Consignor Certification of Packages Prior to Shipment

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INTRODUCTION

As consignor of spent fuel on the public highway, the Nuclear Transport Limited representative has to sign the following declaration prior to any shipment:

> "This is to certify that the contents of this consignment are properly described by name, are properly marked, packaged and labeled and are in proper condition for transport according to the applicable regulations. No supplementary operational controls are necessary during transport" (IAEA 1990; SS6 § 448 and 450).

This paper will describe, through the example of the European spent-fuel transport to the reprocessing plants of COGEMA at La Hague (France) and BNFL at Sellafield (United Kingdom), the organizational system which allows NTL to sign such a declaration and to endorse the consignor responsibilities as described in IAEA SS6 and SS112 § 470-471 (IAEA 1990) (IAEA 1994). This organizational system is called Package Certification Prior to Shipment and focuses on two aspects for the implementation of the regulatory requirements: the off-site and the on-site actions. The off-site actions are performed at each NTL office and correspond to the preparation of shipments and preparation of procedures to be applied at reactor site. This phase also provides the design of the cask loading plans which synthesize the first part of the Package Certification organizational system as the major interface document and input for the on-site actions. On-site actions performed at reactor sites ensure that the preestablished cask loading plans and suitable procedures are observed and that all other regulatory requirements in the field of cask operations are met prior to dispatch.

THE OFF-SITE ACTIONS

Fuel Content

The first key point in the consignor's responsibilities is to have "an appropriate and clear understanding of the radioactive material to be consigned, including its nature, form and activity" (IAEA SS112 § 471(b)). This is particularly important, as the knowledge of the fuel is the starting point for the implementation of subsequent requirements such as the identification of a suitable packaging (IAEA SS112 § 471(d)). The information on the fuel assemblies is of three different sources: the Transport and Reprocessing Fuel Lists (TRFL), the reprocessor acceptance form, and the Reactor Fuel Data Sheets (RFDS).

Transport and Reprocessing Fuel Lists (TRFL)

Prior to each campaign of transports, NTL receives from the reprocessors a list of the concerned fuel assemblies compiled by each electrical company under a standardized format that contains the following information for each assembly:

- identification number / drawing number and reference to applicable reactor fuel data sheet
- characteristics before irradiation including the weight of heavy metal, average initial enrichment in U235 or the plutonium vector at the date of manufacture for MOX fuel assemblies
- irradiation history (irradiation cycle dates, specific power, burnup at end of cycle, number of equivalent days at full power)
- post irradiation characteristics (U and Pu inventory)
- indication of special features such as missing pins
- Euratom code.

Reprocessor Acceptance Form

The TRFL is accompanied by an acceptance form issued by the reprocessors who set out their own requirements for storage and reprocessing. This may result in the rejection of some of the fuel assemblies or special acceptance conditions such as burnup checking or fuel soundness verification during cask loading.

The Reactor Fuel Data Sheet (RFDS) System

Alone, the information contained in the TRFL is insufficient to support a transport safety case or even to fully assess the suitability of a given packaging. Additional detailed information is required, which affects the handling, reactivity, transport, storage, and reprocessing of each fuel assembly. For these reasons, NTL introduced the RFDS system to provide both reprocessor and consignor with all the necessary information either to support a safety case for storage, reprocessing, or transport approval, or simply to determine the packaging suitability. The RFDS consists of a 60-point questionnaire including dimensional information and enrichment patterns in addition to the assembly skeleton sketch. They are issued per type of fuel assembly according to the utilities' quality management system. RFDS forms are completed by the electrical utilities on request of NTL or of the reprocessors sufficiently in advance of the planned transports (typically 1 to 3 years) to allow for flask suitability checking, or for submitting new transport or storage safety cases.

The NTL Computer Data Base

The TRFL, the acceptance form, and the RFDS represent a considerable amount of information that must be accessible at any time and in a reliable and user-friendly way to the reprocessors and to each of the NTL offices throughout Europe. NTL has developed over the last 10 years a large computerized data base containing all the fuel information from the RFDS and from the transport and reprocessing lists and acceptance forms. This data base is located at the NTL Risley (United Kingdom) office and operated under the requirements of the ISO 9001 standard. Connections are provided to the reprocessors and to the NTL offices in Paris (France) and Hanau (Germany) using a secure modem link and personal computer. A link is also supplied to the COGEMA La Hague plant for the criticality department in charge of safety cases and compliance checking of fuel assemblies for unloading, storage, and reprocessing. Currently, the data base contains information on more than 59,000 fuel assemblies and more than 467 RFDSs coming from 36 PWR reactors and 27 BWR reactors.

