Exelon Generation
4300 Winfield Road
Warrenville, IL 60555

www.exeloncorp.com

Exelon Nuclear

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U. S. Nuclear Regulatory Commission
ATTN: 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 Request for Additional Information Related to NRC Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors"

References:

(1) Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors," dated September 13, 2004

(2) Letter from P. B. Cowan (Exelon Generation Company, LLC) to U. S. Nuclear Regulatory Commission, "Exelon/AmerGen Response to NRC Generic Letter 2004-02, 'Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors,'" dated September 1, 2005

(3) Letter from K. R. Jury (Exelon Generation Company, LLC) to U. S. Nuclear Regulatory Commission, "Supplement to Exelon Response to NRC Generic Letter 2004-02, 'Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors,'" dated May 31, 2006

(4) Letter from P. R. Simpson (Exelon Generation Company, LLC) to U. S. Nuclear Regulatory Commission, "Supplemental Response to NRC Generic Letter 2004-02, 'Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors,'" dated December 31, 2007

(5) Letter from M. J. David (U. S. Nuclear Regulatory Commission) to C. G. Pardee (Exelon Generation Company, LLC), "Braidwood Station, Units 1 and 2, and Byron Station, Units 1 and 2 - Request for Additional Information Related to Generic Letter 2004-02," dated July 24, 2008

The U. S. Nuclear Regulatory Commission (NRC) issued Reference 1 to request that addressees perform an evaluation of the emergency core cooling system (ECCS) and containment spray system (CSS) recirculation functions in light of the information provided in the GL and, if appropriate, take additional actions to ensure system function. Additionally, the GL requested addressees to provide the NRC with a written response in accordance with 10 CFR 50.54(f). The request was based on identified potential susceptibility of the pressurized water reactor (PWR) recirculation sump screens to debris blockage during design basis accidents requiring recirculation operation of ECCS or CSS and on the potential for additional adverse effects due to debris blockage of flowpaths necessary for ECCS and CSS recirculation and containment drainage.

Reference 2 provided the initial Exelon Generation Company, LLC (EGC) response to the GL followed by supplemental responses in References 3 and 4. During the review of the Reference 4 submittal, the NRC identified five issues that require clarification (Reference 5). The EGC responses to these five questions are provided in the attachment to this letter. This information is being provided in accordance with 10 CFR 50.54(f).

There are no regulatory commitments contained in this submittal. Should you have any questions concerning this submittal, please contact Lisa Schofield at (630) 657-2815.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 19th day of September 2008.

Respectfully,

Patrick R. Simpson

Patrick R. Simpson
Manager - Licensing

NRC Question 1

Pursuant to the requirements of Title 10 of the Code of Federal Regulations, Section 50.55a, please identify the edition of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code which was used for strainer qualification.

Exelon Generation Company, LLC (EGC) Response

The code that is applicable to the strainer qualification is the American Society of Civil Engineers (ASCE) ASCE-8-90, "Specification for the Design of Cold-Formed Stainless Steel Structural Members, 1991." The structural qualification from the strainer manufacturer (CCI) used stress limits from American Institute of Steel Construction (AISC), "Manual of Steel Construction," Sixth Edition. The AISC limits were used because these limits envelope the requirements of the ASCE Code.

Material properties for the strainer structural qualification were taken from the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (B&PV), Section II, "Materials," Part D, "Properties," 2004 Edition. ASME B & PV Section III, "Rules for Construction of Nuclear Power Plant Components," Subsection NF, "Supports," was used only to justify a safety factor of 2 on the critical buckling stress (Table NF-3552(b)-1, "Elastic Analysis Stress Categories and Stress Limit Factors for Class 2, 3, and MC Plate and Shell-Type Supports Designed by Analysis – Component Supports," 2004 edition).

The analyses done for the Braidwood Station and Byron Station strainers used the material properties, allowable stresses and safety factor values from the applicable sections, listed above, of the 2004 ASME Code Edition. At the time of the analyses, the NRC had approved the use of ASME Code editions up to and including the 2001 Edition through 2003 addenda. However, the material properties, allowable stresses, and safety factors used in the calculations have been reviewed to assure that their 2004 Edition values are identical to the values referenced in the 2001 through 2003 Addenda of ASME Sections III and Section II.

