The Design, Manufacture, and Testing of a New Generation of ISO Freight Container for Certification as an IP-2 Package in Compliance With the IAEA Regulations for the Safe Transport of Radioactive Material, 1985 Edition (as Amended 1990)

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INTRODUCTION

During the operation and maintenance of nuclear power stations and other nuclear facilities, potentially or lightly radioactively contaminated solid waste materials, such as paper, plastics, filters, clothing, wood, and metallic items routinely arise. These items of waste are generally classified as low level waste (LLW) which within the United Kingdom is defined as having a radioactivity content not exceeding 12 GBq/tonne beta/gamma and 4 GBq/tonne alpha. As such, LLW does not normally require shielding during normal handling and transport.

In the United Kingdom, LLW is containerised and routinely disposed of at the British Nuclear Fuels' site at Drigg, in Cumbria, in concrete-lined engineered vaults. During the earlier years of containerised waste disposal, full height ISO freight containers were disposed of as part of the waste packaging. It was soon realised that this was uneconomic and a further container, based upon a half height design of the unit was developed, a variation on which is currently in use today, for supercompacted drums, or pucks and larger, bulky items of solid LLW.

Full height ISO freight containers, refurbished to incorporate a number of enhanced features were used in compliance with the 1973 Edition and 1985 Edition of the IAEA Regulations for the Safe Transport of Radioactive Material but it was recognised as being an interim measure only. A purpose built unit in compliance with the 1990 revision to the 1985 Edition of the Regulations was necessary.

The initial part of this paper addresses the technical justification for the reuse of the earlier refurbished containers, Design No.2912B, while the concluding part addresses the enhanced design or new generation of container, Design No.2044.

TECHNICAL JUSTIFICATION FOR THE REUSE OF CONTAINER, DESIGN NO.2912B

In the United Kingdom, the majority of solid LLW arisings are suitable for drumming within nominal 200 litre capacity cylindrical steel drums. This therefore dictated the design criteria. The packaging standard required for solid low level radioactive waste (LLW) as LSA or SCO, as defined by the 1985 IAEA Regulations for the Safe Transport of Radioactive Material is Industrial Packaging Type 2 (IP-2). In accordance with Paragraph 523 of these Regulations ISO freight containers may be used as Industrial Packages Types 2 or 3 provided that they satisfy the specified criteria. Within these criteria it is noted that the containment requirement is not given as a numerical limit (as in the case for Type B packages) but that the packages would prevent "loss or dispersal of the radioactive contents".

Contents Being Carried Within ISO Freight Containers

The LLW being transported includes materials in both LSA II and SCO II categories. The contents will in almost all cases contain no alpha emitting nuclides in excess of 5% of the total activity of nuclides being carried, and generally will be considerably less. The LLW is packaged in nominal 200-litre mild steel drums with a rubber sealing gasket and steel lid, retained with a single point band type closure system with bolted clamping, conforming to BS 2003: Part 1, 1987. The filling of drums with waste, the lid closure operation and the handling and loading of drums are the subject of Station Management Control Procedures.

Consideration of Normal Conditions and Minor Mishaps During Transport

The general requirement for an IP-2 is that it is capable of withstanding normal conditions of transport; there is no requirement to withstand accident conditions. It is therefore prudent to consider what are normal conditions of transport for an ISO freight container, which of these may be additional to the requirements stated within ISO 1496/1 - 1984 and what is the cut-off between normal and accident conditions. The IAEA definition of normal transport is effectively routine, ie accident free conditions, plus minor mishaps and in the "generic IP-2 requirements" these are equated to a stacking and free drop test.

Performance standards were applied and graded to take into account conditions of transport characterised by severity levels:

- conditions likely to be encountered in routine transport (in incident free conditions),
- normal conditions of transport (minor mishaps), and
- accident conditions of transport

A detailed assessment of likely minor mishaps, incidents and accidents was conducted, and reviewed in the light of regulatory requirements associated with package/container design. The assessment concluded that whilst the more onerous free drop test in the "generic IP-2 requirements" could be accepted as a fair demonstration with regard to smaller packages such as drums, it was considered not to be relevant to ISO freight containers as a representation of a minor mishap during normal conditions of transport. The ISO tests are considered to be more representative of real life conditions experienced during normal transport.

