



CONFIRMATION OF MAINTENANCE OF FUNCTION FOR TRANSPORT AFTER LONG-TERM STORAGE USING DRY METAL DUAL PURPOSE CASKS

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ABSTRACT

Japanese first off-site interim spent fuel storage facility away from any reactor site is now under construction. Dry metal dual-purpose casks will be used on the project for the long term storage of spent fuels. Since the interim storage facility does not have any equipment for opening lids of these casks, safety of both casks and fuels during the post-storage transport is planned to be confirmed without opening lids of casks.

In order to increase the reliability of the safety for the post-storage transportation, Nuclear Safety Commission of Japan, NSC, has been demanding operators to accumulate data about integrity of spent fuels which have been stored in dry conditions. Also, NSC has requested the Japanese authority NISA to establish reasonable rules for inspections at the time of post-storage transport.

In order to meet this demand, Japanese utilities are trying to accumulate technical basis through the investigation of spent fuels which have been stored in on-site dry cask facilities at nuclear power plants (NPP). In addition, Japanese regulator has been building a reasonable regulatory system applied for the interim storage using dual purpose casks.

This paper describes both the methodology and procedure for confirming the safety of dry metal dual purpose cask after long-term storage.

INTRODUCTION

Japanese first off-site interim spent fuel storage facility is currently under construction at Mutsu, Aomori [1]. The facility is owned by Recyclable-Fuel Storage Company (RFS), which was established as a joint company of Tokyo Electric Power Company (TEPCO) and the Japan Atomic Power Company (JAPC). A business license for the facility was permitted in May, 2010 and a license for starting construction was permitted in August 2010. The operation for the facility is scheduled to commence in July 2012.

The outline of the facility is planned as follows;

- Storage capacity: 5,000ton-U of spent fuels
- Storage period: up to 50 years
- Facility type: storage in dry condition using dry metal dual-purpose casks



Here, the term “dual purpose” means each one cask is used both for transportation and long-term storage. Especially in this project, it is planned that the same cask is used for both pre- and post-storage transportation without opening its lid. This is in conjunction with the design concept that the Mutsu facility does not have any utilities for opening lids of casks and handling spent fuels directly. In order to realize this concept, it is important to forecast the future storage condition of the facility and to predict possible phenomena which can cause deterioration of casks and/or spent fuels. In advance to the reviewing process for the application of the Mutsu facility, Japanese regulatory body NISA had compiled a report which summarized safety requirements for the casks. In the report, basic safety functions as both storage and transport casks were discussed and some mechanisms which could cause any deterioration of casks and/or spent fuels were extracted. In addition, a regulatory framework was discussed how to certify the safety of dual-purpose casks for post-storage transportation.

REGURATORY FRAMEWORK

One typical life of a dual purpose dry metal cask is explained here. First, spent fuels are loaded to a new dual-purpose cask in a pool at a nuclear power plant and then inner space of the cask is substituted with inert gas. Then the cask is transported to a storage facility by ship. Once the cask is placed in the storage facility, it will be stored for decades, and then it will finally be re-transported to its destination. In other words, a typical in-service period of a dual-purpose dry metal cask is longer than that of a transport-only cask. Therefore, it is necessary for dual-purpose casks to be used for some decades without any special maintenance or arrangement which needs opening their lids.

In order to build up regulations for this long-term project, a special concept called “holistic approach” [2] was proposed in the NISA report. The holistic approach is a method which harmonizes the regulatory requirements for storage and transportation. In order to assure the safety of post-storage transportation, operators are required to perform enough investigations when loading spent fuels before the pre-storage transportation and to keep their records until the end of its post-storage transportation. In addition, some data, such as dose rate and temperature around casks, are needed to be constantly monitored during storage period, so that the integrity of both casks and inner spent fuels can be confirmed. At the phase of its post-storage transportation, many of such data are required as a series of evidence for certifying the safety of the transportation.

Furthermore, each dual purpose cask is required to maintain its design and packaging approval as a transport cask over its storage period. This demand is to be prepared for any unpredictable deterioration during storage period, that is, even if any unpredictable deterioration happened in the storage facility, all casks could be taken out from the storage facility rapidly and transported to other facilities in order to repair them.

In the following section, more detailed explanation is given for the investigation held before each transportation and the relationship with the monitoring records during storage period.

INVESTIGATIONS AND MONITORING FOR TRANSPORT CASKS

Figure 1 shows a schematic diagram which explains the relationship of investigation and monitoring items required from the viewpoint of transport regulations. Note that in this figure some inspection items required for storage casks are omitted for simplification.



Investigations required for pre-storage transportation

In advance to the transportation from a nuclear power plant to a storage facility, pre-transport inspection is required to a licensee of nuclear reactors. This inspection is conducted in order to certify the safety during the transportation, in the similar manner with investigations for transport-only casks. Table 1 shows a list of inspection items conducted as an inspection before transportation.

Investigations required during storage period

When the cask arrives at the storage facility, a series of pre-storage examination is conducted in order to see if the cask has any defect which could cause deterioration during its storage period. Then throughout the storage period for some decades, pressure drops between double lids of the cask, temperature and dose rate on and around the cask are monitored consecutively. These monitoring records are used as evidence that the cask itself and spent fuels have been kept in good conditions.

