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

November 27, 2018

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

SUBJECT: LIMERICK GENERATING STATION, UNITS 1 AND 2 – ISSUANCE OF AMENDMENT NOS. 232 AND 195 TO REVISE TECHNICAL SPECIFICATIONS TO LOWER THE MINIMUM STANDBY LIQUID CONTROL SYSTEM PUMP FLOWRATE (EPID L-2018-LLA-0020)

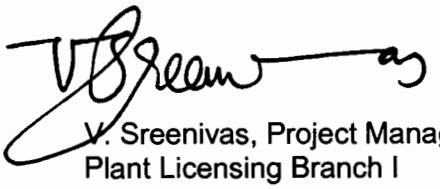
Dear Mr. Hanson:

The U.S. Nuclear Regulatory Commission (the Commission) has issued the enclosed Amendment Nos. 232 and 195 to Renewed Facility Operating License Nos. NPF-39 and NPF-85 for the Limerick Generating Station, Units 1 and 2, respectively, in response to your application dated January 29, 2018, as supplemented by letter dated June 11, 2018.

The amendments lower the Technical Specification (TS) Standby Liquid Control System (SLCS) Surveillance Requirement (SR) (TS 3/4.1.5) pump flow rate value, raise the TS SLCS SR Boron-10 enrichment value of the sodium pentaborate added to the SLCS tank, and expand the operating range in the sodium pentaborate solution temperature/concentration requirements figure.

A copy of the related Safety Evaluation is also enclosed. A notice of issuance will be included in the Commission's biweekly *Federal Register* notice.

Sincerely,



V. Sreenivas, Project Manager
Plant Licensing Branch I
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-352 and 50-353

Enclosures:
1. Amendment No. 232 to Renewed NPF-39
2. Amendment No. 195 to Renewed NPF-85
3. Safety Evaluation

cc: Listserv

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

EXELON GENERATION COMPANY, LLC

DOCKET NO. 50-352

LIMERICK GENERATING STATION, UNIT 1

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 232
Renewed License No. NPF-39

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

   A. The application for amendment by Exelon Generation Company, LLC (Exelon Generation Company), dated January 29, 2018, as supplemented by letter dated June 11, 2018, 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 Renewed Facility Operating License and Technical Specifications as indicated in the attachment to this license amendment.

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

FOR THE NUCLEAR REGULATORY COMMISSION

James G. Danna, Chief
Plant Licensing Branch I
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment:
Changes to the Renewed Facility
Operating License and Technical
Specifications

Date of Issuance: November 27, 2018

ATTACHMENT TO LICENSE AMENDMENT NO. 232

LIMERICK GENERATING STATION, UNIT 1

RENEWED FACILITY OPERATING LICENSE NO. NPF-39

DOCKET NO. 50-352

Replace the following page of the Renewed Facility Operating License with the attached revised page. The revised page is identified by amendment number and contains a marginal line indicating the area of change.

| Page | Page |
|---|---|
| 3 | 3 |

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

| Pages | Pages |
|---|---|
| 3/4 1-20 | 3/4 1-20 |
| 3/4 1-21 | 3/4 1-21 |

(2) Pursuant to the Act and 10 CFR Part 70, to receive, possess and to use at any time special nuclear material as reactor fuel, in accordance with the limitations for storage and amounts required for reactor operation, as described in the Final Safety Analysis Report, as supplemented and amended;

(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, 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, and to receive and possess, but not separate, such source, byproduct, and special nuclear materials as contained in the fuel assemblies and fuel channels from the Shoreham Nuclear Power Station.

C. This renewed license shall be deemed to contain and is subject to the conditions specified in the Commission's regulations set forth in 10 CFR Chapter I (except as exempted from compliance in Section 2.D. below) 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

Exelon Generation Company is authorized to operate the facility at reactor core power levels not in excess of 3515 megawatts thermal (100% rated power) in accordance with the conditions specified herein and in Attachment 1 to this license. The items identified in Attachment 1 to this renewed license shall be completed as specified. Attachment 1 is hereby incorporated into this renewed license.

(2) Technical Specifications

The Technical Specifications contained in Appendix A and the Environmental Protection Plan contained in Appendix B, as revised through Amendment No. 232, are hereby incorporated into this renewed license. Exelon Generation Company shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

SURVEILLANCE REQUIREMENTS (Continued)

b. In accordance with the Surveillance Frequency Control Program by:

1. Verifying the continuity of the explosive charge.

2. Determining by chemical analysis and calculation* that the available weight of Boron-10 is greater than or equal to 185 lbs; the concentration of sodium pentaborate in solution is less than or equal to 13.8% and within the limits of Figure 3.1.5-1 and; the following equation is satisfied:

$$\frac{C}{13\%\ wt.} \times \frac{E}{29\ atom\ \%} \times \frac{Q}{86\ gpm} \geq 1$$

where

C = Sodium pentaborate solution (% by weight)
Q = Two pump flowrate, as determined per surveillance requirement 4.1.5.c.
E = Boron 10 enrichment (atom % Boron 10)

3. Verifying that each valve (manual, power-operated, or automatic) in the flow path that is not locked, sealed, or otherwise secured in position, is in its correct position.

4. Verifying that no more than two pumps are aligned for automatic operation.

c. Demonstrating that, when tested pursuant to Specification 4.0.5, the minimum flow requirement of 37.0 gpm per pump at a pressure of greater than or equal to 1230 ± 25 psig is met.

d. In accordance with the Surveillance Frequency Control Program by:

1. Initiating at least one of the standby liquid control system loops, including an explosive valve, and verifying that a flow path from the pumps to the reactor pressure vessel is available by pumping demineralized water into the reactor vessel. The replacement charge for the explosive valve shall be from the same manufactured batch as the one fired or from another batch which has been certified by having one of the batch successfully fired. All injection loops shall be tested in 3 operating cycles.

