SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 191 TO FACILITY OPERATING LICENSE NO. DPR-19

AND AMENDMENT NO. 185 TO FACILITY OPERATING LICENSE NO. DPR-25

EXELON GENERATION COMPANY, LLC

DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3

DOCKET NOS. 50-237 AND 50-249

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1.0 OVERVIEW

1.1 Introduction

By letter dated December 27, 2000 (Reference 1), Commonwealth Edison Company (ComEd), requested amendments to Facility Operating Licenses DPR-19 and DPR-25 for the Dresden Nuclear Power Station, Units 2 and 3 (DNPS). The proposed amendments would allow an increase in the maximum authorized operating power level from 2527 megawatts thermal (MWt) to 2957 MWt. These proposed changes would increase the current rated thermal power (RTP) by approximately 17 percent and are considered an extended power uprate (EPU). The original rated thermal power (ORTP) for DNPS was 2527 MWt. These amendments would change the Technical Specifications (TS) appended to the operating licenses to allow plant operation at 2957 MWt. These amendments would also modify license conditions and request additional license conditions to support the power uprate.

The original application was submitted by ComEd, the former licensee. ComEd subsequently transferred the licenses to Exelon Generation Company, LLC (EGC, the licensee). By letter dated February 7, 2001, EGC informed the Nuclear Regulatory Commission (NRC) that it assumed responsibility for all pending NRC actions that were requested by ComEd. EGC later supplemented the original license amendment application by letters dated February 12; April 6 and 13; May 3, 18, and 29; June 5, 7, and 15; July 6 and 23; August 7, 8, 9, 13 (two letters), 14 (two letters), 29, and 31 (two letters); September 5 (two letters), 14, 19, 25, 26, and 27 (two letters); October 17; November 2, 16, and 30, and December 10, 17, and 18, 2001.

1.2 Background

The DNPS safety analysis of the proposed EPU was provided in Attachments A and E of the licensee's December 27, 2000, submittal. Attachment E of the licensee's submittal is the licensee's Safety Analysis Report (SAR), General Electric (GE) Nuclear Energy licensing topical report (LTR) NEDC-32962P (Reference 2). Revision 2 of the SAR (Reference 28) changed some proprietary designations and updated the text to reflect information provided to NRC in preceding correspondence or to revise information that does not significantly affect the

AOVs and MOVs for process and ambient condition changes resulting from the power uprate, including parameters such as fluid flow, temperature, pressure, differential pressure, and ambient temperature. In a supplemental response (Reference 49), the licensee indicated that potential pressure locking and thermal binding of its safety-related power-operated gate valves had been evaluated in light of the proposed power uprate. The licensee determined that the power uprate conditions did not affect the scope of valves evaluated in response to GL 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves." The licensee also determined that the valves previously evaluated in response to GL 95-07 would not be adversely affected by potential pressure locking or thermal binding as a result of the proposed power uprate. The staff finds the licensee's evaluation of the effect of the proposed power uprate on the capability of safety-related pumps and valves at DNPS to be acceptable.

The licensee confirmed, in Reference 22, that the setpoints of the RVs installed on the penetration piping and the spring check valves contained in the relief bypass line are not affected by the proposed power uprate. The licensee also indicated that for other water-filled piping, the resulting stresses calculated at the proposed power uprate conditions were found to be within the allowable limit. Therefore, the licensee concluded that the proposed power uprate has no impact on the evaluation in response to GL 96-06 on potential overpressurization of isolated piping segments for DNPS. The staff concurs with the licensee's conclusion.

Based on the information provided by the licensee, the staff concludes that the proposed power uprate will not have an adverse effect on the performance of safety-related valves and mechanical components at DNPS.

10.3 Required Testing

10.3.1 Generic Test Guidelines for GE BWR EPU

Section 5.11.9 of ELTR1 (Reference 3), provides the general guidelines for power uprate testing.

