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

June 14, 2011

Mr. Michael J. Pacilio
President and Chief Nuclear Officer
Exelon Nuclear
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: BYRON STATION, UNIT NOS. 1 AND 2 - ISSUANCE OF AMENDMENTS RE: REVISION OF TECHNICAL SPECIFICATION 3.7.9, ULTIMATE HEAT SINK (TAC NO. ME1669 AND ME1670)

Dear Mr. Pacilio:

The U.S. Nuclear Regulatory Commission (NRC, the Commission) has issued the enclosed Amendment No. 173 to Facility Operating License No. NPF-37 and Amendment No. 173 to Facility Operating License No. NPF-66 for the Byron Station, Unit Nos. 1 and 2, respectively. The amendments are in response to Exelon Generation Company, LLC application dated June 30, 2009, as supplemented by letters dated January 25, July 1, and November 8, 2010, and January 31, March 16, and May 4, 2011, to amend technical specifications (TS) for Byron Station, Unit Nos. 1 and 2.

The amendments requested a revision to TS 3.7.9, "Ultimate Heat Sink," to revise and add additional essential service water cooling tower (SXCT) fan requirements as a function of essential service water pump discharge temperature and ambient wet-bulb temperature to reflect the results of a revised analysis accounting for a single failure loss of two SXCT fans during a design basis accident.

A copy of the safety evaluation (SE) is enclosed. Two regulatory commitments are documented in Section 4.0 of the NRC staff's SE. The Notice of Issuance will be included in the Commission's biweekly *Federal Register* notice.

Sincerely,

Nicholas J. DiFrancesco, Project Manager
Plant Licensing Branch III-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. STN 50-454 and STN 50-455

Enclosures:
1. Amendment No. 173 to NPF-37
2. Amendment No. 173 to NPF-66
3. Safety Evaluation

cc w/encls: Distribution via Listserv

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

EXELON GENERATION COMPANY, LLC

DOCKET NO. STN 50-454

BYRON STATION, UNIT NO. 1

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 173
License No. NPF-37

1. The U.S. Nuclear Regulatory Commission (the Commission) has found that:

    A. The application for amendment by Exelon Generation Company, LLC (the licensee) dated June 30, 2009, as supplemented by letters dated January 25, July 1, and November 8, 2010, and January 31, March 16, and May 4, 2011, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act) and the Commission's rules and regulations set forth in 10 CFR Chapter I;

    B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

    C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

    D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

    E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C.(2) of Facility Operating License No. NPF-37 is hereby amended to read as follows:

(2) Technical Specifications

The Technical Specifications contained in Appendix A as revised through Amendment No. 173 and the Environmental Protection Plan contained in Appendix B, both of which are attached hereto, are hereby incorporated into this license. The licensee shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

3. This license amendment is effective as of the date of its issuance and shall be implemented within 90 days of the date of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

Jacob I. Zimmerman, Chief
Plant Licensing Branch III-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment: Changes to the Technical Specifications and Facility Operating License

Date of Issuance: June 14, 2011

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

EXELON GENERATION COMPANY, LLC

DOCKET NO. STN 50-455

BYRON STATION, UNIT NO. 2

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 173
License No. NPF-66

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Exelon Generation Company, LLC (the licensee) dated June 30, 2009, as supplemented by letters dated January 25, July 1, and November 8, 2010, and January 31, March 16, and May 4, 2011, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act) and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C.(2) of Facility Operating License No. NPF-66 is hereby amended to read as follows:

(2) Technical Specifications

The Technical Specifications contained in Appendix A (NUREG-1113), as revised through Amendment No. 173 and the Environmental Protection Plan contained in Appendix B, both of which were attached to License No. NPF-37, dated February 14, 1985, are hereby incorporated into this license. The licensee shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

3. This license amendment is effective as of the date of its issuance and shall be implemented within 90 days of the date of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

Jacob I. Zimmerman, Chief
Plant Licensing Branch III-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment: Changes to the Technical Specifications and Facility Operating License

Date of Issuance: June 14, 2011

ATTACHMENT TO LICENSE AMENDMENT NOS. 173 AND 173

FACILITY OPERATING LICENSE NOS. NPF-37 AND NPF-66

DOCKET NOS. STN 50-454 AND STN 50-455

Replace the following pages of the Facility Operating License and Appendix "A" Technical Specifications with the attached pages. The revised pages are identified by amendment number and contain marginal lines indicating the areas of change.

Remove	Insert
License NPF-37	License NPF-37
Page 3	Page 3
License NPF-66	License NPF-66
Page 3	Page 3
TSs	TSs
3.7.9-1	3.7.9-1
3.7.9-2	3.7.9-2
3.7.9-3	3.7.9-3
3.7.9-4	3.7.9-4
3.7.9-5	3.7.9-5
3.7.9-6	3.7.9-6
--	3.7.9-7
--	3.7.9-8

(4) Pursuant to the Act and 10 CFR Parts 30, 40 and 70, to receive, possess, and use in amounts as required any byproduct, source or special nuclear material without restriction to chemical or physical form, for sample analysis or instrument calibration or associated with radioactive apparatus or components; and

(5) Pursuant to the Act and 10 CFR Parts 30, 40 and 70, to possess, but not separate, such byproduct and special nuclear materials as may be produced by the operation of the facility.

C. This license shall be deemed to contain and is subject to the conditions specified in the Commission's regulation set forth in 10 CFR Chapter I and is subject to all applicable provisions of the Act and to the rules, regulations, and orders of the Commission now or hereafter in effect; and is subject to the additional conditions specified or incorporated below:

(1) Maximum Power Level

The licensee is authorized to operate the facility at reactor core power levels not in excess of 3586.6 megawatts thermal (100 percent power) in accordance with the conditions specified herein.

(2) Technical Specifications

The Technical Specifications contained in Appendix A as revised through Amendment No. 173 And the Environmental Protection Plan contained in Appendix B, both of which are attached hereto, are hereby incorporated into this license. The licensee shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

(3) Deleted.

(4) Deleted.

(5) Deleted.

(6) The licensee shall implement and maintain in effect all provisions of the approved fire protection program as described in the licensee's Fire Protection Report, and as approved in the SER dated February 1987 through Supplement No. 8, subject to the following provision:

> The licensee may make changes to the approved fire protection program without prior approval of the Commission only if those changes would not adversely affect the ability to achieve and maintain safe shutdown in the event of a fire.

(3) Pursuant to the Act and 10 CFR Parts 30, 40 and 70, to receive, possess, and use at any time any byproduct, source and special nuclear material as sealed neutron sources for reactor startup, sealed sources for reactor instrumentation and radiation monitoring equipment calibration, and as fission detectors in amounts as required;

(4) Pursuant to the Act and 10 CFR Parts 30, 40 and 70, to receive, possess, and use in amounts as required any byproduct, source or special nuclear material without restriction to chemical or physical form, for sample analysis or instrument calibration or associated with radioactive apparatus or components; and

(5) Pursuant to the Act and 10 CFR Parts 30, 40 and 70, to possess, but not separate, such byproduct and special nuclear materials as may be produced by the operation of the facility.

C. This license shall be deemed to contain and is subject to the conditions specified in the Commission's regulation set forth in 10 CFR Chapter I and is subject to all applicable provisions of the Act and to the rules, regulations, and orders of the Commission now or hereafter in effect; and is subject to the additional conditions specified or incorporated below:

(1) Maximum Power Level

The licensee is authorized to operate the facility at reactor core power levels not in excess of 3586.6 megawatts thermal (100 percent rated power) in accordance with the conditions specified herein.

(2) Technical Specifications and Environmental Protection Plan

The Technical Specifications contained in Appendix A (NUREG-1113), as revised through Amendment No. 173, and the Environmental Protection Plan contained in Appendix B, both of which were attached to License No. NPF-37, dated February 14, 1985, are hereby incorporated into this license. The licensee shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

(3) Deleted.

(4) Deleted.

(5) Deleted.

3.7 PLANT SYSTEMS

3.7.9 Ultimate Heat Sink (UHS)

LCO 3.7.9 The UHS shall be OPERABLE and the required SX cooling tower (SXCT) fans shall be OPERABLE and operating as specified in Table 3.7.9-1 or Table 3.7.9-2.