2. Verify all heat-treated piping between storage tank and pump suction is unblocked.**

e. Prior to addition of Boron to storage tank verify sodium pentaborate enrichment to be added is ≥ 49 atom % Boron 10.

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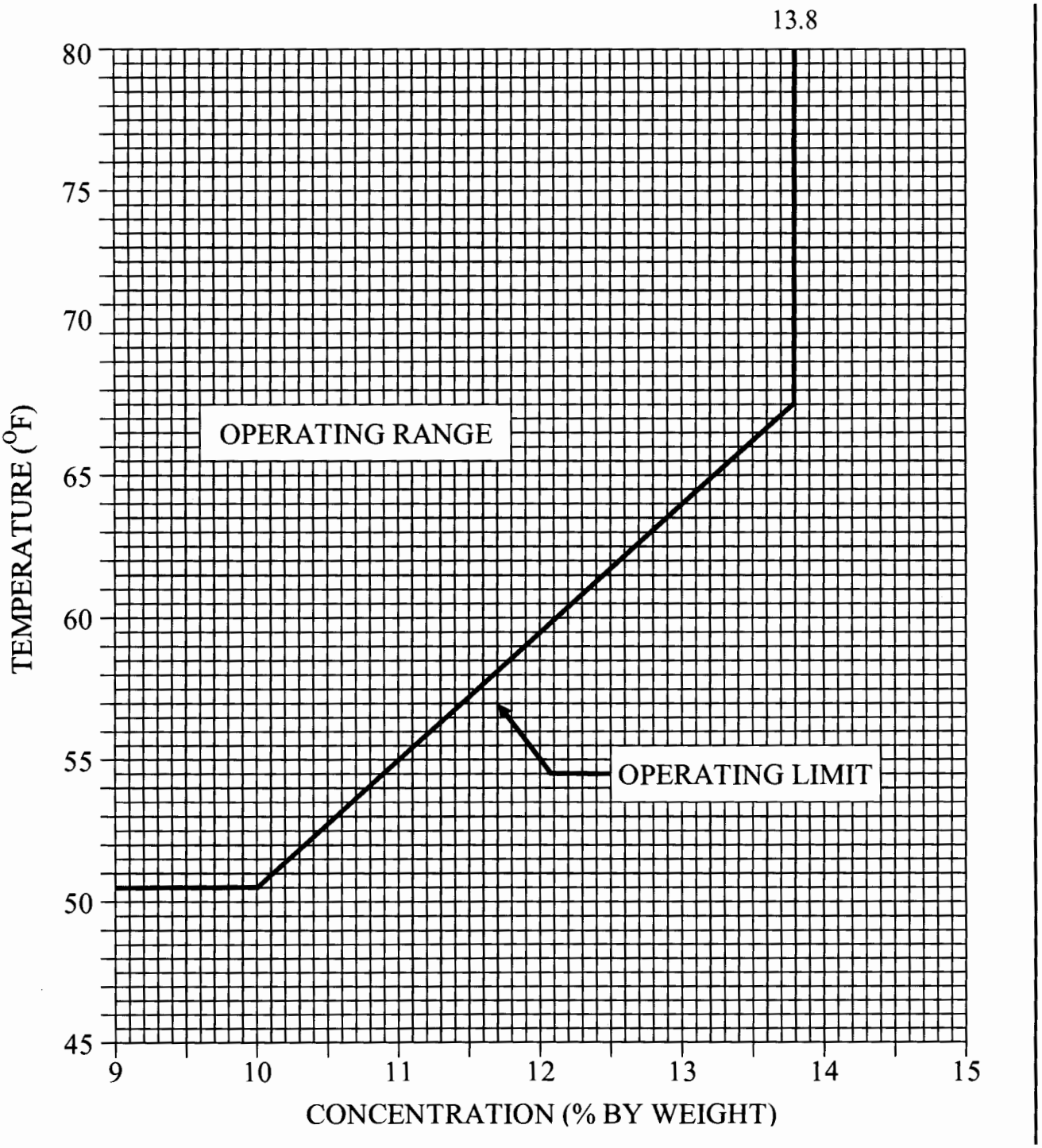
* This test shall also be performed anytime water or boron is added to the solution or when the solution temperature drops below the limits of Figure 3.1.5-1 for the most recent concentration analysis, within 24 hours after water or boron addition or solution temperature is restored.

** This test shall also be performed whenever suction piping temperature drops below the limits of Figure 3.1.5-1 for the most recent concentration analysis, within 24 hours after solution temperature is restored.




SODIUM PENTABORATE SOLUTION
TEMPERATURE/CONCENTRATION REQUIREMENTS

FIGURE 3.1.5-1

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

EXELON GENERATION COMPANY, LLC

DOCKET NO. 50-353

LIMERICK GENERATING STATION, UNIT 2

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 195
Renewed License No. NPF-85

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

   A. The application for amendment by Exelon Generation Company, LLC (Exelon Generation Company), dated January 29, 2018, as supplemented by letter dated June 11, 2018, 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 Renewed Facility Operating License and Technical Specifications as indicated in the attachment to this license amendment.

