Demonstration Tests for Low Level Radioactive Waste Packaging Safety

I.Nagano, S.Shimura, T.Miki, T.Tamamura, K.Kunitomi

Nuclear Fuel Transport Co.,Ltd. Tokyo, Japan

INTRODUCTION

The transport packaging for low level radioactive waste (so-called the LLW packaging) has been developed to be utilized for transportation of LLW in 200 liter-drums from Japanese nuclear power stations to the LLW Disposal Center at Rokkasho-mura in Aomori Prefecture.
Transportation is expected to start from December in 1992.
We will explain the brief history of the development, technical features and specifications as well as two kinds of safety demonstration tests, namely one is "1.2 meter free drop test" and the other is "ISO container standard test".

HISTORY OF DEVELOPMENT

The LLW packaging has been developed as the first domestic packaging for the dedicated use for low level waste mainly through the Joint Study by the power companies as well as our own study by NFT.
In the course of development, the following points were seriously taken into account:

(1) Safety, integrity and reasonableness
(2) Easy handling and maintenance

In the Joint Study by the power companies which started in 1985, we had more than 20 types of the candidate packagings, and selected the following 3 types as the result of the first selection from viewpoint of the efficiencies of packaging capability and handling, the availability of transport vehicles and so on.

(1) Container type for 24 drums (20 feet ocean container type with modification in height)
(2) Container type for 8 drums
(3) Rack type for 8 drums

At the second stage of the selection, the comprehensive review was made for these 3 candidate types by means of "Comparison of size" (which might affect the handling at power stations), "Comparison between open-type and closed-type" (which related to sealing capability and viewpoint of public acceptance, etc) and also the comments from the power companies were taken into account.

In March 1988, we came to the conclusion that the basic specifications would be as follows:.

(type)	container-type for 8 drums
(Size)	approx. 3200 mm in length
	approx. 1600 mm in width
	approx. 1100 mm in height
(Weight)	Tare Weight : approx.1 ton
	Gross Weight : approx.5 tons
(Lid Type)	Removing and fitting

Taking account of the result of the Joint Study, we started our development work from 1988 and proceeded with the detailed design, 1.2 meter free drop test, ISO container standard test to finalize the specification of the container-type for 8 drums.

SPECIFICATION

This packaging consists of a lid and a main body with steel-box configuration,and the measurements are approximately 3.2 meters long, 1.6 meters wide and 1.1 meters high respectively (See Fig1).
The packaging can contain 8 drums of low level wastes, and the tare weight is about 1 ton and the gross weight is approx. 5 tons or less. The LLW drums are cylindrical and contain low level wastes solidified homogeneously with cement, bitumen or plastic.

The packaging is designed in accordance with the domestic transport regulations "Maritime Transport and Storage Regulations for Dangerous Cargo" (Revised in December, 1990) as well as other international regulations such as "IAEA Safety Standards/Safety Series No.6".

According to such regulations, the radioactive transport packages are categorized as Type-L, Type-A, Type-B and Type-IP (IP-1, IP-2 and IP-3) depending upon the radioactivity level and specific activities of the contents. The contents of the packaging are rather low-level radioactive material (Low Specific Activity/LSA-2) and the package is categorized as IP-2.

One of the technical requirements for IP-2 is to satisfy 1.2 meter free drop test, and this was confirmed by the drop test using an actual packaging unit. Additionally, this packaging is designed taking account of other domestic regulations for facilities/equipments for ships as well as international regulations such as ISO 1496/1 which are both applicable to the large containers for international use in order to assure furthermore the integrity of the packaging at the time of handling and transportation in view of the combined transport mode of sea and road transports.

Moreover, the packaging was inspected in accordance with "Regulations for Inspection of Type-IP Package" specified by NIPPON KAIJI KENTEI KYOKAI who was a third-party inspection organization under Japanese Ministry of Transport, and was granted the inspection certificate as Type IP-2.

TECHNICAL FEATURES

This packaging has the following technical features:

(1) Strong structure being compared with other popular freight containers

-The popular freight containers being used for transportation of general cargo are mainly in the size of 12 meters or 6 meters long, and this packaging has stronger structures than the containers in terms of the following aspects:

(a) Despite the overall outer measurements being small, the frames/steel plates/fittings are same as those of the containers.

(b) The weight of contents in the packaging is less than that in the containers.

