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

September 18, 2020

Mr. Robert D. Quinn
Nuclear Material Management, Director
Westinghouse Electric Company
1000 Westinghouse Drive
Cranberry Township, Pennsylvania 16066

SUBJECT: REQUEST FOR SUPPLEMENTAL INFORMATION – WESTINGHOUSE APPLICATION FOR THE SENTRY™ DRY STORAGE CASK SYSTEM, CERTIFICATE OF COMPLIANCE NO. 1026 (DOCKET NO. 72-1026, CAC NO. 001028, EPID: L-2020-LLA-0105)

Dear Mr. Quinn:

By letter dated April 30, 2020 (Agencywide Documents Access and Management System [ADAMS] Accession No. ML20121A196), as supplemented on June 5, 2020 (ADAMS Accession No. ML20164A120), Westinghouse Electric Company LLC (Westinghouse) submitted to the U.S. Nuclear Regulatory Commission (NRC) an application to amend the SENTRY™ Dry Storage System, Certificate of Compliance No. 1026, pursuant to the requirements of Part 72 of Title 10 of the *Code of Federal Regulations*.

The staff has performed an acceptance review of your application to determine if the application contained sufficient technical information to begin a detailed technical review. The staff has determined that the application does not provide sufficient technical information to begin a detailed review and that additional supplemental information is needed. The information needed to continue our review is described in the enclosed request for supplemental information (RSI).

In order to schedule our technical review, responses to the enclosed RSI should be provided within 30 days from the date of this letter. If you are unable to meet this response date, please notify us at least two weeks in advance of your new submittal date and the reasons for the delay. If you are unable to respond within this timeframe or RSI responses provided to the NRC do not provide sufficient information, the application may not be accepted for review. If you have any questions regarding this matter, I may be contacted at (301) 415-5196.

Sincerely,

Nishka Devaser

Nishka Devaser, Project Manager
Storage and Transportation Licensing Branch
Division of Fuel Management
Office of Nuclear Material Safety
and Safeguards

Docket No. 72-1026
EPID L-2020-LLA-0105
Enclosure: Request for Supplemental Information

SUBJECT: REQUEST FOR SUPPLEMENTAL INFORMATION – WESTINGHOUSE APPLICATION FOR THE SENTRY™ DRY STORAGE CASK SYSTEM, CERTIFICATE OF COMPLIANCE NO. 1026 (DOCKET NO. 72-1026, CAC NO. 001028, EPID: L-2020-LLA-0105)

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Request for Supplemental Information
Docket No. 72-1026
SENTRY™ Dry Storage System
Certificate of Compliance No. 1026

By letter dated April 30, 2020 (Agencywide Documents Access and Management System [ADAMS] Accession No. ML20121A196), as supplemented on June 5, 2020 (ADAMS Accession No. ML20164A120), Westinghouse Electric Company LLC (Westinghouse) submitted to the U.S. Nuclear Regulatory Commission (NRC) an application for the SENTRY™ Dry Storage System, Certificate of Compliance No. 1026, pursuant to the requirements of Part 72 of Title 10 of the *Code of Federal Regulations*.

This request for supplemental information identifies information needed by the NRC staff (the staff) in connection with its acceptance review of the SENTRY™ Dry Storage System application to confirm whether the applicant has submitted a complete application in compliance with regulatory requirements.

Of note, an additional consideration the staff would like to call attention to is the applicant's decision to commit to American Society of Mechanical Engineers (ASME) Section III Division 3 Subsections WD and WC. As the agency has not yet endorsed this section of the code, committing to this code may have impacts on the timeliness of the review for multiple disciplines.

Chapter 2 – Structural Evaluation

RSI 2-1. Provide additional information to support the benchmarking effort used to simulate the W180 storage cask with respect to end drop and tipover scenarios.

The applicant used analytical methods to calculate the response of the W180 and benchmarked them against information in NUREG/CR-6608. Appendix 4B of the FSAR, "End and Side Drop Analysis Methodology Evaluation," states that the analytical models were benchmarked against the steel billet drop test results presented in NUREG/CR-6608. Based on this benchmarking, the applicant concluded that their simulation of the W180 will accurately predict the response of the W180 and therefore it is acceptable for use in predicting the impact loads resulting from the postulated storage cask end drop and tip over scenarios. Sections 4.1.5.1, 4.6.5.6.1, and 4.6.5.7.1 of the FSAR discuss the end drop and tipover evaluations performed. In these sections, the applicant discusses design features credited for the mitigation of postulated end drop and tipover events.