Package Approvals and Design Safety Reports

In addition to its own packagings, NTL operates the COGEMA-, BNFL-, and GNS-owned casks, which represent more than 17 different types of packagings of French, U.K., and German origins. Most of the cask bodies can accommodate several types of fuel support frame and fuel spacers, thus increasing the number of packaging configurations, each of them having well-defined operating limits. Accurate knowledge of these operating parameters is fundamental for the determination of suitable packaging and the corresponding configuration for transport. This is realized through the package approvals and package Design Safety Reports (DSR) which constitute the second source of information for packaging suitability analysis. NTL retains and keeps up to date the complete set of documentation for each cask design and uses it as a reference for the packaging suitability analysis.

Fuel and Packaging Suitability Analysis

The purpose of the fuel and packaging suitability analysis is first to verify if the fuel assemblies to be transported are covered by an existing package approval during the full period of transports, then to define as clearly as possible the configuration of the packaging, to design the cask loading plans which will have to be applied on-site, and to determine all other transport parameters such as the minimum fuel cooling time and special loading procedures such as burnup control or fuel soundness verification. Before each campaign of transport, the responsible NTL offices perform a package suitability study using as input data the safety parameters from the package approvals and package DSR, and the fuel data extracted from the TRFL, acceptance form, and RFDS. Other parameters like the reprocessors' unloading and storage safety limits, transport planning, and reactor cask acceptance are taken into account as an input. Before performing the detailed packaging suitability analysis, the first step is to select the appropriate packaging according to the reactor acceptability for the type of cask, the type of fuel assembly for the fuel support frame, and cask availability. At the end of this first step, the possible options of packaging configuration and therefore the applicable DSR and package approval are preliminarily defined.

The analysis is basically a comprehensive comparison of each safety parameter set out in the package DSR and package approval with the actual fuel data. Parameters are of two categories:

- Readily accessible parameters are known from the RFDS and TRFL: type of array, pin pitch, pellet diameter, cladding dimensions, active length and position above feet, oxide density and initial enrichment pattern, irradiation history, etc.
- Parameters requiring further calculations like fuel decay heat and activity, dose-rate profile.

Each parameter is compared individually for compliance, and every difference noticed is treated as an anomaly. In such a case, the approval officer responsible for fuel analysis raises an order to the cask owner describing the new requirements for the safety case to support the approval for the new content. The fuel and package suitability analysis is always performed according to written forms and constitutes part of the quality assurance records of a transport campaign. It also constitutes a hold point in the NTL transport quality plans which, if not satisfactorily completed, prevents the transport from proceeding.

Packaging Configuration

The first output from the packaging suitability is the accurate definition of the packaging configuration for transport, that is to say, type of cask body, type of fuel support frame, type of fuel spacer, and special internals like fuel bottle or fuel frame compartment blanking mask. Packaging configurations are specified to the reprocessors' department in charge of the cask maintenance according to the "Internal Equipment Control Procedure" by raising written orders valid for a campaign of transports. Correct realization of the orders is demonstrated either by direct acknowledgment or through the transport

documents issued prior to each shipment of the empty packaging and further inspections during on-site actions. The applicable marking is determined according to the transport regulations and requirements of all countries crossed during the journey. Again, this is formally ordered to each cask owner or directly realized by NTL.

Characterization of Contents

Fuel Decay Heat and Residual Activity

Fuel decay heat generally affects the package external temperatures and cavity pressure in the case of wet casks. It must always comply with the limit defined by the cask thermal analysis and with the limit of the unloading and storage facilities. On the other hand, the transport planning is to be optimized in terms of transport dates to satisfy both utilities and reprocessors. For these reasons NTL has developed a user-friendly computer code called FAKIR® (Prétesacque et al. 1992), (Huynh et al. 1994) which allows the user to calculate the fuel decay heat and residual activity with an accuracy similar to that given by large codes such as ORIGEN or FISPIN, but with a high flexibility for keeping up with ever-changing transport planning. Input data are extracted from the NTL Risley computer data base and transferred to either NTL Paris or Hanau offices through a modem link. Calculations are performed according to the planned loading dates and checked against the limits of both casks and unloading and storage utilities. This calculation code also provides a standardized basis for comparison of decay heat and activity of LWR fuel assemblies received at La Hague and Sellafield from all utilities throughout the world (France, Europe, and Japan).

