February 8, 2002

Mr. Oliver D. Kingsley, President
and Chief Nuclear Officer
Exelon Nuclear
Exelon Generation Company, LLC
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: THREE MILE ISLAND NUCLEAR STATION, UNIT 1 (TMI-1), EXEMPTION FROM THE HYDROGEN CONTROL REQUIREMENTS OF TITLE 10 OF THE *CODE OF FEDERAL REGULATIONS* (10 CFR) PART 50, SECTION 50.44, 10 CFR PART 50, APPENDIX A, GENERAL DESIGN CRITERION 41, AND 10 CFR PART 50, APPENDIX E, SECTION VI (TAC NO. MB0065)

Dear Mr. Kingsley:

By letter dated September 20, 2000, as supplemented by letters dated August 2 and September 28, 2001, AmerGen Energy Company, LLC, (the licensee) requested an exemption from certain requirements of 10 CFR 50.44; 10 CFR Part 50, Appendix A, General Design Criterion 41; and 10 CFR Part 50, Appendix E, Section VI, pertaining to the hydrogen control system requirements (i.e., containment post-accident hydrogen monitors and recombiners) and removal of the exempted requirements from the TMI-1 design basis. We have reviewed the information provided and concluded that the requested exemption for the hydrogen recombiners and hydrogen purge system is justified since special circumstances necessary to meet the criteria of 10 CFR 50.12(a)(2)(ii) do exist to justify granting the exemption. However, the U.S. Nuclear Regulatory Commission staff has determined that it cannot support your exemption request from the functional requirements for hydrogen monitoring contained in the regulations listed above.

A copy of the exemption is enclosed. The exemption has been forwarded to the Office of the Federal Register for publication. Your submittals also requested certain changes to the TMI-1 Technical Specifications, which are being evaluated separately.

Sincerely,

/RA/

Timothy G. Colburn, Senior Project Manager, Section 1
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-289

Enclosure: Exemption

cc w/encl: See next page

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

AMERGEN ENERGY COMPANY, LLC

THREE MILE ISLAND NUCLEAR STATION, UNIT 1

DOCKET NO. 50-289

EXEMPTION

1.0 BACKGROUND

The AmerGen Energy Company, LLC (AmerGen, the licensee) is the holder of Facility Operating License No. DPR-50, which authorizes operation of the Three Mile Island Nuclear Station, Unit 1 (TMI-1). The license provides, among other things, that the facility is subject to all rules, regulations, and orders of the U.S. Nuclear Regulatory Commission (NRC, the Commission) now or hereafter in effect.

The facility consists of a pressurized water reactor (PWR) located in Dauphin County in Pennsylvania.

2.0 REQUEST/ACTION

Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Section 50.44, "Standards for combustible gas control system in light-water-cooled power reactors," and 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 41, "Containment atmosphere cleanup," establish requirements for controlling the amount of hydrogen inside the reactor containment following a postulated loss-of-coolant accident (LOCA). These requirements provide specific assumptions and methods to define the amount of hydrogen generated, the rate at which hydrogen is generated, and the requirements of a combustible gas control system to control the concentration of hydrogen in the containment following a design-basis LOCA to

