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Regulatory Assessment of a Dual Purpose Cask TN 81 for Interim Storage of Intermediate Level Waste

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Abstract

The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) is the regulatory authority for Commonwealth entities, which operate nuclear installations (e.g. radioactive waste storage facility, research reactor) in Australia. The main legislation and regulatory framework governing the safety of nuclear installations is the *Australian Radiation Protection and Nuclear Safety Agency Act 1998* (the Act) [1] and the Australian Radiation Protection and Nuclear Safety Regulations 1999 (the Regulations) [2]. In addition, ARPANSA is the Competent Authority for Commonwealth entities for inland transport of Australia. In regulating transport of radioactive material ARPANSA has adopted the IAEA Regulations for Safe Transport of Radioactive Material 2012 edition [3] in the form of the ARPANSA's *Code of Practice for Safe Transport of Radioactive Material 2014* (RPS C-2) [4].

Since the dual purpose cask TN 81containing intermediate level waste is stored in a purpose built intermediate level waste storage facility, the storage of TN 81 cask is authorised under the facility licence for operating a nuclear installation. In assessing the application for operating nuclear installations ARPANSA assessor prepares a regulatory assessment report (RAR) which is a recommendation to the Chief Executive Officer (CEO) of ARPANSA whether to issue a licence and/or approve a certain conduct or dealing with radioactive material. Following issuing a licence and/or approval ARPANSA's compliance monitoring emphasises assurance of safety through regular reporting, as well as planned and reactive inspections.

This paper describes the regulatory assessment of storage of a dual purpose cask, TN 81, containing intermediate level solid waste in an interim waste store (IWS). The key aspects for storage of TN 81 package considered in the assessment include storage configuration, package sub-assemblies, containment analysis, radiation protection, stability analysis, thermal analysis, accident analysis for storage operation, management system, inspection and maintenance, and operational limits and conditions. In cases where the test results were not available, calculated results and alternative means were used to demonstrate that the regulatory requirements have been satisfied.

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Introduction

The TN 81 package is a dual purpose cask that is used for both transport and storage of intermediate level solid waste generated from reprocessing of spent fuel of HIFAR research reactor. On 8 May 2015, ARPANSA issued a facility licence to Australian Nuclear Science and Technology Organisation (ANSTO) to operate an IWS. On 30 November 2015, a revised licence was issued with the updated operational limits and conditions including the storage of TN 81 package. The IWS comprises one TN-81 package and six CBF-C2 cemented drums in an ISO container. The TN 81 package was originally designed by AREVA and the design was approved by French Competent Authority (ASN). Since the package is owned by ANSTO and will be part of operation of ANSTO IWS, a full regulatory assessment was performed to authorise the use of TN 81 in Australia. The regulatory assessment has considered the storage safety analysis report (SSAR) [5] and other supporting information such as measured dose results, operational limits and conditions, radionuclide inventory etc. ARPANSA also validated TN 81 cask for transport of intermediate level solid waste from France.

Method of Assessment

The submission was assessed in accordance with the provisions of the Act and the Regulations taking into account ARPANSA's *Regulatory Assessment Principles for Controlled Facilities*, the IAEA's Draft Safety Guide on Safety Analysis Report for a Dual Purpose Cask and ARPANSA's *Code of Practice for Safe Transport of Radioactive Material 2014* (RPS C-2).

Description

The package is stored in the IWS in a vertical position. It includes a cask body, an internal fitting, a closure system, an anti-crash cover and a monitoring system. A diagram of the storage configuration for the package is presented in Figure 1.

Figure 1 Storage configuration of TN-81

The overall length of the loaded package is 6.45 m and the overall diameter is 2.78 m. The maximum mass of the loaded package is 117,750 kg.

The cask body consists of a forged shell, bottom shielding compartments filled with neutron shielding, an external framework containing additional shielding, and four trunnions fitted with shielding plug and two shielding rings.

The closure system is a double leak-tight barrier system comprising two lids - a primary steel lid and a secondary steel lid.

The package is fitted with an anti-crash cover mounted on the secondary lid that provides the package with mechanical resistance against an aircraft crash on the storage site. The storage site surveillance system is connected to the secondary lid via three pressure sensors. A pressurized tank maintains the pressure of the monitoring system.