- A testing plan will be included in the uprate licensing application. It will include pre-operational tests for systems or components which have revised performance requirements. It will also contain a power increase test plan.

- Guidelines to be applied during the approach to and demonstration of uprated operating conditions are provided in Section L.2, "Guidelines for Uprate Testing," of ELTR1. The licensee's SAR (Reference 2), submitted with the licensee's application, provides additional information relative to power uprate testing.

10.3.2 Startup Test Plan

- The licensee will conduct limited startup testing at the time of implementation of power uprate. The tests will be conducted in accordance with the guidelines of ELTR1 to demonstrate the capability of plant systems to perform their designed functions under uprated conditions.

- The tests will be similar to some of the original startup tests, described in Section 14.2.12.2 of the Dresden UFSAR. Testing will be conducted with established controls and procedures, which have been revised to reflect the uprated conditions.

- The tests consist essentially of steady state, baseline testing between 90 and 100 percent of the currently licensed power level. Several sets of data will be obtained between 100 and 117 percent current power with no greater than a 5 percent power increment between data sets. A final set of data at the maximum obtainable uprated power level will also be obtained. The tests will be conducted in accordance with a site-specific test procedure currently being developed by the licensee. The test procedure will be developed in accordance with written procedures as required by 10 CFR Part 50, Appendix B, Criterion XI.

The following power increase test plan is provided in Section 10.4 "Required Testing," of the licensee's SAR (Reference 2).

a. Surveillance testing will be performed on the instrumentation that requires re-calibration for the EPU in addition to the testing performed according to the plant TSs schedule.

b. Steady-state data will be taken at points from approximately 90 percent of previous rated thermal power up to the previous rated thermal power, so that system performance parameters can be projected for EPU before the previous power rating is exceeded.

c. Power increases beyond the previous rated thermal power will be made along an established flow control/rod line in increments of ≤ 5 percent power. Steady-state operating data including fuel thermal margin will be taken and evaluated at each step. Routine measurements of reactor and system pressures, flows and vibration will be evaluated from each measurement point, prior to the next power increment.

d. Control system tests will be performed for the FW/reactor water level controls and pressure controls. These operational tests will be made at the appropriate plant conditions for that test and at each power increment above the previous rated power condition, to show acceptable adjustments and operational capability. The same performance criteria shall be used as in the original power ascension tests.

A summary report will be submitted after the completion of the EPU test program. A description of the test results, any corrective actions, and a brief discussion of why it was not necessary to repeat specific tests listed in Section 14.2.4.2 of the Dresden UFSAR will be included in the summary report.

With the exception stated below regarding large transient testing, the licensee's test plan follows the guidelines of ELTR1 and the staff position regarding individual power uprate amendment requests (Reference 4).

10.3.3 Systems/Components With Revised Performance Requirements

The guidelines in Section 5.11.9 of ELTR1 specify that pre-operational tests will be performed for systems or components which have revised performance requirements. These tests will occur during the ascension to EPU conditions. The performance tests and associated acceptance criteria are based on the Dresden original startup test specifications and previous GE BWR power uprate test programs. The licensee has identified performance tests for the following systems:

- Intermediate range neutron monitors – assure source range monitors (SRM) and average power range monitors (APRM) overlap
- Average power range monitors – calibration
- Pressure regulatory system – setpoint steps, failures, incremental regulation
- Feedwater control system – setpoint changes, incremental regulation
- Radiation measurements – survey
- Feedwater system – vibration
- Main steam system – vibration
- Steam separator/dryer – moisture carryover

With regard to the steam pressure or recirculation flow testing, neither parameter has changed for the uprate program. Therefore, testing of system performance is not necessary.

The results from the uprate test program will be used to revise the operator training program to more accurately reflect the effects of the extended power uprate.

