HOLTEC INFORMATION BULLETIN (HIB)

Parsing the present to protect the future

Title of the Bulletin: Risk of Kr-85 release during Canister drying

CoC Holder:	Holtec	HIB No. (sequential):	HIB-52	**Revision Log:**	Name	Date
System Name:	HI-STORM	Ref. Nuclear Plant:	Holtec Users Group / ANO Unit 1	Author (Rev. 0):	DMM	11/11/11
				Reviewer (Rev 0):	PKC	11/11/11
Holtec Program No.:	Various	Period of Occurrence (m/y):	Rev. 0 : 08/16/2011 Rev 1: 09/2015	Author (Rev. 1):	SPA	02/15/15
				Reviewer (Rev 1):	JDG	02/16/15
Affected Component(s):	N/A	Affected equipment or part	N/A	Author (Rev. 2):	SPA	4/24/2017
				Reviewer (Rev 2):	KM	4/25/2017
Urgency Level*:	3	Event Category**:	G			
Probable Cause***	11	72.48 Applicable (Yes or No) If yes, then list 72.48#.:	No			
Holtec's Corrective Action # if Applicable:	No	10 CFR Part 21 Applicable (Yes or No) If yes, Date NRC Informed:	No			

Legend

* (1) High (Immediate attention required by user); (2) Medium (Action by users should occur within 10 days of receipt); (3) Low (Any required actions should occur as soon as practical); (4) Non- consequential/For Information (No action is required by user)

Note: Severity level indicates the needed urgency of acting on this bulletin to ensure safety of operating or soon -to- be -commissioned SSCs provided by Holtec. This notice should be incorporated prior to next loading campaign, if applicable.

**H: Holtec system related; P: Peer system related; G: Industry generic; Q: Guided by the Company's (proactive) quality initiative program

*** (1) Weakness in Mechanical Design (inappropriate or unachievable tolerances, drafting error, etc.); (2) Unsuitable analysis (erroneous input data, inappropriate analysis methodology, or defect in the computer code utilized); (3) Improper material selection (poor weldability, machinability, lamination concerns, etc.); (4) Inadequacy in the client's ISFSI operation procedure; (5) Inadequacy in a procedure provided by Holtec; (6) Administrative deficiency (such as failure to transmit information to the Client); (7) Human Error; (8) Manufacturing Deficiency; (9) Error in procurement, (10) Not event based, part of quality enhancement initiative, (11) miscellaneous.

POLICY STATEMENT & APPLICABILITY

The Holtec Information Bulletin (HIB) is principally used by the company to document relevant industry events pertaining to fuel storage at nuclear plants and to disseminate the knowledge gleaned from such events to the Holtec Users' Group (HUG) membership, the company's personnel, affected suppliers, and other stakeholders. While the great majority of the events cataloged in the HIBs focus on our system, a HIB may be issued on industry events involving another nuclear supplier system where the lesson learned can be beneficially applied in the Company's fuel storage program. A HIB is prepared, internally reviewed, and issued expeditiously after an event is determined by the company to be significant to warrant dissemination. HUG members are encouraged to contact NPD Program Manager to suggest events that merit a HIB. Revised versions of the HIB may be distributed as the analysis and evaluation of the event proceeds.

A HIB may also be issued to inform/alert our stakeholders of non-event derived information that is deemed to merit immediate release to assist the Company's customers. Such information may pertain to enhancements in system design/operations proactively developed by the Company or to identify latent errors/weaknesses in the Company's information base discovered from ongoing operations.

Finally, the Company uses the HIB as the vehicle, if applicable, to notify Part 71, Part 72 and Part 50 licensees of immediate and/or interim corrective actions to be taken in response to a development (such as notification of a potential Part 21 filing). HIBs are prepared by the Nuclear Power Division of Holtec International and are aimed to help improve the fuel management program of the Company and all of its customers/suppliers. Accordingly, the Company expects its clients and suppliers to take appropriate action pursuant to this bulletin. This bulletin is subject to internal reviews to ensure accuracy and clarity, and, as such, may be used in the corrective action process, if applicable, under the Company's QA program. This form is stored in g:\generic\HIB\ directory.