Assessment

For the purpose of storage ARPANSA assessment has taken into account the following key aspects.

Analysis of package performance under normal conditions of storage

The SSAR has considered the following criteria to demonstrate the behaviour of the package under normal conditions of storage:

- analysis of stresses in the containment system
- analysis of performance of ancillary structures
- analysis of performance of trunnions
- analysis of performance of internal fittings

Details of the calculations and results are presented elsewhere [5].The results show that the performance of the containment system, ancillary structures, trunnions and internal fittings satisfied the specified criteria for safe storage of the TN 81 package.

Thermal analysis

The package was subject to thermal analysis of the TN 81 package loaded with 28 canisters of vitrified waste of CSD-U under normal and accident conditions of storage [Note: TN 81 package of IWS contains 20 canisters of vitrified waste]. The maximum estimated thermal power of a loading of 28 canisters of CSD-U is 15.4 kW.

The following hypotheses have been considered in the analysis:

- the dimensions of the body and the internal fittings in the package. This is verified with the results of the mechanical analysis, which concludes that the permanent stresses and bends are insignificant even during the regulatory impact tests,
- the ambient temperature is 32°C.
- under accident conditions of fire, the outside temperature considered is 800°C for 30 minutes.
- accident conditions of burying correspond to burying of 50%, 75% and 100% of the external surface of the package.
- the overall thermal power considered is 56 kW with homogeneous distribution over the active height of each canister.
- the cavity is filled with helium.
- the package is in a vertical position.

- the calculations are done with the I-DEAS software using an adjusted finite element model.
- the temperatures evaluated under normal and accident conditions of storage correspond to the case of an isolated package.
- accident condition of fire

To validate the thermal behaviour of the package, the thermal test was carried out on completion of manufacture of a full-scale package in storage configuration using simulation.

The results of modelling and test show that the package satisfies all thermal criteria under normal conditions of storage and accident conditions of fire [5]. Furthermore, the TN 81 package satisfies all the thermal criteria under accident conditions of burying to 50%. The integrity of the package is ensured for cases of burying to 100% and 75% for CSDU type vitrified waste.

Radiation protection

The operation of the IWS is subject to appropriate arrangements for radiation protection. These include ALARA considerations, radiation protection systems and radiation dose during operation. The operating organisation has an annual ALARA objective of 2 mSv. The concept of the TN81 package has considered various administrative and engineering features to control the radiological exposure within ALARA levels. These include access control to the radiological zone surrounding the package storage area, shielding provided by the package components, instrumentation used, maintenance program, no significant of release of gaseous discharges or surface contamination and monitoring program for the package.

The package comprises heavy shielding to minimise exposure to the operators. No radioactive material will be unloaded during storage of the package. Considering that the package if fully loaded that is containing 28 CSD-U canisters the following dose criteria have been considered:

Under normal conditions of storage: 0.5 mSv/h at external surface of the package; 0.1 mSv/h at 2 m from the external surface of the package

Under accident conditions of storage: 10 mSv/h at 1 m from the external surface of the package.

However, the package contains 20 canisters, which is about 29% less than full capacity. The measured dose rates of the canisters and the package shows that the maximum dose rate at contact is 150 µSv/hr and at 1 m is 60 µSv/hr. Therefore, the dose criteria considered in the design of the package is conservative.

Containment analysis

The analysis of the containment of the TN 81 package loaded with 28 canisters of vitrified waste CSD-U was performed under normal and accident conditions of storage.
The analysis has considered the following to analyse performance of the package under both normal and accident conditions taking into account the construction and function of the components and sub-components of the containment system, and the operating parameters:

- the maximum temperature of the gases under normal conditions of storage and under accident conditions of fire.
- the temperature of the gaskets under normal conditions of storage
- the guaranteed leakage rate from the containment vessel after manufacturing and during package maintenance operations is: 10^{-8} $Pa.m^3.s^{-1}$
- under normal conditions of storage one canister is ruptured and under accident conditions of storage all canisters are assumed to be ruptured.

The analysis shows that the containment will remain intact under normal and accident conditions of storage, and there is no likelihood of release of activity.