10.3.4 Large Transient Tests

10.3.4.1 Discussion

To achieve the power uprate, the licensee made several major modifications to the plant. However, most of the major modifications were made to secondary plant systems such as the turbine, main generator, and FW heaters, and not to safety systems. The licensee identified (Reference 12) the major components important to the MSIV closure and generator load rejection tests as: MSIVs, TSVs, TCVs, turbine bypass valves, RVs, main steam line geometry, control rod insertion time, and associated scram signal electronic response. The staff evaluated these and electrical equipment changes.

The licensee's power ascension test plan (Reference 12) includes hold points for testing and data collection at approximately 50 percent, 75 percent, 90 percent and 100 percent of the pre-EPU licensed power level. After reaching 100 percent of the pre-EPU licensed power level, the licensee will increase power in increments of ≤ 5 percent per day and hold for additional testing and data collection. Data collection will include chemical/radiochemical samples, radiation monitoring, APRM calibrations, core performance, FW flow element calibration check, main steam flow element calibration check, primary containment piping vibration, power conversion piping vibration, system/equipment performance data. In addition, the licensee will conduct tests and surveillances for pressure control incremental regulation, FW level control incremental regulation, FW pump runout, and steam dryer performance. The licensee will evaluate the power ascension data and project new values for the next power level. The licensee's power ascension test plan also includes testing of systems and components whose performance requirements have changed as a result of the EPU. Therefore, steady state plant response and system and component performance will be confirmed.

The proposed EPU results in approximately a 20 percent increase in steam and FW flow rates. It also results in a small operating pressure/temperature decrease at the turbine inlet. In addition, the proposed EPU results in increased loading of certain electrical equipment. The effects of these changes on the performance of the major components important to the MSIV closure and generator load reject transients were evaluated. The licensee proposed to not perform the MSIV closure and generator load rejection tests included in the NRC-approved topical report, ELTR1. These tests are similar to those conducted during initial plant startup. ELTR1 includes the MSIV closure test for power uprates greater than 10 percent above any previously recorded MSIV closure transient data; and the generator load rejection test for power uprates greater than 15 percent above any previously recorded generator load rejection transient data. The licensee provided the following reasons for not performing these tests: (1) operating history has shown that previous transients are within expected performance, (2) the power uprate transient analyses show that all safety criteria are met, and (3) these tests will not provide significant new information about plant response, therefore performing these tests will unnecessarily challenge safety systems. The licensee's conclusion is that these tests are not needed to demonstrate safety of its plants. In support of these arguments the licensee provided data (Reference 51) from a generator load transient at Liebstadt (i.e., KKL), a foreign plant that has implemented an EPU of 117 percent of original licensed power level; discussion of operating events at the Hatch plant, which implemented an EPU of 113 percent of original licensed power level; and plant-specific information for DNPS related to these tests.

10.3.4.2 Evaluation

In evaluating the licensee's request to not perform the two large transient tests included in the NRC-approved ELTR1, the staff considered (1) the licensee's justification as presented in its December 27, 2000, initial application for the amendment request (Reference 1) and letters dated May 18, 2001, and September 27, 2001 (References 12 and 51), which were provided in response to staff RAIs related to the two tests, (2) the information presented by the licensee to the Advisory Committee on Reactor Safeguards (ACRS) during the ACRS public meetings on October 25, and November 8, 2001, (3) the modifications made to the plant that are related to the two tests, (4) component and system level testing that will be performed either as part of the licensee's power ascension and test plan or to meet SRs contained in the DNPS TSs, and (5) past experience at other plants. The staff also considered the importance of the additional information that could be obtained from performing the two tests with respect to plant safety.