It is considered that whilst specific freight container requirements within the relevant design and testing standards support the use of ISO freight containers, in order to comply with the spirit of the IAEA Transport Regulations during the minor mishap scenarios examined, some reliance may need to be vested in the drums being transported.

Justification for Containment

The justification for the containment criterion being met was based upon a "source term methodology" in which the drums retain their bulk contents and hence only a fraction of their contents is assumed to be available for leakage into the ISO freight container. It is therefore advantageous to define some numerical radioactivity release rate below which the package could be assumed to have effectively, no "loss or dispersal of the radioactive contents". A numerical limit of $A_2 \times 10^{-6}$/hr is given in the IAEA Transport Regulations as an upper acceptable radioactivity release rate for Type B packages during normal conditions of transport. Given the more onerous design criteria for Type B packages, it would appear reasonable to use this limit for a single large IP-2 package. Extensive assessments were conducted which indicated that the maximum activity release rate for those radionuclides being transported was significantly less than $A_2 \times 10^{-6}$/hour.

Consideration was also given to potential inhalation doses to workers in the vicinity of loaded ISO freight containers in notional "on-site" transit areas and to members of the public near to the containers during transport. The dose estimates used were based upon pessimistic exposure models and compared to the appropriate annual dose limits. They showed that under normal conditions of transport, even when considering wastes at the upper limits of the LSA II and SCO II categories, which are substantially greater than the LLW, the inhalation doses to individuals were well within the recommended dose limits.

Summary

In support of the justification for reuse of the refurbished design of ISO freight container, Design No.2912B (Figure 1) as an IP-2 grade package, an assessment of the requirements of the IAEA Transport Regulations was carried out. The assessment was derived from the containment requirement for packages as prescribed in IAEA tests and UN dangerous goods tests, which in turn are

associated with the ISO testing standards.

Consideration was given to normal conditions and minor mishaps during transport of the freight container by comparison of the testing requirements with real life conditions. Performance standards were applied and graded to take into account conditions of transport characterised in accordance with a number of severity levels.

The justification for containment, based upon the use of the ISO freight container and the pessimistic assessment of potential inhalation doses to those persons involved with the packaging and transport of Nuclear Electric's LLW, supports the reuse of the refurbished design of ISO freight container Design No.2912B and its certification as an IP-2 package, for the transport of LLW from the site of arising to either an intermediate processing facility or final disposal site.

THE NEW GENERATION OF CONTAINER, DESIGN NO.2044

The earlier design of full height ISO freight container, Design No.2912B was certified solely for the transport of drummed LLW within the UK. This was extremely limiting given that Nuclear Electric also have other contaminated items that need to be transported between sites such as materials which require processing, and plant and machinery for repair or disposal. The development of a new generation of container for materials classified as LSA-II, SCO II or LSA III (when transported under Exclusive Use) therefore became necessary.

Design

A design study was initiated in order to produce a container design in accordance with the requirements of the IAEA Transport Regulations and ISO freight container standards. The design study concluded that a design, based upon a conventional refrigerated type of freight container with a number of enhanced features, was acceptable in principal. A container of this type (Figure 2) offers a number of benefits in the transport of LLW or other contaminated items:

(a) The enhanced design of door seal fitted in order to minimise leakage and maintain the internal temperature of a refrigerated container provides suitable sealing to comply with the requirements of the IAEA Regulations.

(b) The double skinned, insulated design should prevent condensation arising within the container. By maintaining dry conditions the risk of spreading contamination is reduced.

(c) Stainless steel construction of the container makes decontamination easier, should it prove necessary.

The ability to purchase a suitably modified ISO freight container, coupled with the Regulatory option of using such a container as an IP-2 packaging, has reduced the amount of development work necessary prior to the manufacture of a fleet of containers to Nuclear Electric's requirements. The technical justification allowing the use of an ISO freight container, its components and sub-assemblies is already established.

