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U. S. Nuclear Regulatory Commission
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Clinton Power Station, Unit 1
Facility Operating License No. NPF-62
NRC Docket No. 50-461

Subject: Additional Information Supporting the Request for a License Amendment to Modify Clinton Power Station Facility Operating License in Support of the Use of Isotope Test Assemblies

References:

1. Letter from Mr. Jeffrey L. Hansen (Exelon Generation Company, LLC) to U. S. NRC, "License Amendment Request to Modify Clinton Power Station Facility Operating License in Support of the Use of Isotope Test Assemblies," dated June 26, 2009

2. Letter from U. S. NRC to Mr. Charles G. Pardee (Exelon Generation Company, LLC), "Clinton Power Station, Unit No. 1 – Request for Additional Information Related to License Amendment Request to Modify Clinton Power Station Facility Operating License in Support of the Use of Isotope Test Assemblies (TAC No. ME1643)," dated November 2, 2009 (ADAMS Accession No. ML093030218)

3. Letter from Mr. Jeffrey L. Hansen (Exelon Generation Company, LLC) to U. S. NRC, "Additional Information Supporting the Request for a License Amendment to Modify Clinton Power Station Facility Operating License in Support of the Use of Isotope Test Assemblies," dated November 17, 2009

In Reference 1, Exelon Generation Company, LLC (EGC) requested an amendment to the facility operating license for Clinton Power Station (CPS), Unit 1. Specifically, the proposed change would modify CPS License Condition 2.B.(6) and create new License Conditions 1.J and 2.B.(7) as part of a pilot program to irradiate cobalt (Co)-59 targets to produce Co-60. In addition to the proposed license condition changes, EGC also requests an amendment to Appendix A, Technical Specifications (TS), of the CPS Facility Operating License. This proposed change would modify TS 4.2.1, "Fuel Assemblies," to describe the Isotope Test Assemblies (ITAs) being used.

In Reference 2, the NRC requested that EGC provide additional information in support of their review of Reference 1. The NRC request for additional information and the specific EGC responses are provided in Attachment 1 to this letter.

EGC has reviewed the information supporting a finding of no significant hazards consideration that was provided to the NRC in Reference 3. The additional information provided in this submittal does not affect the bases for concluding that the proposed license amendment does not involve a significant hazards consideration. No new regulatory commitments are established by this submittal.

If you have any questions concerning this letter, please contact Mr. Timothy A. Byam at (630) 657-2804.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 20th day of November 2009.

Respectfully,

Jeffrey L. Hansen

Jeffrey L. Hansen
Manager – Licensing
Exelon Generation Company, LLC

Attachments: Additional Information Supporting the Request for a License Amendment to Modify Clinton Power Station Facility Operating License in Support of the Use of Isotope Test Assemblies

ATTACHMENT

Additional Information Supporting the Request for a License Amendment
to Modify Clinton Power Station Facility Operating License
in Support of the Use of Isotope Test Assemblies

In reviewing the Exelon Generation Company's submittal dated June 26, 2009 (Agencywide Documents Access and Management System Accession No. ML091801061) (Reference 1), related to modifying License Condition 2.B.(6) and create new License Conditions 1.J and 2.B.(7) as part of a pilot program to irradiate Cobalt (CO)-59 targets to produce Co-60, for the Clinton Power Station, Unit No. 1 (CPS), the Nuclear Regulatory Commission (NRC) staff has determined that the following information is needed in order to complete its review:

NRC RAI 1:

The release fraction for Cobalt 60 (Co-60) used in the design bases analyses assumes that the Co-60 is in the fuel cladding and structural materials. For the proposed change, the Co-60 available to be released during a design-basis accident (DBA) is not mixed with cladding and structural materials, but is in high concentrations within the isotope rods. Please justify why the DBA Co-60 release fraction used is applicable for the proposed isotope test assemblies. Please include any experimental data to justify the proposed release fraction.

