Form10/00

HITACHI

UK ABWR

Document ID	:	GA91-9101-0101-18004
Document Number	:	WE-GD-0020
Revision Number	:	A

UK ABWR Generic Design Assessment

Generic PCSR Sub-chapter 18.4 : Solid Radioactive Waste Management System

Hitachi-GE Nuclear Energy, Ltd.

DISCLAIMERS

Proprietary Information

This document contains proprietary information of Hitachi-GE Nuclear Energy, Ltd. (Hitachi-GE), its suppliers and subcontractors. This document and the information it contains shall not, in whole or in part, be used for any purpose other than for the Generic Design Assessment (GDA) of Hitachi-GE's UK ABWR. This notice shall be included on any complete or partial reproduction of this document or the information it contains.

Copyright

Table of Contents

18.4.1 Outline

The Solid Radioactive Waste Management System (SWMS) will be designed to receive, sort and process/condition all solid and wet-solid LLW and ILW waste streams resulting from ABWR operation. Following processing and conditioning LLW is dispatched off site for either incineration, recycling (in the case of recyclable metals), or direct disposal, while ILW is transferred for interim storage (pending availability of the Geological Disposal Facility(GDF)) in an on-site shielded ILW store.

The SWMS concept design currently comprises the following facilities:

- Solid LLW treatment facility
- Solid ILW treatment facility
- Wet-solid LLW treatment facility
- Wet-solid ILW treatment facility
- LLW marshalling area (pending transport for off-site incineration/recycling/disposal).
- Interim ILW shielded store (dedicated building)

The information in the following sections is indicative of one possible solution to the need to treat wastes generated by UK ABWR reactor and turbine operations for final disposal (in the case of LLW) and into a passively safe and disposable form awaiting availability of the GDF (for ILW). Further assessment within the GDA process and site specific applications will be conducted as the design is developed, further discussions on the options available will be provided in later submissions.

18.4.2 Design Basis

The SWMS does not provide a reactor safety function and is not required for safe shutdown of the reactor. However, the SWMS handles and processes radioactive solids and liquids and the safety function in this respect is to ensure that the radioactive inventory is passively safe and any radiation doses and risks to the public or operators are ALARP.

18.4.2.1 Safety Requirement

This section summarises the nuclear safety requirement for the SWMS for the UK ABWR design. The safety requirement for the storage and packaging of spent fuel prior to final disposal, including the fuel channel boxes which are integral to the spent fuel assemblies, are addressed separately in [PCSR Ch.32 Spent Fuel Interim Storage]. The UK ABWR has been designed to ensure that total solid radioactive waste volumes generated during operation are minimised. The SWMS ensures safe:

- Segregation at source and collection of the various solid and wet-solid waste streams resulting from UK ABWR reactor and turbine operations

18.4.2.1.1 Normal Operation

Doses to both the operators and the public from normal operation of the UK ABWR Solid Radioactive Waste Management system are ALARP.

Doses to the Public

The design of the SWMS ensures that:

- Direct radiation to the most exposed member of the public resulting from normal operation of the Solid Radioactive Waste Management system is ALARP through optimisation and use of BAT, for example, the provision of shielding and distance to ensure public exposures are ALARP.
- Doses to the public associated with the off-site transport of processed and packaged wastes are ALARP.

Doses to Workers

The design of the SWMS ensures that:

- Appropriate shielding against direct radiation is provided for operators in line with approach/principles described in [PCSR Ch.20 Radiation Protection] such that doses received are ALARP.
- Radiological protection measures for workers are provided through the use of BAT in line with the principles described in [PCSR Ch.20 Radiation Protection] such that doses received are ALARP. For example the use of enhanced area designation for the basis of dose control and cascading air flows from areas of low contamination to areas of high contamination (through HEPA filtration) to provide a higher degree of containment in open systems.
- All ILW handling and processing uses remote operations techniques with engineered interlocks or suitable administrative controls to prevent operator access to processing and storage areas when ILW is present.
- Processed ILW packages are appropriately shielded or overpacked before and during cross-site transport to the interim ILW storage facility to limit the dose uptake to personnel required to handle the package, and to other onsite personnel during cross-site transport.
- The SWMS equipment (optioneered to ensure that the BAT are used) design and health physics control and systems of work ensure that worker doses during normal operation and maintenance (including recovery from plant breakdowns) are ALARP.
- The wet-solid processing systems include engineered flushing points which so far as is reasonably practicable (SFAIRP) enable any settled radioactive contamination to be flushed from system prior to maintenance work being carried out thus ensuring operator doses during maintenance are ALARP.

General

Solid and wet-solid radioactive wastes are contained, controlled and processed within appropriately engineered facilities (see Section 18.4.2.4). In addition, appropriate monitoring, measuring, and sampling equipment is provided so that operators can check and record that wastes coming into and being dispatched from the facility are as expected.

18.4.2.1.2 Faults

Potential Doses to the Public in Faults

The design of the SWMS ensures that doses to public in faults are ALARP and within limits/targets given in [PCSR Ch.5.3].

Natural Hazards

The radioactive waste civil structures/building envelopes etc are designed and qualified to appropriate standards and provide protection against the following natural events:

- Earthquake
- High Wind
- Flooding
- Extreme temperature
- Snow loading

- Other external hazards as appropriate.

Fire/explosion

The overall design and layout of the radioactive waste buildings are compliant with the relevant UK fire regulations. In the unlikely event that a significant fire/explosion did result in damage to the radwaste building and a consequential radiological release, then even on a bounding conservative assessment the consequential off site dose to the most exposed member of the public would be less than the limits identified in [PCSR Ch.5.3].

Internal Flooding

The overall design and layout of the radwaste treatment facilities are such that in the unlikely event that internal flooding did result in damage to the SWMS and a consequential radiological release, then even on a bounding conservative assessment the consequential off site dose to the most exposed member of the public would be less than the limits identified in [PCSR Ch.5.3].

Missiles

The overall design and layout of the radwaste treatment facilities are such that in the unlikely event that an internally generated missile did result in damage to the SWMS and a consequential radiological release, then even on a bounding conservative assessment the consequential off site dose to the most exposed member of the public would be less than the limits identified in [PCSR Ch.5.3].

Potential Doses to Operators in Faults

Potential doses to operators in faults are ALARP, including potential doses associated with post-fault operator actions required to secure affected plant in a safe condition. Where appropriate the design includes specific engineered provisions to facilitate identified fault recovery actions by the operators.

18.4.2.2 Functional Requirement

The various SWMS facilities, currently at a concept design stage, will be designed to provide the following functional requirements:

- The Wet-solid ILW treatment facility is designed to condition wet-solid ILW into a passively safe form compatible with Nuclear Decommissioning Authority (NDA) Radioactive Waste Management Limited (RWM) requirements for ultimate disposal in the GDF.
- The Wet-solid LLW treatment facility is designed to condition wet-solid LLW into a form compatible with disposal at the LLWR.
- The Solid ILW Treatment Facility is designed process solid ILW into a passively safe form compatible with NDA RWM requirements for ultimate disposal in the GDF.
- The Solid LLW Treatment Facility is designed to process wastes into packages suitable for off-site transport to the appropriate nominated facility for incineration, recycling or direct disposal.
- The on-site Interim ILW Store is designed to receive processed and packaged wet-solid ILW, and processed and packaged Solid ILW. The Store is designed to hold all of the processed ILW generated in the operating lifetime of the ABWR, i.e. 60 years plus any additional ILW resulting from Post-Operation Clean-Out (POCO) of the LWMS. The proposed design life of the Interim ILW Store is 100 years. The store is designed to provide conditions that will minimise as far as reasonably practical any degradation of the packaged wastes by corrosion or similar processes during the period of interim on-site storage.