-The lid is firmly fitted with 4 bolts, and not easily opened compared with the door-type of containers.

(2) The drums fixed firmly

In order to avoid movements of drums during transportation, they are fixed firmly with the rubber packings and ring holders (See Fig.2).

(3) Remote cranage and lid handling

The corner-fittings and lid lifting holes are specially designed for the purpose of remote cranage of the whole packaging and lid handling operation respectively, which consequently contributes to the reduction of dose-rate to the workers.

(4) Equipped with Data Carrier (DAC) System

The packaging is equipped with an automatic-reading system (so-called DACSystem) which allows the packaging numbers to be read during the cranage operation.

SAFETY DEMONSTRATION TESTS

1) 1.2 meter free drop test

(1) Purpose

This packaging is categorized as Type IP-2, and subject to 1.2 meter free drop test in accordance with the transport regulations.

This drop test is to confirm the durability against the possible shocks which may happen during the normal transportation, such as sudden stop of a vehicle, sudden lifting-up or lifting-down and so on.

(2) Test Method

The test was carried out using an actual unit of the packaging with 8 dummy drums. The gross weight is about 5 tons, and the regulations require the height of 1.2 meters for free drop test.

These test conditions were interpreted as the distance between the flat rigid target (made of thick steel plate on the concrete stage) and the lowest point of the packaging was vertically 1.2 meters.

Three kinds of drop tests in each position of horizontal/vertical/corner were carried out (See Photo. 1 to 3).

(3) Test Results and Evaluations

The test results are shown in Table 1, which confirmed the integrity of the packaging as follows:

(a) As far as the enclosure capability is concerned, there happened to be no breakage penetrating

through the packaging, and the reduction of the tightening by rubber-gasket was 5mm or less, which is enough lower than the acceptance criteria of 10 mm. We confirmed no loss of the contents.

(b) As for the radiation level, it is affected by the deformation of the packaging and the shifts of the inner drums.
The test results confirmed no remarkable increase of radiation level because of very minor deformation and shifts.

2) ISO Container Standard Test

(1) Purpose

This packaging is designed in accordance with ISO 1496/1 Container Standards to withstand any loadings during the normal transportation.
In order to confirm that the packaging satisfied these standards, the tests were carried out using an actual unit.

(2) Test Method

To simulate the test conditions for 6 pieces Stacking-up/Lifting-up/Rigidity/Weather Proofness based upon ISO 1496/1 Container Standards, an actual packaging unit was tested using a loading machine, fork-lift, shower-test equipment and so on (See Photo.4).
The methods are shown on Table 2.

(3) Test Result and Evaluations

No deformation and damage preventing use was found in the tests. No water leaked into the packaging in the weather-proofness test.

CONCLUSION

The LLW packaging has been developed for domestic LLW transportation. The packaging was supplied to the 1.2 meter free drop test and ISO container standard test. We confirmed the integrity of the packaging from the good test results as stated above.

