Plutonium Contaminated Waste Materials From Storage

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ABSTRACT

Plutonium Contaminated Material (PCM) originating from the early 1950s operations was placed for storage in magazines at Drigg situated about 6km from Sellafield. A program to retrieve the PCM from the Drigg site has been under way since 1976. This has included the design and procurement of purpose-built facilities. Retrieval of the drummed waste was undertaken first. A procedure was developed whereby a re-usable module was sealed to the face of each magazine in turn to allow operators access without breaching containment in the magazine. Each drum was then individually checked, over drummed or bagged, checked free of contamination, relabeled, surface dose rate recorded, and assayed for fissile material content.

The project team addressed all aspects of safety and obtained all necessary consents and authorization from authorizing bodies.

The retrieval of crated waste has yet to be carried out. A specially designed module is ready for use and regulatory permission is awaited to start operations. The crates will be retrieved, overcrated, monitored (to determine fissile material content and to demonstrate acceptable levels of radiation or external contamination), and transported to Sellafield for storage awaiting treatment.

An application under the IAEA Regulations to transport the PCM waste by rail from Drigg to Sellafield has been raised with the Department of Transport. Given the nonstandard and differing space needs of the waste items, it was not possible to design and procure a transport package that would accommodate the waste items within realistic time scales and with a guarantee of success.

The Special Arrangements provision is included in the IAEA Regulations for Transport operations which do not satisfy all of the applicable requirements. The IAEA Regulations allow for Special Arrangements to be approved given the required provisions ensure that the overall level of safety in transport is at least equivalent to that which would be provided if all the applicable requirements had been complied with.

A fully documented safety case has been prepared for ISO freight containers providing the primary containment for overcrates when traveling through public domain.

The ISO containers are purpose designed, are constructed of high-yield steel, and have demonstrated their ability to meet the requirements of the IAEA Safety Series 6, 1985 Regulations. The safety case covers the regulatory requirements for Type B quantities of radioactive material namely, containment, shielding, criticality, and thermal demands. At this time, the Special Arrangement Approval has been endorsed by the DOT, acknowledging that the compensatory safety arrangements meet the regulations for this specific case.

INTRODUCTION

BNFL owns and operates the principal Solid Low Level Radioactive Waste (LLW) Disposal Site in the UK. The site is located at Drigg in West Cumbria some 6 km (4 miles) to the southeast of BNFL's Sellafield Site.

PCM waste originating from early operations was placed for storage in existing structures, known as magazines, at Drigg. The waste was contained within steel drums of up to 205 liter (55 US gallons) capacity or in larger timber and plastic cuboid containers known as "crates."

In the mid-1970's a commitment was given that PCM waste would be removed from the Drigg site, thus generating additional space for the construction of new facilities for the disposal of LLW and leaving it to fulfill its role within the UK for the disposal of LLW. In 1976, eight magazines on the Drigg site contained about 10,000 drums and some 200 non-drummed packages. Since then, most of the drums have been recovered and preparations are well advanced to retrieve the remaining material.

GENERAL DESCRIPTION OF MAGAZINES

The magazines were constructed during the Drigg site's prior use as a Royal Ordnance Factory. Each was a buffer store within which the high-explosive product could be transferred to railway cars for transport off-site. A schematic view of a typical magazine is shown at Figure 1. The magazines are similar in construction, each comprising a reinforced concrete structure mounded over with earth. The whole magazine structure is buried beneath a 1.5m layer of soil, giving external dimensions of approximately 55m long by 40m wide. The magazines are constructed above ground and rise to an overall height of 6m above the surrounding ground level.

DESIGN PHILOSOPHY OF CRATE RETRIEVAL FACILITIES

The project philosophy is that following retrieval, and for the duration of subsequent storage at Sellafield, the wastes will be provided with a high-integrity containment. For crates and large packages, the containment will be provided by an overcrate fabricated from glass-reinforced plastic (GRP) with a core of fire retardant foam. Existing drummed wastes will be repacked into new drums and drumming of some of the other retrieved wastes will also be appropriate. Design features of the overcrates include requirements:

- To receive loads up to a maximum of 7t for subsequent on-site and off-site transportation;
- To have a maximum leak rate of 12 l/h per m^2 of vertical surface for a 250 Pa suction (for the final sealed crate);

- To have a leak rate of not more than 120 l/h per m^2 of vertical surface for a 250 Pa suction (inner closure panel and end panel temporarily fixed);

- No increase in leak rate following a minimum drop from at least 0.6m with full load.

- During a 10-minute petrol fire, the protection offered by the container should limit the temperature at the interior of the overcrate to a maximum of 80°C with no loss of containment;

- To be fitted with a HEPA filter to permit "breathing" after sealing; and

- To have only one crate/package loaded into each overcrate.

The design has been executed on the basis that in-magazine retrieval operations will be carried out in protective clothing (supplied air suits) with provision incorporated to achieve high-integrity containment at points of export from the magazine, such that all subsequent operations will not require extensive use of protective clothing.