- The LLW Marshalling Area is designed to have sufficient capacity to receive and temporarily store processed and packaged LLW, VLLW and Exempt Waste, pending the dispatch of this waste off site for incineration, recycling or direct disposal at the appropriate nominated facility.

18.4.2.3 Design Related Requirement

Categorisation and classification of structures, systems and components are decided based on fault studies.

Seismic category is decided based on fault studies.

18.4.2.4 Design Criteria

The construction and design of the SWMS buildings and processing equipment (pipes, tanks, sumps etc.) have used appropriate engineering design principles and are engineered to the required withstands (pressure, seismic etc.). Material selection is based on corrosion resistance and operating conditions. The equipment is designed in accordance with ISO, BS and European Standards and the following general design features are also included:

- Tanks, pipes, pumps etc. in the SWMS use appropriate materials, are designed against appropriate design temperatures and pressures and are manufactured and tested in accordance with UK engineering standards.
- Except where the design allows for break-in for maintenance or recovery from breakdowns, the systems used for processing wet-solid wastes are fully welded systems.
- The wet-solid waste processing systems include monitoring of all the main process parameters (level, pressure, flow, temperature, etc.) with appropriate alarms provided to the operators in the event of abnormal conditions.
- The systems used for processing wet-solid wastes are provided with adequate bunding.
- All floor drainage and bunding sumps include leak detectors/alarms and pumps to recover any spilt liquids to prevent the spread of any spilt liquids outside of the facility. In addition forced ventilation, and operation of the facility at a depression with respect to outside air pressures will prevent the spread of contamination outside of the facility.
- Solid ILW handling equipment is purpose designed to appropriate engineering standards to ensure integrity of lifting/handling of wastes.
- Appropriate shielding and radiological protection provisions are provided to minimise operator doses to ALARP during normal operation and during examination, inspection, maintenance and testing of equipment.

18.4.3 System Description

The Solid Radioactive Waste Management System (SWMS) will be designed to receive, sort and process/condition all solid and wet-solid waste streams resulting from ABWR operation. The assorted LLW solid and wet-solid waste is conditioned for either off site incineration, offsite recycling (in the case of recyclable metals) or direct disposal. The ILW is conditioned and transferred for interim storage (pending availability of the GDF) to an on-site shielded ILW store. The method described below for dealing with the different waste streams uses cement encapsulation in preparation for interim storage (ILW) or disposal (LLW). This is an indicative option for use in GDA and further work will be undertaken to underpin this option within GDA. Any future site operator will undertake a full options assessment to underpin their LLW/ILW decisions as required under UK regulations.

The SWMS concept design currently comprises the following facilities:

- Solid LLW treatment facility
- Solid ILW treatment facility
- Wet LLW treatment facility
- Wet ILW treatment facility
- LLW marshalling area (pending transport for off-site incineration/recycling/disposal)
- Interim ILW store (dedicated building).

The current working assumption for the waste treatment facilities is that there will be separate buildings for processing the different waste types. Further assessment during GDA and for specific site licensing may confirm there is sufficient space for the facilities to be enclosed within the Rw/B or in a single extra structure. This will be determined at later stages of the GDA process as the design develops and by specific site licensee. However there are numerous benefits from maintaining separate buildings for the different waste streams, for example: it ensures better segregation of wastes, thus minimising personnel exposures to multiple sources, reduces the risks from fault scenarios as the local inventory is greatly reduced and fewer operators will be affected, and allows for more stringent access controls to be in place as required.

18.4.3.1 Solid LLW Treatment Facility

This facility processes the following wastes;

- CF spent hollow fibre media.
- LCW filter spent hollow fibre media.
- Miscellaneous soft wastes such as paper, polythene, cloths etc, comprising combustible and non-combustible material.
- Other miscellaneous non-combustible wastes including metals, cables, lagging, gas filters, concrete, glass, etc, comprising recyclable metal and non-recyclable material.
- Activated carbon
- HVAC filters including Medium Efficiency bag type filters and HEPA filters.