APPLICABILITY: MODES 1, 2, 3, and 4.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more OPERABLE SXCT fan(s) not running in required high speed as required by Table 3.7.9-1 or Table 3.7.9-2.	A.1 Initiate actions to operate OPERABLE SXCT fan(s) in high speed.	Immediately
B. One required SXCT fan inoperable.	B.1 Verify OPERABLE SXCT fans are capable of being powered by an OPERABLE emergency power source.	1 hour
	AND	
	B.2 Restore required SXCT fan to OPERABLE status.	72 hours

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
C. Outside air wet bulb temperature > 76°F. AND Any electrical division not capable of providing power to at least one OPERABLE SXCT fan.	C.1	Verify OPERABLE SXCT fans are capable of being powered by an OPERABLE emergency power source.	1 hour
	AND		
	C.2	Restore SXCT fan configuration such that each electrical division is capable of providing power to at least one OPERABLE SXCT fan.	72 hours
D. SX pump discharge water temperature > 96°F.	D.1	Be in MODE 3.	6 hours
	AND		
	D.2	Be in MODE 5.	36 hours
E. One or more basin level(s) < 60%.	E.1	Restore both basin levels to ≥ 60%.	6 hours

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
F. One Essential Service Water (SX) makeup pump inoperable.	F.1	Verify basin level for each tower is ≥ 90%.	72 hours <u>AND</u> Once per 2 hours thereafter
	<u>AND</u>		
	F.2	Verify OPERABILITY of associated makeup source.	72 hours
	<u>AND</u>		
	F.3	Restore SX makeup pump to OPERABLE status.	7 days if both units are in MODE 1, 2, 3, or 4 <u>AND</u> 14 days if one unit is in MODE 5, 6 or defueled
G. Two SX makeup pumps inoperable.	G.1	Verify basin level for each tower is ≥ 90%.	1 hour <u>AND</u> Once per 2 hours thereafter
	<u>AND</u>		
	G.2	Verify OPERABILITY of at least one makeup source.	1 hour
	<u>AND</u>		
	G.3	Verify OPERABILITY of second makeup source.	72 hours

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
H. Rock River water level ≤ 670.6 ft Mean Sea Level (MSL).	H.1	Verify Rock River water level is > 664.7 ft MSL and flow ≥ 700 cubic feet per second (cfs).	1 hour <u>AND</u> Once per 12 hours thereafter
I. Required Action of Condition H not met. <u>OR</u> Rock River water level forecast to exceed 702.0 ft MSL by the National Weather Service (NWS). <u>OR</u> Tornado Watch issued by the NWS that includes the Byron site.	I.1	Verify basin level for each tower is ≥ 90%.	1 hour <u>AND</u> Once per 2 hours thereafter
	<u>AND</u>		
	I.2	Verify OPERABILITY of at least one deep well pump.	1 hour
	<u>AND</u>		
	I.3	Verify OPERABILITY of both deep well pumps.	72 hours
J. Required Action and associated Completion Time of Condition A, B, C, E, F, G, or I not met. <u>OR</u> UHS inoperable for reasons other than Condition A, B, C, D, E, F, G, H, or I.	J.1	Be in MODE 3.	6 hours
	<u>AND</u>		
	J.2	Be in MODE 5.	36 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.7.9.1	Verify water level in each SXCT basin is ≥ 60%.	In accordance with the Surveillance Frequency Control Program
SR 3.7.9.2	Verify SXCT fan requirements in Table 3.7.9-1 or Table 3.7.9-2 are met.	In accordance with the Surveillance Frequency Control Program
SR 3.7.9.3	Verify river water level is > 670.6 ft MSL and ≤ 702.0 ft MSL.	In accordance with the Surveillance Frequency Control Program
SR 3.7.9.4	Operate each required SXCT fan on high speed for ≥ 15 minutes.	In accordance with the Surveillance Frequency Control Program
SR 3.7.9.5	Verify each SX makeup manual, power operated, and automatic valve in the flow path that is not locked, sealed, or otherwise secured in the open position, is in the correct position.	In accordance with the Surveillance Frequency Control Program
SR 3.7.9.6	Verify that each SX makeup pump starts on a simulated or actual low basin level signal and operates for ≥ 30 minutes.	In accordance with the Surveillance Frequency Control Program

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.7.9.7	Verify each diesel driven SX makeup pump fuel oil day tank level ≥ 47%.	In accordance with the Surveillance Frequency Control Program
SR 3.7.9.8	Cycle each testable valve in the SX makeup pump flow path through at least one complete cycle of full travel.	In accordance with the Surveillance Frequency Control Program
SR 3.7.9.9	Verify fuel oil properties are tested in accordance with and maintained within the limits of the Diesel Fuel Oil Testing Program.	In accordance with the Diesel Fuel Oil Testing Program
SR 3.7.9.10	--------------------NOTE------------------ Only required to be performed when any electrical division is not capable of providing power to at least one OPERABLE SXCT fan. -- Verify outside air wet bulb temperature is ≤ 76°F.	12 hours

Table 3.7.9-1 (page 1 of 1)
SXCT Fan Requirements with SX Trains on Both Units Crosstied

--------------------------NOTE--------------------------
When outside air wet bulb temperature is > 76°F, then each electrical division must be capable of providing power to at least one OPERABLE SXCT fan.

SX PUMP DISCHARGE WATER TEMPERATURE REGION	REQUIREMENTS
≤ 77°F	6 SXCT fans are required to be OPERABLE
> 77°F and ≤ 82°F	Either 6 required OPERABLE SXCT fans running in high speed, or 7 SXCT fans are required to be OPERABLE
> 82°F and ≤ 84°F	6 required OPERABLE SXCT fans running in high speed
> 84°F and ≤ 91°F	7 required OPERABLE SXCT fans running in high speed
> 91°F and ≤ 96°F	8 required OPERABLE SXCT fans running in high speed

Table 3.7.9-2 (page 1 of 1)
SXCT Fan Requirements with SX Trains on Either Unit Split

SX PUMP DISCHARGE WATER TEMPERATURE REGION	REQUIREMENTS
≤ 82°F	8 SXCT fans are required to be OPERABLE
> 82°F and ≤ 96°F	8 required OPERABLE SXCT fans running in high speed

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 173 TO FACILITY OPERATING LICENSE NO. NPF-37

AND AMENDMENT NO. 173 TO FACILITY OPERATING LICENSE NO. NPF-66

EXELON GENERATION COMPANY, LLC

BYRON STATION, UNIT NOS. 1 AND 2

DOCKET NOS. STN 50-454 AND STN 50-455

1.0 INTRODUCTION

By letter dated June 30, 2009 (Reference 1), as supplemented by letters dated January 25, (Reference 2), July 1, (Reference 3), November 8, 2010 (Reference 4), and January 31, (Reference 5), March 16, (Reference 6), and May 4, 2011 (Reference 7), Exelon Generation Company, LLC (EGC, the licensee) requested an amendment to the technical specifications (TS) of Facility Operating License Nos. NPF 37 and NPF-66 for Byron Station, Unit Nos. 1 and 2. The license amendment request (LAR) requested a revision to TS 3.7.9, "Ultimate Heat Sink (UHS)," to revise and add additional essential service water cooling tower (SXCT) fan requirements as a function of essential service water (SX) pump discharge temperature and ambient wet-bulb temperature to reflect results of a revised analysis for the UHS.

A revised analysis for the UHS was necessary to account for a single failure of a 4160 volt or 480 volt feeder breaker which could result in a loss of two SXCT fans after a design basis accident (DBA) initiation. Consideration of a single failure is necessary to meet the requirements of General Design Criteria (GDC) 44, "Cooling water." The single failure analysis for the current TS 3.7.9 considered the loss of only one SXCT fan. The failure of a 4160 volt or 480 volt feeder breaker for the SXCT fans resulting in the loss of two SXCT fans should be considered to be consistent with the definition of a single failure presented in Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50, Appendix A, "General Design Criteria for Nuclear Power Plants," and GDC 44, "Cooling water."

References 2, 3, 4, 5, 6, and 7 provided clarifying information within the scope of the original application, and did not change the U.S. Nuclear Regulatory Commission (NRC, the Commission) staff initial proposed no significant hazards consideration determination.

