December 7, 2005

Mr. Christopher M. Crane, President
and Chief Nuclear Officer
Exelon Generation Company, LLC
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: ISSUANCE OF SAFETY EVALUATION RELATED TO LICENSE CONDITION FOR MAIN STEAM SAFETY VALVE SETPOINT TOLERANCES AND TOLERANCE UNCERTAINTY TREATMENT METHODOLOGY (TAC NOS. MC5018 AND MC5019)

Dear Mr. Crane:

The Nuclear Regulatory Commission (Commission) is transmitting the enclosed safety evaluation regarding Exelon Generation Company, LLC's (Exelon's) response to the item 4 license condition for Amendment No. 208 to Facility Operating License No. DPR-19 and Amendment No. 200 to Facility Operating License No. DPR-25 for Dresden Nuclear Power Station, Units 2 and 3 (Dresden), issued on July 30, 2004. The amendments revised the Dresden technical specifications to increase the required number of operable main steam safety valves (MSSVs) from eight to nine and added surveillance requirements for the ninth valve.

One of the additional conditions (item 4) added to the amendments stated, "Exelon shall submit, for NRC approval, values for the safety valve and safety/relief valve setpoint tolerances and the tolerance uncertainty treatment methodology applied to the main steam safety valve and safety/relief valve [(S/RV)] setpoint test data by October 29, 2004." Another of the additional conditions (item 5) stated, "Exelon shall submit a Technical Specification amendment request to change this tolerance value to one derived from item 4 above, if necessary, and the results of revisions to all applicable design basis analyses, within six months of NRC approval of item 4." In a letter dated October 29, 2004, Exelon submitted information in response to the item 4 license condition. This safety evaluation documents the staff's review of the licensee's response to the item 4 license condition imposed by the license amendments. A copy of the Safety Evaluation is enclosed.

Based on a review of the licensee's submittals dated October 29, 2004, and April 15 and May 26, 2005, the staff finds that the licensee's method of determining the MSSV and S/RV setpoint tolerances and the tolerance uncertainty treatment methodology is acceptable. Therefore, the licensee has adequately satisfied the item 4 condition imposed by the July 30, 2004, license amendment. As a reminder, Exelon must submit a Technical Specification amendment request to change the tolerance value within six months of the date of this letter in order to satisfy the item 5 condition of the July 30, 2004 amendments.

Sincerely,

/RA/

Maitri Banerjee, Project Manager
Plant Licensing Branch III-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-237 and 50-249

Enclosure: Safety Evaluation

cc w/encl: See next page

Based on a review of the licensee's submittals dated October 29, 2004, and April 15 and May 26, 2005, the staff finds that the licensee's method of determining the MSSV and S/RV setpoint tolerances and the tolerance uncertainty treatment methodology is acceptable. Therefore, the licensee has adequately satisfied the item 4 condition imposed by the July 30, 2004, license amendment. As a reminder, Exelon must submit a Technical Specification amendment request to change the tolerance value within six months of the date of this letter in order to satisfy the item 5 condition of the July 30, 2004 amendments.

Sincerely,

/RA/

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Plant Licensing Branch III-2
Division of Operating Reactor Licensing
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO LICENSE CONDITION FOR MAIN STEAM SAFETY VALVE SETPOINT