Safety Case

The Safety Case was prepared in two phases; phase one comprising an outline safety statement based upon the Design Study, and phase two, the finalised safety case, following the successful completion of container trials, drawings and operating and maintenance instructions. The Safety Case included supporting documentation such as: Administrative Requirements, Design and Approval Request, Container Specification (inclusive of design details against which the container was purchased), Handling and Transport Arrangements, Inspection Procedures and Quality Assurance.

Design Approval

To qualify for approval for safety purposes under the present Convention all new designs of container shall comply with the requirements of Annex II "Structural Safety Requirements and Tests". The container was manufactured by "design type series", application for approval being accompanied by drawings, a design specification and such other data as required by the recognised Approval Authority, in this case Lloyds Register.

Container Testing

In order to demonstrate compliance with the recognised container testing standards it was necessary to conduct a series of mandatory tests.
They are summarised as:

- a lifting test
- a stacking test
- a concentrated load test
- a transverse racking test
- a longitudinal restraint (static) test
- an end-walls test
- a side-walls test

These tests were supplemented by further tests as it was recognised that conventional ISO freight containers, whilst being robust, are only designed to protect the contents from rough handling and severe weather conditions as experienced during ocean voyages. Containers are not designed to withstand rigorous leak tests as may be considered necessary due to the contents being transported. Nuclear Electric therefore demonstrated by testing, that the container was capable of meeting a predetermined leak tightness criterion.

The test method used was unsophisticated, the freight container being located in a darkened area and connected to a metered air supply to simulate the volume flow arising from changes in ambient pressure and temperature. Fluorescein treated dust particles were dispersed inside the container and evenly suspended in the air by fans. Any migration from the containment boundary (and particularly across the door seals) was then monitored by visual inspection using an ultra-violet lamp.

No dust leakage was observed, further demonstrating the suitability of the container to meet the requirements of the IAEA Regulations for the Safe Transport of Radioactive Material.

Quality Assurance

In accordance with the IAEA Transport Regulations, quality assurance programmes shall be established for the design, manufacture, testing, documentation, use, maintenance and inspection of all packages and for transport and in-transit storage operations, where applicable. In addition, the manufacturer, consignor, or user of a package shall be able to demonstrate that:

(a) The construction methods and materials used for the construction of packaging are in accordance with the approved design specifications; and

(b) All packagings built to an approved design are periodically inspected and, as necessary, repaired and maintained in good condition so that they continue to comply with all relevant requirements and specifications, even after repeated use.

Nuclear Electric comply with these requirements by adhering to recognised standards and practices for design and construction. Packaging is assessed and certified in accordance with Nuclear Electric document, HSD/NSOB/HPS/TG/SP7 "Standard Procedure for the Certification of Package Designs which do not require Competent Authority Approval". Operating and Maintenance Instructions are prepared thereby satisfying completely, the regulatory requirements.

Conclusion

Following final acceptance of the Safety Case and Supporting Documentation, a Certificate of Regulatory Compliance was issued. The prototype container was viewed by various Nuclear Electric sites and other interested parties within the UK; it met with general acclaim. It is now in service within Nuclear Electric and a Contract has recently been placed for the supply of a further 15 units to enhance Nuclear Electric's fleet of full height ISO freight containers.

REFERENCES

BS 3951 : Part 1 : Section 1.1 1989, ISO 668-1988 (latest issue)
Specification for Series 1 Freight Containers:
Classification, External Dimensions and Ratings,

BS 3951 : Part 2 : Section 2.1 : 1991, ISO 1496/1 - 1990
Freight Containers, Specification and Testing of Series 1 Freight Containers,
General Cargo Containers for General Purposes

IAEA Safety Series No. 6 - Regulations for the Safe Transport of Radioactive Material, 1985 Edition (As Amended 1990).