2.0 REGULATORY EVALUATION

The NRC requirements and review criteria that the staff considered to be most applicable include:

- 10 CFR 50.36, "Technical specifications," paragraph (c) (2) (ii) (C), Criterion 3, requires that TS limiting condition for operation (LCO) be established for "A structure, system, or component that is part of the primary success path and which functions or actuates to mitigate a design basis accident or transient that either assumes the failure of or presents a challenge to the integrity of a fission product barrier."

- 10 CFR 50.36, paragraph (c) (3), "Surveillance requirements [SR] ," states: "Surveillance requirements are requirements relating to test, calibration, or inspection to assure that the necessary quality of systems and components is maintained, that facility operation will be within safety limits, and that the limiting conditions for operation will be met."

- 10 CFR 50.49, "Environmental qualification of electric equipment important to safety for nuclear power plants," requires that the safety-related electrical equipment which are relied upon to remain functional during and following design basis events be qualified for accident (harsh) environment. This provides assurance that the equipment needed in the event of an accident will perform its intended function.

- 10 CFR 50.120, "Training and qualification of nuclear power plant personnel," requires training programs to meet the requirements specified in paragraphs (b)(2) and (b)(3) of this section. These requirements specify that the training program (a) must be derived from a systems approach to training; (b) must incorporate the instructional requirements necessary to provide qualified personnel to operate and maintain the facility in a safe manner in all modes of operation; (c) must be developed to be in compliance with the facility license, including all technical specifications and applicable regulations; (d) must be periodically evaluated and revised as appropriate to reflect industry experience as well as changes to the facility, procedures, regulations, and quality assurance requirements; and (e) be periodically reviewed by licensee management for effectiveness.

- Appendix A of 10 CFR, Part 50, defines single failure as "an occurrence which results in the loss of capability of a component to perform its intended safety functions. Multiple failures resulting from a single occurrence are considered to be a single failure. Fluid and electric systems are considered to be designed against an assumed single failure if neither (1) a single failure of any active component (assuming passive components function properly) nor (2) a single failure of a passive component (assuming active components function properly), results in a loss of the capability of the system to perform its safety functions."

- GDC 5, "Sharing of structures, systems, and components," states that "Structures, systems, and components important to safety shall not be shared among nuclear power units unless it can be shown that such sharing will not significantly impair their ability to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cool down of the remaining units."

- GDC 17, "Electric power systems," requires, in part, that nuclear power plants have onsite and offsite electric power systems to permit the functioning of structures, systems, and components that are important to safety. The onsite system is required to have sufficient independence, redundancy, and testability to perform its safety function, assuming a single failure. The offsite power system is required to be supplied by two physically independent circuits that are designed and located so as to minimize, to the extent practical, the likelihood of their simultaneous failure under operating and postulated accident and environmental conditions. In addition, this criterion requires provisions to minimize the probability of losing electric power from the remaining electric power supplies as a result of loss of power from the unit, the offsite transmission network or the onsite power supplies.

- GDC 18, "Inspection and testing of electric power systems," requires that electric power systems that are important to safety must be designed to permit appropriate periodic inspection and testing.
- GDC 19 "Control room," requires that a control room shall be provided from which actions can be taken to operate the nuclear power unit safely under normal conditions and to maintain it in a safe condition under accident conditions, including loss-of-coolant accidents (LOCAs).
- GDC 44, "Cooling water," requires that a system to transfer heat from structures, systems, and components important to safety, to a UHS shall be provided. The system safety function shall be to transfer the combined heat load of these structures, systems, and components under normal operating and accident conditions.

  "Suitable redundancy in components and features, and suitable interconnections, leak detection and isolation capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure."

- NUREG-0800, "Standard Review Plan," Revision 3, Chapter 9.2.5, "Ultimate Heat Sink," provides regulatory guidance for acceptable adherence to NRC regulations. The design of the UHS must satisfy the requirements of GDC 2, 5, 44, 45, and 46.
- NUREG-0800, "Standard Review Plan," Revision 1, Chapter 13.2.1, "Reactor Operator Requalification Program; Reactor Operator Training," provides regulatory guidance for the training program for reactor operators and senior reactor operators.
- NUREG-0800, "Standard Review Plan," Revision 1, Chapter 13.2.2, "Non-Licensed Plant Staff Training," provides regulatory guidance for the description and scheduling of the training and re-training programs for the non-licensed plant staff.
- NUREG-0800, "Standard Review Plan," Revision 1, Chapter 13.5.2.1, "Operating and Emergency Operating Procedures," provides regulatory guidance for the operating procedures that will be used by the operating organization (plant staff) to ensure that routine operating, off-normal, and emergency activities are conducted in a safe manner.
- NUREG-0800, "Standard Review Plan," Revision 1, Chapter 18.0, "Human Factors Engineering," provides regulatory guidance for human performance reviews.
- NUREG-1764, "Guidance for the Review of Changes to Human Actions," provides regulatory guidance to determine the appropriate level of human factors engineering review of human actions based upon their risk importance.

- NUREG-0711, "Human Factors Engineering Program Review Model," Revision 2, provides regulatory guidance on the verification of accepted human factors engineering design and practices.

- Regulatory Guide (RG) 1.27, "Ultimate Heat Sink for Nuclear Power Plants," describes an acceptable basis to the NRC staff that may be used to implement GDC 44, "Cooling water." Specifically, the UHS serving multiple units should be capable of providing sufficient cooling water to permit simultaneous safe shutdown and cool down of all units it serves and to maintain them in a safe shutdown condition. Also, in the event of an accident in one unit, the UHS should be able to dissipate the heat for that accident safely, to permit the concurrent safe shutdown and cool down of the remaining unit, and to maintain all units in a safe shutdown condition.

3.0 TECHNICAL EVALUATION

System Description

As described by the licensee in letter dated June 30, 2009:

> The UHS provides a heat sink for processing and operating heat from safety related components during a transient or accident, as well as during normal operation. This is done by utilizing the SX system and the Component Cooling Water (CC) system. In addition, the UHS is the safety related source of Auxiliary Feedwater (AF) in case the Condensate Storage Tank is unavailable.
>
> The UHS is the sink for heat removed from the reactor core following all accidents and anticipated operational occurrences in which the unit is cooled down and placed on Residual Heat Removal (RHR) operation, as well as the sink for heat removed from containment via the reactor containment fan coolers.
>
> The UHS is a common system and consists of two, four-cell, mechanical draft cooling towers, 0A and 0B, and a makeup system. Each tower has four manually actuated fans. Each fan can be run in either high or low speed. Two of the Tower 0A fans are powered from Unit 1, Division 11 and the other two fans are powered from Unit 2, Division 21. Similarly, two Tower 0B fans are powered from Unit 1, Division 12 and the other two fans are powered from Unit 2, Division 22.

All safety-related heat transfer equipment cooled by SX is designed for a 100 °F inlet temperature (Reference: UFSAR, Section 9.2.1.2, "Essential Service Water System"). The CC system design is based on the design basis SX supply maximum temperature of 100 °F (Reference: UFSAR, Section 9.2.2.1, "Design Bases"). Accordingly, the maximum temperature of the UHS basin (SXCT basin) is 100 °F during accident conditions.

The DBA scenario considered for the Byron UHS design is a LOCA coincident with a loss of offsite power (LOOP) on one unit and the concurrent orderly shutdown and cool down from maximum power to cold shutdown of the other unit using normal shutdown operating procedures. The analyses of the DBA include worst-case meteorological conditions, conservative uncertainties when calculating decay heat, and worst-case single failures. The licensee stated in TS bases 3.7.9 that the UHS maximum post-accident heat load occurs near the time the unit switches from injection to recirculation and the containment cooling systems and residual heat removal systems are required to remove core decay heat.

The number of running SXCT fans during the LOCA is a primary success path to mitigate the DBA. In accordance with 10 CFR 50.36, "Technical specifications," paragraph (c) (2) (ii) (C), Criterion 3, a TS LCO is established to ensure the required number of SXCT fans are OPERABLE and running. The TS LCO specifies the required number of operable SXCT fans and whether the fans should be running in high speed. The TS LCO requirements vary, based on SX pump discharge temperature and ambient wet-bulb temperature.

The TS LCO requirements also consider a single failure in accordance with GDC 44, "Cooling water." Previous single-failure analysis considered the failure of one SXCT fan, but the single failure could be a 4160 volt or 480 volt feeder breaker failure that results in a loss of two SXCT fans. Therefore, the licensee had to re-perform its UHS cooling tower basin temperature analysis considering the single failure resulting in the loss of two SXCT fans. The revised analysis is the supports the technical basis for this LAR.