Stability analysis of the package

The SSAR has analysed the stability of the package in the event of an earth quake noting that the this natural event was considered construction and operation of the facility taking into account the site seismic characteristics considered for other nuclear installations (e.g. research reactor). This analysis aims to demonstrate that the during storage condition the package will not tip over in a seismic event taking into account site-specific assumptions. Finite Element Model has been used in calculation. The model has considered package storage configuration and its internal arrangement loaded with 24 and 20 canisters of vitrified waste.

The calculated stability factors for loading of 24 and 20 canisters show that there is essentially no risk of tripping over of the package, and the maximum sliding displacement compared to the ground is negligible at the bottom or at the top of the packaging.

Accident analysis

The following potential scenarios have been considered for storage operation:

- tripping of the package during handling operations
- an aircraft (type F-18) crashing into the storage facility
- a fire due to explosion of a vehicle (Note: bushfire was considered in siting, construction and operation of the facility)
- an earthquake

Considering the number of package stored and controls in place the analysis shows that tripping scenario is almost incredible.

The aircraft crash was simulated and took into account the ant-crash lid. The results show that the containment will not be breached.

The fire test was also part of design requirement of SSR-6. Further the impact of external event such as bushfire was also considered during assessment of siting application for the facility.

Earthquake was considered as part of siting and the interim waste store is located at a multi-installation site where a research reactor is also located. The site was found suitable for a nuclear installation.

Operational limits and conditions

The operational limits and conditions (OL&Cs) form a boundary of parameter values and/or system conditions for specified processes/facilities where associated structures, systems and components (SSCs). The OL&Cs contribute to the prevention of accidents and the mitigation of the consequences of accidents should they occur. The OL&Cs are considered mandatory and must be complied with at all applicable times.

For storage of TN-81 cask the following OLCs has been specified:

- The temperature at the external metal surface of the TN 81 cask shall not exceed 112°C
- The dose rate at the external surface of the TN 81 cask shall not exceed 0.5 mSv per hour.
- Pressure in the TN-81 interspace shall be above 4 bar (abs) with no pressure drop greater than 0.5 bar per 24 hour period
- The helium leak rate from the seals of the TN 81 cask shall not exceed $1x10^{-8}$ $Pa.m^3.sec^{-1}$

Operating arrangements

The key operational parameters such as pressure transducers, gauges, etc. are continuously monitored by a computer controlled system. Any variation from the set levels will result in an alarm that will be recorded and sent to the site control centre for any corrective action if required.

ARPANSA has assessed the operating procedures, and arrangements for testing, inspection and maintenance. The package is stored vertically, and written procedures and instructions are in place for operation of the facility including specific maintenance and inspection program including visual inspection, repairing surface defects etc.

The facility is operated by trained operators, and has taken into international best practice (e. Zwilag facility). Overall the facility is operated under an ISO accredited quality system (management system).

Storage licence

The licence of the storage of the TN 81 package was issued with certain conditions including quarterly reporting, compliance with OLCs, periodic review of safety analysis and restriction on unloading of the package [Note: there is no unloading and reloading features in the facility]. The requirement of periodic review of the safety analysis for the package is every ten (10) years. The first safety analysis must be undertaken by 31 December 2025. Further, transport of the TN 81 package after storage will be subject to regulatory approval.

Regulatory compliance monitoring

The facility commenced operation in December 2015 and was subject to two regulatory inspections. The first inspection in December 2015 was in the areas of Performance Reporting and Verification, Training, Inspection Test and Maintenance, Radiation Protection, Configuration Management; the second inspection included Event Management, Emergency Preparedness and Security. The inspections did not identify any non-compliance with the legislative requirements and licence conditions.

Conclusions

The elements considered in ARPANSA's regulatory assessment have been found to be adequate for assuring safe storage of TN 81 cask containing intermediate level waste. ARPANSA's regulatory approach for licensing and compliance monitoring for the TN 81 package is effective for safe storage of intermediate level solid waste and for transport of radioactive material using such package.

References

1 Australian Radiation Protection and Nuclear Safety Agency Act 1998

2 Australian Radiation Protection and Nuclear Safety Regulations 1999

3 International Atomic Energy Agency, Regulations for Safe Transport of Radioactive Material (SSR-6) 2012 edition

4 Australian Radiation Protection and Nuclear safety Agency, Code: Safe Transport of Radioactive Material (RPS C-2) 2014 edition

5 Storage Safety Analysis Report, DOS-13-00089962-001, 2014