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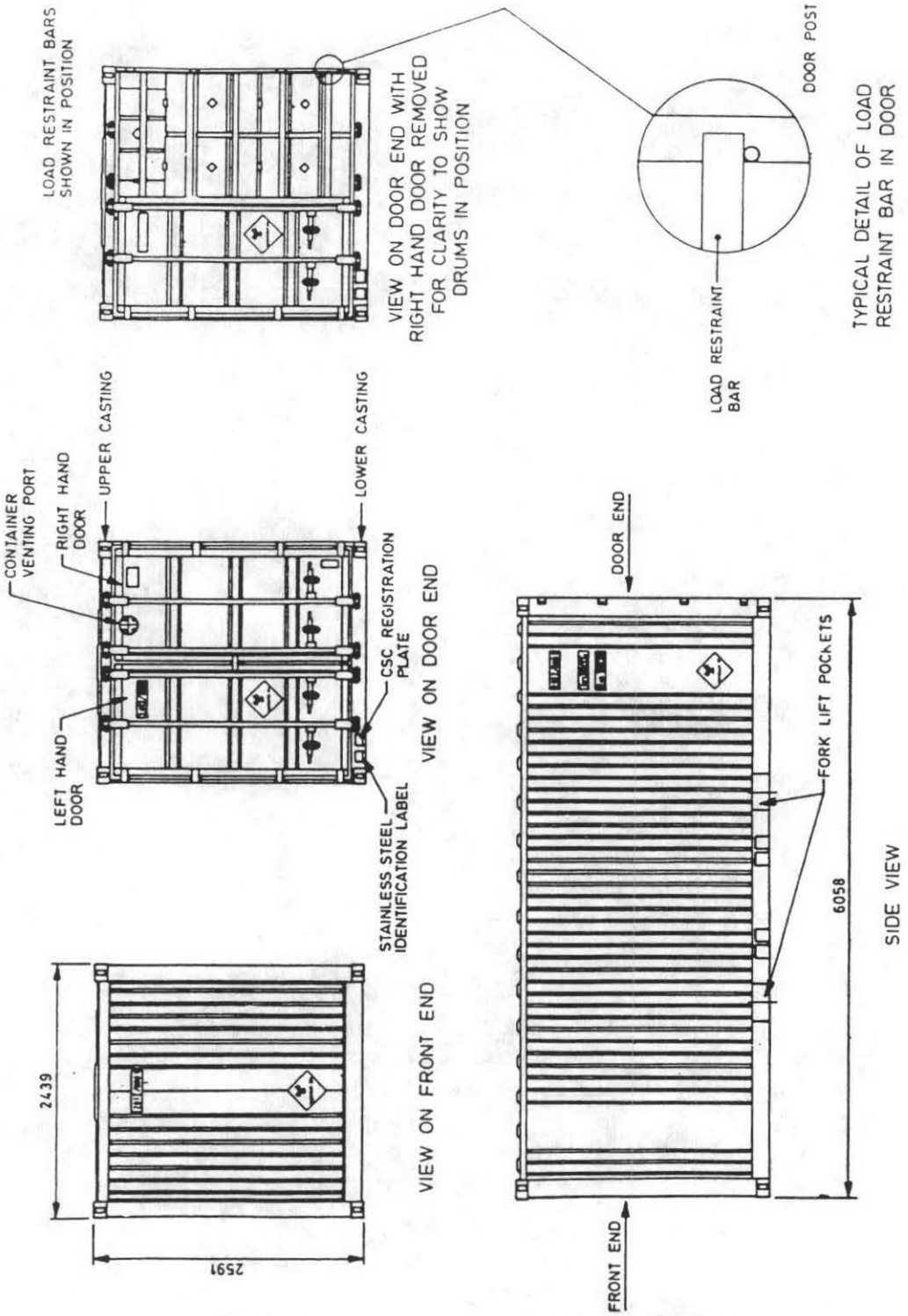
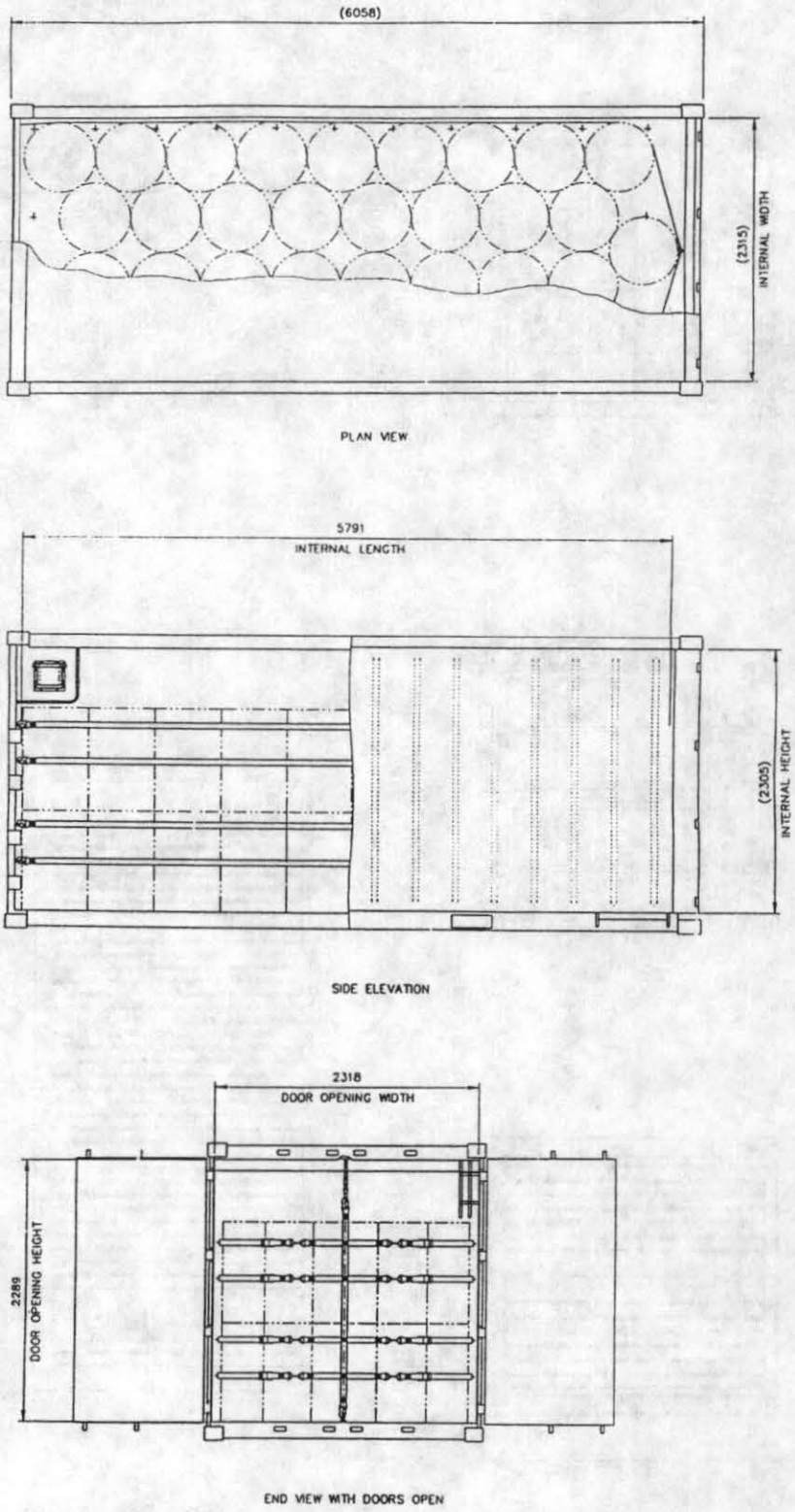
Technical Justification for the Certification for Reuse of ISO Freight Container Design No. 2912B as an Industrial Type (IP-2) Package



CONTAINER DETAILS:	Maximum Gross Weight	25.0 tonnes
	Tare Weight	2.4 tonnes
Note: All Dimensions in mm	Payload (maximum)	22.6 tonnes

Figure 1
Schematic Layout of ISO Freight Container Design No. 2912B



CONTAINER DETAILS:	Maximum Gross Weight	25.0 tonnes
	Tare Weight	3.8 tonnes
Note: All Dimensions in mm	Payload (maximum)	21.2 tonnes

Figure 2
Schematic Layout of ISO Freight Container Design No. 2044