As mentioned, each cask is required to maintain its design and packaging approval as a transport cask over its duration of storage. According to Japanese transport regulations, it is required to submit an application form for the license renewal of its design and packaging approvals every 5 years. Since the application form needs to attach a pile of records of periodical inspection certificates (PICs), the licensee has to conduct PICs every once a year. Although the inspection items for the PICs are same as the ones for transport-only casks, contents of some inspections are different from them. For example, leak-tight inspection is required to be conducted at each PIC for transport-only casks. However in the case of dual-purpose casks, the monitoring record of pressure drop obtained during its storage period can be alternatively used as a record for PICs. This is an example of the holistic approach. That is, some data obtained during storage period can be used also as data attached to the application form of the license renewal of its design and packaging approvals as the transport cask.

Investigations required for post-storage transportation

When the cask is planned to be taken out of the storage facility, another pre-transport inspection is conducted. Table 1 shows a list of inspection items conducted as an inspection before the post-storage transportation.

This time, the inspection is necessary to be conducted in the storage facility which doesn't have any equipment for opening lids of casks and investigating inside the casks. Therefore some inspection items need to be replaced with a pile of records as an alternative method of direct measurement.

Among such investigations are;

- A pressure retaining inspection can be replaced with records of fuel-loading procedure and pressure record charts obtained before and during the storage period.
- A visual inspection of fuel baskets for a subcriticality check can be replaced with a record of subcriticality check conducted at the first pre-transportation inspection before storage.
- A visual inspection of spent fuels for a content inspection can be replaced with a record of content inspection conducted at the first pre-transportation inspection before storage.

It should be emphasized that these ideas of replacement can only become effective when the following conditions are fulfilled;

- 1) Integrity of spent fuels is verified when loaded in the cask and these spent fuels are kept in inactive condition during whole duration of storage.

- 2) Fuel cladding temperatures are kept under threshold value so that spent fuels will not be thermally deteriorated during long-term storage period.
- 3) Sealing system of the cask is effective during the whole period of storage.
- 4) Heat removal performance is well provided as designed.

In addition, licensees are requested to accumulate enough knowledge about long-term storage of spent fuels under dry conditions. In order to meet this demand, TEPCO has conducted investigations to see the integrity of both casks and spent fuels stored in our on-site dry storage facility in 2000 and 2005 [3]. At the inspections, both sealing performance of metal gaskets and fuel cladding integrity were checked cautiously.

The integrity inspection of the sealing performance was composed of a visual inspection of metal gasket of the primary lid and the flange seal surface and a leak test. The examination of fuel claddings was composed of a visual inspection of a spent fuel and Kr-85 detection within the cask by a gas sampling. As a result of these investigations, it was clarified that even after 10-year storage in dry condition, both casks and spent fuels could be stored in good conditions.

For further accumulation of knowledge, TEPCO is planning to continue integrity investigations. If any new findings on unpredictable deterioration were obtained from such activities, the safety of the casks and spent fuels stored in the Mutsu storage facility would be checked and if the licensees could not confirm their safety, it would be required to take out these casks to nuclear power plants or reprocessing plants.

Table 1(1/2). Investigation items conducted at the inspection before transportation

Inspection items	Inspection method	
	Pre-storage transportation	Post-storage transportation
1. External appearance inspection	The packaging containing spent fuels shall be visually inspected for anomaly. (1-A, 1-B)	
2. Leak tightness inspection	The double sealing systems of both second and third lids shall be tested for leak rate.	
3. Pressure retaining inspection	1) The amount of residual water in the packaging is investigated. (3-1-A) 2) The amount of inert gas shall be recorded. (3-2-A) 3) The initial pressure of the gas introduced into the packaging shall be measured. (3-3-A)	1) The record of initial pressure retaining inspection (3-1-A, 3-2-A and 3-3-A) shall be attached. 2) The records* obtained during storage period are attached to check the integrity of the sealing system during storage period.
4. Dose rate inspection	The packaging containing the fuels shall be measured for gamma dose rate and neutron dose rate using survey meters.	

Table 1(2/2). Investigation items conducted at the inspection before shipment (contd.)

Inspection items	Inspection method	
	Pre-storage transportation	Post-storage transportation
5. Subcriticality inspection	The basket installed in the cask shall be visually inspected for anomaly.(5-A)	1) The record of initial subcriticality inspection (5-A) shall be attached. 2) The records* obtained during storage period are attached to check the inert gas condition. 3) The record of external appearance inspection (1-B) shall be attached.
6. Temperature measurement inspection	The temperature of the external surface readily accessible of the packaging shall be measured.	
7. Lifting inspection	After lifting the packaging, the trunnions and the adjacent areas shall be visually inspected for anomaly.	
8. Weight inspection	The total weight of the packaging and the contents are calculated from the manufacturing record.	
9. Content inspection	1) The content shall be visually inspected for anomaly.(9-A)	1-1) The record of initial content inspection (9-A) shall be attached. 1-2) The records* obtained during storage period are attached to check the inert gas condition. 1-3) The record of external appearance inspection (1-B) shall be attached.
	2) The data of the fuels contained in the packaging shall be checked by reviewing documents.	
10. Surface contamination inspection	The surface contamination density of the package shall be inspected by smear method.	

