NRC Responses to Questions on Proposed Waste Storage at SONGS

1. **How many thick-wall canister applications has the NRC received in the past 10 years? Which applications were approved?**

   The U.S. Nuclear Regulatory Commission (NRC) has not received any applications for what you refer to as "thick-wall" dry cask storage systems in the past 10 years. These "thick-wall" systems are metal storage casks with bolted lids sealed by metal O-rings between the cask body and the bolted lid. These systems are designed with low alloy steel plates and forgings with neutron absorbing material or cast iron materials for radiation shielding and physical protection.

   All dry cask storage system designs must meet applicable NRC regulatory requirements in order to be used at independent spent fuel storage installations (ISFSIs). There are several "thick-wall" dry cask storage systems that were reviewed and approved by NRC more than 10 years ago and are in use at ISFSIs in the U.S. These systems include:

   (i) TN Americas TN-32 for pressurized water reactor (PWR) fuel (Certificate of Compliance [CoC] 1021) and the TN Americas TN-68 for boiling water reactor (BWR) fuel (CoC 1027).

   (ii) TN Americas TN-40 and TN-40HT metal storage casks with bolted lids. This system is similar to the TN-32 (CoC 1021) metal cask with the capacity for storing up to 40 PWR fuel assemblies. This system is used at the Prairie Island ISFSI which was approved in 1993.

   (iii) GNB CASTOR systems are in use at the specifically licensed ISFSI at Surry. The GNB CASTOR V/21 and X/33 were manufactured using nodular cast iron sections for radiation shielding and physical protection. The Surry ISFSI was approved in 1986.

   (iv) Holtec HI-STAR 100 systems are in use for dry storage of BWR fuel assemblies and greater than class C waste at the Humboldt Bay, Dresden, and Hatch ISFSIs. The HI-STAR 100 systems use a welded stainless steel multipurpose canister inside of a "thick-wall" carbon steel overpack for radiation shielding and physical protection. The Holtec HI-STAR 100 system was approved in 1999.

2. **Why were thin-wall canisters with lids welded shut approved for SONGS, while thick-wall canisters with bolted lids were approved for seven sites across the nation: Arkansas Nuclear One (AR), Palisades (MI), Prairie Island (MN), McGuire (NC), Peach Bottom (PA), Surry (VA), and Point Beach (WI)?**

   Before approving any dry cask storage system for use, the NRC first determines that it meets all applicable regulatory requirements through a robust engineering review of the design. After a system is approved, the NRC conducts inspections of ISFSI operations and manufacturing of the dry cask storage systems to ensure continued compliance with all applicable regulatory requirements.

   A licensee selects the dry cask storage system to be used at its facility. Selection of a dry cask storage system is based on the operational needs of the ISFSI. Every licensee

using an NRC approved dry cask storage system listed in 10 CFR 72.214 is required to perform an evaluation to show that for the conditions at the ISFSI location, the dry cask storage system(s) selected will meet all of the applicable requirements. This evaluation, described in Chapter 10 of the *Code of Federal Regulations* (10 CFR) 72.212, "Conditions of general license issued under § 72.210," requires the licensee to consider, among other things, the range of natural hazards for the ISFSI location. The NRC inspects the 10 CFR 72.212 evaluation as part of ISFSI inspection activities.

Most of the welded stainless steel canisters, including the systems in use at the San Onofre Nuclear Generating Station (SONGS) ISFSI, are designed to be transportable inside a specially designed transportation overpack. This allows the fuel to be stored and transported without the need for additional fuel handling. Some of the "thick-wall" carbon steel or cast iron casks with bolted lids were designed for storage only which may require the fuel to be transferred to a transportation cask for shipment.

There are a total of 225 of the "thick-wall" dry cask storage systems in use at NRC licensed ISFSIs. Thick-wall metal casks with bolted lids are used at Prairie Island, McGuire, Peach Bottom, Surry, Dresden, Hatch and Humboldt Bay. The ISFSIs at Arkansas Nuclear One, Point Beach and Palisades use only welded canister based systems for dry storage rather than the "thick-wall" metal casks with bolted lids.