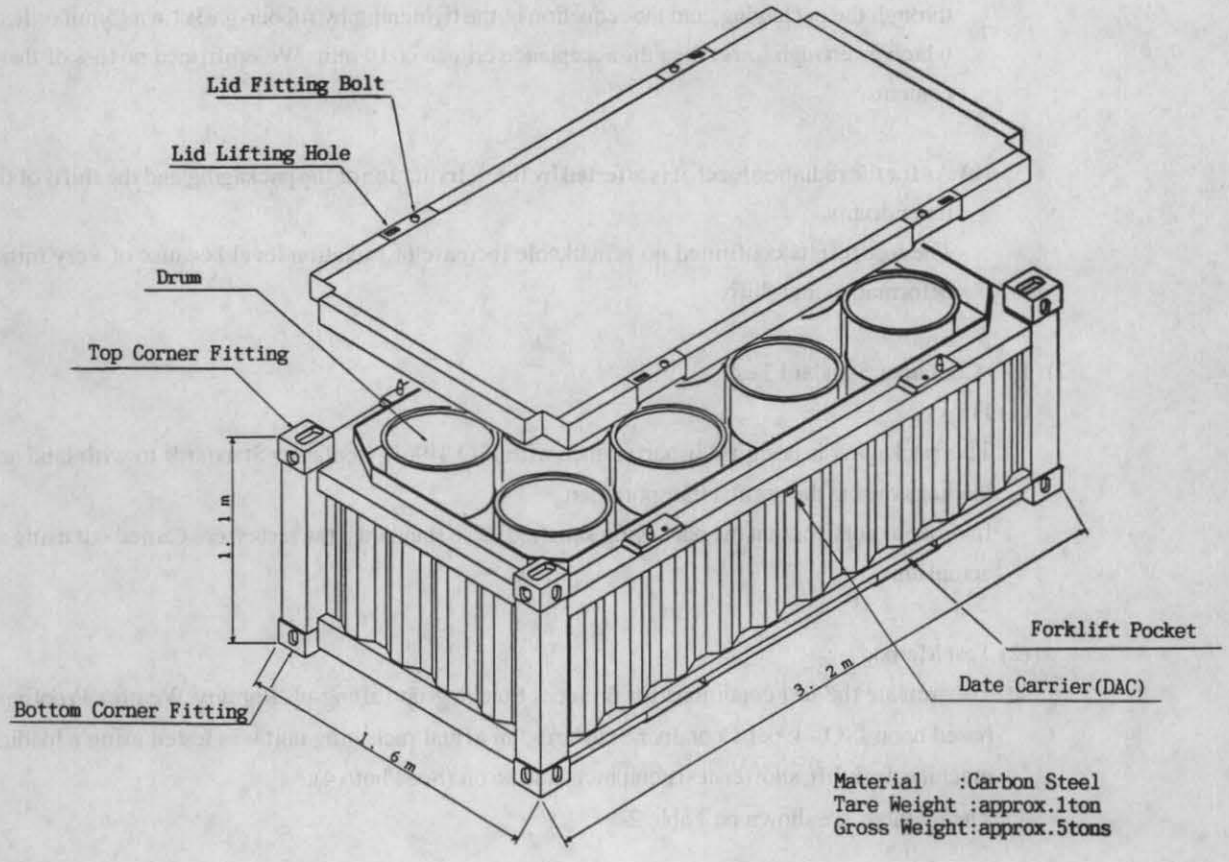

Fig.1 The LLW Packaging

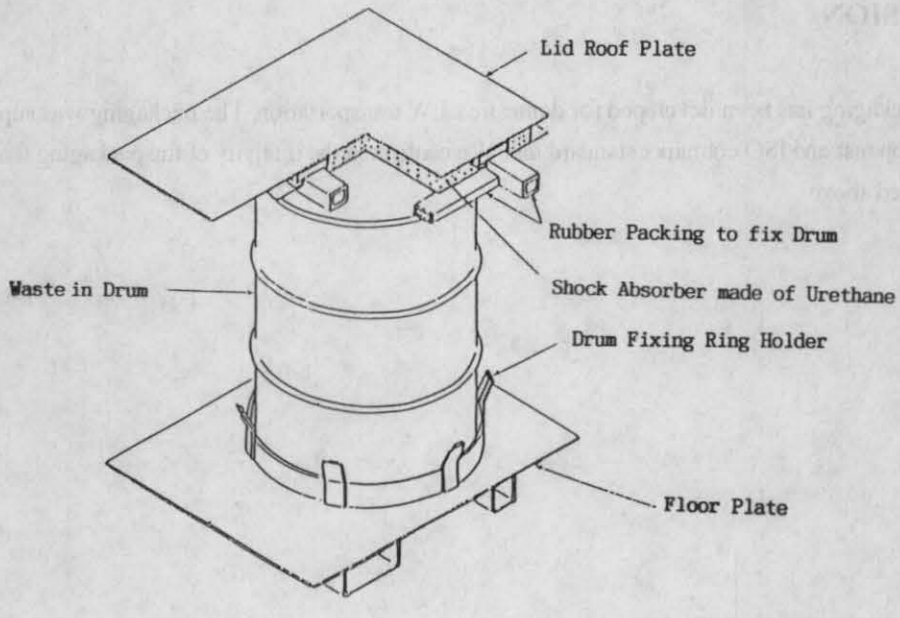

Fig.2 Fixing Condition of Drum

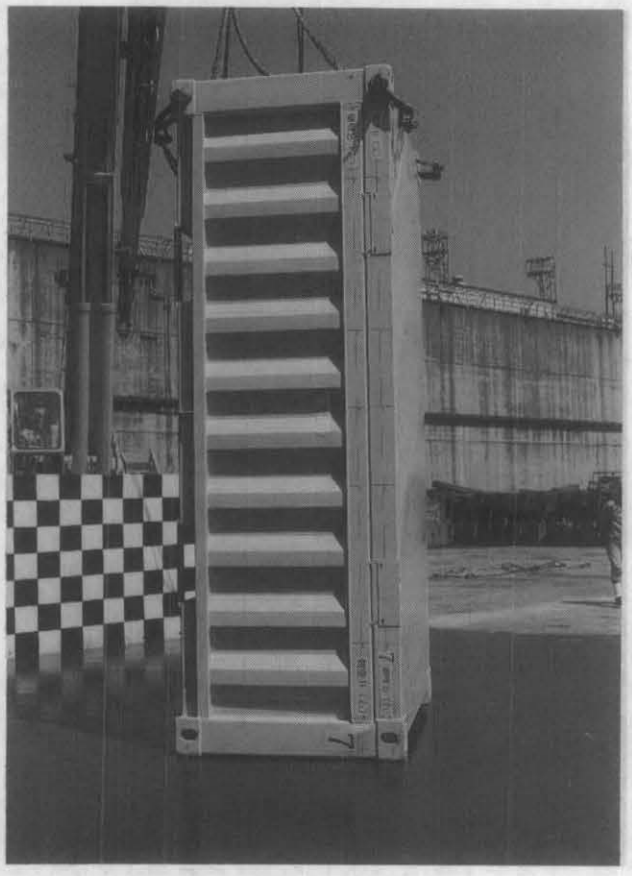

Photo.1 Vertical Drop Test

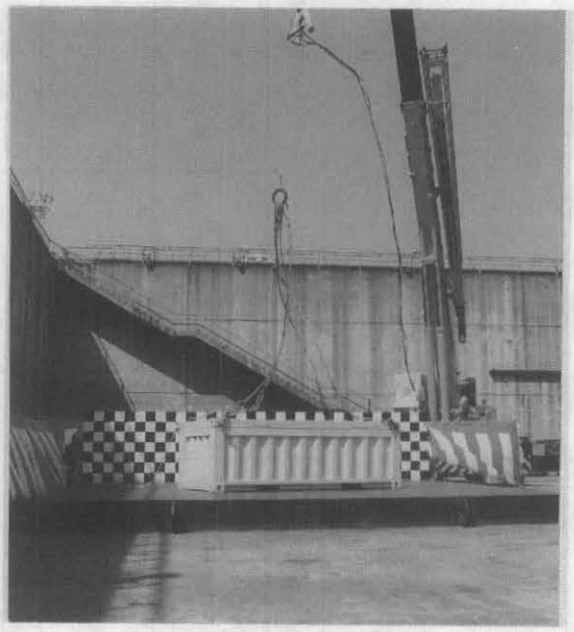

Photo.2 Horizontal Drop Test

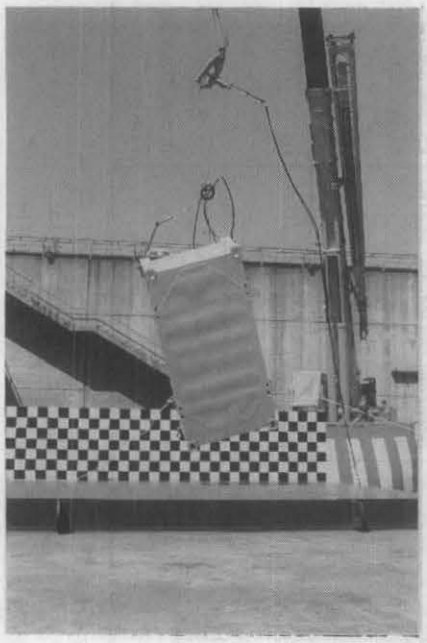

Photo.3 Corner Drop Test

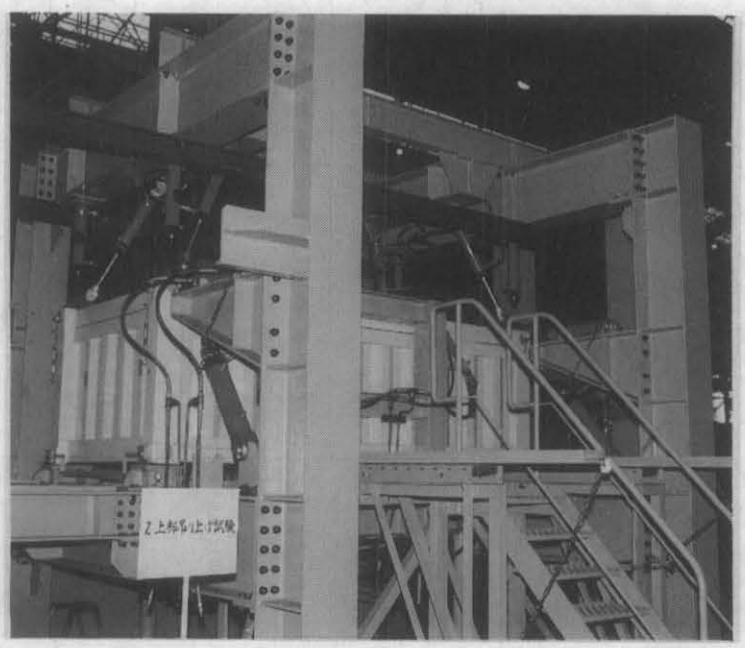

Photo.4 ISO Container Standard Test

TABLE 1. THE RESULTS OF DROP TEST

ITEM			ACCEPTANCE CRITERIA *	VERTICAL DROP	HORIZONTAL DROP	CORNER DROP
TEST ITEM	Enclosure Capability	Gap between Lid and Body	Reduction of Gasket Tightening is 10 mm or Less	5 mm or less	1 mm or less	3 mm or less
		Presence of Penetration	No Breakage Penetrating through Packaging	None	None	None
		Leakage of Contents	No Loss of Contents	None	None	None
		Conditions of Lid Fixing Bolts	No Breakage of Bolts	None	None	None
		Conditions of Gasket	No Breakage to Lose Enclosure Capability	None	None	None