TOLERANCES AND TOLERANCE UNCERTAINTY TREATMENT METHODOLOGY

EXELON GENERATION COMPANY, LLC

DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3

DOCKET NOS. 50-237 AND 50-249

1.0 INTRODUCTION

In a submittal dated October 10, 2002 (Reference 1), Exelon Generation Company, LLC (the licensee) requested changes to the Technical Specifications (TS) for Dresden Nuclear Power Station (Dresden), Units 2 and 3. The proposed changes increased the number of main steam safety valves (MSSVs) required to be operable from eight MSSVs to eight MSSVs and one safety/relief valve (S/RV). The licensee's request was also supplemented with submittals, including those dated January 13 and July 8, 2004 (References 2 and 3). The NRC approved the proposed changes in a license amendment dated July 30, 2004 (Reference 4). As described in the amendment for Dresden, the operating experience indicates that the as-found lift setpoints of the MSSVs and Target Rock safety/relief valves (S/RVs) have deviated from the TS tolerance limit of +/-1 percent multiple times. As such, the NRC approval of the proposed changes included additional conditions that were added to the license to affect resolution of the issue of valve lift setpoint drift beyond the TS tolerance value. One of the additional conditions (item 4) stated, "Exelon shall submit, for NRC approval, values for the safety valve and safety/relief valve setpoint tolerances and the tolerance uncertainty treatment methodology applied to the main steam safety valve and safety/relief valve setpoint test data by October 29, 2004." Another of the additional conditions (item 5) stated, "Exelon shall submit a Technical Specification amendment request to change this tolerance value to one derived from item 4 above, if necessary, and the results of revisions to all applicable design basis analyses, within six months of NRC approval of item 4." In a letter dated October 29, 2004 (Reference 5), the licensee submitted information in response to the item 4 license condition. In addition, the licensee provided responses to the staff's requests for additional information in submittals dated April 15 and May 26, 2005 (References 6 and 7). This safety evaluation documents the staff's review of the licensee's response to the item 4 license condition imposed by the July 30, 2004, license amendments.

ENCLOSURE

2.0 REGULATORY EVALUATION

The requirement of General Design Criterion (GDC) 15 of Appendix A of Part 50 of Title 10 of the *Code of Federal Regulations* (10 CFR) specifies that "the reactor coolant system and associated auxiliary, control, and protection systems shall be designed with sufficient margin to assure that the design conditions of the reactor coolant pressure boundary are not exceeded during any condition of normal operation, including anticipated operational occurrences." The overpressure protection system is relied upon to maintain reactor coolant system pressure within acceptable design limits during certain analyzed transients. Application of GDC-15 to the overpressure protection system provides assurance that the reactor coolant pressure boundary will have an extremely low probability of failure during transients.

Guidance for the implementation of GDC-15 is covered in NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," Section 5.2.2 as follows:

> Safety valves shall be designed with sufficient capacity to limit the pressure to less than 110% of the reactor coolant pressure boundary design pressure, as specified by the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, during the most severe abnormal operational transient with reactor scram. Also, sufficient margin shall be available to account for uncertainties in the design and operation of the plant assuming:
>
> (1) The reactor is operating at a power level that will produce the most severe over-pressurization transient.
>
> (2) All system and core parameters are at values within normal operating range, including uncertainties and technical specification limits that produce the highest anticipated pressure.
>
> (3) The reactor scram is initiated by the second safety-grade signal from the reactor protection system.
>
> (4) The discharge flow is based on the rated capacities specified in the ASME Boiler and Pressure Vessel Code, for each type of valve. Full credit is allowed for spring-loaded safety valves designed in accordance with the requirements of the ASME Boiler and Pressure Vessel Code.

Specifically, as it relates to the pressure relief system, item (2) above requires that the uncertainty of the setpoints of the MSSVs and S/RVs be included in the plant safety analysis that demonstrates that the GDC-15 requirements are met.

3.0 TECHNICAL EVALUATION

3.1 LICENSEE’S ANALYSIS OF VALVE SETPOINT UNCERTAINTY

Generally, safety valve drift is considered as a fixed percentage of the setpoint. In safety analyses, this drift allowance is generally applied additively and uniformly to a valve or group of valves having the same setpoint. With groups of valves, assuming all of them drift to the highest possible setpoint is a conservative approach. To support approval of the October 10, 2002 (Reference 1), amendment request, the licensee used this approach in an ASME overpressure analysis, and the results were submitted to the NRC in the January 13, 2004, submittal. The ASME overpressure analysis was performed using valve setpoint tolerances that were determined using a 95/95 tolerance limit as described in NUREG-1475, "Applying Statistics." Using the 95/95 methodology, the licensee determined that the setpoint tolerances based on actual valve performance were 2.2 percent for the MSSVs and 4.1 percent for the S/RVs.