Burnup Control: Off-Site Actions

The ever-growing number of fuel assemblies transported using the burnup credit assumption has put considerable responsibilities on the consignor for the control of the fuel assemblies burnup (Zachar and Prétesacque 1994). Depending on the fuel element size, initial enrichment in fissile material, and packaging / storage rack performance, three different cases are possible: no burnup control, qualitative or quantitative burnup control. The type of burnup control required for transport or storage is determined during the fuel and packaging suitability analysis on the basis of the characteristics and package approval as well as La Hague unloading and storage requirements. When burnup control is required, the off-site actions are to obtain and check for conformity the measurement records before designing the cask loading plans.

Soundness of Fuel Assemblies

This parameter affects the release of activity of the package and the possible contamination of the unloading facilities. It is mainly verified by the reactors prior to submitting the list of fuel assemblies to the reprocessors, either by analysis of the activity of the reactor primary coolant over the concerned irradiation cycles or by individual sipping test on fuel assemblies (Prétesacque and Corny 1989 a). However, it happens that fuel assemblies cannot be tested in due time and they are accepted under the Provisional Acceptance Criteria, whereby their soundness is checked during the cask loading operations using the packaging as a sipping bottle. If the sipping test has revealed a leak in the fuel cladding, the assembly may be accepted for transport under special conditions, such as the use of a bottle to avoid spillage of debris in the cask cavity (Rouquette and Prétesacque 1989 b). All this information is passed on to NTL during the transport campaign preparation phase in order to allow the determination of the packaging configuration and the applicable operating instructions for loading.

Cask Loading Plans

The cask loading plans represent one of the main outputs from the off-site actions of the package certification system as it constitutes the interface document between the office staff in charge of the off-site actions and the NTL Technical Assistants at reactor sites in charge of the on-site actions. They represent the guarantee that, if followed, the parameters defined in the safety case will be satisfied. On a single sheet document, we find:

- transport reference number and loading date
- packaging configuration
- fuel identification numbers and corresponding storage pond positions
- fuel element position inside the package
- fuel decay heat and residual activity
- special loading procedures to be applied such as burnup or fuel soundness verification
- fuel identification and burnup verification records.

Among the number of fuel assemblies suitable for transport and reprocessing, i.e., within the safety limits, cask loading plans ensure the best configuration in terms of package external dose rates and therefore operators and public dose uptake. Using the sources and dose-rate module of FAKIR® 6.0 (Messaoudi et al. 1994), we select the "hottest" assemblies for loading into the central compartments of the fuel support frame, and the cooler assemblies for loading into the outer compartments, thus providing an extra shielding.

Cask Maintenance Management System

Under paragraph 471 (f) of SS 112, it is required that "the consignor has procedures which ensure that the packaging conforms to the specification of the approval certificate and is in an acceptable condition." All casks operated by NTL follow the same maintenance policy, which consists of turnaround inspection, basic maintenance every 3 years or 15 transports, and main maintenance every 6 years or 60 transports. Maintenance activities are planned well in advance according to the transport planning; maintenance certificates are transmitted to each cask owner when operations are completed and filed in the cask log books. Cask maintenance status is then updated before planning new transports. The non conformances raised during maintenance are reported to the cask owners according to a four-level grading system involving the maintenance facility, the cask owner, the cask designers and the competent authority. This system ensures that NTL-operated casks are always in full compliance with their DSR specification. The evidence of the cask maintenance status is recorded in the transport documents.

Transport Documents

The transport documents issued by NTL and traveling with the cask during the whole journey are divided into part A, dedicated to the shipment of the empty packaging, and part B, applicable for the shipment of the loaded packaging. This document will contain the records of all the inspections that will be performed throughout the transport according to the package certification system as well as all the required regulatory information according to SS6 § 447-451.

THE ON-SITE ACTIONS

Inspection of Empty Packaging on Departure

NTL is consignor of the empty packagings from the reprocessing plant of La Hague. On departure, each cask dispatched is checked by NTL on the following points:

- Transport documents, i.e., radiological survey and turnaround inspection of packaging and vehicle, compliance of internal equipment with NTL's order
- Compliance of the cask serial number with the transport planning
- Applicable package approval and foreign validation
- Labeling and marking.

Technical Assistance at Reactor Sites

The key point in on-site implementation of NTL consignor responsibilities is the technical assistance at reactor sites whereby one or several NTL technicians attend the loading operations from the arrival to the departure of the cask from the reactor sites. Their role and responsibilities are to ensure that the casks operations are carried out according to the preestablished documentation reflecting the regulatory requirements and to report to their base office in case of non conformance or any problem that may arise.

Packaging Operating Instructions

Packaging operating instructions are supplied by NTL to the reactors either in the form of a cask handling specification or of a complete package of detailed procedures supplied with the ancillary equipment. In both cases, the documentation is written in compliance with the cask DSR specification, owner requirements, and the NTL experience feedback. As consignor, the NTL technician is responsible for the application of the correct operating procedures at reactor site.