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

FOR THE NUCLEAR REGULATORY COMMISSION

James G. Danna, Chief
Plant Licensing Branch I
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment:
Changes to the Renewed Facility
Operating License and Technical
Specifications

Date of Issuance: November 27, 2018

ATTACHMENT TO LICENSE AMENDMENT NO. 195

LIMERICK GENERATING STATION, UNIT 2

RENEWED FACILITY OPERATING LICENSE NO. NPF-85

DOCKET NO. 50-353

Replace the following page of the Renewed Facility Operating License with the attached revised page. The revised page is identified by amendment number and contains a marginal line indicating the area of change.

| Page | Page |
|---|---|
| 3 | 3 |

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

| Pages | Pages |
|---|---|
| 3/4 1-20 | 3/4 1-20 |
| 3/4 1-21 | 3/4 1-21 |

(2) Pursuant to the Act and 10 CFR Part 70, to receive, possess and to use at any time special nuclear material as reactor fuel, in accordance with the limitations for storage and amounts required for reactor operation, as described in the Final Safety Analysis Report, as supplemented and amended;

(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, 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, and to receive and possess, but not separate, such source, byproduct, and special nuclear materials as contained in the fuel assemblies and fuel channels from the Shoreham Nuclear Power Station.

C. This renewed license shall be deemed to contain and is subject to the conditions specified in the Commission's regulations set forth in 10 CFR Chapter I (except as exempted from compliance in Section 2.D. below) 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

Exelon Generation Company is authorized to operate the facility at reactor core power levels of 3515 megawatts thermal (100 percent rated power) in accordance with the conditions specified herein.

(2) Technical Specifications

The Technical Specifications contained in Appendix A and the Environmental Protection Plan contained in Appendix B, as revised through Amendment No. 195, are hereby incorporated into this renewed license. Exelon Generation Company shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

SURVEILLANCE REQUIREMENTS (Continued)

b. In accordance with the Surveillance Frequency Control Program by:

1. Verifying the continuity of the explosive charge.

2. Determining by chemical analysis and calculation* that the available weight of Boron-10 is greater than or equal to 185 lbs; the concentration of sodium pentaborate in solution is less than or equal to 13.8% and within the limits of Figure 3.1.5-1 and; the following equation is satisfied:

$$\frac{C}{13\%\ \text{wt.}} \times \frac{E}{29\ \text{atom}\ \%} \times \frac{Q}{86\ \text{gpm}} \geq 1$$

where

C = Sodium pentaborate solution (% by weight)
Q = Two pump flowrate, as determined per surveillance requirement 4.1.5.c.
E = Boron 10 enrichment (atom % Boron 10)

3. Verifying that each valve (manual, power-operated, or automatic) in the flow path that is not locked, sealed, or otherwise secured in position, is in its correct position.

4. Verifying that no more than two pumps are aligned for automatic operation.

e. Demonstrating that, when tested pursuant to Specification 4.0.5, the minimum flow requirement of 37.0 gpm per pump at a pressure of greater than or equal to 1230 ± 25 psig is met.

d. In accordance with the Surveillance Frequency Control Program by:

e. Initiating at least one of the standby liquid control system loops, including an explosive valve, and verifying that a flow path from the pumps to the reactor pressure vessel is available by pumping demineralized water into the reactor vessel. The replacement charge for the explosive valve shall be from the same manufactured batch as the one fired or from another batch which has been certified by having one of the batch successfully fired. All injection loops shall be tested in 3 operating cycles.

2. Verify all heat-treated piping between storage tank and pump suction is unblocked.**

e. Prior to addition of Boron to storage tank verify sodium pentaborate enrichment to be added is ≥ 49 atom % Boron 10.

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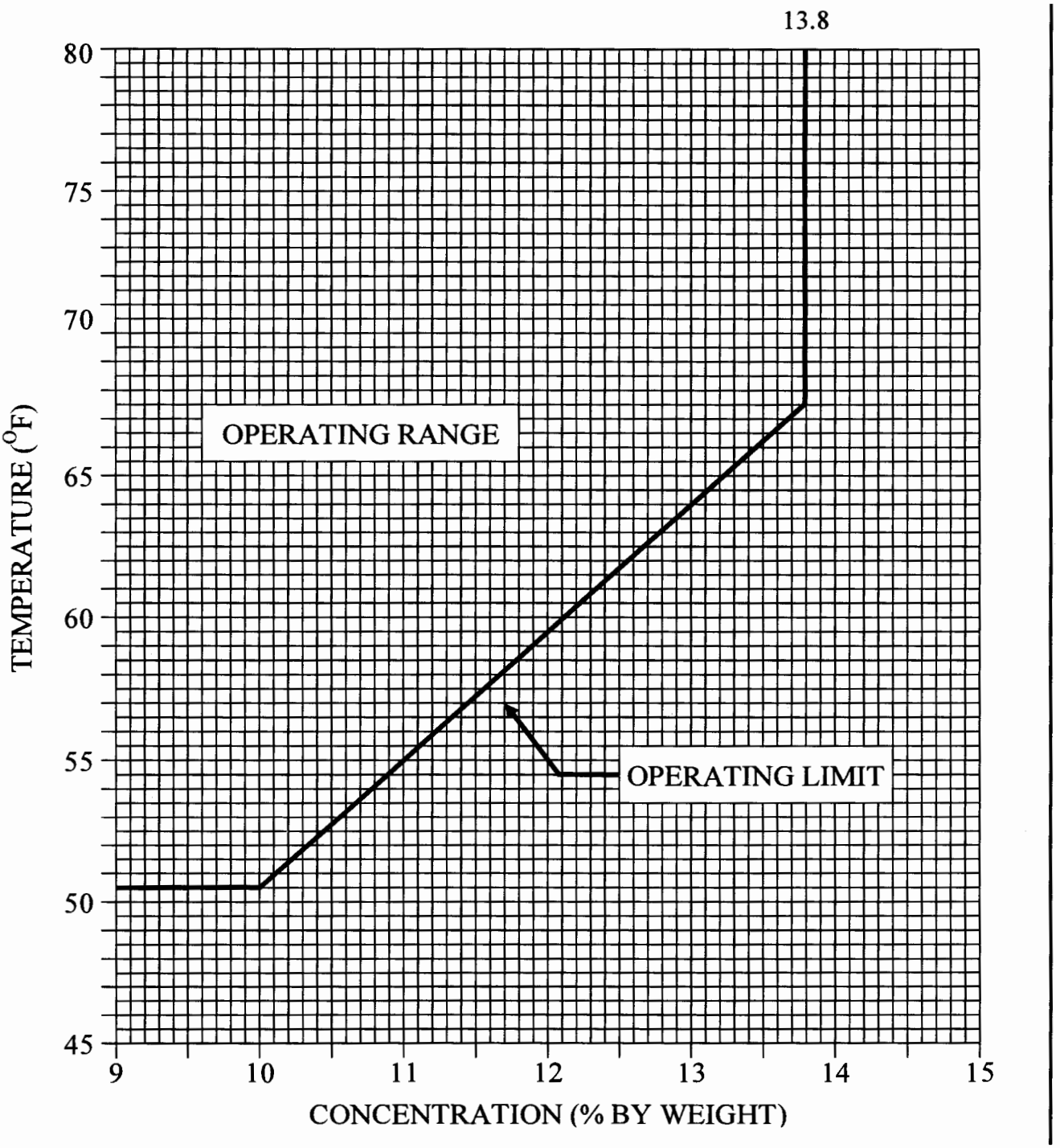
* This test shall also be performed anytime water or boron is added to the solution or when the solution temperature drops below the limits of Figure 3.1.5-1 for the most recent concentration analysis, within 24 hours after water or boron addition or solution temperature is restored.