Response 1:

For the purpose of this pilot program at CPS, the number of isotope rods is very small compared to the number of fuel rods in the CPS core. While the amount of cobalt (Co) in the core will be greater than that in a core without Isotope Test Assemblies (ITAs), the amount of Co remains very small compared to the amount of fuel and other materials present in the core. The isotope rods have a lower heat generation rate compared to fuel rods, and the isotope rods also contain a double layer of zircaloy encapsulation before exposure of the nickel-plated cobalt targets. In a Loss of Coolant Accident (LOCA) the cobalt will be mixed with the other metals surrounding the targets (i.e., zircaloy, zinc, uranium) and therefore there will not be a significant increase in the amount or fraction of cobalt released.

As documented in Attachment 3 to Reference 1, the release fraction for cobalt is based on the guidance provided in Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors." This is a conservative approach to the analysis of the LOCA results and is consistent with the analyses performed in support of the use of the alternate source term (AST) at CPS. There is no experimental data to support the use of this release fraction. It is expected that the release fractions from RG 1.183 will remain conservative for the CPS core containing ITAs.

NRC RAI 2:

Attachment 4, Section 4.3, "Evaluation of Design-Basis Accidents," of Reference 1 it states: The CPS Design-Basis Accidents (DBAs) to be evaluated are identified in Chapter 15.0 of the Clinton Power Station (CPS) Updated Safety Analysis Report (USAR). The Control Rod Drop Accident (CRDA), Main Steamline Break (MSLB)accident outside containment, Fuel Handling Accident (FHA), and Loss-of-Coolant Accident (LOCA) are licensed under Title 10 of the Code of Federal Regulations (10 CFR) Section 50.67, "Accident Source Term," per Regulatory Guide (RG) 1.183, *"Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors." In Reference 2, it states that the information needed includes a description of the analyses used to evaluate the impact of the proposed change on radiological consequences of DBAs in the CPS design bases. The proposed change only evaluates the impact on the DBAs described above. Please provide the information requested in Reference 2 for all DBAs in the CPS design bases or justify why this information is not needed.*

Response 2:

In addition to the Design Basis Accidents (DBAs) analyzed in Reference 1, the Clinton Power Station (CPS) design bases include eight limiting fault accidents or DBAs. These DBAs have been analyzed and are listed below by Updated Safety Analysis Report (USAR) location. As explained in the response to RAI 12(b) in Reference 3, the integrity of the isotope rods is expected to be maintained during the operational lifetime of an ITA. Furthermore, the response to RAI 12(b) in Reference 3 outlines the CPS ability to detect increased Co-60 activity in the reactor coolant and take appropriate response. Because of this, for all DBAs, the integrity of the isotope rods is expected to be maintained at the initiation time of the accident. A detailed explanation of all probable isotope rod failure modes was provided in the response to RAI 9(a) in Reference 3, along with key protective design features of the isotope rods. The response provides a technical basis to conclude that isotope rods are not more vulnerable to common failure modes than normal fuel rods during operation. Furthermore, the isotope rods have a lower heat generation rate compared to fuel rods, and the isotope rods also contain a double layer of zircaloy encapsulation before exposure of the nickel-plated cobalt targets. The isotope rods are therefore not more susceptible to failure during an accident than a fuel rod. Therefore, the radiological consequences are unchanged for a core operating with ITAs for a DBA in which no fuel failures occur as a result of the event.

Recirculation Pump Seizure (USAR 15.3.3)
The results of the CPS Recirculation Pump Seizure design basis radiological analysis concludes no fuel failures result due to the event. Therefore, the radiological consequences are unchanged for operation with ITAs.

Recirculation Pump Shaft Break (USAR 15.3.4)
The results of the CPS Recirculation Pump Shaft Break design basis radiological analysis concludes no fuel failures result due to the event. Therefore, the radiological consequences are unchanged for operation with ITAs.

Feedwater Line Break Outside Containment (USAR 15.6.6)
The results of the CPS Feedwater Line Break Outside Containment radiological analysis concludes no fuel failures result due to the event. Therefore, the radiological consequences are unchanged for operation with ITAs.