Large transient testing is normally performed on new plants because experience does not exist to confirm plant's operation and response to events. However, these tests are not normally performed for plant modifications following initial startup because of well established quality assurance programs, maintenance programs including component and system level post modification testing, and extensive experience with general behavior of the equipment not modified. When major modifications are made to the plant, large transient testing can be performed to confirm that the modifications were correctly implemented. However, such testing should only be imposed if it is deemed necessary to demonstrate safe operation of the plant. The determination for the need of such testing considers the extent of modification being made to the equipment, the expected impact of the modifications on performance of the equipment, other testing being performed, and past experience. The components, parameters of interest, and summary evaluations of the effect of the EPU on the parameters of interest are provided in the table below:

COMPONENT	PARAMETER OF INTEREST	SUMMARY EVALUATION
MSIVs	Minimum Closure Time	These valves are required to maintain the minimum closure time under much higher steam line break flows. The higher flow rate in the steam line assists in valve closure, which can lead to a faster closure time. TS SR 3.6.1.3.6 requires the licensee to verify that the isolation time of each MSIV is ≥ 3 seconds and ≤ 5 seconds. This SR is done by test in accordance with the licensee's inservice testing program and ensures that valve closure time is consistent with analyses assumptions.
Main Steam Line Geometry	Length and Volume	Acoustic phenomena will increase as a result of the increased steam flow. The change is included in transient and dynamic loads analyses using approved codes.
Control Rod Insertion for Scram	Maximum Delay and Rod Insertion Time	Steam dome pressure is unchanged. Therefore, control rod insertion times are not affected. In addition, scram times are included in TS 3.1.4 and are required to be verified per the associated SRs.
Relief and Safety/Relief Valves	Opening Delay and Time to Establish Full Flow	Licensing safety analyses show that, for EPU conditions, additional valves will open during pressurization transients. However, the opening delay and time to establish full flow for individual valves are not affected by EPU conditions.

COMPONENT	PARAMETER OF INTEREST	SUMMARY EVALUATION
TSVs/TCVs	Minimum Closure Time	EPU operation results in a slight change in full power operating position of TCVs and slight increase in effective closure time. This effect is included in analyses and is negligible. The TCV and TSV stroking rate will not be affected because these valves are controlled by a servo-controlled hydraulic system designed for valves-wide-open flow.
Scram Signals on MSIV Closure and Turbine-Generator Trip	Maximum Time Signal is Passed to Reactor Protection and Control Rod Drive Systems	Electronic system response is not affected by the EPU. Verification of response time of RPS instrumentation, including those associated with MSIV closure and turbine-generator trip is required by the SRs for TS 3.3.1.1.
Turbine Bypass Valves	Opening Delay and Stroke Time	Turbine bypass opening response is not affected by the EPU because there is no change to the system or the operating conditions. The percent of licensed power capacity of the turbine bypass system is reduced proportional to the increase in power level, however system design is not modified. In addition, turbine bypass system response time testing is required by TS SR 3.7.7.3.
Main Generator, Isophase Bus	Response to Trip	This equipment is fully loaded at power not during plant transient.
Non-Class 1E Switchgear	Breaker Rating	This equipment is individually tested for short circuit current. The tests included in ELTR1 do not include such a testing.
Unit Aux. Transformer (UAT) and Reserve Aux. Transformer (RAT)	RAT at Full Load	No changes were made to existing equipment; however, additional non-safety loads were added. Plant procedures adequately address operator action.

The table shows that changes in the parameters of interest for the identified mechanical equipment important to the MSIV closure and generator load rejection transients are either negligible, covered by other tests, or adequately covered in the models used in the analyses. In addition, with regard to the effect of the EPU on the loading (i.e., stresses) on the piping systems and in-line components, the staff, consistent with the ASME Code, allows such components to be designed using either analysis or testing. The staff has assessed the potential benefits and information to be obtained and has determined that the analyses performed by the licensee are adequate and sufficient and large transient testing would not provide significant additional insights regarding the staff's analysis. The staff notes that the large transient tests would not challenge instrumentation set points modified for the EPU or provide additional information to demonstrate the adequacy of major electrical equipment changed as a result of this EPU. Most of this latter equipment experiences higher load during operation at the EPU power level or during other scenarios not encountered during the two large transient tests in ELTR1.