The technical evaluation for the LAR includes a balance of plant, electrical engineering, and human factors evaluation as discussed below.

3.1 Balance of Plant Review

3.1.1 Evaluation

The primary design function of the UHS is to ensure that the SX supply temperature to safety-related equipment does not exceed 100 °F during normal and accident conditions. The limit of 100 °F is based on the maximum design basis temperature of the SX system to the various safety-related components during the design basis event. The design basis event for the UHS is a LOCA coincident with a LOOP in one unit and a concurrent orderly shutdown from maximum power to cold shutdown of the other unit. The analyses of the LOCA include worst-case meteorological conditions, conservative uncertainties when calculating decay heat, and worst-case single failures.

The number of running SXCT fans during the LOCA is a primary success path to mitigate a DBA; therefore, the SXCT fans have a mandatory TS LCO. The current TS LCO requirements for fan operation considered a failure of a single fan. As discussed in the licensee's LAR, passive failure of a 4160 volt or 480 volt feeder breaker, which could de-energize a bus and result in the loss of two SXCT fans, was not considered in the current analysis. The spurious failure or opening of a 4160 volt or 480 volt feeder breaker for the SXCT fans should have been considered a valid single failure causing the loss of two SXCT fans. This is consistent with the definition of single failure in 10 CFR 50, Appendix A, "General Design Criteria for Nuclear Power Plants," and GDC 44, "Cooling water." Therefore, the licensee had to reanalyze the LOCA event for the cooling tower to account for a single failure resulting in the loss of two SXCT fans.

The proposed LAR makes the following changes to TS 3.7.9:

(1) A new Condition A to address when the required numbers of operable SXCT fans are not running in required high speed. If one or more SXCT fans, which are required to be

operable and running in high speed, are not running in high speed, then the required action is to initiate actions immediately to operate the fan(s) in high speed.

(2) Current Condition A is changed and moves to new Condition B. New Condition B addresses when one required SXCT fan is inoperable. The required actions are to verify within one hour that operable cooling tower fans are capable of being powered by an operable emergency power source and to restore the cooling tower fan to operable status within 72 hours.

(3) A new Condition C is added to address the condition when outside air wet-bulb temperature is greater than 76 °F and any electrical division cannot provide power to at least one operable SXCT fan. The required actions are to verify within one hour that operable cooling tower fans are capable of being powered by an operable emergency power source and to restore the SXCT fan configuration such that each electrical division is capable of providing power to at least one operable SXCT fan within 72 hours.

(4) A new Condition D is added to address the condition of exceeding the maximum allowed SX pump discharge temperature of 96 °F. The required action in this condition is to bring the Byron unit(s) to MODE 3 in 6 hours and MODE 5 in 36 hours.

(5) Current Conditions B through G and their associated required action steps are re-lettered to account for the added new Conditions A, B, C and D. Current Condition F becomes new Condition I and Current Condition G becomes new Condition J and they are revised to reflect the new actions and re-lettering.

(6) Completion times carried over from existing required actions to new required action items F.1, G.1, H.1, and I.1 are clarified by adding the words, "Once per."

(7) The SR 3.7.9.2 is revised to implement the new SXCT fan requirements resulting from the revised analysis of the UHS as listed in Table 3.7.9-1 and Table 3.7.9-2. The surveillance frequency is changed to, "In accordance with the Surveillance Frequency Control Program." The initial surveillance frequency is 12 hours. By letter dated February 24, 2011 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML110060811), the NRC granted the licensee's request to change the SR frequency for the previous version of SR 3.7.9.2 from 24 hours to, "In accordance with the Surveillance Frequency Control Program." The NRC staff determined that the new language of SR 3.7.9.2 provided the same assurance that the LCO would be met, and that the SR frequency met the requirements for control by the Surveillance Frequency Control Program. Future revisions of the surveillance frequency would be based on evaluations program criteria, for instance plant-specific operating experience.

(8) A new SR 3.7.9.10 is added to verify outside air wet-bulb temperature is less than or equal to 76 °F when any electrical division is not capable of providing power to at least one operable SXCT fan. The surveillance frequency is 12 hours.

(9) Surveillance frequencies for SR 3.7.9.1 through SR 3.7.9.8 are changed to, "In accordance with the Surveillance Frequency Control Program."

The TS revisions are based on a revised UHS analysis. The revised UHS analysis differs from the existing UHS analysis as follows: (a) accounts for a single failure where two SXCT fans fed from the same feeder breaker fail, (b) removes the heat load from the recycle evaporator that had been abandoned in place, (c) assumes that the operators will shed heat load to the cooling tower by securing up to two of the four reactor containment fan coolers (RCFC) on the LOCA unit within 21.6 minutes of initiation of the LOCA. The licensee added this assumption because failure scenarios in the summer months could cause basin temperature to exceed the 100 °F limit. With redundant RCFC trains, only two of the four RCFC are required to mitigate a LOCA, and (d) assumes that there is 10 percent cooling for the two cooling tower cells having the failed SXCT fans as a result of the single failure, because the riser valves for those cells could not be shut remotely from the control room due to the failure of the feeder breaker and would require local operator action, allowing 10 percent cooling in the inactive cells. This assumption is consistent with SXCT vendor information as explained in Attachment 5 of the LAR. The licensee has made a regulatory commitment in Reference 1 to revise appropriate procedures to ensure procedural guidance is put into place to shed heat load by securing two of the four RCFCs within the assumptions of the UHS analysis (Section 4.0 – Regulatory Commitment No. 1).

The licensee performed the revised analysis by running additional failure scenarios in its already existing UHS Basin Temperature Calculations, NED-M-MSD-009 and NED-MSD-011. The new analyses have the following inputs: (1) the new postulated accident scenarios that consider loss of two SXCT fans, (2) SX flows to the cooling tower cells which are dependent on individual riser valve and bypass valve position during the LOCA, (3) the cooling tower performance characteristics which were determined during initial testing of the cooling tower, (4) time dependent LOCA heat loads which also include other miscellaneous loads and the cool down load of the non-accident unit, and (5) the time dependent cooling tower model. From the revised analysis as described above, the licensee has submitted the following new TS LCO fan requirements to account for the potential loss of two SXCT fans as a single failure event:

When SX trains for both units are crosstied:

A. When SX pump discharge temperature is less than or equal to 77 °F, then at least six SXCT fans are required to be OPERABLE.

B. When SX pump discharge temperature is greater than 77 °F and less than or equal to 82 °F, then either six SXCT fans are required to be OPERABLE and all six SXCT fans are required to be running in high speed or seven SXCT fans are required to be OPERABLE.

C. When SX pump discharge temperature is greater than 82 °F and less than or equal to 84 °F, then six SXCT fans are required to be OPERABLE and all six SXCT fans are required to be running in high speed.

D. When SX pump discharge temperature is greater than 84 °F and less than or equal to 91 °F, then seven SXCT fans are required to be OPERABLE and all seven SXCT fans are required to be running in high speed.

E. When SX pump discharge temperature is greater than 91 °F and less than or equal to 96 °F, then eight SXCT fans are required to be OPERABLE and all eight SXCT fans are required to be running in high speed.

F. Additionally, if outside wet-bulb temperature is greater than 76 °F, each electrical division must be capable of providing power to at least one OPERABLE SXCT fan.

When the SX trains on either unit are split:

A. When SX pump discharge temperature is less than or equal to 82 °F, then all eight cooling tower fans are required to be OPERABLE.

B. When SX pump discharge temperature is greater than 82 °F, and less than or equal to 96 °F, then all eight cooling tower fans are required to be OPERABLE and running in high speed.

If any of these fan requirements or temperature requirements is not met, then the licensee has one hour to verify OPERABLE SXCT fans are capable of being powered by an OPERABLE emergency power source and 72 hours to restore the required SXCT fan to OPERABLE status. If the above required actions cannot be completed or if SX pump discharge water temperature is greater than 96 °F, the unit(s) must be shutdown and cooled down in accordance with the time requirements of the TSs.