below flammability limits. Appendix E to 10 CFR Part 50, Section VI, "Emergency Response Data System [ERDS]," contains requirements to provide information on the concentration of hydrogen inside the containment following accidents as part of the ERDS. Section 50.44(a) to 10 CFR Part 50 requires a means for control of hydrogen that may be generated following a postulated LOCA by 1) a metal-water reaction involving the fuel cladding and the reactor coolant, 2) radiolytic decomposition of the reactor coolant, and 3) corrosion of metals. Section 50.44(b) of 10 CFR and 10 CFR Part 50, Appendix E, Section VI.2.a.(i).4 require that the hydrogen control measures must be capable of measuring the hydrogen concentration in the containment, ensuring a mixed atmosphere in the containment and controlling combustible gas concentrations in the containment following a LOCA. Section 50.44(c)(1) of 10 CFR Part 50 requires that it must be shown that following a LOCA, but prior to effective operation of the combustible gas control system, either an uncontrolled hydrogen-oxygen recombination would not take place in containment, or the plant could withstand the consequences of uncontrolled hydrogen-oxygen recombination without loss of safety function. Section 50.44(h)(2) requires a combustible gas control system to maintain the concentration of combustible gases following a LOCA to below flammability limits. These systems can be of two types: those allowing controlled release from containment such as a purge system, or those that do not result in a significant release from the containment such as recombiners. GDC 41 of Appendix A to 10 CFR Part 50 requires that the hydrogen control system described above must control hydrogen as necessary following a LOCA to assure that containment integrity is maintained, and must meet redundancy and single failure requirements. Additional NRC staff guidance is provided in Regulatory Guide (RG) 1.7. NRC staff review and acceptance criteria are specified in Section 6.2.5 of the Standard Review Plan (NUREG-0800, July 1981). By letter dated September 20, 2000, as supplemented by letters dated August 2 and September 28, 2001, the licensee requested an exemption to the above requirements in order to remove requirements for a

hydrogen control system from the TMI-1 design basis. The proposed request for exemption included a related license amendment application which would remove the hydrogen control system from the plant's operating license Technical Specifications and the Updated Final Safety Analysis Report.

3.0 DISCUSSION

Pursuant to 10 CFR 50.12, the Commission may, upon application by any interested person or upon its own initiative, grant exemptions from the requirements of 10 CFR Part 50 when (1) the exemptions are authorized by law, will not present an undue risk to public health or safety, and are consistent with the common defense and security; and (2) when special circumstances are present. These circumstances include the special circumstances as stated in 10 CFR 50.12(a)(2)(ii), "Application of the regulation in the particular circumstances would not serve the underlying purpose of the rule or is not necessary to achieve the underlying purpose of the rule." The underlying purpose of 10 CFR 50.44 is to show that following a LOCA, an uncontrolled hydrogen-oxygen recombination would not take place, or that the plant could withstand the consequences of an uncontrolled hydrogen-oxygen recombination without loss of safety function.

In its request, AmerGen asserts that the TMI-1 containment has sufficient safety margin against hydrogen burn following design-basis and severe accidents without use of the hydrogen monitoring or concentration control systems. The TMI-1 Probabilistic Risk Assessment (PRA) indicates that none of the accident sequences addressed that could realistically threaten containment due to hydrogen combustion are impacted by the hydrogen monitoring or concentration control systems. The TMI-1 Individual Plant Examination (IPE) concluded containment survival is almost certain following hydrogen combustion when the reactor building cooling units and the reactor building spray system are operating. The licensee's plant-specific containment integrity analysis for TMI-1 indicates that the ultimate pressure capacity of the

containment is between 137 and 147 psig (TMI-1 PRA, Level 2, Appendix 1). This estimate is reasonable when compared to Table 6.1 of NUREG/CR-6475, “Resolution of the Direct Containment Heating Issue for Combustion Engineering Plants and Babcock & Wilcox Plants.” A safety margin exists for containment integrity even for conservative hydrogen concentration levels. The NRC staff has found that the relative importance of hydrogen combustion for large, dry containments with respect to containment failure is quite low. This finding supports the argument that the hydrogen recombiners are not risk significant from a containment integrity perspective and that the risk associated with hydrogen combustion is not from design-basis accidents but from severe accidents. NRC sponsored studies, such as NUREG-1150, “Severe Accident Risks: An Assessment For Five U.S. Nuclear Power Plants,” December 1990, and NUREG/CR-5662, “Hydrogen Combustion, Control And Value Impact Analysis For PWR [pressurized water reactor] Dry Containments,” June 1991, have found hydrogen combustion to be a small contributor to containment failure for large, dry containment designs due to the robustness of these containment types and the likelihood of a spurious ignition source. Additionally, studies have shown that the majority of risk to the public is from accident sequences that lead to containment failure or bypass, and that the contribution to risk from accident sequences involving hydrogen combustion is actually quite small for large, dry containments such as TMI-1's. This is true despite the fact that the hydrogen quantities produced in these events is substantially larger than the hydrogen production postulated by 10 CFR 50.44(d) and RG 1.7, Revision 2, “Control of Combustible Gas Concentrations in Containment Following a Loss-of-Coolant Accident [LOCA],” November 1978. Hydrogen combustion sequences that could lead to early containment failure typically involve up to 75 percent core metal-water reaction. Hydrogen combustion sequences that could lead to late containment failure involve additional sources of hydrogen due to the interaction of corium and the concrete basemat after vessel breach. Although the recombiners are effective in