Main Condenser Offgas Treatment System Failure (USAR 15.7.1.1)
The CPS Main Condenser Offgas Treatment System Failure design basis radiological analysis is based on a 100,000 μCi/sec after 30 minutes delay noble gas source term.

Particulates such as cobalt have no effect on the accident consequences. Therefore, the radiological consequences are unchanged for operation with ITAs.

Malfunction of Main Turbine Gland Sealing System (USAR 15.7.1.2)
The CPS Malfunction of Main Turbine Gland Sealing System design basis accident occurs outside the containment and does not involve any barrier integrity aspects. Therefore, the radiological consequences are unchanged for operation with ITAs.

Failure of Main Turbine Steam Air Ejector Lines (USAR 15.7.1.3)
The CPS Failure of Main Turbine Steam Air Ejector Lines design basis accident analysis concludes there is no radiological release due to the event. Therefore, the radiological consequences are unchanged for operation with ITAs.

Liquid Radwaste Tank Failure (USAR 15.7.3)
The CPS Liquid Radwaste Tank Failure design basis accident analysis is based on a 100,000 μCi/sec after 30 minutes delay noble gas source term. Particulates such as cobalt have no effect on the accident consequences. Therefore, the radiological consequences are unchanged for operation with ITAs.

Cask Drop Accident (USAR 15.7.5)
The CPS Cask Drop Accident analysis determined that a dropped cask would not rupture, and no radiological release is associated with this event. Therefore, the radiological consequences are unchanged for operation with ITAs.

NRC RAI 3:

Reference 1 states, "The CPS licensing basis MSLB analyzed in Section 15.6.4 [Steam System Piping Break Outside Containment] of the CPS UFSAR assumes no fuel damage occurs as a result of the event." The NRC staff is concerned that the analysis assumes that no fuel damage occurs, but does not state whether damage occurs to the isotope rods. Confirm that no damage to the isotope rod occurs because of the event.

Response 3:

No damage to the isotope rods occurs due to this event. A detailed explanation of all probable isotope rod failure modes was provided in the response to RAI 9(a) in Reference 3, along with key protective design features of the isotope rods. The response provides a technical basis to conclude that isotope rods are not more vulnerable to common failure modes than normal fuel rods during operation. Furthermore, the isotope rods have a lower heat generation rate compared to fuel rods, and the isotope rods also contain a double layer of zircaloy encapsulation before exposure of the nickel-plated cobalt targets. The isotope rods are therefore not more susceptible to failure during an MSLB accident than a fuel rod.

NRC RAI 4:
During circulation, the reactor coolant acquires radioactive materials due to release of fission products from fuel leaks into the coolant and activation of corrosion products in the reactor coolant. These radioactive materials in the coolant can plate out in the reactor coolant system (RCS), and, at times, an accumulation will break away to spike the normal level of radioactivity. The release of coolant during a DBA could send radioactive materials into the environment. Limits on the maximum allowable level of radioactivity in the reactor coolant are established to ensure, in the event of a release of any radioactive material to the environment during a DBA, radiation doses are maintained within the limits of 10 CFR 100, "Reactor Site Criteria," and 10 CFR 50.67. The limits on RCS specific activity are also used for establishing standardization in radiation shielding and plant personnel radiation protection practices.

Technical Specification Limiting Condition for Operation (LCO) 3.4.8, "RCS [Reactor Coolant System] Specific Activity," states that "the DOSE EQUIVALENT I-131 specific activity of the reactor coolant shall be < 0.2 μCi/gm." Per the definition in Technical Specifications, DOSE EQUIVALENT I-131 is based upon I-131, I-132, I-133, I-134, and I-135. The NRC staff is concerned about whether the LCO adequately addresses the release of Co-60 into the RCS, since the DBA accident analyses (MSLB) does not appear to consider Co-60, nor does the RCS specific activity Surveillance Requirement monitor Co-60 in the RCS. In addition, Co-60 isotopic rods might fail independently of any fuel rod failures and operational data does not appear to exist for Clinton with the proposed isotope rods.