In the revised UHS analysis, the licensee computed the SX basin temperature as a function of time after initiation of a design basis LOCA with a single failure of two SXCT fans. The analysis was performed with varying initial conditions where one, two, or no SXCT fans were initially out of service before the LOCA with a single failure of two additional SXCT fans. The calculations showed that the 100 °F temperature limit of the SX pump discharge was not exceeded provided sufficient SXCT fans were operable and running in high speed if necessary. The detailed calculations modeled each new accident scenario where two SXCT fans fail and their associated riser valves cannot be shut from the control room.

The calculations also accounted for the time variant LOCA heat loads that are transferred to the UHS mainly through the RCFCs and the component cooling water heat exchangers via the residual heat removal (RHR) exchangers and the containment sump. Miscellaneous safety-related heat loads and loads from the non-accident unit were also considered. The LAR also contained design input from the SX flow series calculation which determined the varying SX water flow rate to each of the SXCT cells depending on the position of the eight riser valves and the four bypass valves for each accident scenario. The LAR used the SXCT computer model, which is based on previous SXCT performance testing, to develop SXCT characteristic curves. The results of these calculations were inputted into the basin temperature time dependent calculation to verify that the SX pump discharge temperature did not exceed the design limit of 100 °F during the design basis accident.

The NRC staff reviewed the design inputs and assumptions of the analysis and found them reasonable and logical after all requests for additional information (RAI) were satisfactorily answered. The NRC staff submitted RAIs where design inputs and assumptions did not necessarily represent actual conditions. The licensee revised or added calculations as appropriate to answer the NRC staff questions stated in the RAIs. The NRC staff also reviewed the process and methodology of the calculations described above and found them acceptable. The NRC staff reviewed the SXCT fan and riser valve and bypass valve lineups for the various new accident scenarios which were used as design input and found them acceptable. The licensee used a design maximum wet-bulb temperature of 82 °F for SXCT analysis. The wet-bulb temperature of 82 °F is consistent with Byron UFSAR Section 2.3.1.2.4, "Ultimate Heat Sink Design." The NRC staff also reviewed how the licensee translated the results of the analysis into TS Action statements and found them acceptable.

In an RAI dated December 11, 2009, the NRC staff asked the licensee to explain the LOCA heat load profiles presented in the analysis, specifically, the rapid change in the rate of decreasing heat rate at 1400 and 1800 seconds after accident initiation. The NRC staff asked this RAI because the licensee stated that one of the assumptions is that the operators will shed heat load by securing up to two RCFC on the unit with the LOCA within 30 minutes.

In its response dated January 25, 2010, the licensee stated that the large decrease in load between 1299 and 1799 seconds is caused by the reduction in RCFC heat load assumed to be complete at time 30 minutes after LOCA initiation. The licensee also stated in its response that the time to complete the action to shed heat load is actually 21.6 minute and that the operator actions to secure RCFCs are expected to start and complete well before 21.6 minutes. The NRC staff finds the licensee's action to secure up to two of the four RCFCs on a LOCA acceptable because UFSAR, Section 6.2.2.1.1, "Reactor Containment Fan Cooler [RCFC] System," states that blow down and heat removal analysis is based on the availability of at least one of the two redundant trains provided by the RCFC system.

In an RAI dated December 11, 2009, the NRC staff asked the licensee to specify operator actions from the control room and outside the control room for each scenario after a LOCA. In the licensee's January 25, 2010, response, the licensee stated that one of the operator actions in its procedures is to close the associated riser valve within the first 10 minutes from the control room of any SXCT fan that does not start in high speed. The NRC staff sent a follow-up email RAI dated May 18, 2010, because this operator action did not appear to be consistent with the calculations, which assumed the associated riser valves of failed SXCT fans could not be operated. This assumption was used by the licensee in scenarios 8A through 8D, which assumed 10 percent effective cooling for cells whose fans fail after LOCA initiation. The 10 percent effective cooling was based on the inability to shut the associated riser valve and still take credit for some cooling in an inactive cell with SX flow.

In its email RAI, dated May 18, 2010, the NRC staff asked the licensee to confirm and justify the proposed TS requirements if the operators were able to close one or both of the riser valves associated with the failed SXCT fans as specified in the current procedure. In its response dated July 1, 2010, the licensee stated that for the initial basin temperatures greater than 82 °F, all required fans will be operating in high speed with their associated riser valves open. Upon failure of two SXCT fans after LOCA initiation, the riser valves will fail as is, i.e., open, which are consistent with the existing calculations. For initial basin temperatures less than 82 °F, the required SXCT fans may not be in operation at LOCA initiation and their associated riser valves could be open or closed. Current calculations accounted for the associate riser valves being open.

The licensee performed additional calculations for associated riser valves being closed at LOCA initiation. The new calculations showed that the basin temperature did not exceed 100 °F after LOCA initiation. The NRC staff finds the licensee's response acceptable because additional calculations showed that basin temperature would not exceed 100 °F after LOCA initiation for cases where the associated riser valves of the two failed SXCT fans were closed by the operators after LOCA initiation.

In an RAI dated August 18, 2010, the NRC staff asked the licensee whether the proposed revisions to TS 3.7.9 are satisfactory for keeping basin temperature below 100 °F during a LOCA when the SX system trains are aligned as two separate loops in one or both units. The NRC staff also asked the licensee to account for stratification in the SXCT basins because loss of an emergency diesel generator (EDG) in this lineup could cause SX flow to only one SXCT. The NRC staff asked these questions because UFSAR, Section 9.2.1.2, and TS Bases B 3.7.8 have provisions for operating the SX system for either unit as two separate SX trains, whereas, the licensee's calculations used to justify the LAR assumed a normal SX system alignment which has the unit-specific crosstie valves open for each unit.

In its response dated November 8, 2010, the licensee stated that if the SX loops were split on a unit, a single failure of an EDG or SX pump during a LOCA could result in SX water flow to only one SXCT. The licensee stated that new calculations show that the one SXCT with SX flow would require four SXCT fans to maintain basin temperature below 100 °F during a LOCA. Thus, if any SXCT fans were not operable prior to a LOCA, it is possible that the one SXCT with SX flow would not have the four required SXCT fans for cooling basin temperature below 100 °F during a LOCA. Therefore, the licensee submitted a revision to the proposed TS in its November 8, 2010, letter to accommodate more restrictive SXCT fan requirements when either unit is operating with the SX trains in a split lineup.

The licensee's calculations to justify the more restrictive SXCT fan requirements, where only one SXCT has SX flow, accounted for SXCT basin stratification by considering only half of the SX basin water mass to be available for heat storage. The NRC staff finds the licensee's response acceptable because the revised TS changes establish revised LCO requirements for SXCT fans with SX trains split on either unit. The TS was revised to clearly define UHS operability by specifying that when the SX trains on either unit are split, the following LCO requirements are applicable:

A. When SX pump discharge temperature is less than or equal to 82 °F, then all eight cooling tower fan are required to be OPERABLE.

B. When SX pump discharge temperature is greater than 82 °F and less than or equal to 96°F, then all eight cooling tower fans are required to be OPERABLE and operating in high speed.

In an RAI dated August 18, 2010, the NRC staff asked the licensee whether the proposed revisions to TS 3.7.9 are satisfactory for keeping basin temperature below 100 °F during a LOCA when the SX system is aligned with the unit crosstie valves open. The NRC staff asked this question because UFSAR, Section 9.2.1.2, and TS Bases B 3.7.8 have provisions to crosstie the Byron Units 1 and 2 SX systems, whereas the licensee's calculations used to justify the LAR assumed a normal SX system alignment which has the unit-specific crosstie valves open and the opposite unit crosstie valves closed. The licensee stated in the response dated November 8, 2010, that:

> In the unlikely event that both opposite-unit crosstie valves are open for the postulated loss of offsite power (LOOP)/LOCA event, there would be some redistribution of flow

within the SX system. Based on sensitivity runs using the Byron SX system flow model, the net change in overall system flow and flow through the essential service water cooling tower (SXCT) cells is very small and would not significantly impact the previous analysis of basin temperature. Additionally, the operating procedures for post-LOCA alignment of the component cooling (CC) system would align the Unit 0 CC heat exchanger (HX) to the accident unit. This operator action includes verifying/closing one of the unit crosstie valves (1 SX005 or 2SX005). Thus, the proposed revisions to Technical Specification (TS) 3.7.9 are satisfactory for maintaining basin temperature below 100 °F when the SX system is aligned with the unit crosstie valves open.