In addition, as described in a Federal Register notice dated September 10, 2008, the NRC has modified 10 CFR 50.55a, "Codes and standards," and has approved the 2004 Edition of ASME Code Sections III and XI effective October 10, 2008.

NRC Question 2

The supplemental GL response states on page 71 of 102, "The design requirements also ensure that it (the strainer) is capable of withstanding the hydrodynamic loads and inertial effects of water at full debris loading without loss of structural integrity." However, in the summary of design assumptions (page 73 of 102), the statement is made, "For the stress analysis no hydrodynamic loads or masses has [sic] been considered." Please clarify these seemingly contradictory statements.

EGC Response

The procurement specification for the containment recirculation sump strainers does include the requirement that the strainers shall be designed to withstand the hydrodynamic loads and inertial effects of water in the containment basement due to a safe shutdown earthquake (SSE) and an operating basis earthquake (OBE), at full debris loading, without loss of structural integrity. However, at the time of issuance of this specification, the specific location (i.e., above or below containment floor elevation 377 ft) of the replacement strainers was not yet known. The wording given in page 71 of 102 of the submittal (i.e., letter from P. R. Simpson (Exelon Generation Company, LLC) to U. S. Nuclear Regulatory Commission, "Supplemental Response to NRC Generic Letter 2004-02, 'Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors,'" dated December 31, 2007) was taken from the procurement specification but the extent of analysis was dependent on the configuration of the final design.

Subsequent to the issuance of the procurement specification it was determined that the replacement strainers would be located inside the containment recirculation sump pits, below containment floor elevation 377 ft. The structural qualification analysis concluded the interaction between the strainer and the water inside the sump pit is not relevant due to the small volume of the sump, and therefore hydrodynamic loads need not be evaluated.

NRC Question 3

The supplemental GL response states on page 71 of 102, "...the trash rack protects the strainer from potential dynamic effects." However, page 72 of 102 states, "...dynamic effects from breaks considered for GSI-191 in the vicinity of the trash rack are not considered in the structural analysis/design of the trash rack." The paragraph continues by stating, "...dynamic effects due to design basis breaks are not considered in the structural analysis of the trash rack." The page 71 statement indicates that the design function of the trash rack is to protect the strainers from dynamic effects, but the statements on page 72 show that the trash rack has not been evaluated for any dynamic effects. Please clarify these seemingly contradictory statements.

EGC Response

The trash rack structure is located above floor elevation 377 ft and encloses and protects both recirculation sump pits. The analysis for dynamic loads determined that there were no jet force effects on the trash racks from postulated breaks (see response to NRC Question 5). Therefore, the trash rack qualification analysis did not need to include loads from the dynamic effects of jet forces.

The analysis does analyze and qualify the trash racks for the hydrodynamic effects of the flood pool (seismic acceleration and sloshing). Since the trash racks are protected against these types of hydrodynamic effects, the trash rack does assure the ability of the screens to perform their design function.

NRC Question 4

Please provide a stress ratio summary table similar to Table 3k2-1 for the trash rack analysis.

EGC Response

The ratios of design stress and corresponding allowable stress for the various components of the Braidwood trash rack structural assembly are provided in Table 4-1. The corresponding information for the Byron Station trash rack is provided in Table 4-2.

Table 4-1
Ratios of Design Stress and Corresponding Allowable Stress for Various Components of the Braidwood Station Trash Rack Structural Assembly

Component	**Component Element**	**Maximum Stress Ratio**
Vertical Grating Panels		
Sectors 5&6	Bearing bars	0.842
Other Sectors	Bearing bars	0.944
Bolting	3/8 inch hex head bolts	0.312
Grating Panel on Outside of Rack	Panel Rated Uniform Load	0.399
Grating Panel on Inside of Rack	Panel Rated Uniform Load	0.657
Debris Interceptor Plate		
	1/4 inch Plate	0.69
	Bolts	0.25
Column Base Plates		
	Hilti Kwik Bolts	0.73
	Weld	0.30
	Plate	0.45
Structural Members & Component Connections		
	Governing Structural Member (Double angle 3.5x3.5x1/4)	0.125
	TS 4x4 to TS 6x6 weld	0.56
	Double angle 3.5x3.5 to TS 4x4 welds	0.28 (Instanding Leg) 0.03 (Outstanding Leg)
	TS 6x6 to Embed Plate	0.14 (weld)
		0.15 (studs)
		0.93 (embed plate)
Impact Loading of Insulation Debris		
	Trash Rack Structure	0.78 (Ductility Ratio)