maintaining the RG 1.7 hydrogen concentration below the lower flammability limit of 4 volume percent, they are overwhelmed by the larger quantities of hydrogen associated with severe accidents that would typically be released over a much shorter time period (e.g., 2 hours). However, NUREG/CR-4551, Revision 1, Volume 7, Part 1, “Evaluation of Severe Accident Risks: Zion Unit 1,” March 1993, states that hydrogen combustion in the period before containment failure is considered to present no threat to large, dry containments. Table A.4-5 of NUREG/CR-4551 shows that the contribution of hydrogen combustion to late containment failure is also very small. Therefore, the relative importance of hydrogen combustion for large, dry containments with respect to containment failure has been shown to be quite low.

The recombiners can, however, prevent a subsequent hydrogen burn if needed due to radiolytic decomposition of water and corrosion in the long term. Analysis performed in accordance with the methodology of RG 1.7 shows that the hydrogen concentration will not reach 4 volume percent for 15 days after initiation of a design-basis LOCA. Additionally, hydrogen concentrations on the order of 6 percent or less are bounded by hydrogen generated during a severe accident and would not be a threat to containment integrity, since there is ample time between burns to reduce elevated containment temperatures using the installed containment heat removal systems. The TMI-1 IPE concluded that containment survival is almost certain following hydrogen combustion when the reactor building cooling units and the reactor building spray system are operating.

Although hydrogen igniter systems would provide some added margin that containment integrity can be maintained during hydrogen burns, Generic Issue (GI)-121, "Hydrogen Control for PWR Dry Containments,” found that hydrogen combustion was not a significant threat to dry containments, and concluded that there was no basis for new generic hydrogen control measures (i.e., igniters). Equipment survivability in concentrations greater than 6 percent was addressed as part of GI-121, which references NUREG/CR-5662, which assessed the benefits

of hydrogen igniters. NUREG/CR-5662 concluded that simulated equipment can withstand a LOCA and single burn resulting from a 75-percent metal-water reaction in a large, dry containment. However, the multiple containment burns due to the operation of ignition systems could pose a serious threat to safety-related equipment located in the source compartment. The multiple burn environment was found potentially to be a threat because the source compartment temperature remains elevated from the previous burn. However, for TMI-1, this is not a concern for the above radiolysis and corrosion case because there is ample time between burns to reduce elevated containment temperatures via containment heat removal systems. Therefore, an additional burn in the long term due to radiolysis and corrosion would not have a similar impact on equipment survivability at TMI-1.

In a postulated LOCA, the TMI-1 emergency operating instructions (EOIs) direct the control room operators to monitor and control the hydrogen concentration inside the containment after they have carried out the steps to maintain and control the higher priority critical safety functions. Key operator actions associated with the control of hydrogen include placing the hydrogen recombiners or hydrogen purge system in operation at very low hydrogen concentration levels. These hydrogen control activities could distract operators from more important tasks in the early phases of accident mitigation and could have a negative impact on the higher priority critical operator actions. An exemption from hydrogen recombiner and purge-repressurization system requirements will eliminate the need for these systems in the EOIs and hence simplify the EOIs. The NRC staff still expects the licensee's severe accident management guidelines to address combustible gas control. The NRC staff has determined that the simplification of the EOIs would be a safety benefit.