The staff notes that physical test data used to validate or benchmark an analytical model for the W180 should be similar to ensure that the analytical model accurately predicts the behaviors of interest for the package (see Appendix 4A of NUREG-2215 for additional details). For instance, a package with similar design features credited to mitigate the effects of postulated end drop and tipover events as the W180 storage cask should be used for benchmarking. The applicability of the steel billet used in the drop tests presented in NUREG/CR-6608 as a benchmark for the W180 storage cask should be further substantiated. In addition, the W180 also has a construction that is composed of several shells and lids, which is unlike the solid cylinder in NUREG/CR-6608. Therefore, the W180 would be expected to have a different response behavior than the steel billet described in NUREG/CR-6608 in an end drop or tip-over scenario.

To allow the NRC staff to make its safety determination with respect to end drop and tipover evaluations, the following information is requested:

a. Additional benchmarking information. Analytical models used to represent the W180 storage system must be of good “quality,” which includes being based on a physical set of data from a system that is similar to the W180. In particular, physical testing of a given system should be representative of the W180. Any model used for simulation of a storage system needs to accurately capture items important to safety such as bolt behavior, plate vs shell behavior, welds that are three dimensional in behavior rather than just two dimensional, key design features as configured within the W180, plastic strain data at the confinement boundary etc. The solid cylinder in NUREG/CR-6608 does not capture all of the features and physical behaviors of the W180 storage system that are relied upon to ensure safety with respect to criticality, shielding and dose during end drop and tipover scenarios.

b. Input and output files of the analytical models used to simulate the storage system. Input and output files describe complex nonlinear behavior found in an end drop or tip-over analysis whose accuracy cannot be determined sufficiently solely by text descriptions or screen shots in an FSAR. A determination of reasonable assurance cannot be made without the input/output files used in these analyses.

This information is required to comply with 10 CFR 72.122(a)(b) and 72.236 (b).

RSI 2-2. Provide stability calculations that support the W180 storage cask when subjected to accident conditions.

Table 4.4-4 of the SENTRY FSAR lists the analytical approach used to evaluate the W180 Storage Cask. It mentions stability evaluations for various scenarios such as earthquake, flooding, tornado and explosion and refers to appropriate sections in the FSAR for additional information. However, the information provided in the FSAR does not have sufficient detail for the staff to reach a safety finding. The applicant is requested to provide the data/calculations labeled as “Stability Evaluation” for the accident conditions identified in Table 4.4-4.

This information is necessary to allow compliance with 10 CFR 72.122 and 72.103.

Chapter 3 – Thermal Evaluation

<u>Observations</u>

Obs 3-1. Provide the SSCs ITS temperatures and canister pressures during accident transfer conditions, especially a condition that challenges shielding materials.

There was limited information about canister pressures and SSCs ITS temperatures during accident transfer conditions that challenge concrete and the lead and epoxy resin of the W110 transfer cask, which are used for shielding. For example, it is possible fire could impact the transfer cask, considering that safety analysis report (SAR) Sections 3.2.2.3.6 and 5.4.1.2.7 stated there is enough fuel within the vehicle that could result in a fire.

This information is needed to determine compliance with 10 CFR 72.236(b).

Obs 3-2. Clarify in SAR Chapter 3 and Chapter 5 that the 80°F ambient temperature specified in the Chapter 5 thermal analyses is one modeling temperature used to demonstrate SENTRY dry storage system (DSS) performance at a specified normal condition, rather than a representation of a bounding normal condition ambient temperature to be used by licensees.

SAR Section 5.3.1 stated "… a long-term annual average design temperature of 80°F is selected for the SENTRY DSS normal storage, which bounds all site locations in the contiguous United States" and SAR Section 3.2.2.1.1 indicated that a licensee is to confirm that a site's annual average ambient temperature is bounded by 80°F. However, it is noted that the thermal analysis performed by a licensee is to demonstrate safe DSS operation at all normal conditions, including high seasonal (e.g., summer) ambient temperatures, which may be greater than 80°F.

This information is needed to determine compliance with 10 CFR 72.236(f).