The NRC staff finds the licensee's response acceptable because operating the SX system crossties between Byron Units 1 and 2 has little effect on overall system flow and, thus, the licensee's calculation results which justified the LAR, would be minimally impacted.

The NRC staff questioned whether the indicated SX pump discharge temperature may be different than actual temperature in determining compliance with the UHS LCO. Therefore, the NRC staff submitted an RAI dated December 28, 2010, asking the licensee how the temperature instrument and loop uncertainty/inaccuracy has been factored into the proposed TS revision. In a letter dated January 31, 2011, the licensee responded saying that the surveillance procedure will be revised to accommodate instrument uncertainty. To ensure indicated UHS temperature does not exceed the TS surveillance limit, temperature corrections have been factored into UHS surveillance procedures. Currently, the surveillance procedures have been reduced 2 °F to account for instrument measurement uncertainties. Additionally, the SXCT operation guideline has the operators keep the indicated basin temperature 2 °F below the required TS temperature. The NRC staff finds the licensee's response acceptable because the licensee accounts for instrument and loop uncertainty/inaccuracy in determining compliance with the UHS LCO.

The NRC staff noted that the proposed TS LCO changes bound the current TS LCO, i.e., are more conservative than the current TS, except that the proposed TS LCO has two additional conditions. These new TS LCOs are represented by scenarios 8D1 and 8C1 in the licensee's calculations. Scenario 8D1 requires seven SXCT fans to be OPERABLE for SX pump discharge temperature between 77 °F and 82 °F if the SXCT fans are not running in high speed. Scenario 8C1 requires all electrical divisions to be available to power at least one SXCT fan when wet-bulb temperature is greater than 76 °F. The proposed TS LCO accounts for a single failure of two SXCT fans, whereas, the current TS were evaluated for single failure scenarios of (1) containment spray pump failure, (2) SXCT fan failure, (3) EDG failure, (4) SX pump failure, and (5) SXCT bypass valve failure.

Since the proposed TS LCO bound the current TS, except for the two scenarios described above, the NRC staff asked the licensee to verify that the proposed TS LCO determined by scenarios 8C1 and 8D1 keep SX pump discharge temperature below 100 °F for the other single failure scenarios considered in the original analysis. In its reply dated November 8, 2010, the licensee confirmed that the postulated failures of (1) a containment spray pump, (2) SXCT fan failure, (3) EDG failure, (4) SX pump failure, and (5) SXCT bypass valve failure for scenarios 8D1 and 8C1 are bounded by a single failure of two SXCT fans for these same scenarios. The NRC staff found the licensee's reply acceptable because all new TS LCOs are not only satisfactory for a single failure of two SXCT fans, but also are satisfactory for the other single failures that were evaluated for the current TS.

Using the heat load given by the licensee in calculation M-MSD-009, the NRC staff performed independent analyses and found a basin peak temperature above 100 °F for scenarios 8C and 8D at approximately 10 hours after the LOCA. In an RAI dated August 18, 2010, the NRC staff asked the licensee to verify its calculations to determine whether basin temperature peaked above 100 °F (during cool down of the non-accident unit) and asked what course of action is necessary to prevent basin temperature from exceeding 100 °F for a LOCA and a non-accident unit cool down. In its reply dated November 8, 2010, the licensee stated that when scenarios 8C, 8D, 8C1, and 8C2 are extended, a second peak in basin temperature occurs when the non-accident unit is cooled down. The heat input from the non-accident unit is based on RHR cool down starting eight hours after the event with a 50 °F/hr reactor coolant system cool down rate. If required, the start of RHR cooling can be delayed on the non-accident unit and/or the cool down rate slowed. The licensee made a regulatory commitment in Reference 4 to revise the appropriate procedures to caution operators on the non-accident unit to monitor SX temperature and to manage heat inputs to the UHS to maintain SX pump discharge temperature less than or equal to 100 °F (Section 4.0 – Regulatory Commitment No. 2). The NRC staff finds this answer acceptable because the licensee made a regulatory commitment to revise appropriate procedures to caution operators on the non-accident unit to monitor SX temperature and to manage heat inputs to the UHS.

The NRC staff notes that the licensee has a Technical Requirements Manual Surveillance Requirement 2.7.a.5, which requires the licensee to visually inspect and verify no abnormal breakage or degradation of the fill materials in the UHS cooling tower every 18 months.

On the basis of this review, the NRC staff finds the licensee's LAR will meet the requirements of GDCs 5 and 44, 10 CFR 50.36, and the guidance of RG 1.27 considering the loss of two SXCT fans as a single failure.

3.1.2 Summary

The licensee has performed calculations to determine the minimum number of operable SXCT fans necessary to ensure that SX pump discharge temperature does not exceed the design limit of 100 °F during a design basis LOCA. The licensee's calculations consider the loss of two SXCT fans as a single failure during a design basis LOCA event. The calculations start with various scenarios where zero, one or two fans are initially out of commission before the design basis LOCA event and then the subsequent loss of two additional SXCT fans (single failure). The licensee's calculations account for varying SX flow to each SXCT cell which is dependent on the position of the associated riser valve. The time dependent LOCA heat load and shutdown load from the other unit which are transferred to the UHS are also design input to the calculations. The licensee found it necessary to secure two of four RCFCs within 21.6 minutes of the LOCA initiation if the single failure was loss of two SXCT fans under design conditions. From these calculations, the licensee has determined new operability requirements for the SXCT fans and established new TS actions and SRs.

3.1.3 Summary and Conclusion

Based on a review of the design inputs and assumptions and the methodology of the licensee's submittal, the NRC staff finds the revised TS actions and SRs submitted by the licensee to be acceptable from a balance-of-plant perspective and to meet the requirements of GDCs 5 and 44, 10 CFR 50.36, and RG 1.27.

3.2 Electrical Engineering Review

3.2.1 Background

During the 2005 NRC safety systems design and performance capability inspection, the NRC identified a concern with respect to the single failure assumptions taken in the UHS analyses (Unresolved Items (URI) 05000454/2005002-06 and 05000455/2005002-06). On March 28, 2008 (Reference 8), the NRC completed a follow-up inspection of the URI, and the results are documented in inspection report Nos. 05000454/2008008 and 05000455/2008008. The follow-up inspection determined that (1) the passive failures of electrical components need to be postulated and (2) a single failure of the 4160 volt or 480 volt circuit breakers feeding the service water cooling towers bus would de-energize the bus and result in the loss of two service water cooling tower fans. As a result, to address the single failure concern, the licensee performed time dependent basin temperature calculations to evaluate the postulated passive breaker failures.

3.2.2 Evaluation

The licensee, as stated in Section 3 of Attachment 1 of the LAR, made the following input changes to the additional time dependent basin temperature calculations to evaluate the postulated passive breaker failures:

(1) New scenarios were developed for postulated breaker failures with zero, one, and two SXCT fans assumed to be inoperable.

(2) The previous analysis assumed that for an active fan failure, operator action would be taken to isolate the associated riser valve to optimize heat removal in the cooling tower. Cooling was previously assumed to occur only for the cells with fans running at high speed. Postulated breaker failures would also result in the loss of power to the motor-operated riser valves for the impacted SXCT fan. If the riser valve for the affected fan was open prior to the postulated breaker failure, operator actions to isolate the riser valves and redistribute SX return water to active cooling tower cells cannot be taken from the control room. For the revised analysis, the fraction of water cooled for SX cooling tower cells with fans not running is assumed to be 0 .10 (i.e., 10 percent of the water delivered to that cell is effectively cooled). This is based on input from the cooling tower manufacturer of minimum cooling tower performance without fan airflow.

(3) The SX flow model was used to calculate SX flow to the cooling tower cells for the new scenario alignments. Cooling tower cell flow is an input to the steady state tower performance analysis.

(4) The heat load on the UHS was recalculated to remove the heat load from the recycle evaporator that has been abandoned in place.

(5) In a LOCA event, under the most severe design basis weather conditions (i.e., maximum air wet-bulb temperature), with a breaker failure that results in the loss of two SXCT fans, it is assumed that operators will shed heat load by securing up

to two of the four reactor containment fan coolers on the LOCA unit within 30 minutes. Only one of the two reactor containment fan cooler trains is required for post-accident containment heat removal.