The licensee has also performed a Monte Carlo statistical analysis of the MSSV networks to determine an upper tolerance limit that more accurately predicts the distribution of setpoint values. The licensee stated that the intent of the analysis was to demonstrate a statistically based, technically valid alternative to traditional deterministically applied setpoint drift, which assumes that all of the valves drift to a highest setpoint value. The licensee's Monte Carlo statistical analysis was performed using actual as-found MSSV and S/RV test data. To obtain a larger amount of data, the licensee included Quad Cities test data with the Dresden test data, after verifying via statistical tests that the data could be combined in a common pool. The Monte Carlo analysis of the valve network takes into account the fact that valve openings for a group of valves with the same setpoint will display a distribution, with some valves opening at lower pressures and some opening at higher pressures. The licensee also modeled the setpoint distributions such that the standard deviations were multiplied by the appropriate tolerance limit factor for a 95 percent confidence considering the number of data points in the measured data sample.

The licensee performed several Monte Carlo analyses using various analytical computer program tools, ultimately developing a distribution of setpoint values for each of the eight MSSVs and one S/RV, from which the selection of the 95th percentile setpoints were chosen. In order to evaluate the performance of the pressure relief system for these setpoints compared to setpoints based on a fixed percentage drift applied to all valves, the licensee performed a calculation based on a simple numerical integration model of flow quantity discharged over time. This flow model assumes a constant system pressurization rate as input and models the valve flow characteristic. The valves are assumed to pop open 50 percent at the setpoint value; then the valve opening increases linearly with pressure, up to the fully open positions at a pressure of 3 percent above the setpoints. Based on the results of the licensee's Monte Carlo analysis, the licensee found that the actual MSSV setpoint drift data does not support the current TS upper tolerance limit of one percent on all valves. The analysis did initially appear to show that the quantity of main steam flow relieved through the valve network modeled for the Monte Carlo analysis would significantly exceed the quantity of main steam flow relieved when an upper tolerance of 1.5 percent is applied to all valves. However, in response to a question from the staff regarding common cause effects when valves drift high by some threshold amount, the licensee determined that a +0.5 percent bias on the nominal MSSV setpoints was necessary to adequately model the potential common cause effect. The licensee determined the +0.5 percent bias by evaluating setpoint tests that were performed at a common time. The licensee's 95th percentile setpoints with the +0.5 percent bias are as follows:

Valve	Monte Carlo Setpoint with +0.5% bias (psia)
S/RV	1196.3
Group 1 MSSV	1264.2
" " "	1271.3
Group 2 MSSV	1276.9
" " "	1282.0
Group 3 MSSV	1287.4
" " "	1293.2
" " "	1300.7
" " "	1313.5

In the May 26, 2005, submittal (Reference 7), the licensee revised the estimate of the upper tolerance value to be 1.75 percent applied to all valves, which the licensee states would be comparable to the above Monte Carlo analysis setpoints which account for the +0.5 percent bias.

As noted above, the quantity of main steam flow that results for the licensee's Monte Carlo analysis, without consideration of a bias, is significantly greater than for an upper tolerance of +1.5 percent applied to all valves. Therefore, it only requires the addition of 0.25 percent to the +1.5 percent upper tolerance applied to all valves (i.e., +1.75 percent) to compensate for a +0.5 percent bias used in determining the Monte Carlo setpoints.

The licensee also stated that it was evaluating potential design modifications that would increase the MSSV and S/RV relief capacity in order to regain margin that was lost as a result of implementing extended power uprate and more efficient reactor core designs. The MSSV and S/RV setpoint tolerances were also being evaluated in conjunction with the potential design modifications.

The license further stated that an amendment request and supporting analyses will be performed in accordance with General Electric Nuclear Energy licensing topical report NEDC-31753P, "BWROG In-Service Pressure Relief Technical Specification Revision Licensing Topical Report," to support the future TS amendment request. This licensing topical report was previously reviewed and approved by the NRC as documented in a safety evaluation dated March 8, 1993, and provided the basis for NRC approval of TS amendments for several other boiling water reactors.