** This test shall also be performed whenever suction piping temperature drops below the limits of Figure 3.1.5-1 for the most recent concentration analysis, within 24 hours after solution temperature is restored.




SODIUM PENTABORATE SOLUTION
TEMPERATURE/CONCENTRATION REQUIREMENTS

FIGURE 3.1.5-1

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

# SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

# RELATED TO AMENDMENT NO. 232 TO

# RENEWED FACILITY OPERATING LICENSE NO. NPF-39 AND

# AMENDMENT NO. 195 TO RENEWED FACILITY OPERATING LICENSE NO. NPF-85

# EXELON GENERATION COMPANY, LLC

# LIMERICK GENERATING STATION, UNITS 1 AND 2

# DOCKET NOS. 50-352 AND 50-353

## 1.0 INTRODUCTION

By letter dated January 29, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18029A509), as supplemented by letter dated June 11, 2018 (ADAMS Accession No. ML18162A014), Exelon Generation Company, LLC (the licensee) submitted a license amendment request (LAR) for the Limerick Generating Station, Units 1 and 2 (Limerick). The proposed amendments would lower the Technical Specification (TS) Standby Liquid Control System (SLCS) Surveillance Requirement (SR) (TS 3/4.1.5) pump flow rate value, raise the TS SLCS SR Boron-10 enrichment value of the sodium pentaborate added to the SLCS tank, and expand the operating range in the sodium pentaborate solution temperature/concentration requirements figure. These changes would provide increased testing margin and operational flexibility.

The supplement dated June 11, 2018, provided additional information that clarified the application, did not expand the scope of the application as originally noticed, and did not change the U.S. Nuclear Regulatory Commission (NRC or the Commission) staff's original proposed no significant hazards consideration determination as published in the *Federal Register* on March 27, 2018 (83 FR 13150).

## 2.0 REGULATORY EVALUATION

*General Design Criteria*

The General Design Criteria (GDC) are provided in Appendix A, "General Design Criteria for Nuclear Power Plants," to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50. The following GDC are applicable to this LAR:

GDC 19, "Control room," which states:

> 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. Adequate radiation protection shall be provided to permit access and occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of 5 rem [roentgen equivalent man (0.05 Seiverts (Sv))] whole body, or its equivalent to any part of the body, for the duration of the accident. Equipment at appropriate locations outside the control room shall be provided (1) with a design capability for prompt hot shutdown of the reactor, including necessary instrumentation and controls to maintain the unit in a safe condition during hot shutdown, and (2) with a potential capability for subsequent cold shutdown of the reactor through the use of suitable procedures.

GDC 26, "Reactivity control system redundancy and capability," which states:

> Two independent reactivity control systems of different design principles shall be provided. One of the systems shall use control rods, preferably including a positive means for inserting the rods, and shall be capable of reliably controlling reactivity changes to assure that under conditions of normal operation, including anticipated operational occurrences, and with appropriate margin for malfunctions such as stuck rods, specified acceptable fuel design limits are not exceeded. The second reactivity control system shall be capable of reliably controlling the rate of reactivity changes resulting from planned, normal power changes (including xenon burnout) to assure acceptable fuel design limits are not exceeded. One of the systems shall be capable of holding the reactor core subcritical under cold conditions.

*Technical Specifications Requirements*

As discussed in 10 CFR 50.36, "Technical specifications," TSs are required to include items in the following categories: (1) safety limits, limiting safety system settings, and limiting control settings; (2) limiting conditions for operation; (3) SRs; (4) design features; and (5) administrative controls. The regulation does not specify the particular requirements to be included in a plant's TSs.

As discussed in 10 CFR 50.36(c)(3), SRs 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.