The licensee provided (Reference 12) additional information related to the ability of the NRC approved ODYN transient code to model the DNPS response to these events following EPU, past power uprate experience at other plants (domestic and foreign), and the risk associated with performing the two tests. Reference 12 also included a summary of the DNPS power ascension and test plan, which includes tests such as pressure control incremental regulation, FW level control incremental regulation, FW pump runout data collection, and steam dryer performance. In addition, the licensee provided a summary of its evaluation of the effects of the proposed EPU on major components important to the MSIV closure and generator load rejection tests. These components included the MSIVs, the main steam piping, scram signals, safety/relief valves, and the turbine valves. The licensee's evaluation concluded that the effects of the EPU do not warrant the performance of these tests.

In Reference 51 and during presentations to the ACRS in public meeting on October 25, 2001, and November 8, 2001, the licensee provided additional information to justify its request. In summary, the licensee indicated that the DNPS safety analyses were performed using the NRC-approved ODYN Code, which has been benchmarked against BWR test data and incorporates industry experience. The licensee further indicated that the DNPS analyses were performed using post-EPU plant-specific inputs to predict integrated plant response. The licensee concluded that ODYN simulations show that no significant changes will occur as a result of the EPU. The licensee added that experience with power uprates has shown that the response of uprated plants to tests and events are within expected code predictions. In addition, the licensee stated that GE has concluded that these tests are no longer necessary for power uprates that do not involve a change in reactor steam dome pressure.

The NRC staff does not consider the information that could be obtained from the large transient tests included in ELTR1 to be necessary for validation of analytical codes for transient analyses. The basis for this conclusion is that these codes have been validated using test data obtained from numerous test facilities and operational experience in operating BWRs at power levels in excess of those proposed for the DNPS EPU. Therefore, additional large transient testing is unnecessary for purposes of validation of analytical codes.

10.3.4.3 Summary

The results of the tests under consideration are not directly comparable to the results of safety analyses used for licensing plants or granting amendments. In performing safety analyses, licensees use bounding assumptions such as assuming the failure of the most limiting component (i.e., single failure). In addition, when performing licensing analyses, licensees do not rely on non-safety related equipment or anticipatory trips for mitigation. In performing the tests under consideration, the licensee would not be expected to disable the limiting component, non-safety equipment, or anticipatory trips to mimic the safety analysis cases. Therefore, the results of the tests would be much less limiting than those of the safety analyses.

Furthermore, because of the availability of the additional equipment (e.g., non-safety related equipment and anticipatory trips), the test cases would be significantly different scenarios (i.e., follow different success paths) from the corresponding safety analyses. Therefore, successful large transient testing in accordance with ELTR1 would not necessarily confirm the adequacy of the safety analyses.

The staff considered the importance of the information that could be gained from the transient tests discussed above in light of experience to date with EPUs at other BWR plants including KKL and Hatch. Equipment modifications made to these plants in order to achieve the higher power levels are similar to those made for DNPS. Although the designs of these plants are not identical to DNPS, the staff considers the experience with EPUs at these plants useful because it provides a measure of how well GE can predict the impact of the power uprate and hardware modifications on equipment response during events. The staff received information from the licensee regarding startup testing performed at KKL including a generator load rejection test. The staff reviewed the information provided and finds that no significant anomalies related to plant safety were identified by the tests.

Tests were not performed at the Hatch plant following that plant's EPU, which increased its licensed power level to 113 percent of the original licensed power level. However, after approval of the Hatch EPU, Hatch Unit 2 experienced an unplanned event that resulted in a generator load rejection in May of 1999. The transient occurred at 98.3 percent of the plant's post-EPU licensed power level or approximately 111 percent of the original licensed power level. This event was reported to the NRC in Licensee Event Report 1999-005. In addition, Hatch Unit 1 experienced a turbine trip event and a generator load reject event from 100 percent of the EPU power level in July 2000 and March 2001. These events were reported to the NRC in Licensee Event Reports 2000-004 and 2001-002. No significant anomalies as a result of the Hatch EPU were identified by these events.