As stated previously, the underlying purpose of 10 CFR 50.44 is to show that, following a LOCA, an uncontrolled hydrogen-oxygen recombination would not take place, or that the plant could withstand the consequences of uncontrolled hydrogen-oxygen recombination

without loss of safety function. Based on the licensee's analysis, the NRC staff's evaluation of the risk from hydrogen combustion, resolution of GI-121, and the TMI-1 IPE, the NRC staff has determined that the plant could withstand the consequences of uncontrolled hydrogen-oxygen recombination without loss of safety function without credit for the hydrogen recombiners for not only the design-basis case, but also for the more limiting severe accident with up to 100 percent metal-water reaction. Therefore, the requirements for hydrogen recombiners as part of the TMI-1 design basis are unnecessary, and their removal from the design basis is acceptable. Additionally, elimination of the hydrogen recombiners from the EOIs would simplify operator actions in the event of an accident and, therefore, would be a safety benefit. Consequently, pursuant to 10 CFR 50.12(a)(2)(ii), application of the regulation is not necessary to achieve the underlying purpose of the rule.

In the submittal, the licensee also requested an exemption from the functional requirement for hydrogen monitoring as promulgated in Part 50, Appendix E, Section VI, "Emergency Response Data System (ERDS)," and the elimination of any commitments made in regard to NUREG-0737, Item II.F.1, Attachment 6, "Containment Hydrogen Monitor." However, in the Statement of Considerations for Appendix E to Part 50, the Commission stated that the ERDS data (which include data from the continuous hydrogen monitors) provide the data required by the NRC to perform its role during an emergency. This conclusion is still valid for not only the NRC staff, but also for licensees. The major vendors' core damage assessment methodologies continue to include continuous hydrogen monitoring. Core damage assessment methodologies were reviewed by the NRC staff in response to NUREG-0737, Item II.B.3(2)(a). Continuous hydrogen monitoring is needed to support a plant's emergency plan as described in 50.47(b)(9). Implementing documents such as RG 1.101, Revision 2, which endorsed NUREG-0654, and RG 1.101, Revision 3, which endorsed NEI-NESP-007, Revision 2, define the highest Emergency Action Level, a General Emergency, as a loss of any two barriers and

potential loss of the third barrier. Potential loss of a third barrier depends on whether or not an explosive mixture exists inside containment. The continuous hydrogen monitors are used for determining whether an explosive mixture exists inside containment. Therefore, the licensee's request for exemption from the functional requirements for hydrogen monitoring is not approved.

The NRC staff has determined that for the requested exemptions related to the hydrogen recombiners and backup hydrogen purge system, pursuant to 10 CFR 50.12(a)(2)(ii), special circumstances are present, in that application of the regulations in the particular circumstances is not necessary to achieve the underlying purpose of the rule.

4.0 CONCLUSION

Accordingly, the Commission has determined that, pursuant to 10 CFR 50.12(a), the exemption from the hydrogen recombiner and hydrogen purge system requirements is authorized by law, will not present an undue risk to the public health and safety, and is consistent with the common defense and security. Also, special circumstances are present. Therefore, the Commission hereby grants AmerGen Energy Company, LLC, an exemption from the requirements for hydrogen recombiners and the hydrogen purge system of 10 CFR 50.44, and 10 CFR Part 50, Appendix A, General Design Criterion 41, for the TMI-1.

Pursuant to 10 CFR 51.32, the Commission has determined that the granting of this exemption will not have a significant effect on the quality of the human environment (67 FR 1788).

This exemption is effective upon issuance.

Dated at Rockville, Maryland, this 8th day of February 2002.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

John A. Zwolinski, Director
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