While no "fuel damage" due to the event is assumed, the current design basis safety analysis conservatively assumes the fuel pins leak. Clarify whether the operational design limit for the isotope rods is no leakage. Since the technical specifications are derived from the safety analysis, describe how the technical specifications will ensure that this assumption remains valid. Justify how LCO 3.4.8 remains able to insure that 10 CFR 50.67 and 10 CFR 100 limits (as applicable), and radiation shielding and plant personnel radiation protection design limits are met, or modify LCO 3.4.8 so that and these limits continue to be met after the proposed change.

Response 4:
As stated above, the Technical Specification (TS) LCO 3.4.8 is based on iodine specific activity limits. The iodine isotopic activities per gram of reactor coolant are expressed in terms of a DOSE EQUIVALENT I-131. The allowable levels are intended to limit the two hour radiation dose to an individual at the site boundary to a small fraction of the 10 CFR 50.67 limit. The specific iodine activity is limited to ≤ 0.2 μCi/gm DOSE EQUIVALENT I-131 since this ensures the source term assumed in the safety analysis for the MSLB is not exceeded and any release of radioactivity to the environment during an MSLB is less than a small fraction of the 10 CFR 50.67 limits.

CPS USAR Section 15.6.4.5.1.1 states that for a MSLB accident the "only activity available for release from the break is that which is present in the reactor coolant and steam lines prior to the break..." A number of isotopes are present in the reactor coolant during operation including cobalt. These isotopes are monitored on a regular basis by the station Chemistry department. Reactor water sampling procedures for CPS describe the frequencies of analysis, chemistry control specifications, and corrective actions for reactor water chemistry control. These procedures also define the requirements for the Reactor Water Chemistry control program based on BWRVIP-190, "BWR Water Chemistry Guidelines – 2008 Revision," TR-1016579. These procedures include periodic sampling for Co-60 activity.

The plant chemistry sampling programs provide detection capability to measure significant increases in Co-60 activity and take appropriate response, which can include plant shutdown. The rate of increase is affected by the amount of cobalt exposed to the reactor coolant; therefore, a catastrophic failure of the isotope rod would be readily detectable.

Failure of the isotope rods such that they were to become significantly compromised (i.e. that cobalt may have escaped from the cobalt isotope rods) is highly unlikely. References 1 and 3 document the multiple cobalt isotope rod design features intended to mitigate the failure and/or consequences of the failure of the ITA during operation. Regardless of the failure mode, two layers of zircaloy cladding and a layer of nickel plating must be breached before cobalt is exposed to reactor coolant. In order for an entire target to escape, the outer cladding and the inner cladding must be breached, then the two breach points would need to be aligned and of sufficient size. Beyond this, the nickel coating on the cobalt targets provides a protective barrier against releasing cobalt from the targets to the reactor coolant.

If an entire target were to become lodged where plant radiation monitors and radiological surveys provide detection capabilities, then appropriate response can be taken, which can include plant shutdown. If the target were to become lodged at a location remote to the plant radiation monitors, significant increases in radioactivity would be detected while performing radiological surveys during operation or shutdown.

As documented in Reference 3, the double containment design of the target rods provides additional protection against content release in comparison to normal fuel rods. The lack of gaseous fission products in the target rods ensure that the consequences in terms of radiological release are bounded by those of a standard fuel rod.

In summary, EGC monitors the reactor coolant chemistry on a regularly scheduled basis for radioactive isotopes including cobalt. TS 3.4.8, adequately addresses the specific activity of concern from an offsite dose consequence standpoint. The ITAs have been designed to ensure rod integrity is maintained and thus the introduction of cobalt to the RCS is not expected to occur. If the Co-60 targets were to be released into the reactor coolant, they are expected to remain in solid form and therefore, will not result in additional gaseous fission products to be released. While the TS 3.4.8 LCO does not address the additional cobalt in the CPS core, it does address the isotopic specific activity that ensures the source term assumed in the safety analysis for the MSLB is not exceeded. This is the basis for the LCO. In the unlikely event that Co-60 targets were to become loose in the reactor coolant system, radiation monitors and radiological surveys would identify the increased dose and if necessary increased shielding and radiological controls would be implemented to ensure worker safety.

