	Section A.2.1.28 LGS Letter dated 2/28/12 RAI B.2.1.28-1 ***LGS Letter dated 4/27/12*** ***RAI B.2.1.28-2***