NTL Teams' Responsibilities

Packaging Turnaround Inspection and Maintenance

Packaging turnaround inspection and maintenance is part of the cask maintenance policy and is performed on each safety-related cask component according to a written inspection schedule. This consists mainly in visual inspections. However, precise or unbiased criteria are provided as far as practicable.

Checking of Internal Equipment

Checking of internal equipment covers the identification of the type and visual inspection of fuel support frame and verification of conformity with the transport documents. This is followed by the checking of the fuel spacers by inserting a dummy fuel assembly into each compartment in order to verify that the fuel active length will be positioned in front of the basket's boronated area and that fuel assemblies will not protrude from the cavity when closing the cask.

Fuel Identification, Burnup Control, and Cask Loading

Due to the implementation of the burnup credit assumption, fuel identification and burnup control are classified as special processes in the NTL quality management system, which also satisfies the requirements of SS112 § 471(c). NTL has developed fuel identification and burnup control procedures focusing on the prevention of the misloading of fuel assemblies. Its reliability has been assessed as a prerequisite for the French competent authority to accept the burnup credit assumption in cask safety cases (Prétesacque et al 1992). In case of burnup verification, the physical on-site measurements are performed under the responsibility of the reactors between the fuel assembly identification step and before cask loading. It is controlled by the NTL technical assistant, who gives the authorization to load

the cask after checking that the actual fuel burnup is in accordance with the criteria specified on the loading documentation (Zachar and Prétesacque 1994).

Fuel Soundness Verification

Application of fuel assembly provisional acceptance criteria is specified on the cask loading plan. A sample of the cavity water is taken 4 hours after removal of the cask from the loading pond and analyzed by the reactor under the supervision of the NTL technical assistant. Results are transmitted to the reprocessors for decisionmaking. When additional measurements are required or for application of the acceptance procedure, the NTL technician ensures the interface with the reactor.

Dryness/Ullaging and Transport Pressure

Transport cavity pressure is governed by the dryness of the cavity for the dry casks and by the ullage level on the wet casks. In order to avoid pressure buildup during the journey, the casks are vacuum dried or ullaged according to pre-set criteria. Both parameters are measured prior to dispatch and certified by the NTL technician in the transport documents.

Cask Closure and Leaktightness (SS 112 § 471(e))

The cask closure system comprises the orifice plugs, gaskets, and their tightening device. Each orifice component's sealing face and gaskets are inspected before use according to a written procedure and defective components replaced by new ones. The torques specified by the cask DSR are also applied according to written procedures and using periodically calibrated equipment. Then, all orifices are leak tested according to the DSR criteria. Leak tests results are recorded in the transport documents and certified by the NTL technician.

Radiological and Temperatures Survey

Radiological and temperatures survey are performed by the reactor using reactor's equipment under the supervision of the NTL technician. Contamination survey, dose-rate levels, and temperature measurements are checked for compliance with the regulatory limits, recorded into the transport documents, and certified by the NTL technician.

Labeling

Regulatory labels are determined and applied on casks and vehicle by the NTL technician according to written instructions derived from the applicable regulations. The transport index for radiation exposure is determined from the dose-rate survey and compared to the transport index for nuclear criticality control; the greater of the two figures is indicated on the regulatory label and transport documents.

Vehicle Turnaround Inspection, Maintenance and Stowage

As transport equipment owner representative, the NTL technician is responsible for the vehicle turnaround inspection and maintenance. Stowage of the cask on the transport vehicle is also witnessed by NTL. The records of both operations are included in the transport documents.

Discharged Responsibilities

As can be noticed, the package certification system discharges some of the consignor's responsibilities on the reactors. Measurements in general are performed by the reactor personnel using the reactor's equipment. In order to compensate, NTL has developed a two-step system to ensure that the discharged

responsibilities are correctly enforced. In addition to the NTL technical assistance, NTL requires the reactors to provide evidence of the implementation of their QA arrangements in the field of calibration of measuring equipment (dose rate, contamination, pressure, temperature, and torquing equipment), measurement working procedures, training certificates, and document control procedure.

CONCLUSION

Apart from the other consignor responsibilities such as legal authorization, implementation of specific quality management system, notification to various authorities, emergency preparedness, etc. NTL has developed the system of package certification prior to shipment to fully enforce the regulatory requirements. Consignor responsibilities cannot be restricted to on-site actions and, in the field of spent-fuel transport, also include the correct package configuration. This can only be achieved if the material to be transported is perfectly known and if a thorough analysis including characterization is performed. This system has proved its efficiency over the last 23 years and is a *sine qua non* in the implementation of burn credit.

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