Obs 3-3. Demonstrate with supporting analyses and discussion that the thermal models discussed in the thermal chapter accurately model the thermal-related phenomena for steady-state storage and transient operations.

SAR Chapter 5 described both three-dimensional (3D) and two-dimensional (2D) FLUENT models that were used in the SAR thermal analyses and which are the basis for the reported Important-to-Safety (ITS) component temperatures. The thermal analyses considered the W37 canister and W21H canister in the W180 storage cask, the W37 canister and W21H canister in the W110 transfer cask, and various thermal transient analyses (e.g., vacuum drying). a) It is noted in the thermal analysis that the PCT results for canister W37 (45 kW) and canister W21H (65 kW) were at similar temperatures. The chapter does not demonstrate how the unique thermal aspects associated with the W21H canister, with much greater power density (kW/m^3), would have resulted in a similar PCT as the lower power density canister, nor does it provide input, convergence, energy balances, and solution values to confirm performance of the two canister models. b) There was limited information and validation associated with the "equivalence" between the (transient) two-dimensional and three-dimensional thermal models, recognizing that a steady-state comparison between 2D and 3D models would not explicitly demonstrate appropriate consideration of thermal mass effects. Using appropriate models are needed to ensure bounding temperatures on important to safety components during steady-state and transient operations. c) There was limited information on the methodology for modeling fin performance, in the 3D and 2D representations including fin effectiveness and fin efficiency found in ta detailed sub-model. It is noted that details of the turbulence model and its parameters would impact results, especially considering the flow field around the fins is within an enclosed annular gap; these details were not provided. Likewise, there was no validation of the "non-thermal equilibrium porous media" to model the 2D fins, which is an important heat transfer component. Considering the extent of the above-mentioned issues that need to be addressed, the applicant can provide the input and output files of the 2D and 3D FLUENT thermal models presented in SAR Chapter 5 to aid the review.

This information is needed to determine compliance with 10 CFR 72.234(a) and 72.236(f).

Chapter 4 – Containment Evaluation

Observations

Obs 4-1. In SAR Sections 9.1.1 Design Criteria and 9.1.2.1 Confinement Vessel, reference is made to "Sections 3.1.1 and 3.4.2." These sections do not seem to exist in the SAR.

Chapter 5 – Shielding Evaluation

RSI 5-1. Provide code benchmarking analyses for the DORT code for shielding analyses or references that demonstrate the code has been adequately benchmarked for this application.

The applicant used the DORT code to calculate the adjoint function that is used in the shielding calculation. In accordance with the ANSI/ANS standard ANSI/ANS-6.1.2-2013[1], the analyses performed for numerical benchmarking shall be documented in sufficient detail to allow an experienced shielding analyst to duplicate the results. In order to assure the validity of the method of evaluation for shielding design, it is imperative to have the code benchmarked for the specific application. However, the applicant provides little information regarding how the code is benchmarked for this application. In addition, in the description of the DORT code, the Nuclear Energy Agency (NEA)[2] states: "[T]the Boltzmann transport equation is solved, using either the method of discrete ordinates or diffusion theory approximation. In the discrete ordinate's method, the primary mode of operation, balance equations are solved for the flow of particles moving in a set of discrete directions in each cell of a space mesh and in each group of a multigroup energy structure." It does not provide code benchmarking or references that demonstrate the code has been adequately benchmarked for this application. As such, the staff cannot determine if the code is appropriate for this application.

The staff needs this information to proceed with its review of the SENTRY dry storage system design to determine if the design meets the regulatory requirements of 10 CFR 72.236(d).

[1] ANSI/ANS standard ANSI/ANS-6.1.2-2013, "Group-Averaged Neutron and Gamma-Ray Cross Sections for Radiation Protection and Shielding Calculations for Nuclear Power Plants," American Nuclear Society, 2013.
[2] http://www.oecd-nea.org/tools/abstract/detail/ccc-0543.

Observations

Obs 5-1. Explain how the adjoint function calculated by the two-dimensional transport theory-based DORT code is used to calculate the dose rates around the cask.

The applicant used the DORT code to calculate the adjoint function that is used in the shielding calculation. However, there is no detailed information on how the discrete-ordinate adjoint function is used in the MCNP model to calculate the dose rates of the cask.