The general philosophy is to provide a semi permanent structure (Magazine Modules) for the controlled removal of PCM (see Figures 2 and 3). The existing magazines are to be extended by means of a purpose-designed fabricated facility. The facility will be relocated at intervals of approximately 1 year in order to carry out operations at the five magazines containing PCM waste. The modules are steel fabrications bolted together, incorporating weathertight sealed joints capable of multiple dismantling and re-erection over a 5 year period without loss of alignment. Each module is thermally insulated with floors suitably reinforced to sustain a 10-tonne floor loading. The modules when assembled, provide for access of personnel in protective clothing and systems for the loading, assay, and handling of retrieved wastes. From knowledge of the relatively low prevailing dose rates within the magazines and that wastes being retrieved are PCM, the principal radiological hazard is considered to be the spread of contamination and release of contaminated airborne material. A dedicated ventilation extract system is provided to draw clean air through the modules (low contamination) to areas of higher contamination.

Considerable attention has been paid to appropriate fissile content assay systems. Initial monitoring takes place immediately out of the magazine environment in the magazine extension. Crates and drums are subsequently moved to a Central Monitoring Facility.

Arising from the identified operational requirements and design provisions, the following services are provided:- ventilation, monitoring , showering and personnel change rooms , and effluent handling systems.

PLANT DESCRIPTION

The Magazine Facility consists of eight basic areas: (See Figure 2).

- Magazine Extension (modules 6 and 7)

- Crate Closure and Monitoring Area (modules 4 and 5)

- Crate Transfer Area (modules 2 and 3).

- External Loading Area (module 1)

- Control Room (module 8)
- Changeroom (including the Health Physics and Safety Department office with alarm repeaters) (module 9 and 10).
- Plant Modules (11-13)
- Monitoring Instrument Module

CENTRAL MONITORING FACILITY

The central monitoring building contains the following items:-

The crate monitor located within the monitoring building is of sufficient size to enclose the largest overcrated PCM waste package and monitors each crate for up to 48 hours to obtain an accurate fissile material content.

The drum monitor located in the monitoring building is capable of accepting up to 500-liter drums and uses total and coincidence neutron counting and gamma spectrometer techniques to determine the fissile content of all drummed waste.

An area of the monitoring building is partitioned so as to form the monitoring control room.

Adjacent to the central monitoring building is a storage compound for monitored, unmonitored, and unused overcrates and drums. Within this area the monitored overcrates and drums are loaded and secured inside ISO freight containers for transportation to Sellafield site. Unloaded ISO freight containers are to be returned to Drigg for reuse.

SAFETY

It will be appreciated from the foregoing descriptions that the retrieval facilities have taken account of the following key safety aspects:-

- Criticality: measurement of the contents of crates/drums as close to point and time of retrieval as possible, following careful initial move.
- Plutonium ingestion: containment of magazines, contaminated areas, and the waste itself, using physical barriers, air flows, developed transport containers, and suitable protective clothing for operators.
- Fire: minimization of combustible material loadings, including over-containment, with fire detection and alarm systems.
- External radiation: monitoring of items, use of suitable handling equipment, with area gamma radiation measurement and alarm systems.
- Industrial safety: suitable equipment will be provided for in-magazine and subsequent handling of heavy items.

During the crate retrieval campaign, group average radiation dose uptake is assessed not to exceed 5 mSv per annum.

PLANT WASTES

Protective clothing will form a major constituent, the amount of more expensive clothing being minimized by the use of over-suits.

In general, no liquids will be required in the magazine (as a result of design requirements). The exception will be hydraulic fluid (aqueous ethylene glycol) to operate the hydraulic scissor lift. The system is installed such that the hydraulic hose has a secondary containment within the magazine to prevent release of aerosols/sprays. There remains a possibility that fluid can arise in the magazine as a result of a spillage/leakage of a liquid associated with the wastes or as a result of rain water seepage which occurred prior to the magazines being sealed. Such wastes will be absorbed on to a suitable material and disposed of as solid waste.

Shower and wash hand-basin water from the change rooms is the only envisaged source of liquid effluent. The effluent is accumulated alternately in one of a pair of holding tanks. For each tank there are alarms, sample systems, vents to atmosphere, and a common secondary containment of stainless steel.

Future weekly risings will effectively fill one tank. The contents are to be sampled and the effluent transferred to a transportable approved tank for transport back to Sellafield for treatment/discharge.

One of the principal design safeguards against the spread of contaminated airborne material and contamination outside the magazine is the ventilation system. The system draws air through the modules to the magazine. The aerial effluent passes through primary and secondary filters prior to discharge from a local stack. The discharge is continuously monitored and alarmed. In addition the discharge is sampled and the flow recorded such that the annual discharge can be calculated and recorded.

ISO FREIGHT CONTAINERS

ISO freight containers provide the primary containment for both overcrates and drums when traveling through the public domain. The ISO containers are purpose designed in order to comply with safety requirements as stated in the Special Transport Authorisation submission for approval by the Department of Transport. ISO freight containers 6.1m long x 2.4m wide x 2.6m high are used with rail transportation and 6.1m x 2.8m x 3.6m high for road transportation. (Road transportation is used to convey a limited number of larger crates).