*Other Regulatory Requirements*

The following regulatory requirements are also applicable to this LAR:

- 10 CFR 50.62, "Requirements for reduction of risk from anticipated transients without scram (ATWS) events for light-water-cooled nuclear power plants," which states, in part:

  > Each boiling water reactor must have a standby liquid control system (SLCS) with the capability of injecting into the reactor pressure vessel a

borated water solution at such a flow rate, level of boron concentration and boron-10 isotope enrichment, and accounting for reactor pressure vessel volume, that the resulting reactivity control is at least equivalent to that resulting from injection of 86 gallons per minute of 13 weight percent sodium pentaborate decahydrate solution at the natural boron-10 isotope abundance into a 251-inch inside diameter reactor pressure vessel for a given core design.

- 10 CFR 50.55a(f)(4)(iv),"Applicable IST [Inservice Testing] Code: Use of later Code editions and addenda," which states that the "[i]nservice tests of pumps and valves may meet the requirements set forth in subsequent editions and addenda that are incorporated by reference in paragraph (a)(1)(iv) of this section, subject to the conditions listed in paragraph (b) of this section, and subject to NRC approval. Portions of editions or addenda may be used, provided that all related requirements of the respective editions or addenda are met."

- 10 CFR 50.67, "Accident source term," paragraph (b)(2), which states that "[t]he NRC may issue the amendment only if the applicant's analysis demonstrates with reasonable assurance that:

  (i) An individual located at any point on the boundary of the exclusion area for any 2-hour period following the onset of the postulated fission product release, would not receive a radiation dose in excess of 0.25 Sv (25 rem) total effective dose equivalent (TEDE).

  (ii) An individual located at any point on the outer boundary of the low population zone, who is exposed to the radioactive cloud resulting from the postulated fission product release (during the entire period of its passage), would not receive a radiation dose in excess of 0.25 Sv (25 rem) total effective dose equivalent (TEDE).

  (iii) Adequate radiation protection is provided to permit access to and occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of 0.05 Sv (5 rem) total effective does equivalent (TEDE) for the duration of the accident."

The NRC staff also reviewed the LAR based on the following regulatory guidance documents:

- NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR [Light Water Reactor] Edition" (hereinafter referred to as the SRP).

- Regulatory Guide (RG) 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," dated July 2000, which provides an acceptable methodology for analyzing the radiological consequences of several design-basis accidents (DBAs) to demonstrate compliance with 10 CFR 50.67 and GDC 19. RG 1.183 discusses the use of SLCS to maintain the suppression pool inventory at a minimum pH of 7.0 following a loss-of-coolant accident (LOCA).

License Amendment No. 185 (Unit 1) and No. 146 (Unit 2), dated August 23, 2006 (ADAMS Accession No. ML062210214), approved the use of the alternate source term (AST) methodology at Limerick for analyzing radiological consequences of DBAs using RG 1.183. The NRC staff also considered relevant information in the Limerick Updated Final Safety Analysis Report, which describes the DBAs and evaluation of their radiological consequences. The NRC staff based its acceptance of the DBA radiological consequences on the reference values in 10 CFR 50.67, the accident specific guideline values in Regulatory Position 4.4 of RG 1.183, and Table 1 of SRP Section 15.0.1.

## 3.0 TECHNICAL EVALUATION

### 3.1 Proposed TS Changes

- TS 3/4.1.5, "Standby Liquid Control System," SR 4.1.5.c, currently states:

  > Demonstrating that, when tested pursuant to Specification 4.0.5, the minimum flow requirement of 41.2 gpm [gallons per minute] per pump at a pressure of greater than or equal to 1230 ± 25 psig [pounds per square inch gauge] is met.

  TS 3/4.1.5, "Standby Liquid Control System," SR 4.1.5.c, would be revised to state:

  > Demonstrating that, when tested pursuant to Specification 4.0.5, the minimum flow requirement of 37.0 gpm per pump at a pressure of greater than or equal to 1230 ± 25 psig is met.

- TS 3/4.1.5, "Standby Liquid Control System," SR 4.1.5.e, currently states:

  > Prior to addition of Boron to storage tank verify sodium pentaborate enrichment to be added is ≥ 29 atom % Boron 10.

  TS 3/4.1.5, "Standby Liquid Control System," SR 4.1.5.e, would be revised to state:

  > Prior to addition of Boron to storage tank verify sodium pentaborate enrichment to be added is ≥ 49 atom % Boron 10.

- TS 3/4.1.5, "Standby Liquid Control System," Figure 3.1.5-1, "Sodium Pentaborate Solution Temperature/Concentration Requirements," would be revised to provide a new figure. The new figure would extend the minimum operating range limit for the sodium pentaborate concentration from 10 percent to 9 percent, while retaining the lower temperature limit of 50.5 degrees Fahrenheit (°F).

### 3.2 System Description

Limerick, Units 1 and 2, are based on the General Electric Boiling Water Reactor/4 with Mark II containment design. The SLCS is designed to be manually initiated from the control room to cause a sodium pentaborate solution to be pumped into the reactor if the operator determines that the reactor cannot be shut down or kept shut down with the control rods. The sodium pentaborate solution is injected through the core spray line and sparger, which is also used by the high-pressure coolant injection system. With two pumps operating, the SLCS can begin to

deliver the control liquid to the core spray line and spray radially over the top of the core within about 53 seconds after actuation.

The SLCS is a backup reactivity control system and is maintained in an operable status whenever the reactor is critical. The SLCS is also a chemical control system and is required to be operable whenever the potential for a LOCA exists. SLCS pumps sodium pentaborate to the reactor vessel, where it is mixed with the reactor coolant that flows to the suppression pool through the LOCA pipe break. The SLCS addition must occur within 13 hours following a LOCA to ensure that pH is maintained at 7.0 or above. The addition of sodium pentaborate to the suppression pool maintains the pool pH at a minimum of 7.0 to minimize iodine releases from primary containment.