ISSUE BACKGROUND

There have been several instances during loading and drying of fuel in dry storage canisters where a release of radioactive material, notably Krypton-85, a fission product gas, was observed. These releases have occurred with both Holtec and TN systems.

The observation of fission product gases during the drying raises several related questions:

- Was the actual fuel cladding condition been correctly classified as "intact/ undamaged" before loading?
- Has the loading and drying process potentially changed fuel cladding condition?
- What action needs to be taken when such a release is detected?

These question need to be addressed since the approved contents in the Certificate of Compliance are conditional on the fuel classification, using the following principal definitions:

- Intact/ Undamaged: Fuel cladding defects are limited to pin hole leaks or hairline cracks (PL&HCs). Such defects would not affect the geometric arrangement of the fissionable material, hence they would be inconsequential from a criticality safety perspective. Note that for some canisters, even larger defects are permissible under the undamaged category for fuel that meet certain criteria.
- Damaged: Fuel defects are sufficiently large to allow fuel particles to exit the fuel rod and the potential changes in geometric arrangement need to be considered.

This HIB presents discussions of the technical and historical background associated with Krypton releases during drying and loading, and provides recommendations for the users of the Holtec system.

PROBABLE CAUSE

The release of Kr-85 during the drying process has been attributed to the release of remaining fission product gases contained in the fuel cladding through existing pin hole leaks and hairline cracks. In general, the release of radioactive material, specifically fission gases, from fuel characterized as "intact", during drying is not unexpected. During the drying

process, fuel temperatures increase and pressures inside the fuel rods increase. The increased internal cladding pressure will tend to enlarge an existing defect. In addition, if the vacuum drying process is used, an increase in the differential pressure inside and outside of the fuel cladding occurs. The increase in differential pressure can cause the release of fission product gases remaining in the fuel rods through existing pin hole defects.

Forced Helium Dehydration (FHD), used with Holtec systems, maintains low fuel temperatures during drying; however, the release of contained fission product gases at low pressure can still occur.

For gas releases from Holtec systems, no deficiency or inadequacy in the equipment or system used in the dry storage operation has been identified.

PRELIMINARY SAFETY ASSESSMENT

Specific examples of recent Krypton releases during canister drying are listed below. All cask loading operations were completed and met all safety limits for storage.

At Surry (TN Systems), a Krypton release during vacuum drying was attributed to existing hair line cracks in the fuel cladding. Hair line cracks do not pose a concern from a criticality viewpoint and are categorized as “intact/ undamaged” for purposes of dry cask storage. The fuel loaded in the cask at Surry remained classified as “intact/ undamaged” following the observed release during the drying process.

At ANO, the plant concluded that the observed Krypton release during FHD operation was most likely from cladding damage beyond PL&HCs and decided to reclassify some of the fuel in the canister as “damaged” even though no definitive evidence of macro-cladding damage existed. This decision was based on plant knowledge of the fuel condition prior to drying. The specific fuel loaded into the canister at ANO was known to be prone to grid strap fretting. Following the Krypton release, the canister was placed in a safe condition. Since the canister that was loaded, an MPC-24, is not generically analyzed and qualified for damaged fuel, ANO submitted an exemption request to continue to store this canister with the now classified “damaged” fuel. Holtec supported the submittal with all the necessary safety evaluations demonstrating that it would be safe to do so. From a criticality perspective, the analyses demonstrated that the criticality safety limits for all conditions of storage are satisfied with adequate margins. The exemption was granted by the NRC and the MPC was placed on the ISFISI; however, the loading process had been on hold for several months while the exemption was reviewed.