10.3.4.4 Conclusion

Based on the staff's evaluation of the information provided by the licensee in support of its proposal to not perform the MSIV closure and generator load rejection tests, the staff finds that the licensee's plan to perform numerous component, system, and other testing in combination with the evaluation of the systems and components discussed above, are sufficient to satisfactorily demonstrate successful plant modifications and overall equipment operability. The staff finds that information obtained from the MSIV closure and generator load rejection tests could be useful to confirm plant performance, adjust plant control systems, and enhance training material. However, the staff does not consider the benefits to be sufficient to justify the challenges to the plant and its equipment; the potential risk, although small, associated with performing these tests (i.e., the risk due to potential random equipment failures during the test); and the additional burden that would be imposed on the licensee. The staff has concluded that these two large tests do not provide a significant safety benefit in confirming the adequacy of the staff's analysis and evaluation. Therefore, the staff finds the licensee's proposal not to conduct these tests acceptable.

10.3.5 Required Testing Conclusion

The guidelines of NEDC-32424P-A (Reference 3) have been accepted by the NRC as the generic review basis for extended power uprate amendments requests. The staff finds that there is reasonable assurance the applicant's power uprate testing program is consistent with the requirements of 10 CFR 50, Appendix B, and NRC-approved topical report NEDC-32424P-A, Section 5.11.9, for an extended power uprate, except for the recommended large transient testing.

10.4 Risk Implications

To evaluate the impact on risk at DNPS from the proposed EPU, the licensee assessed its plant-specific probabilistic risk assessment (PRA). The results of the assessment were reported in the licensee's EPU SAR (Reference 2), which was provided to the staff for review as Attachment E to the licensee's EPU license amendment request (Reference 1). The assessment was further described and explained in supplemental information and responses to the NRC staff (References 8, 25, 32, 48, 49, 53, and 57). In addition, in July 2001, the NRC staff reviewed the DNPS PRA maintenance and update procedures and processes to support its review of the licensee's proposed EPU.

The NRC SER on the DNPS individual plant examination (IPE) was issued in October 1997 and concluded that the licensee had met the intent of GL 88-20, "Individual Plant Examination for Severe Accident Vulnerabilities." The licensee has significantly upgraded the DNPS PRA models since the staff review relative to GL 88-20 and has used the latest PRA models to support a license application for establishing a risk-informed inservice inspection program. The DNPS PRA has been through two peer reviews as part of the BWR Owners Group PRA certification process. The first peer review, which was performed in January 1998, resulted in a major upgrade of the PRA models. The second peer review, which was performed in November 2000, concluded that the DNPS PRA was adequate to support regulatory applications, when combined with deterministic insights.

The current, pre-uprate plant CDF for internal events is about 2.6E-6/year and the large early release frequency (LERF) is about 1.4E-6/year. Under EPU conditions, the licensee estimated that the CDF increases by 2.1E-7/year to an EPU CDF of about 2.8E-6/year. Likewise, under EPU conditions, the licensee estimated that the LERF increases by 1.4E-7/year to an EPU LERF of about 1.6E-6/year.

The NRC SE on the DNPS IPEEE was issued in September 2001 and concludes, based on the staff's screening review, that the licensee's process is capable of identifying the most likely severe accidents and severe accident vulnerabilities and that DNPS has therefore met the intent of Supplement 4 to GL 88-20.

For the IPEEE seismic analysis, DNPS is categorized as a 0.3g focused-scope plant per NUREG-1407, "Procedural and Submittal Guidance for the Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities." The licensee performed the DNPS seismic evaluation using the Electric Power Research Institute (EPRI) seismic margins assessment (SMA) methodology described in EPRI NP-6041-SL, "A Methodology for Assessment of Nuclear Power Plant Seismic Margin." Therefore, the licensee did not quantify a seismic CDF. However, the licensee states in its supplemental information for the EPU license amendment that the conclusions and results of the SMA were judged to be unaffected by the EPU.