The minimum average concentration of natural boron required in the reactor core to provide adequate shutdown margin, after operation of the SLCS, is 660 parts per million (ppm), or the equivalent concentration of enriched boron. With the use of enriched boron having a minimum Boron-10 enrichment of 29 atom percent, the minimum weight of Boron-10 available for injection into the reactor is 185 pounds. This quantity is based on the equivalent average concentration of natural boron (660 ppm) in the reactor coolant (including residual heat removal system in the shutdown cooling mode and recirculation loops), at 68 °F with vessel water level at level 8. This result includes an increase of 25 percent to allow for imperfect mixing and leakage.

The specified neutron absorber solution is an aqueous solution of sodium pentaborate decahydrate (Na2B10O16, 10H20). It is prepared by dissolving either sodium pentaborate decahydrate or stoichiometric quantities of borax and boric acid in the SLCS tank with demineralized water so that the solution fills the tank to at least the low level alarm point. The solution can be diluted with water to allow for evaporation losses or to lower the solution saturation temperature, provided that solution concentration requirements are met. An air sparger is provided in the tank for mixing. To prevent system plugging, the tank outlet is raised above the bottom of the tank.

The minimum temperature of the solution in the tank and piping is consistent with the saturation temperature. The saturation temperature is about 60 °F, with the solution at the recommended concentration of 13.4 percent. The maximum concentration of boron is required after xenon concentration reaches zero at the subcooled conditions. TS 3/4.1.5 and Figure 3.1.5-1 for SLCS Boron-10 weight shows the sodium pentaborate concentration and temperature limits. The equipment containing the solution is installed in an area in which the air temperature is designed to be maintained within the range of 65 °F to 106 °F. An electrical resistance heater system consisting of a cycling heater, a mixing heater, and heat tracing provides backup heat sources to prevent precipitation of the sodium pentaborate from solution. The cycling heater is rated at 10 kilowatts (kWs) and operates automatically between 75 °F and 85 °F. The mixing heater is rated at 40 kW, is manually operated, and is used to facilitate chemical mixing. Heat tracing with automatic temperature control is provided between the storage tank and pump inlet to prevent sodium pentaborate precipitation in the pipe. Any portion of the electrical resistance heater system can be removed from service without affecting operation of the SLCS, as long as the temperature of the solution in the tank and heat traced piping remains above 70 °F. High or low temperature, or high or low liquid level, causes an alarm in the control room. The upper limit concentration of 13.8 percent has been established as a reasonable limit to prevent precipitation of the sodium pentaborate in the event of a loss of tank heating, which will allow the solution to cool.

Each positive displacement pump is sized to inject the solution into the reactor at 43 gpm.

### 3.3 NRC Staff Evaluation

As described in the LAR, the reason for the proposed TS changes is to increase testing margin and operational flexibility. If the proposed TS change for the required minimum SLCS pump flow rate were approved, the licensee could avoid the need for immediate repairs required to maintain the SLCS pump capability and could avoid unnecessary entry into TS Action 3.1.5.a, which would require a plant shutdown in 7 days if two SLCS pumps are not restored to operable status. The licensee also proposed to raise the TS Boron-10 enrichment value of the sodium pentaborate added to the SLCS tank from 29 to 49 atom percent to ensure that the minimum amount of Boron-10 remains available in the SLCS storage tank when considering the lower limit for the minimum pump flowrate and the lower limit for the sodium pentaborate solution concentration. Regarding the sodium pentaborate solution operating limit change, the licensee proposed to change TS Figure 3.1.5-1 for the lower sodium pentaborate solution concentration limit value from 10 percent to 9 percent by weight, while retaining the lower temperature limit of 50.5 °F. This would improve operational flexibility, while continuing to confirm that the SLCS tank contents meets the TS limits.

The NRC staff reviewed what the licensee identified as the safety analyses that are potentially affected by these proposed TS changes. In summary, the affected analysis areas, as identified in the LAR, include anticipated transient without scram (ATWS) and AST. In the following sections, the staff summarizes its review of the licensee's evaluation on these areas against the regulatory requirements as identified in Section 2.0 above.

#### 3.3.1 ATWS Analysis

An ATWS is defined as an anticipated operational occurrence followed by the failure of the reactor trip portion of the protection system specified in GDC 20. The acceptance criteria for NRC staff review on ATWS analysis include confirming the peak reactor pressure to be less than 1,500 psig, the peak fuel cladding temperature to be less than 2200 °F, and the peak bulk suppression pool temperature to be less than 190 °F, and systems required in accordance with 10 CFR 50.62 (e.g., alternate rod injection system and standby liquid control system during an ATWS).

For Limerick, the current analysis of record for the ATWS event was performed for the implementation of License Amendment No. 201 (Unit 1) and No. 163 (Unit 2), dated April 8, 2011 (ADAMS Accession No. ML110691095), which approved a measurement uncertainty recapture power uprate. With the increase in licensed power, the ATWS analysis was re-performed. This analysis is the current licensing basis (CLB) for the SLCS system relative to compliance with 10 CFR 50.62. Table 1 below shows the assumptions and results of the bounding ATWS equation analysis that supported the measurement uncertainty recapture power uprate amendments and that forms the CLB. The CLB analysis requires that a minimum of 185 pounds of Boron-10 be available to maintain reactivity control requirements and is specified in TS SR 4.1.5.b. Regarding the ATWS equation, the details will be discussed in Section 3.3.1.2 below.