3.2 STAFF EVALUATION OF LICENSEE'S VALVE SETPOINT UNCERTAINTY TREATMENT

The staff has determined that the use of a Monte Carlo sampling methodology to analyze the valve setpoint uncertainty is an acceptable statistical approach. While less conservative than simply applying a statistical tolerance limit simultaneously to all nominal valve setpoints, the Monte Carlo method is a more rigorous treatment of the setpoint uncertainty since it involves random estimates of setpoint deviations for a large number of cases.

In order to evaluate the licensee's valve setpoint uncertainty treatment, the staff developed a simple analytical Monte Carlo sampling model, which used as input the same nominal setpoints and standard deviation distribution parameters used for the licensee's analysis. The model involved use of a random uniform number generator from which random normal variants were determined for a large number of cases (i.e., 100,000 cases). In making the calculations, it was verified that no two cases produced the same setpoints, that the normal variants are indeed normally distributed, and that the average and standard deviation values of the uniform and normal variants are correct. There are potentially several methods for ranking each of the cases, including the following:

1. Evaluation of the valve flow quantity over time using a constant system pressurization rate.

2. Evaluation of the valve flow quantity over time using a variable system pressurization rate based on the pressure dependent valve flow rate.

3. Evaluation of the sum of the setpoint pressures for each case.

There could be more elaborate methods for ranking the cases, which might involve evaluation of the peak pressure for a specified reactor transient of interest using an acceptable thermal-hydraulic analysis code (such as RELAP) for each case. However, it is expected that this method would be time and resource prohibitive, since the thermal-hydraulic code itself would have to be modified to include the Monte Carlo sampling, or the analyst would have to provide the varying setpoints as input for each analysis of peak pressure.

The staff performed calculations for all three of the ranking methods listed above. It was found that the three methods provided somewhat different ranking; however, the 95th percentile cases for all three methods demonstrated that the licensee's 95th percentile setpoints were conservatively selected.

As stated above, the staff requested information regarding the possible common cause effects of setpoints that drift high. Operational experience at several facilities has shown that in some cases, there have been safety valves that have drifted in the upward direction due to common cause effects (e.g., due to excessive friction or bonding). A review of the Dresden and Quad Cities MSSV setpoint test data indicates that there is such a common cause effect. Specifically, it is noted that when any one MSSV had drifted high by approximately +1.75 percent or greater, then all other MSSVs that were tested at that time had also drifted in the high direction (reference data from tests performed in October 1999 for Dresden and in June 1994, April 1997, and September 2001 for Quad Cities). This indicates that the proposed Monte Carlo sampling should model a bias in the positive direction when any setpoints have drifted high, above a threshold value. To account for this effect, the licensee included a +0.5 percent bias on the eight MSSV setpoints, as described above. The staff also verified the effect of a possible common cause by including the proposed +0.5 percent increase to the nominal setpoints and by another method in which the randomly chosen setpoint deviations in the Monte Carlo analysis were simply converted to absolute values (i.e., always positive) when any setpoint deviation was +1.75 percent or greater. Again, for the three ranking methods discussed above, the 95th percentile cases demonstrated that the licensee's 95th percentile setpoints were conservatively selected.

The +0.5 percent bias, described above for the eight MSSVs, was not applied to the one Target Rock S/RV. However, there has been experience in 2004 with excessive setpoint spring tilt and wearing of grooves in the spring cap, which caused excessive upward setpoint drift in one Target Rock valve at Quad Cities. This resulted in the valve drifting high by about +6.8 percent.