3. What is the rationale for the NRC not having real time radiation monitoring on the internet or EPA RadNet monitors near nuclear plants - active and decommissioned?

The NRC staff evaluated imposing new requirements associated with real time radiation monitoring and provided the information to the Commission in SECY-16-0144, "Proposed Resolution of Remaining Tier 2 and 3 Recommendations Resulting from the Fukushima Dai-ichi Accident" dated December 29, 2016 (Agencywide Documents Access and Management System [ADAMS] Accession No. ML16286A586). Details of the evaluation specific to real time radiation monitoring are in Enclosure 3 (ADAMS Accession No. ML16286A583).

4. What are the emergency plans for nuclear waste at SONGS in the case of mishandling, leaks, natural disasters or act of terrorisms?

The emergency plan for the ISFSI at SONGS is covered by the reactor license (10 CFR Part 50) and satisfies the requirements of 10 CFR Part 72, in accordance with 10 CFR 72.32(c). The emergency plan identifies actions to be taken to address a release and mitigate the consequences of a release regardless of the initiating event. This emergency plan is publicly available (ADAMS Accession No. ML14339A667).

Protection from and responses to security-related events are addressed in the licensee's NRC-approved Physical Security Plan, which is not publicly available.

5. How are the Holtec and Areva canisters secure against terrorism, mishandling, earthquakes, floods, tsunamis, humidity and other corrosive conditions?

An ISFSI licensee must comply with the security requirements which are implemented in the licensee's NRC-approved Physical Security Plan. NRC regularly inspects the

licensee's implementation of the approved security plan to ensure compliance with the security requirements.

All dry cask storage systems approved by the NRC for use at ISFSIs, including the Holtec and Areva systems used or proposed for use at SONGS, must be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, lightning, hurricanes, floods, tsunami, and seiches, without impairing their capability to perform safety functions. The materials used in the construction of dry cask storage systems are evaluated to ensure they will not degrade when exposed to the range of operating environments encountered in fuel loading, transfer and storage. In addition, the NRC has evaluated potential corrosive conditions and determined that they will not have an impact during the initial licensing period for the Holtec and Areva systems used or proposed for use at SONGS.

Implementation of aging management programs approved by the NRC will provide the mechanisms by which the environmental effects on the storage cask systems, such as corrosive conditions, can be detected, assessed, and mitigated to maintain the canister confinement boundary integrity after the initial license period (i.e., the period of extended operation).

6. Describe the material construction of the Holtec and Areva canisters. Why are they a safe device to store in the concrete storage ISFSI onsite at San Onofre?

The Holtec and Areva systems have been reviewed and, after determining that the systems meet all applicable requirements so that fuel would be stored safely, approved by the NRC. The engineering evaluation of each dry cask storage system is documented in a Safety Evaluation Report (SER), which describes the basis for the NRC's approval. The NRC's SERs are available for public review in ADAMS.

A description of the TN Americas (formerly Areva TN) CoC 1029 canisters currently in use at SONGS and the NRC's safety evaluation of this dry cask storage system are included in the NRC's SERs (ADAMS Accession Nos. ML030100459 and ML15054A499).

A description of the Holtec CoC 1040 canisters proposed to be used at SONGS and the NRC's safety evaluation for this dry cask storage system are included in the NRC's SERs (ADAMS Accession Nos. ML15093A510, ML15252A423, and ML16341B129).

7. What are the warranty details for the concrete over pack? Does a failure of the concrete over pack nullify either the Areva or Holtec canister warranty?

The NRC does not review, nor do its regulations require, purchase agreement warranties between a dry cask storage system manufacturer and the owner of an NRC-licensed ISFSI.

Regardless of any warranty or purchase agreement, an ISFSI licensee is required to maintain the dry cask storage systems, including any concrete over packs, so that they function in accordance with the NRC's regulatory requirements.