The Solid LLW Treatment Facility is designed to process wastes into packages suitable for off-site transport (meeting the transport requirements for the package type as required by the radioactive inventory) to the appropriate nominated facility for incineration, recycling or direct disposal. The facility is designed and sized to handle the following typical solid LLW. Annual volumes of these solid LLW arisings are given in [Ref-1].

The Solid LLW Treatment Facility is a self-contained building. The building is nominally un-shielded, although temporary modular shielding blocks may be used during the processing of some types of waste as required to ensure operator exposures are ALARP. Containment, ventilation and contamination control will prevent the spread of contamination to clean areas of the facility and outside of the building. The facility has Fork Lift Truck (FLT) access at both its reception and dispatch bays.

The main equipment items in the Solid LLW Treatment Facility include:

- Sorting conveyor array
- Combustible waste shredder
- Low force compactor
- Over Head Crane (OHC)
- Linear conveyors for discharge of filled HHISO containers and skips
- HVAC system

18.4.3.1.1 Solid LLW Receipt and Sorting

All suspected solid LLW is initially delivered to the LLW Reception Bay of the LLW Facility. The waste is normally pre-sorted and segregated at the point of origin into different coloured LLW Transfer Containers. If not pre-sorted, the first step is to manually sort the waste into three generic categories with different treatment and disposal routes: combustible waste that can be sent to incineration facilities for volume reduction; metallic components that can be recycled and other miscellaneous waste that requires direct disposal.

Dewatered Granular Activated Carbon (GAC) and Bead Activated Carbon (BAC) from the Laundry Drains processing system (see Section 18.2.3.4 above) is also delivered to the Solid LLW Facility packed in 200 litre drums. These drums are weighed and beta/gamma dose monitored to identify those drums containing activated carbon waste that meets the LLWR Waste Acceptance Criteria (WAC) for combustible waste. These drums are segregated to be processed as combustible waste, while the drums containing activated carbon above the WAC dose rate threshold are sent to the Wet LLW Treatment Facility for cement encapsulation.

18.4.3.1.2 Combustible Waste Treatment and Packaging

Combustible LLW includes items such as HVAC (Medium Efficiency and HEPA type) Filters, CF or LCW Hollow Fibre Filters and other combustible materials such as paper towels, etc. Sorted combustible LLW is placed in LLW Transfer Containers and transferred using the sorting conveyor array to the Shredder and Low Force Compactor, where the waste is volume reduced and then re-packaged into a container (e.g Dolav 800 Tri-Hi 870 boxes). These boxes are weighed and beta/gamma dose monitored to confirm that the waste that meets the LLWR Waste Acceptance Criteria (WAC) for combustible waste, and are then placed into 2 off ½ S1 Stillages in a Reusable HHISO container. The 200 litre drums of BAC and GAC which have been confirmed to be within the LLWR WAC for combustible waste (see above) are also placed into 2 off ½ S1 Stillages (Drum Variant) in a Reusable HHISO container. The completed HHISO containers (containing boxes and drums of combustible LLW) are then dispatched to the LLW Marshalling Area awaiting collection and shipment to the LLW incinerator as specified on the Environment Agency EPR Waste authorisation.

18.4.3.1.3 Metallic Waste Transferred from Solid ILW Facility

Pre-characterised and pre-sorted Low Level activated metallic waste from the Solid ILW Treatment Facility (see Section 18.4.3.4) is delivered to the Solid LLW Facility Reception Bay in LLW Transfer Containers. This waste is transferred directly into a container (e.g. WB-1 Waste Boxes), which are then packed into two off ½ S3 Stillages in a Reusable HHISO container. Once full the HHISO containers are dispatched to the LLW Marshalling Area awaiting collection and shipment to the nominated off-site LLW Metal Recycling Facility.

The Metallic LLW is packaged in accordance with the requirements of the Metallic LLW WAC.