In the April 15, 2005 (Reference 6), submittal, the licensee stated that the degradation occurred both prior to and subsequent to extended power uprate (EPU) operation. However, in a submittal dated January 5, 2005, regarding a review of EPU vulnerability for both Dresden and Quad Cities, the licensee's root cause evaluation identified that the S/RV degradation was caused by EPU-related vibration. As a corrective action, the licensee modified the spring cap with a hard coating and adjusted the spring straightness tolerance to reduce the wear of the cap surface by spring contact. Further, in a discussion with the staff on October 6, 2005 (Reference 8), the licensee stated that these valve internal parts will be inspected each refueling outage through the licensee's internal procedures to monitor for excessive material wear. It is expected that the licensee's modification and inspection procedure for the S/RVs will reduce and adequately monitor the rate of wear of these parts. However, as a bounding case, the staff also evaluated the effect of an S/RV drifting high by +6.8 percent together with the MSSVs having a +0.5 percent bias. For the three ranking methods discussed above, the 95th percentile cases were also bounded by the licensee's 95th percentile setpoints listed above or by an upper tolerance limit of +1.75 percent applied to all valves.

As a result of the staff evaluation of the licensee's proposed setpoint tolerance and tolerance uncertainty treatment, the staff finds that the licensee's method using a Monte Carlo analysis to evaluate the setpoint drift deviation is acceptable. The staff also finds that a TS upper setpoint tolerance value applied to all valves equal to or greater than +1.75 percent is acceptable, based on the licensee's statistical analysis of actual valve setpoint test data. Using the above setpoint tolerance uncertainty treatment method with additional test data, as it becomes available, the licensee could establish a smaller TS upper tolerance value in the future, subject to the review of the NRC.

4.0 CONCLUSION

Based on a review of the licensee's submittals dated October 29, 2004, and April 15 and May 26, 2005, the staff finds that the licensee's method of determining the MSSV and S/RV setpoint tolerances and the tolerance uncertainty treatment methodology is acceptable.

Therefore, the licensee has adequately satisfied the item 4 condition imposed by the July 30, 2004, license amendment.

5.0 REFERENCES

1. Letter from Patrick R. Simpson, Licensing Manager, Exelon Generation Company, LLC, to U.S. Nuclear Regulatory Commission, "Request for Technical Specifications Changes Related to Main Steam Safety Valve Operability Requirements," dated October 10, 2002.

2. Letter from Patrick R. Simpson, Licensing Manager, Exelon Generation Company, LLC, to U.S. Nuclear Regulatory Commission, "Additional Information Regarding Request for Technical Specifications Changes Related to Main Steam Safety Valve Operability Requirements," dated January 13, 2004.

3. Letter from Patrick R. Simpson, Licensing Manager, Exelon Generation Company, LLC, to U.S. Nuclear Regulatory Commission, "Additional Information Regarding Request for Technical Specifications Changes Related to Main Steam Safety Valve Operability Requirements," dated July 8, 2004.

4. Letter from U.S. Nuclear Regulatory Commission to Mr. Christopher M. Crane, President, Exelon Generation Company, LLC, "Issuance of Amendments for Main Steam Safety Valve Technical Specifications," dated July 30, 2004.

5. Letter from Patrick R. Simpson, Licensing Manager, Exelon Generation Company, LLC, to U.S. Nuclear Regulatory Commission, "Main Steam Safety Valve Setpoint Tolerances and Tolerance Uncertainty Treatment Methodology," dated October 29, 2004.

6. Letter from Patrick R. Simpson, Licensing Manager, Exelon Generation Company, LLC, to U.S. Nuclear Regulatory Commission, "Additional Information Supporting Main Steam Safety Valve Setpoint Tolerances and Tolerance Uncertainty Treatment Methodology," dated April 15, 2005.

7. Letter from Patrick R. Simpson, Licensing Manager, Exelon Generation Company, LLC, to U.S. Nuclear Regulatory Commission, "Additional Information Supporting Main Steam Safety Valve Setpoint Tolerances and Tolerance Uncertainty Treatment Methodology," dated May 26, 2005.

8. Minutes of Conference Call Regarding Dresden MSSV Setpoint Tolerance (Response to License Condition 4 from July 30, 2004 Amendment), dated October 24, 2005.

Principal Contributor: G. Hammer, NRR/DE

Date: December 7, 2005