All important-to-safety structures, systems, and components of the dry cask storage system, including the canisters, must satisfy applicable regulatory requirements for the

duration of the initial license period. Before license renewal, the licensee must demonstrate that the ISFSI structures, systems and components will continue to meet applicable design criteria and will perform applicable safety functions. Any aging processes that could adversely affect an important-to-safety structure, system, or component must be addressed through an aging management program. These aging management programs are inspected by the NRC. If the licensee should discover degradation of an over pack, the NRC would provide oversight of the licensee's corrective actions to ensure that the over pack continues to fulfill its safety functions.

8. Under environmental conditions like SONGS, what specific Reliability Tests has the NRC staff conducted on either the Holtec and/or Areva canisters? What are the Mean Time Between Failure for each canister and at what confidence level? Please provide a copy of the test and the results of each test.

The NRC does not conduct or require specific reliability tests on passive components and systems such as canisters. Reliability tests are typically performed on active components and systems like pumps and valves at operating power reactors that are relied upon for safe system operation. Dry cask storage systems do not contain active components which would require reliability testing. Implementation of aging management programs provides the mechanisms by which aging effects on a passive system, such as storage casks, can be detected, assessed, and mitigated early.

Before approving a dry cask storage system, the NRC conducts a deterministic evaluation of the dry cask storage system design based on the engineered design of the system and the performance of known materials. The NRC also conducts inspections of the licensee's engineering evaluation, quality assurance programs, maintenance operations, and dry cask storage system fabrication and testing activities.

The NRC and the Electrical Power Research Institute (EPRI) have also conducted risk analyses for dry cask storage systems. Results from these analyses, including the probability of canister failure, were documented in the following publically available reports.

(i) NUREG-1140, "A Regulatory Analysis on Emergency Preparedness for Fuel Cycle and Other Radioactive Material Licensees" (ADAMS Accession No. ML062020791), August 1991.

(ii) NUREG-1864, "A Pilot Probabilistic Risk Assessment of a Dry Cask Storage System at a Nuclear Power Plant" (ADAMS Accession No. ML071340012), March 2007 (conducted for a specific dry cask system (Holtec International HI-STORM 100) which uses a welded stainless steel canister similar to the canisters used at many ISFSI locations in the U.S, including the ISFSI at SONGS).

(iii) EPRI Technical Report 1009691, "Probabilistic Risk Assessment (PRA) of Bolted Casks, Revised Quantification and Analysis Report," December 2004.

(iv) EPRI Technical Report 1002877, "Probabilistic Risk Assessment (PRA) of Bolted Casks, Quantification and Analysis Report," December 2003.

9. Has the NRC performed a Failure Modes and Effects Analysis on either the Holtec or Areva canister used or proposed for San Onofre? If not why? If yes, please provide copies of the FMEA for both canisters?

The NRC recently completed an extensive review of dry cask storage systems for the development of aging management guidance. This review was documented in NUREG-2214, "Managing Aging Processes in Storage (MAPS) Report, Draft Report for Comment." The NRC review considered specific dry cask storage system designs, operating environments, materials of construction, and potential aging mechanisms that could affect the intended functions of the important-to-safety structures, systems and components. For welded stainless steel canisters, chloride induced stress corrosion cracking (CISCC) was determined to be the only plausible mechanism that could affect the confinement function provided by the canister. Potential CISCC is considered by the NRC during its review of proposed storage systems, including measures to detect and mitigate CISCC. The NRC report NUREG-2214 is publicly available (ADAMS Accession No. ML17289A237) and the NRC is soliciting public comments on the report through December 26, 2017 (*Federal Register* Notice, 82 FR 49233).