Several other instances of Krypton release have occurred throughout the industry. In all of these cases it was concluded that the release most likely came from existing PL&HCs. These conclusions were based on the practice of evaluating fuel for cladding damage during discharge from the core. Documentation of this process prior to MPC loading allowed these sites to conclude that gross cladding damage did not exist in the loaded assemblies following release of Krypton during the loading and drying process. This pre-loading documentation allowed the loading campaigns to safely continue without delay.

All these examples of previous experience with releases during loading and drying highlight the importance of appropriate and thorough fuel characterization as part of the loading preparations, so the relevant information is available should a release be observed.

LESSONS LEARNED & GUIDANCE

Recommendations:

- In addition to the records of plant fuel cladding integrity history, typically including core water chemistry history, inspection and fuel sipping results, that are reviewed and compiled prior to cask loading to correctly

categorize the fuel as “intact/undamaged” or “damaged”, each user should review and compile additional information to be used in case any release is observed during the loading and drying process. The goal is that if any release is observed, information is already on hand to provide reasonable assurance that fuel remains in compliance with the CoC requirements, and hence no delay in the loading evolution is needed. Examples of what may be included in such information are

  - Results of any more extensive visual and/or sipping campaigns that confirm the absence of large cladding defects.
  - Inspection results for fuel that was identified as damaged. If those only show no or only minor cladding damage beyond PL&HCs, this can be utilized as reasonable argument that extended damage is expected, even in assemblies that were not specifically inspected. This may be applicable to assembly configurations where additional inspections are difficult, for example for channeled BWR assemblies.
  - General knowledge of the absence of specific cladding damage mechanisms that may lead to cladding failure during loading and drying (e.g. grid strap fretting). Conversely, if such mechanisms are expected to be present in the fuel, this should be considered when determining the inspection level for those assemblies.

- If a release of radioactive material occurs during drying, use the methodology determined for the initial classification of the fuel prior to cask loading and the additional information (see above) to support the classification of the fuel condition after drying. If the records used for the initial classification indicated that the fuel is “intact/undamaged”, and if the additional information indicates there is reasonable assurance no larger cladding defects are expected, and the release during drying does not indicate fuel particulate, then it can be concluded that the release is only from PL&HCs. Note that it is not possible to specify a release limit criteria for intact fuel other than the stated requirement that no fuel particulate should be found.
- A release of either gaseous or particulate activity during processing of a canister containing known damaged fuel (stored in a damaged fuel container, DFC) does not require action beyond those normally taken to control the release of radioactive materials.
- In the case of an unusual or unexpected release, such as a release of fuel particulate, an evaluation would be needed to establish a conclusion with respect to the condition of the fuel.
- If it is concluded that some assemblies in the MPC previously evaluated as undamaged are now considered damaged, two options are available:
  - Opening and unloading the canister, inspecting the assemblies to determine the fuel condition and loading them into a new (or modified) canister. There is precedent for opening a canister, and it was performed without incident; however, in that case the fuel was not unloaded.
  - Applying for an exemption based on the assumed change in fuel condition and placing the canister in storage as-is. The safety of the cask would be maintained. There is precedent from the ANO 2014 campaign.
    - If an exemption request is used to qualify the MPC for storage of “damaged” fuel, a license amendment would also be required to qualify the MPC for transportation. Since transportation casks for HBF, such as the HI-STAR 190, already contain consideration of fuel damage of assemblies not placed in DFCs, as part of the qualification of the cask for HBF fuel, the additional potential fuel damage would already be bounded by the existing analyses. From a technical perspective, this would not present any challenge of the safety of the system.
- Drying temperatures should be as low as practically possible to limit expansion of existing PL&HCs. Holtec’s FHD system is specifically beneficial since it allows low fuel temperatures.
- Gaseous discharge should be plumbed to a common location that can be connected directly to the plant ventilation system to process any radioactive gas that may be discharged if a fuel rod were to fail during drying or from an existing defect.

ATTACHMENTS: (None)