Table 1: ATWS Equation Calculation Results of CLB vs. Proposed Changes

| Parameter | Units | Value CLB | Value LAR |
|---|---|---|---|
| Sodium Pentaborate Concentration | % | 13.4 | 9.0 |
| Boron-10 Enrichment | % atom | 29 | 49 |
| Injection Pump Flowrate (2 pumps) | gpm | 82.4 | 74.0 |
| ATWS Equation Calculation Result | ------ | 0.9876 | 1.0065 |

3.3.1.1 Proposed TS Change to SLCS Pump Flow Rate Limit

The licensee requested a change to the SLCS pump flowrate TS SR in order to provide margin between the Limerick IST program required limits and the Limerick TS SR limit. Presently, the TS SR limit of 41.2 gpm (Column E in Table 2 below) is more restrictive than the IST program alert low limit (Column C) and the required action low limit (Column D) specified by the American Society of Mechanical Engineers (ASME) Code for Operation and Maintenance of Nuclear Power Plants, ASME OM-2004 Code, and the Limerick IST program.

The licensee proposed to use Table ISTB-5321-2 of the ASME OM-2004 Code to change the TS SR 4.1.5.c limit as illustrated in Table 2 below. The licensee's code of record is the ASME OM Code, 2004 Edition. The application of the Code edition meets the 10 CFR 50.55a(f)(4)(iv) requirements. For a reference value (RV) of 44.1 gpm, these limit values could be 41.1 gpm and 39.7 gpm, respectively, per Table ISTB-5321-2 of the ASME OM-2004 Code. The current TS SR limit also reduces the margin between the IST program low values for the acceptable low limit (Column B) and the alert low limit (Column C) compared to the required action low limit (Column D), where the pump must be declared inoperable. The licensee stated that some small changes in measured flowrates can result in inoperability of the tested SLCS pump, while the flowrate would still be in the alert range using the ASME Code requirements. Table 2 below shows the proposed new IST flowrate limits based on the proposed SLCS pump TS SR flowrate value of 37.0 gpm. This change would provide the desired margin between the alert and the required action (i.e., inoperability) limits. This change could avoid the need for immediate repairs required to maintain the SLCS pump capability and could avoid unnecessary entry into TS Action 3.1.5.a, which would require a plant shutdown in 7 days if two SLCS pumps are not restored to operable status.

Table 2: SLCS 1A Pump IST Program Test Acceptance Criteria vs. TS SR Limit

| | Column A | Column B | Column C | Column D | Column E |
|---|---|---|---|---|---|
| | Reference Valve (RV) (gpm) | Acceptable Low Limit (95% of RV for Comprehensive Tests) (gpm) | Alert Low Limit (93% of RV for Comprehensive Tests) (gpm) | Required Action Low Limit (90% of RV for Quarterly Tests) (gpm) | TS SR 4.1.5.c Limit (gpm) |
| Current | 44.1 | 41.9 | 41.2[1] | 41.2[1] | 41.2 |
| Proposed | 44.1 | 41.9 | 41.1[2] | 39.7[2] | 37.0 |

[1] Limited by current SR value

[2] Specified by ASME Code

According to 10 CFR 50.36(c)(3) for TS SR 4.1.5.c, the SLCS pump shall be tested to assure that the necessary quality of pump performance on the flow rate is maintained. In this regard, request for additional information (RAI) SRXB-RAI-1, dated May 15, 2018 (ADAMS Accession No. ML18135A112), requested justification for the proposed minimum limit of 37.0 gpm for TS SR 4.1.5.c, noting that the ASME OM-2004 Code suggests a low limit of 39.7 gpm for required action.

In its June 11, 2018, response to the RAI, the licensee provided the SLCS pump performance testing results for the last 2 years for the staff to review. The staff found that the SLCS pumps on both units have performance trends above the current TS SR limit. The performance data did not show any tendency for pump degradation. The licensee stated that the alert low and required action low limits specified by its IST program are set more conservative than the proposed TS SR limits and, therefore, any future pump degradation will be identified before the pump's performance falls below the minimum flowrate necessary to meet the design basis and the TS limiting conditions for operation.

Based on the above, the NRC staff concludes that the proposed TS change to the SLCS minimum pump flow rate requirement from 41.2 gpm to 37.0 gpm to increase the testing margin and operational flexibility is acceptable, because the necessary quality of pump performance on the flow rate will be maintained.

3.3.1.2 Proposed TS Changes to Boron-10 Enrichment Limit and Sodium Pentaborate Solution Concentration Limit

According to 10 CFR 50.62(c)(4), the SLCS shall have the capability of injecting into the reactor vessel a borated water solution with reactivity control at least equivalent to that resulting from injection of 86 gpm of a 13 weight percent sodium pentaborate decahydrate solution at the natural Boron-10 isotope abundance into a 251-inch inside diameter reactor vessel. Column "Value CLB" of Table 1 above shows the analysis input for the SLCS system used in the Limerick ATWS analysis. The analysis input complies with 10 CFR 50.62 because the associated analysis results as presented in the analysis of record have been demonstrated to meet the ATWS acceptance criteria.