The staff needs this information to proceed with its review of the SENTRY dry storage system design to determine if the design meets the regulatory requirements of 10 CFR 72.236(d).

Obs 5-2. Demonstrate that the 1980 version of the ORIGEN 2.1 computer code is adequate for calculating the source terms of fuel assemblies with burnup exceeding 45 GWd/MTU.

The applicant used the 1980 version of the ORIGEN 2.1 computer code to calculate the source terms. However, the staff's understanding is that the code is not capable for accurately calculating the source terms of fuel assemblies with burnup exceeding 45 GWd/MTU because the algorithm and cross section library the code uses are known to have deficiencies.

The staff needs this information to proceed with its review of the SENTRY dry storage system design to determine if the design meets the regulatory requirements of 10 CFR 72.236(d).

Obs 5-3. Provide the referenced document for the ADSORB computer code.

The applicant developed a computer code, ADSORB, that is used to determine the allowable contents. The applicant referenced a document titled "CMPC.1703.006, Development and Validation of ADSORB Computer Code, Revision 2." The applicant states that this computer code is used to determine the allowable contents based on combining the shielding and thermal acceptance criteria, the adjoint shielding and the generic decay library and the output of the ADSORB code is in the fuel cooling tables. The applicant, however, did not provide this document. The staff cannot assess the validity of the computer code without the referenced document. An annotated sample input will be helpful for the staff to understand the code since this code is not in the Radiation Safety Information Computational Center (RSICC) collection and hence the staff does not have access to this code.

The staff needs this information to proceed with its review of the SENTRY dry storage system design to determine if the design meets the regulatory requirements of 10 CFR 72.236(d).

Chapter 6 – Criticality Safety Evaluation

Observations

Obs 6-1. Demonstrate how the GBC-32 Canister is sufficiently similar/applicable to the SENTRY W37 Canister for burnup credit analyses.

The applicant took burnup credit in its criticality safety analyses for the SENTRY W37 Canister and states that it used the guidance provided in NUREG/CR-7108 and NUREG/CR-7109. However, the staff notes that the guidance in ISG-8, Rev. 3 explicitly states that the users of the guidance must demonstrate that the neutronic characteristics of the W37 cask are sufficiently similar to that of the GBC-32 cask in order to be able to use the recommendations provided in Revision 3 of Interim Staff Guidance No. 8 (ISG-8). Specifically, ISG-8, Rev. 3 states: “This demonstration should consist of a comparison of system materials and geometry, including neutron absorber material and dimensions, assembly spacing, and reflector materials and dimensions, etc. This demonstration should also include a comparison of neutronic characteristics such as hydrogen-to-fissile atom ratios (H/X), energy of average neutron lethargy causing fission (EALF), neutron spectra, and neutron reaction rates.”

Also, the staff notes that the applicant took burnup credit only for some of the fuel assemblies as shown is Figure 7.2-2 of the SAR. In addressing the similarity requirement of recommendation of the ISG-8, Rev. 3, the applicant needs to consider this unique feature of the W37 canister design.

The staff needs this information to proceed with its review of the SENTRY dry storage system design to determine if the design meets the regulatory requirements of 10 CFR 72.124 and 72.236(c).

Obs 6-2. Explain how the grid spacers are treated in the SCALE models for criticality safety analysis and why it is acceptable.

SAR Table 3-1 indicates that the design basis minimum soluble boron concentration is 2600 PPM. The staff’s experience is that the grid spacers and non-fuel hardware (if loaded), should be explicitly represented in the criticality safety analysis models when the required soluble boron concentration is at an elevated level because the displacement of the highly borated water could cause the reactivity to increase.

The staff needs this information to proceed with its review of the SENTRY dry storage system design to determine if the design meets the regulatory requirements of 10 CFR 72.124 and 72.236(c).

Chapter 7 – Materials Evaluation

Observations

Obs 7-1. In SAR Section 8.6.1, clarify the penetrant testing acceptance criteria for indications in the canister closure lid-to-shell weld.

SAR Section 8.6.1 describes a calculation of the "allowable weld flaw depth" for the closure lid-to-shell welds, which is based on ASME Boiler and Pressure Vessel (BPV) Code Section XI Nonmandatory Appendix C, "Evaluations of Flaws in Piping."