The UHS maximum basin design temperature is 100 °F and must be capable of performing its cooling function during the design basis event for the worst-case three-hour wet-bulb temperature. The licensee conducted analyses using a worst-case three-hour, wet-bulb, temperature of 82 °F. In the scenarios evaluated, initial SX basin temperatures were calculated to maintain the peak basin temperature less than the system design temperature of 100 °F.

A postulated breaker failure would cause the loss of two SXCT fans. If two fans are initially out of service, the licensee stated that the results of the calculations determined that either the fans need to be powered by different buses or the outside wet-bulb air temperature must be less than 76 °F. With two fans out of service and if a breaker failure occurred, another two fans on the same cooling tower would be lost, resulting in no fans running on one tower and all four fans running on the other cooling tower.

The NRC staff reviewed the additional scenarios evaluated for postulated single failures of electrical breakers, which consider zero, one or two fans initially out of service and the loss of two additional fans, and requested the licensee to provide a detailed discussion why the scenarios analyzed in the LAR are bounding, considering both active and passive failures. The licensee stated in its January 25, 2010, letter, that previous UHS analyses included evaluating the following postulated single active failures: (a) containment spray pump failure, (b) SXCT fan (c) EDG failure, (d) SX pump failure, and (e) SX bypass valve failure. The licensee further stated that these scenarios are bounding since two fans are assumed to fail with full heat input until operator action can be taken to reduce the load.

The operators, in a LOCA event, will secure two of the four RCFCs within 30 minutes for post-accident containment heat removal. During a LOCA event, the reactor coolant pumps could be running, which would create a significant heat load. In comparison, an EDG failure results in the loss of power to two SXCTs and two RCFCs, but the reactor coolant pumps would not be running if a LOOP occurred and the EDGs were powering the safety loads. Hence, the heat load is lower under an EDG failure scenario and the postulated breaker failure scenarios (a loss of two SXCT fans) are more limiting. Based on the above information, the NRC staff agrees that the scenarios that the licensee analyzed for a postulated breaker failure are bounding.

Attachment 5, "Validation of Assumption 3.1 of Analytical Basis for Proposed Changes to Technical Specifications (TS)," of the LAR discusses the validation of Assumption 3.1 from the calculation in Attachment 4, "Analytical Basis for Proposed Changes to TS" of the LAR. Assumption 3.1 states that the fraction of water cooled for SX cooling tower cells with fans not running is assumed to be 0.10, i.e., 10 percent of the water delivered to that cell is effectively cooled. Assumption 3.1 also states that the cooling tower manufacturer provided 10 percent as a reasonable estimate for minimum cooling tower performance without fan air flow. Section 2.3 of Attachment 5 assumes an initial service water temperature of 98 °F, and the resulting maximum basin temperature is 113.7 °F, when 10 percent cooling was used. Attachment 5, Section 8.0, concludes that in comparison, greater than 10 percent cooling was used to calculate the maximum basin temperature of 109.3 °F in Ceramic Cooling Tower Company Engineering Report NCT-683-55, "Response to Sargent and Lundy letter of 11-17-81; Complete Loss of Fans," and hence, 10 percent cooling is conservative. However, Report NCT-683-55 (pg I-15 of Attachment 5) states that the initial SX temperature entering the plant is 91 °F and after the first cycle of cooling, the water leaving the fill area is 92.8 °F.

The NRC staff requested the licensee to provide a detailed explanation of the assumptions used in Report NCT-683-55 with regard to the SX temperature used, and in addition, explain how the calculations are correlated (and can be compared) when different initial conditions are used and how the comparison of the calculations validate the 10 percent cooling. In its January 25, 2010, letter, the licensee stated that the calculated equilibrium temperature is independent of the initial basin temperature, and in Attachment 3.3, "MathCAD file for NRC Request 6," showed that using an initial basin temperature of 91 °F the calculated equilibrium temperature remained 113.7 °F. As a result, comparing the equilibrium temperatures does indicate that greater than 10 percent cooling was used to calculate the maximum basin temperature of 109.3 °F in Report NCT-683-55 and that 10 percent is a conservative value.

Furthermore, the licensee discussed SXCT performance testing from 1987, which included testing of a fan cell with the fan off. The licensee stated that under similar outside air conditions and water flow rates, the heat removal rate with the fan off was between 16-21 percent of the heat removal rate with the fan on. Based on test data showing a heat removal rate of 16-21 percent with the fan off compared to the fan on, the NRC staff agrees that the 10 percent value is conservative.

The NRC staff requested additional information regarding how the value of 10 percent cooling is affected by weather conditions, such as outside temperature, wet-bulb temperature, or humidity. In its January 25, 2010, letter, the licensee stated that the percentage of water cooled with fans off versus fans on is reduced as the wet-bulb temperature drops; however, the 10 percent value is conservative under different weather conditions and the analyses were performed with wet-bulb temperatures of 70 °F, 76 °F, 78 °F, and 82 °F. The NRC staff finds this acceptable since the 10 percent value is conservative, and the licensee has accounted for different weather conditions in the analyses to create bounding scenarios.

3.2.3 Summary and Conclusion

Based on the above evaluation, the NRC staff finds the proposed revisions to the Byron TSs are reasonable and acceptable from an electrical engineering perspective. The NRC staff finds that the licensee evaluated and addressed postulated passive electrical failures, which could result in the loss of two SXCT fans and the UHS will continue to accomplish its safety function, assuming a single failure. The NRC staff also concludes that with the proposed TS changes, the licensee will continue to meet the requirements of 10 CFR 50.49 and GDCs 5, 17, 18, and 44. Therefore, the NRC staff finds the proposed changes acceptable.

3.3 Human Factors Review

3.3.1 Evaluation of Operator Actions

The licensee provided in the supplement dated January 25, 2010, a list of three tasks assumed to be performed by plant personnel in the UHS revised analysis:

A. Operator action will be taken within 10 minutes to align the SXCT to maximize the heat removal capacity. This action includes:

(1) Opening riser valves,
(2) Closing hot water basin bypass valves,
(3) Verifying/Starting cooling tower fans in high speed, and
(4) Closing the associated riser valve of any fan that does not start in high speed.

B. If a bypass valve fails to close, operator action will be taken within 30 minutes to manually close the bypass valve at the cooling tower.

C. If required, operator action will be taken at or prior to 21 minutes to turn off two of the four RCFCs to shed load.

The licensee estimated the time required to perform each of the three tasks was obtained from a review of simulator training records, time testing at the simulator, and from the estimates of operators. Other than the manual closing of the bypass valve(s), all actions can be taken from the control room.

Regarding operator action A, "Align the SWCT to maximize heat removal capacity," the licensee estimates, based on simulator records, that the first two sub-actions "open riser valves," and "close hot water basin bypass valves," are typically accomplished in six minutes or less, leaving a four minute margin to complete the other two in-control-room sub-actions, "verify/start cooling tower fans in high speed" and "close associated riser valve of any fan that did not start in high speed,". The NRC staff is satisfied that the proposed operator actions are within the operators' capability to complete within the time constraints assumed in the analysis.

Regarding operator action B, "If a bypass valve fails to close, [. . .] manually close the bypass valve at the cooling tower location [within 30 minutes]," the licensee estimates, based on timed testing, that this action can be completed in 20 minutes or less. The NRC staff is satisfied that the proposed operator action is within the operator's capability to complete within the time constraints assumed in the analysis.

Regarding operator action C, "If required [at or prior to 21 minutes after safeguard initiation signals,] turn off two of the four RCFCs to shed load," the licensee assumes that this in-control-room action can be done in less than 21 minutes. Because this is a proceduralized step performed from the control room, the NRC staff finds this assumption reasonable.

The load shedding task, operator action C, has not yet been proceduralized. In the submittal dated June 30, 2009, EGC committed to "revise appropriate procedures to ensure that the proposed change guidance is put in place to direct operators to shed heat load during a LOCA, under the most severe design basis weather conditions (i.e., maximum air wet-bulb temperature), with a breaker failure that results in the loss of two Essential Service Water cooling tower fans," upon implementation of the proposed change (Section 4.0 – Regulatory Commitment No. 1).

Based on the above, and on the licensee's commitment to develop procedures for operator action C prior to implementation, the NRC staff finds that the proposed operator actions are within the operator's capability to complete within the time constraints assumed in the analysis.