* Records include monitoring data of pressure between lids, surface and building temperature, dose rate around casks and external appearance inspection records of casks.



CONCLUSIONS

In order to fulfill the safety standards required for dual-purpose casks for transportation and storage, it is necessary to have enough quality assurance for each procedure, that is, from the loading of spent fuels throughout the storage for decades. Since Japanese first off-site interim storage facility doesn't have any equipment for opening lids of casks, it is very important to monitor and check the condition of casks by alternative measurements from outside of casks. A pile of such records are used as evidence for licensing renewal procedure of design and packaging approval as transport casks. Also the same records will be used as a part of records which is necessary to be attached as an inspection before shipment record for post-storage transportation.

Since the post-storage transportation will be generally held after several decades' storage, maintenance of various records can be one of the key issues in safety.

REFERENCES

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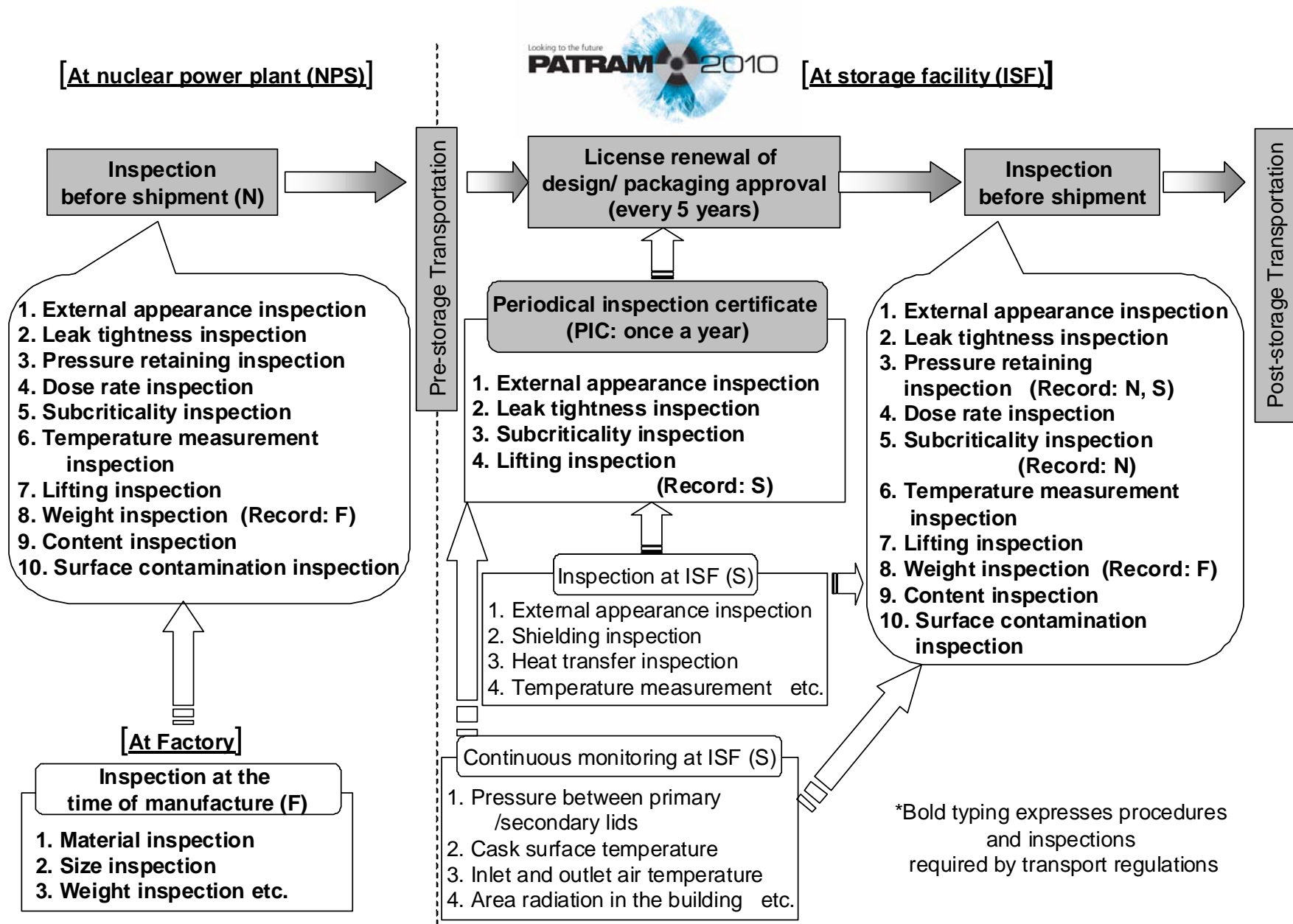


Figure 1. Schematic diagram of a series of investigations required for dual-purpose casks (from the viewpoint of transportation)