The containers are constructed from high-yield steel (BS Specification 4360-508) and have demonstrated their ability to meet the tests specified for freight containers under paragraph 523 of the IAEA Safety Series 6 1985 Regulations. The containers are also tested and certified to be leaktight prior to each movement of PCM between Drigg and Sellafield.

TRANSPORT SPECIAL ARRANGEMENTS

The retrieval of PCM from the Drigg Magazines, transport to Sellafield, and the arrangements for storage at Sellafield are part of the overall strategy for the use of the Drigg site. As there are currently no Type B containers large enough to carry these wastes, the best practical means of safe transport has been identified as a specially designed ISO freight container, which although designed to provide adequate safety for the specific journey cannot meet the full Type B requirements. Therefore, the appropriate method of competent approval is a Special Arrangement Shipment Operation.

The approval of the special ISO freight package is offset by imposing particular controls during transit. The main functions of the packaging are: confinement, containment, thermal insulation, shielding, and assurance of adequate nuclear sub-criticality.

Primary confinement of PCM will be as new 200/400 liter steel drums or glass reinforced plastic (GRP) boxes.

The special ISO freight container design provides the containment boundary against loss of the contents to the environment: meets BS3951.

The internal walls, roof, and door of the container are thermally insulated. Insulation against contents heat generation is not required for this application. The insulation is designed such that it is likely to provide insulation against an 800°C external temperature for 30 minutes.

The arrangement will not be transported with dose rates exceeding the agreed levels. The packaging will provide adequate alpha shielding. Controls on moves and the limits of nuclear materials inventory have been fully assessed as being very sufficient.

In addition to the above there are controls on the number of packages per shipment, the communications and supervisory cover for the shipment, and the security and maintenance arrangements required.

CONCLUSIONS

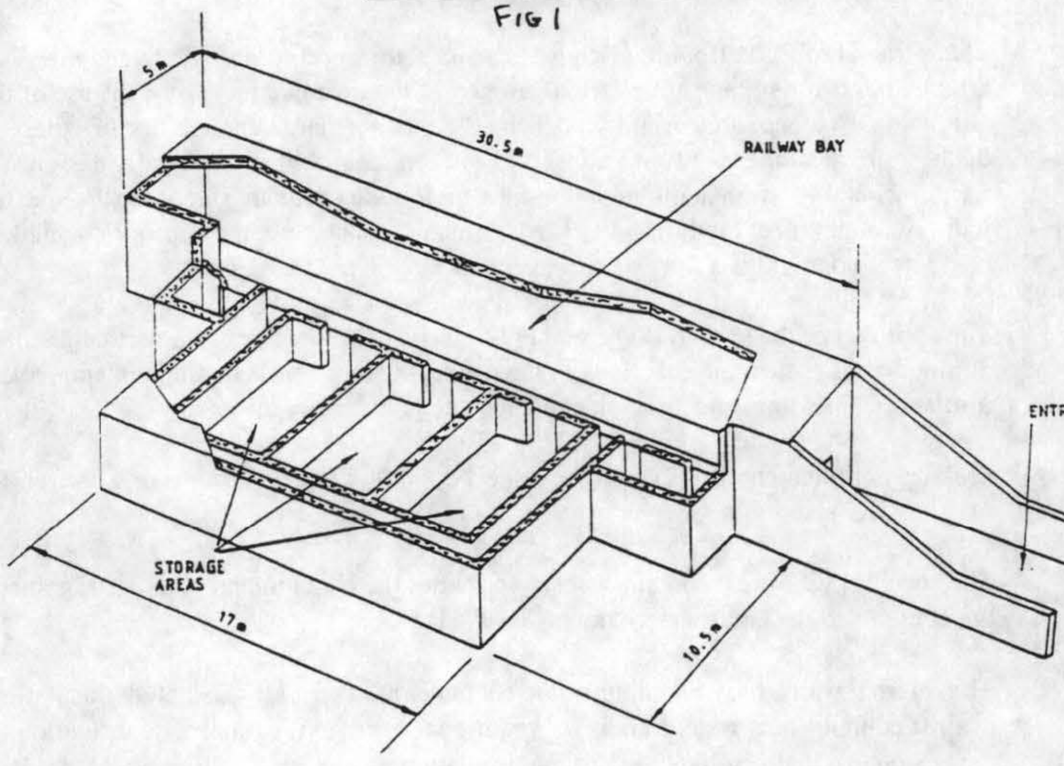
The crate retrieval operations are expected to begin in 1996 and will take about 6 years.

The retrieval and monitoring plans for the magazines are based on previous experience and the facilities installed fully provide for the safe packaging of the material within a defined quality assurance system.

The Special Arrangement defined for this particular application has been assessed and shows that the risks for the shipment are well within the regulatory acceptance criteria relevant for this specific movement.

SECTIONAL VIEW OF DRIGG MAGAZINE

FIG 1



MAGAZINE MODULE FACILITIES

FIG 2

Drigg Waste Retrieval Facilities