	Deformation	Deformation of Packaging Outside	No Remarkable Deformation	Very Minor Deformation around Hit Surface	None	Very Minor Deformation around Hit Surface, But None on The Side Walls
		Deformation of Inner Drums	No Remarkable Bulge	None	None	None
		Shift of Inner Drums	No Remarkable Shift of Drums towards The Wall Plates	A Little Shift within The Drum Fixing Ring Holder	Very Little Shift	A Little Shift within The Drum Fixing Ring Holder

* This criteria is NFT's own criteria.

TABLE 2.

METHOD OF ISO CONTAINER STANDARD TEST

R:Maximum Gross Weight =5,000kg
P:Maximum Load Capacity=4,000kg
T:Tare weight =1,000kg

ITEM	TEST METHOD
STACKING TEST	Load onto floor : 1.8R-T=8,000kg Compression stress on each corner pillar : 2.25R=11,250kg The corner metal fitting(or plate with same square measure) to press and the same to be pressed are shifted relatively by 38mm longitudinaly and by 25.4mm transversely for testing.
LIFTING TEST FROM TOP	Load onto floor : 2R-T=9,000kg Lifting from top by 4 corner fittings at lifting angle of 60° for 5 minutes
LIFTING TEST FROM BOTTOM	Load onto floor : 2R-T=9,000kg Lifting from bottom by 4 corner fittings at lifting angle of 45° for 5 minutes
RESTRAINT TEST	Load onto floor : R-T=4,000kg Compression and tensile strength on each lower beam : R=5,000kg
LONGITUDINAL RIGIDITY TEST	By fixing the lower corner fittings, compression and tensile strength londitudinal on the upper corner fittings : 7,620kg
TRANSVERSAL RIGIDITY TEST	By fixing the lower-corner fittings, compression and tensile strength transversely on the upper corner fittings : 15,240kg
LIFTING TEST BY FORK-LIFT	Load onto floor : 1.6R-T=7,000kg Inserting plates with 200mm width throughout the pocket and lifting for 5 minutes
STRENGTH TEST OF SIDE WALL	Load onto wall : 0.6P=2,400kg
STRENGTH TEST OF END WALL	Load onto wall : 0.4P=1,600kg
STRENGTH TEST OF ROOF	300 kg onto the weakest part of the roof (300mm×600mm square)
WEATHER PROOFNESS	Caliber of nozzle : 12.5mm Pressure at nozzle end : at least 1 bar. (equivalent to 10m water-head) Distance between nozzle and packaging : less than 1.5m Velocity of nozzle slide : lower than 100mm/s