Table 4-2
Ratios of Design Stress and Corresponding Allowable Stress for Various Components of the Byron Station Trash Rack Structural Assembly

Component	**Component Element**	**Maximum Stress Ratio**
Vertical Grating Panels		
Sectors 5&6	Bearing bars	0.842
Other Sectors	Bearing bars	0.969
Bolting	3/8 inch hex head bolts	0.312
Grating Panel on Outside of Rack	Panel Rated Uniform Load	0.399
Grating Panel on Inside of Rack	Panel Rated Uniform Load	0.657
Debris Interceptor Plate		
	1/4 inch Plate	0.72
	Bolts	0.26
Column Base Plates		
	Hilti Kwik Bolts	0.76
	Weld	0.28
	Plate	0.46
Structural Members & Component Connections		
	Governing Structural Member (Double angle 3.5x3.5x1/4)	0.125
	TS 4x4 to TS 6x6 weld	0.52
	Double angle 3.5x3.5 to TS 4x4 welds	0.28 (Instanding Leg) 0.03 (Outstanding Leg)
	TS 6x6 to Embed Plate	0.09 (weld)
		0.12 (studs)
		0.34 (embed plate)
Impact Loading of Insulation Debris		
	Trash Rack Structure	0.78 (Ductility Ratio)

NRC Question 5

The NRC staff has not endorsed the use of NUREG/CR-2913 for the calculation of jet forces within a 10-diameter distance of potential targets. Please utilize the simplified methods per the current licensing basis to address potential jet forces on the trash rack structure and provide a summary of the results to the NRC staff.

EGC Response:

Based on concerns regarding the general application of the NUREG/CR-2913 methodology, EGC has reevaluated the jet force impacts on the trash racks using current licensing basis procedures described in the Braidwood and Byron UFSAR (Section 3.6.2.3.3.3). The method used to compute the jet impingement force (F_j) on the target, (i.e., the trash rack) is as follows.

$$F_j = K_o P_o A_{mB} R S$$

Where:

F_j = jet impingement load on target
K_o = dimensionless jet thrust coefficient based on initial fluid conditions in broken loop
P_o = initial system pressure
A_{mB} = calculated maximum break flow area
R = fraction of the jet intercepted by target
S = target shape factor

In assessing piping stresses in the area of the trash racks only the 2-inch diameter line 2RC26A was determined to be susceptible to a potential line break and within 10 pipe diameters of the trash rack. Based on the criteria provided in Section 3.6.2.5.2.1, "Implementation of Criteria for Defining Pipe Break Locations and Configurations," of the Braidwood Station and Byron Station UFSAR, breaks in 2RC26A are only postulated for Byron Unit 2. Two break locations were postulated: C450 and C451 (Figure 5-1). As indicated in Figure 5-2, postulated breaks C450 and C451 on 2RC26A are located 1 foot above and parallel to the trash rack and within 10 pipe diameters from the trash rack. Since pipe movement is limited and occurs in the initial plane of the pipe, the jet path will be parallel to the top of the trash rack and will not intersect with the trash rack; consequently, the factor R would equal 0. Therefore, no load is imposed on the trash rack from Breaks C450 and C451.

In addition, for the upstream side of breaks C450 and C451, the force exerted from a postulated break from the 2-inch line is applied against a 4-inch header line, and therefore a hinge will not form and the pipe (2RC26A) will remain in the horizontal plane.

Breaks C450 and C451 are located on the ends of valve 2RC8057. This valve is normally closed and the piping downstream is to the Reactor Coolant Drain Tank, which is a low-pressure line. Therefore, there would be no jet thrust from the downstream side of these postulated breaks.