3.3.2 Procedures

There is no need to change procedures to accommodate operator actions A and B above. These two actions were integrated into the emergency operating procedures in 1992 as part of the design basis reconstitution effort and associated TS changes. Regarding operator action C, as stated above, EGC has committed to revise appropriate procedures to direct operators to shed heat load during a loss-of-coolant accident, under the most severe design basis weather conditions (i .e., maximum air wet-bulb temperature), with a breaker failure that results in the loss of two SX cooling tower fans. Also, procedures will be changed so that in the situation when two fans are going to be taken out-of-service (OOS) for maintenance on the same electrical breaker, operators would have to check that the wet-bulb temperature is < 76 °F before taking the fans OOS. Contingent upon appropriate implementation of the licensee's commitment, the NRC staff is satisfied that EGC has appropriately identified required operator actions and will revise emergency operating procedures to incorporate the required actions.

3.3.3 Training and Simulation

The licensee indicated that no changes to the control room or the simulator will be required to support the proposed LAR. Training on operator actions A and B is currently part of the Licensed Operator Continuing Training Program. Training on operator action C will be done when the associated procedure change is implemented, and will be integrated into the Licensed Operator Continuing Training Program. Contingent upon appropriate implementation of the licensee's commitment, the NRC staff finds the licensee's proposed actions regarding training and simulation are acceptable.

3.3.4 Equipment and Environmental Conditions

The licensee stated that with the exception of manually closing the bypass valve(s) at the cooling tower, all actions can be taken from the main control room. There are no required actions to be taken in areas in which environmental conditions preclude access. No special tools are required. Controls and displays are accessible in the control room for monitoring relevant process variables. The NRC staff finds the equipment use and environmental conditions described by the licensee are acceptable.

3.3.5 Staffing and Qualifications

No changes to staffing or qualifications are required.

3.3.6 Summary and Conclusion

The NRC staff has reviewed the licensee's assumptions in the revised UHS analysis regarding operator actions, the incorporation of the three identified actions into TS, procedures, and training. The NRC staff concludes that the licensee has adequately considered the impact of the proposed license amendment on operator staffing, procedures, equipment, and associated training. The information provided by the licensee establishes reasonable assurance for allowing credit for the proposed actions. The NRC staff further concludes that the licensee will continue to meet the requirements of GDC 19, 10 CFR 50.54(i) and (m), 10 CFR 50.120, 10 CFR Part 55. Therefore, contingent upon appropriate implementation of the licensee's commitment, the NRC staff finds the operator performance aspects of the licensee's proposed LAR acceptable.

4.0 REGULATORY COMMITMENTS

In support of the proposed application, in its letters dated June 30, 2009, and November 8, 2010, the licensee provided the following regulatory commitments:

(1) To revise appropriate procedures to ensure procedural guidance is put into place to shed heat load by securing two of the four RCFCs within the assumptions of the UHS analysis (Reference 1).

(2) To revise the appropriate procedures to caution operators on the non-accident unit to monitor SX temperature and to manage heat inputs to the UHS to maintain SX pump discharge temperature less than or equal to 100 °F (Reference 4).

The licensee committed to complete the commitments programmatically upon the implementation of the amendment. The NRC staff concludes that these commitments are acceptable.

5.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Illinois State was notified of the proposed issuance of the amendment. The State official had no comments.

6.0 ENVIRONMENTAL CONSIDERATION

The amendments change requirements with respect to installation or use of a facility's component located within the restricted area as defined in 10 CFR Part 20. The NRC staff has determined that the amendments involve no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendments involve no significant hazards consideration, and there has been no public comment on such finding (74 FR 46241; September 8, 2009). Accordingly, the amendments meet the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b) no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendments.

7.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendments will not be inimical to the common defense and security or to the health and safety of the public.

8.0 REFERENCES

1. Letter from Patrick R. Simpson (Manager - Licensing), Exelon Generation Company, LLC to U.S. Nuclear Regulatory Commission, "License Amendment Request Regarding Ultimate Heat Sink," dated June 30, 2009. (ADAMS Accession No. ML091831253).

2. Letter from Patrick R. Simpson (Manager - Licensing), Exelon Generation Company, LLC to U.S. Nuclear Regulatory Commission, "Additional Information Supporting Request for License Amendment Regarding Ultimate Heat Sink," dated January 25, 2010. (ADAMS Accession No. ML100280553).

3. Letter from Jeffrey L. Hansen (Manager - Licensing), Exelon Generation Company, LLC to U.S. Nuclear Regulatory Commission, "Additional Information Supporting Request for License Amendment Regarding Ultimate Heat Sink," dated July 1, 2010. (ADAMS Accession No. ML101830041).

4. Letter from Jeffrey L. Hansen (Manager - Licensing), Exelon Generation Company, LLC to U.S. Nuclear Regulatory Commission, "Additional Information Supporting Request for License Amendment Regarding Ultimate Heat Sink," dated November 8, 2010. (ADAMS Accession No. ML103120556).

5. Letter from Jeffrey L. Hansen (Manager - Licensing), Exelon Generation Company, LLC to U.S. Nuclear Regulatory Commission, "Response to Request for Additional Information related to License Amendment Regarding Ultimate Heat Sink," dated January 31, 2011. (ADAMS Accession No. ML110310612).

6. Letter from Jeffrey L. Hansen (Manager - Licensing), Exelon Generation Company, LLC to U.S. Nuclear Regulatory Commission, "Additional Information Supporting Request for License Amendment Regarding Ultimate Heat Sink," dated March 16, 2011. (ADAMS Accession No. ML110750587).

7. Letter from Jeffrey L. Hansen (Manager - Licensing), Exelon Generation Company, LLC to U.S. Nuclear Regulatory Commission, "Supplement to Information Supporting Request for License Amendment Regarding Ultimate Heat Sink," dated May 4, 2011. (ADAMS Accession No. ML111240290).

8. Letter from Ann Marie Stone (U.S. Nuclear Regulatory Commission) to Charles G. Pardee, Exelon Generation Company, LLC, "Byron Station, Units 1 and 2 Follow up Inspection of an Unresolved Item (URI) 05000454/2008008; 05000455/2008008,"dated May 5, 2008. (ADAMS Accession No. ML081260359).

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Date of issuance: June 14, 2011

June 14, 2011

Mr. Michael J. Pacilio
President and Chief Nuclear Officer
Exelon Nuclear
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: BYRON STATION, UNIT NOS. 1 AND 2 - ISSUANCE OF AMENDMENTS RE: REVISION OF TECHNICAL SPECIFICATION 3.7.9, ULTIMATE HEAT SINK (TAC NO. ME1669 AND ME1670)

Dear Mr. Pacilio:

The U.S. Nuclear Regulatory Commission (NRC, the Commission) has issued the enclosed Amendment No. 173 to Facility Operating License No. NPF-37 and Amendment No. 173 to Facility Operating License No. NPF-66 for the Byron Station, Unit Nos. 1 and 2, respectively. The amendments are in response to Exelon Generation Company, LLC application dated June 30, 2009, as supplemented by letters dated January 25, July 1, and November 8, 2010, and January 31, March 16, and May 4, 2011, to amend technical specifications (TS) for Byron Station, Unit Nos. 1 and 2.

The amendments requested a revision to TS 3.7.9, "Ultimate Heat Sink," to revise and add additional essential service water cooling tower (SXCT) fan requirements as a function of essential service water pump discharge temperature and ambient wet-bulb temperature to reflect the results of a revised analysis accounting for a single failure loss of two SXCT fans during a design basis accident.

A copy of the safety evaluation (SE) is enclosed. Two regulatory commitments are documented in Section 4.0 of the NRC staff's SE. The Notice of Issuance will be included in the Commission's biweekly *Federal Register* notice.

Sincerely,
/RA/
Nicholas J. DiFrancesco, Project Manager
Plant Licensing Branch III-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. STN 50-454 and STN 50-455
Enclosures:
1. Amendment No. 173 to NPF-37
2. Amendment No. 173 to NPF-66
3. Safety Evaluation

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Amendment: ML111310633 *revised on 6/14/11 *via memo NRR-058

OFFICE	LPL3-2/PM	LPL3-2/PM	LPL3-2/LA	DSS/SBPB	DIRS/ITSB	EEEB	DIRS/IHPB	OGC	LPL3-2/BC
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