EPRI has also conducted a failure modes and effects analysis for dry cask storage systems that use welded stainless steel canisters. The EPRI failure modes and effects analysis report concluded that CISCC is the only credible mechanism that could lead to loss of confinement for a welded stainless steel canister. According to this report, the effects of CISCC penetration of the canister confinement boundary would be limited to the release of fission product gasses through the small, tight cracks created by CISCC. For the small crack opening areas expected in the event of canister penetration by CISCC during storage, the EPRI report states that a low canister leak rate is expected that would release few, if any, particulates. The EPRI failure modes and effects analysis report is publically available through EPRI. (EPRI-3002000815, "Failure Modes and Effects Analysis (FMEA) of Welded Stainless Steel Canisters for Dry Cask Storage Systems," December 2013).

10. Has the NRC performed environment stress screening tests on either the Holtec or Areva canister used or proposed for SONGS? If not why? If yes, please provide copies.

The NRC has conducted testing to determine the conditions under which welded stainless steel canisters, such as the Holtec and Areva canisters used or proposed for use at SONGS, may be susceptible to stress corrosion cracking, including CISCC. The results of these studies were published in two publicly available NUREG/CR reports:

NUREG/CR-7030, "Atmospheric Stress Corrosion Cracking Susceptibility of Welded and Unwelded 304, 304L, and 316L Austenitic Stainless Steels Commonly Used for Dry Cask Storage Containers Exposed to Marine Environments." ADAMS Accession No. ML103120081, October 2010.

NUREG/CR-7170, "Assessment of Stress Corrosion Cracking Susceptibility for Austenitic Stainless Steels Exposed to Atmospheric Chloride and Non-Chloride Salts." ADAMS Accession No. ML14051A417, February 2014.

The NRC used the information documented in these reports, along with relevant operating experience at commercial nuclear power plants and research conducted by

engineers in the United Kingdom and Japan, to develop the example aging management program for localized corrosion and stress corrosion cracking of welded stainless steel dry storage canisters included in Appendix B of NUREG-1927, "Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel Final Report", Revision 1 (ADAMS Accession No. ML16179A148).

11. How would the NRC inspect and determine if a SONGS canister was compromised?

NRC licensees are responsible for safety and security at NRC-licensed facilities. This responsibility includes the acceptance testing, maintenance, and inspection of dry cask storage systems. The NRC reviews and approves acceptance testing, maintenance, and inspection programs, including aging management programs, for dry cask storage systems to ensure that those programs meet the NRC's regulatory requirements. The NRC also reviews the implementation of inspection programs as part of ISFSI inspection activities. These programs and inspections allow licensees, including SONGS, and the NRC, respectively, to identify a compromised canister.

12. What would happen if a SONGS spent fuel canister sustained corrosion that led to a through-wall crack?

The NRC does not consider that through-wall cracking of a spent fuel canister is credible during the initial licensing period of 20 years for the Areva and Holtec systems that are or are proposed for use at SONGS, because of the long time needed for CISCC to grow through the thickness of the canister under typical storage conditions (i.e., 30 years based on site specific National Oceanic and Atmospheric Administration data). After the initial 20-year license period for these systems, aging management programs would be implemented to detect the effects of aging and apply corrective actions such that the safety functions of the system are maintained. Similar to the approach used for nuclear power reactor high pressure piping, any identified areas of canister degradation would trigger additional examinations capable of fully characterizing the extent and severity of degradation. The licensee then must demonstrate that the canister continues to fulfill its safety function or must pursue repair or other options to ensure that the spent fuel is safely confined.

13. How would a potentially compromised SONGS spent fuel canister be repaired or replaced?

Any potential corrective actions for a dry cask storage system would be case-specific. The NRC does not prescribe how licensees would take corrective action with respect to specific spent fuel canister designs. The NRC evaluates whether the corrective action taken is effective and sufficient to maintain the intended functions of the important-to-safety structures, systems, and components, and remain compliant with the requirements in 10 CFR Part 72.

Mitigation options for welded stainless steel canisters are expected to be similar to those that have actually been used on components in commercial nuclear power reactors, such as the application of remote repair welding techniques. Proposed repair methods require demonstration and compliance with an NRC-approved quality assurance program.