The ATWS rule on the SLCS in terms of injecting flow rate (Q), sodium pentaborate solution concentration (C), and Boron-10 enrichment (E) is further expressed in an equation named the ATWS equation by the licensee to facilitate its surveillance testing. The ATWS equation is documented in TS SR 4.1.5.b. Since the licensee adopted the concept of equivalency for reactivity control as permitted by 10 CFR 50.62(c)(4), the NRC staff considers the use of the ATWS equation as acceptable in the determination of the required sodium pentaborate solution concentration (C) and Boron-10 enrichment (E) when the SLCS pump flow rate is lowered. Therefore, a proposal to change the TS limit on the sodium pentaborate solution concentration and Boron-10 enrichment as based on the ATWS equation is acceptable. However, as noted by the licensee in the LAR, and also as documented in the current TSs, each of the ATWS reactivity control parameters still has its own allowable range. For SLCS pump flow rate Q, the Q shall be greater than the TS SR 4.1.5.c limit. For the sodium pentaborate solution concentration C, the C shall be bounded by TS Figure 3.1.5-1. For the Boron-10 enrichment E, the E to be added shall be greater than the TS SR 4.1.5.e value. All of the Q, C, and E shall also combine together to satisfy the ATWS equation of TS SR 4.1.5.b. As shown in Table 1 above in the last column, the proposed values for Q, C, and E will satisfy the ATWS equation with margin. Therefore, the NRC staff finds these values acceptable.

3.3.2 AST Analysis

The SLCS is also designed to be manually initiated from the Control Room within 13 hours of the onset of a large-break LOCA to meet dose limits for the Control Room, Exclusion Area Boundary, and Low Population Zone, as specified in GDC 19 and 10 CFR 50.67, respectively.

The current AST LOCA analysis considers a complete and instantaneous severance of one of the recirculation loops. The pipe break results in a blowdown of the reactor pressure vessel (RPV) liquid and steam to the drywell via the severed recirculation pipe. The resulting pressure buildup drives the mixture of steam, water, and other gases through the suppression pool (SP) water and into the primary containment. The SP water condenses the steam and reduces the pressure. (It is noted here that the pH of the SP is not controlled under normal conditions.) After the initial RPV blowdown, emergency core cooling system water injected into the RPV will spill into the drywell, transporting fission products to the SP and then into the primary containment.

The analysis assumes that the iodine released to the containment consists of 95 percent cesium iodide (CsI), 4.85 percent elemental iodine, and 0.15 percent in organic forms. The assumption in this iodine speciation is predicated on maintaining the containment sump water at 7.0 pH or higher. Upon dissolution in the SP, the predominant form of iodine would be the iodide ion. The radiation-induced conversion of iodide in water into elemental iodine is strongly dependent on the pH. Without pH control, a large fraction of the iodine dissolved in water in the ionic form will be converted to elemental iodine and released into the containment atmosphere. If the pH is maintained above 7.0, less than 1 percent of the dissolved iodine will be converted to elemental iodine. To prevent the release of elemental iodine during a LOCA, an alkaline chemical capable of buffering the pH at a value above 7.0 must be added to the SP. Therefore, the addition of sodium pentaborate via the SLCS into the reactor coolant system maintains the SP pH at a level of 7.0 or higher for a period of 30 days to prevent the release of radioactive iodine. This is accomplished by injecting a minimum volume of 1,600 gallons of sodium pentaborate solution with a minimum concentration of 10 percent into the RPV using the SLCS. A minimum volume of 1,600 gallons of sodium pentaborate solution with a minimum allowable concentration of 10 percent, based on TS Figure 3.1.5-1, is required to achieve the minimum weight of sodium pentaborate to be injected.

3.3.2.1 Proposed TS Change to SLCS Minimum Sodium Pentaborate Solution Concentration

Per the proposed TS change, if the minimum sodium pentaborate solution concentration in the SLCS tank is lowered from 10 percent to 9 percent, the minimum required sodium pentaborate solution volume shall be correspondingly increased from 1,600 gallons to 1,786 gallons in order to maintain the same SP pH above 7.0 for 30 days to meet the AST analysis requirement. Limerick TS SR 4.1.5.a.2 requires the available SLCS tank volume of sodium pentaborate solution to be at least 3,160 gallons.

The licensee proposed to revise TS 3/4.1.5, Figure 3.1.5-1. The new figure would extend the minimum operating range limit for the sodium pentaborate concentration from 10 percent to 9 percent, while retaining the lower temperature limit of 50.5 °F. The staff finds this acceptable because it will improve operational flexibility while continuing to confirm that the SLCS tank contents meet the TS limits.

Based on the above evaluation, the NRC staff finds that the proposed TS change to SLCS minimum sodium pentaborate solution concentration from 10 percent to 9 percent is acceptable

because it still maintains a considerable margin of sodium pentaborate solution available (3,160 gallons) to meet the AST analysis requirement (1,786 gallons).

### 3.4 Technical Conclusion

The NRC staff reviewed the licensee's assessment, as well as the RAI response, and found that they meet the related regulatory requirements in 10 CFR 50.36; 10 CFR 50.55a; 10 CFR 50.62; 10 CFR 50.67; and Appendix A to 10 CFR Part 50. Therefore, the NRC staff finds that the proposed TS changes are acceptable.

## 4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the NRC staff notified the Pennsylvania State official on September 12, 2018, of the proposed issuance of the amendments. The State official had no comments.

## 5.0 ENVIRONMENTAL CONSIDERATION

The amendments change requirements with respect to the installation or use of facility components located within the restricted area as defined in 10 CFR Part 20 or change inspections or surveillance requirements. 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, which was published in the *Federal Register* on March 27, 2018 (83 FR 13150), that the amendments involve no significant hazards consideration, and there has been no public comment on such finding. 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.

## 6.0 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) there is reasonable assurance that 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.

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Date: November 27, 2018

SUBJECT: LIMERICK GENERATING STATION, UNITS 1 AND 2 – ISSUANCE OF AMENDMENT NOS. 232 AND 195 TO REVISE TECHNICAL SPECIFICATIONS TO LOWER THE MINIMUM STANDBY LIQUID CONTROL SYSTEM PUMP FLOWRATE (EPID L-2018-LLA-0020) DATED NOVEMBER 27, 2018

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