NRC RAI 5:

Please provide calculations/dose information on the dose rate changes that can occur in the occupied areas of the plant as the result of handling a spent fuel assembly with the Co-60 in lieu of a fuel assembly (e.g., in the drywell), and the impact of those changes on occupational doses.

Response 5:

During refueling outages, dose rates on the refueling bridge (i.e., located at the 828' elevation of containment) average around 4 mR/hr while moving irradiated fuel. Additionally, dose rates on the 360 degree auxiliary work platform (i.e., a work platform located directly above the vessel) average 4 mR/hr on the work platform and 1 mR/hr inside the work platform carriage while fuel movement is in progress. On the 755' elevation of the fuel building, dose rates on the fuel handling bridge over the spent fuel pool average 1.5 mR/hr during fuel movement.

Physical interlocks are installed on both the refueling and fuel handling bridges in order to protect radiation workers from irradiated fuel being raised too close to the surface of the water. These interlocks include an uptravel interlock to maintain the top of active fuel in a fuel assembly at greater than or equal to 8.5 feet below the water level. Additionally, area radiation monitors (ARMs) are installed in both the refueling and fuel handling bridges cabs that notify the operator if the bridge cab radiation levels reach 10 mR/hr and cut power to the main hoist when the refueling platform ARM dose rate exceeds 50 mR/hr. ARMs are also installed along the pool handrails to notify personnel if a highly irradiated item approaches the surface of the water. These ARMs also help to alert personnel of rising dose rates on the pool skimmers. Remotely monitored telemetry is also installed on bridges, platforms, and pool handrails to monitor the environmental conditions in the area of the refueling operations. Workers may also be required to wear telemetry if their Radiation Work Permit (RWP) requires its use.

These above measures ensure the safety of plant personnel and contractors while moving fuel during refueling outages. The additional dose associated with the movement of the ITAs was determined and provided in Attachment 3 to Reference 1. Based on the single rod dose rate values documented in Table 4-4 of Attachment 3 to Reference 1, the additional contribution to the dose rate at the surface of the water (i.e., with the ITA top of active fuel at 8.5 feet below the surface of the water) from an irradiated ITA is expected to be less than 1 mR/hr. The dose rate on the refueling bridge and fuel handling bridge is expected to increase by a very small amount as a result of handling an irradiated ITA. As a result, the historical average dose rate for these activities is not expected to significantly change when handling the ITAs.

In addition to the fuel handling dose rates, it is recognized that the dose rates associated with the ITAs will affect the dose rate present when using the inclined fuel transfer system (IFTS). The IFTS is used to transfer fuel, control rods, defective fuel storage containers, and other small items between the containment and the fuel building pools by means of a carriage traveling in a transfer tube. The controls in place to prevent overexposure of workers while the IFTS is in use will ensure worker safety when transferring the ITAs. These include Operational Requirements Manual testing requirements that verify no personnel are in areas adjacent to the IFTS and that all access doors (including moveable shields) to rooms through which the IFTS penetrates are closed and locked.

In conclusion, the handling of the irradiated ITAs will not result in a significant increase in the dose rates in the occupied areas of the plant and therefore will not result in worker overexposure.

References:

1. Letter from Jeffrey L. Hansen (Exelon Generation Company, LLC) to U. S. Nuclear Regulatory Commission, "License Amendment Request to modify Clinton Power Station Facility Operating License in Support of the Use of Isotope Test Assemblies," dated June 26, 2009

2. Letter from Peter Bamford (USNRC) to Charles G. Pardee (Exelon Generation Company, LLC), "Clinton Power Station, Unit 1 – Withdrawal of License Amendment Request Regarding Bulk Isotope Generation Project (TAC No. ME0657)," dated May 19, 2009

3. Letter from Jeffrey L. Hansen (Exelon Generation Company, LLC) to U. S. Nuclear Regulatory Commission, " Additional Information Supporting the Request for a License Amendment to Modify Clinton Power Station Facility Operating License in Support of the Use of Isotope Test Assemblies," dated November 4, 2009