Figure 5-1
Postulated Break Locations

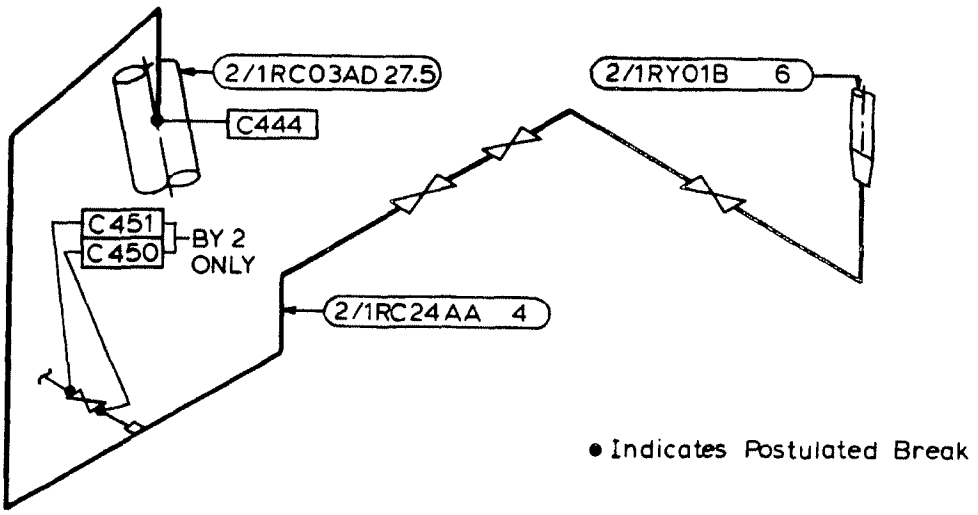
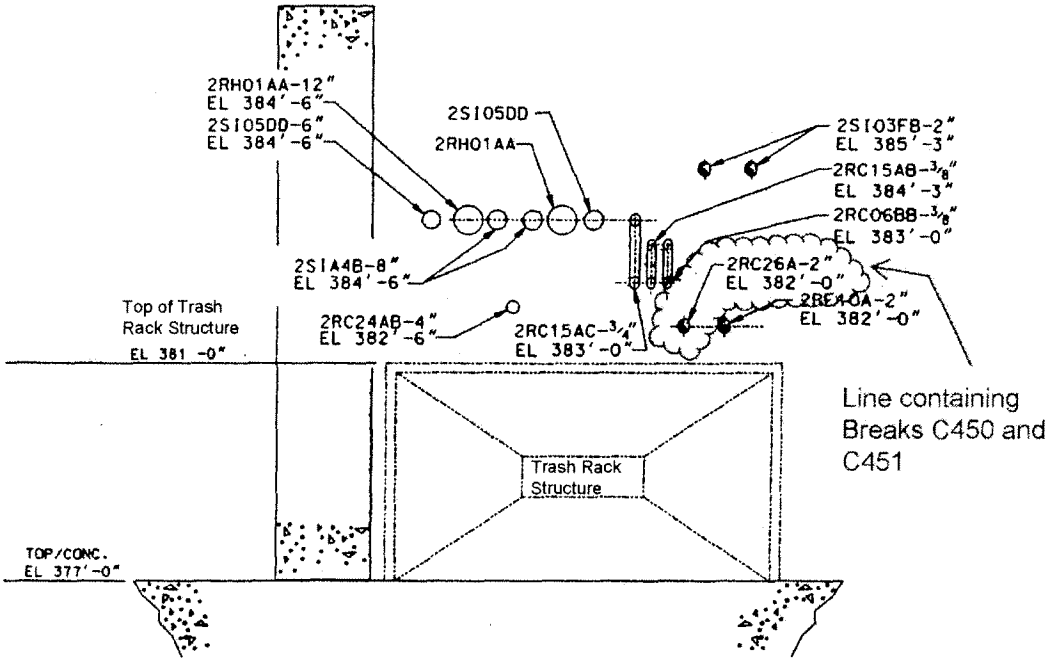


Figure 5-2
Trash Rack Cross Section



ELEVATION A

Trash Rack Structure Overhead Clearance

Of the lines shown on this sketch, only line 2RC26A-2" contains postulated breaks in the area of the trash rack.