SHIELDING SUPPORT FOR D3900 FACILITY – DOUNREAY, DSRL

Introduction

The primary purpose of the D3900 RHILW (Remotely Handled Intermediate Level Waste) Facility at Dounreay is to immobilise PFR (Prototype Fast Reactor) liquid raffinate and encapsulate solid RHILW in a cement matrix. Both these streams are currently held in interim stores on the Dounreay site. D3900 will also be used to immobilise DFR raffinate, ADU (Ammonium Di-Uranate) Floc and D1208 wash liquors.

Liquid waste will be transferred to D3900 from the D1208 tanks, via an underground coaxial active transfer line (ATL). Solid waste, currently stored in 200 litre drums in DCP-IDS (Dounreay Cementation Plant Interim Drum Store) and D9875 will be transported to D3900 via road in shielded flasks. At D3900 the waste will then be immobilised/conditioned by grouting.

The conditioned waste will be produced in 500l stainless steel drums and will be in a form suitable for long-term storage. Since the time scales for a UK National Waste Repository are uncertain, the D3900 facility will include a store for several thousand 500l drums designed for a period of 100 years. In addition the D3900 facility will also contain a 3M^3 box store capable of storing several thousand boxes.

Our Role

Nuclear Technologies was the sole provider of shielding support for the entire facility. Our role included:

- The development of the Shielding Design Basis;
- Bulk & Detailed Shielding Assessments for the entire facility;
- Dose uptake and ALARP Assessment.

Shielding Design Basis

A Shielding Design Basis is a key shielding design document as it provides a single reference that contains all of the information required for all shielding assessments supporting a facility. The D3900 Shielding Design Basis included:

- The design standards for radiation exposure control, for anticipated operation and maintenance tasks on the plant;
- Outline of the basis of shielding design;
- The radiation source strengths, material compositions and response functions to be used in shielding design calculations;
- Indication of the design standards for radiation exposure control during potential incident conditions in the plant.

Shielding Assessments

- Shielding Assessments were performed for the entire facility using the design criteria set within the shielding design basis. Assessments used the latest computational codes and techniques facilitate engineering design.

Radiation Shielding Codes

- **ATTILA**

Attila is a deterministic code using multi-group energy, discrete-ordinates and angular discretisation used to solve complex radiation shielding calculations. Models are created using CAD and results can be presented graphically for efficient interpretation.

Nuclear Technologies are the leading users of Attila in the UK for radiation shielding applications.

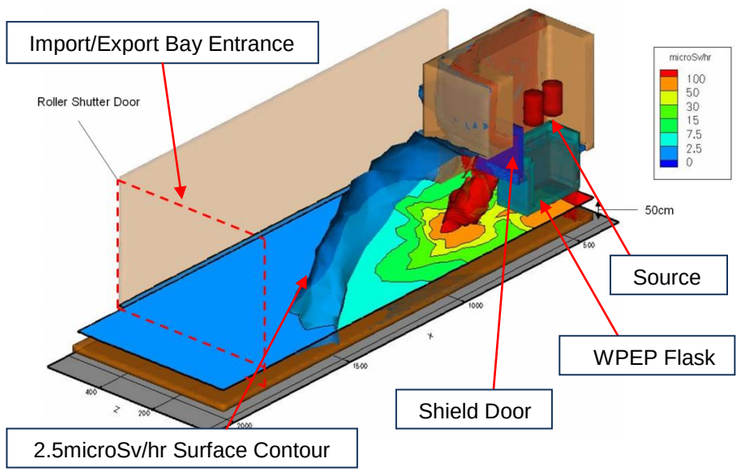
- **MCNP**

MCNP is a Monte Carlo radiation transport code used for complex radiation shielding calculations involving Neutrons Photons and Electrons. The use of MCNP combined with Attila provides a very robust, independent cross check of results.

Shielding Assessments for the facility were split into two areas:

- Bulk shielding assessment throughout the entire facility which included areas such as:
  - Chemical cell
  - Solids Cell
  - Analytical cell
  - Curing Line
  - Box store
  - Drum store
- Detailed assessments which included penetrations within bulk shielding, wall ducts, shield door optimisation, streaming paths etc.

Figure 1: Import/Export Bay Dose Rate Contour Map



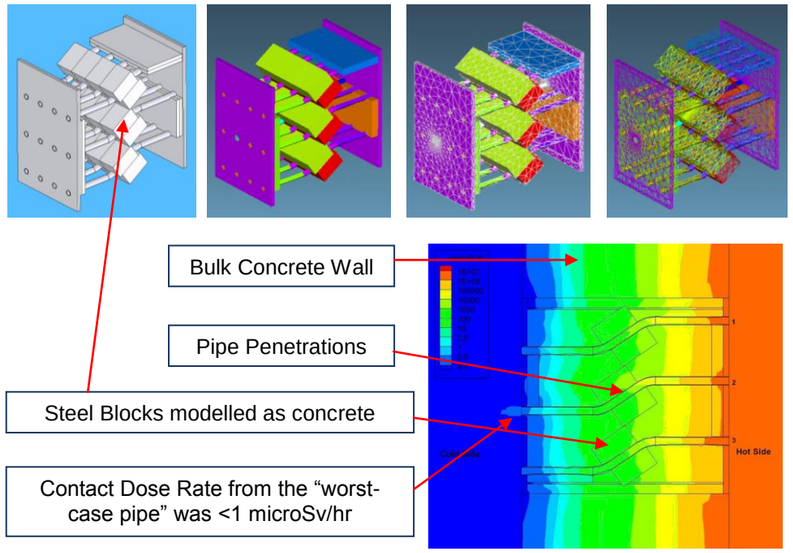
Import/Export Bay

Figure 1 shows the results of a detailed shielding optimisation study and assessment for the Import/Export Area of the D3900 facility. The radiation shielding code Attila was used. The results determined that a shield door was not required at the Import/Export Bay entrance. As a result engineering design and construction costs were reduced.

Wall Box Assessment

The purpose of this assessment was to demonstrate that a proposed wall box design had sufficient shielding to reduce dose rates to below the criterion for occupied areas. It was found that the proposed steel compensation shielding was not required in order to meet the dose criterion for the worst case position and source. As a large number of these wall boxes were to be used throughout the facility, this resulted in a significant project cost saving.

Figure 2: Wall Box Detailed Shielding Assessment



Dose Uptake and ALARP Assessment

The Dose Uptake and ALARP assessment presented an estimate of the accrued whole-body dose to individual worker groups and the plant-wide workforce based on results of shielding assessments and supplied occupancy data. The assessment;

- Identifies significant sources of Dose Uptake (aids ALARP optimisation);
- Determines overall Dose Uptake During Plant Operation;
- ALARP/ALARA Justification of Doses.

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