It is unclear to the staff whether that calculated flaw depth will be used to define the minimum intervals for surface examinations for the multi-pass closure weld (per NUREG-2215, Section 8.5.3.2.1), or if it may also be used to define the acceptance criteria for the liquid penetrant examination of the closure welds. The staff notes that SAR Table 12.1-3 states that the examinations of welds are to be performed in accordance with ASME BPV Code Section III, Division 3, Subsections WC and WD. Paragraph WC-5352 states that any crack or linear indication is not acceptable when examined with the liquid penetrant method.

This information is needed to evaluate compliance with 10 CFR 72.236(d), (e), and (j).

Obs 7-2. Provide the technical basis for the maximum allowable concrete overpack temperatures for off-normal and accident conditions that appear to exceed the cited American Concrete Institute (ACI) standard.

Section E-4 of ACI 349-13, "Code Requirements for Nuclear Safety-Related Concrete Structures," states that, for accidents or other short-term periods, the temperature of the concrete surface shall not exceed 350°F. A local area from a steam or water jet due to pipe failure is allowed to reach 650°F. ACI 349-13 allows higher temperatures than these if tests are provided that evaluate the potential loss of strength.

SAR Table 5.2-2 references the ACI 349-13 limits, but the SAR appears to apply these limits in manner that is not consistent with the code. Whereas ACI 349-13 applies the 350°F limit to the concrete surface, the SAR applies it to the bulk average concrete temperature. Also, ACI 349-13 applies the 650°F limit to a local area (e.g., location of a steam leak); it is not clear how the SAR defines a "local" area allowed to reach 650°F.

As a result, the staff requests the following:

1. A technical basis that demonstrates that a bulk average concrete temperature exposure of 350°F (where the surface may reach as high as 558°F per SAR Figure 5.4-14) will not decrease strength and lead to moisture loss to an extent that could prevent the overpack from fulfilling its structural and shielding functions.

2. Clarification of what defines the extent a "local" area (i.e., area and depth affected), and a demonstration that the exposure of the concrete

overpack to conditions where a local area reaches 650°F will not prevent the overpack from fulfilling its structural and shielding functions.

This information is needed to determine compliance with the requirements of 10 CFR 72.236(b) and (d).

Obs 7-3. Demonstrate that stresses caused by differential thermal expansion cannot lead to overloading of ITS bolting.

SAR Section 8.7 states that no bolts are used in the confinement boundary for the SENTRY dry cask storage system. It does not address other ITS bolting (e.g., transfer cask and storage cask lid bolts) that may experience loads due to different coefficients of thermal expansion of bolting materials and the materials being joined.

This information is needed to determine compliance with the requirements of 10 CFR 72.236(b) and (d).

Chapter 8 – Operations Evaluation

Observations

Obs 8-1. Provide the time required for loading, welding, and transferring the canisters to storage pad and appropriate justification for these time estimates (e.g., procedures).

The applicant provided some general descriptions for loading, welding, and transferring the canisters to storage pad. However, not enough information is available for the staff to assess the adequacy of the radiation protection plan for workers as provided in SAR Chapter 10.

The staff needs this information to proceed with its review to determine if the SENTRY dry storage system design meets the regulatory requirement of 10 CFR 72.236(d).

Chapter 9 – Quality Assurance Evaluation

RSI 9-1. Revise SAR 15.1, QUALITY ASSURANCE PROGRAM FOR SENTRY DSS, Reference 3.0, to reflect currently approved WEC QAP, Revision 8.

SAR 15.1 QUALITY ASSURANCE PROGRAM FOR SENTRY DSS, states that the requirements of Subpart G "Quality Assurance" of 10 CFR 72 are met by the Westinghouse Quality Management System (QMS), Reference 3. Reference 3 commits to Westinghouse Electric Company QMS, Revision 7, dated August 2013. The NRC staff has subsequently reviewed Westinghouse's QMS, Revision 8.0 and has concluded that there is reasonable assurance that Westinghouse's QMS will continue to meet the requirements of Appendix B to 10 CFR Part 50 and 10 CFR Part 71 Subpart H. Subsequently, the NRC staff found Westinghouse's proposed changes in the QMS, Revision 8.0, to be acceptable (ADAMS Accession No. ML20132A321).

The staff needs this information to proceed with its review to determine if the SENTRY dry storage system design meets the regulatory requirement of 10 CFR 72.140(c).