18.4.3.1.4 Other Metal Waste Items Capable of Being Recycled

Metallic waste items from across the site may constitute part of the general LLW arisings. These items are visually identified and segregated at source or separated out during sorting in the Solid ILW Facility. Following surface decontamination (if required), any LLW metallic waste items that are recyclable are transferred to a container (e.g. WB-1 Waste Boxes), which are then packed into two off ½ S3 Stillages in a Reusable HHISO container. Once full, the HHISO containers are dispatched to the LLW Marshalling Area awaiting collection and shipment to the nominated off-site LLW Metal Recycling Facility.

The Metallic LLW is packaged in accordance with the requirements of the Metallic LLW WAC.

Any small amounts of metallic LLW not suitable for recycling are dealt with as Miscellaneous LLW as described in Section 18.4.3.1.5 below.

18.4.3.1.5 All other Miscellaneous LLW

The beta-gamma activity levels of all other miscellaneous suspected LLW items are monitored, allowing the waste to be appropriately categorised as LLW, VLLW or Exempt depending on its activity levels. LLW and VLLW are placed directly into separate containers ready for direct disposal at the appropriate facility - the LLWR for LLW or an approved VLLW disposal facility for VLLW. The LLW and VLLW containers are dispatched to separate zones in the LLW Marshalling Area awaiting collection and shipment by LLWR. Exempt waste is placed in commercial waste skips for disposal via the Local Authority route. The skips of exempt waste are dispatched to the central site conventional waste collection area.

VLLW is packaged in accordance with the VLLW Disposal WAC, the LLW is packaged in accordance with the LLW Disposal WAC.

18.4.3.2 Solid ILW Treatment Facility

This facility processes the following wastes;

- Control rods
- Local Power Range Monitors (LPRMs)
- Start-up Range Neutron Monitors (SRNMs)
- Traversing In-core Probes (TIPs)
- Neutron Source Units (NSUs).

The Solid ILW Treatment Facility is designed to process and package waste in 3 m^3 boxes into a passively safe form compatible with NDA RWM requirements for ultimate disposal in the GDF. The volume of these Solid ILW arisings are given in [Ref-1].

The Solid ILW Treatment Facility is a self-contained multi-storey building. The building is heavily shielded, consisting of a shielded reception facility, a shielded buffer storage area, a shielded processing area and a shielded export facility. Each area is contained, with appropriate air cascades to maintain containment and prevent the spread of contamination.

The main equipment items in the Solid ILW Treatment Facility include:

- OHC
- Cask linear conveyor
- Miscellaneous Waste Transfer Container (MWTC) linear conveyor
- Cask lid removal and fitting equipment
- MWTC lid removal and fitting equipment
- Remotely operated OHC with assorted grapples or power manipulator on mast
- Dose and gamma spectrometry assay equipment
- Hydraulic Roller Crusher (for Control Rods)
- Hydraulic Pinch and Shear croppers (for Control Rods)
- Hydraulic Rotating Shear croppers
- Remotely operated linear conveyor
- Remotely operated grab / manipulator for posting cropped waste items
- OHC for handling 3 m^3 Boxes
- Assorted shield gates
- Air compressor
- HVAC system

18.4.3.2.1 Solid ILW Reception

Solid ILW is transferred from the Fuel Pool to the ILW Treatment Facility in two different casks types, Casks and MWTCs. Both cask types are drained at source, so that the ILW they contain is in a nominally dry condition prior to transfer. Casks are then loaded onto a dedicated purpose built transporter and transferred to the reception bay of the Solid ILW Treatment Facility. After monitoring and decontamination of the cask has been carried out.

18.4.3.2.2 Opening a Transfer Cask/MWTC

Once the transporter has been positioned in the reception bay, for Casks only, the impact limiters on both ends of the Cask are removed and placed in a dedicated lay-down area. The OHC is then used to rotate the Cask to the vertical and lift it from the transporter (which remains in the unloading bay). The OHC combined with a linear conveyor is then used to manoeuvre the Cask into a shielded Unloading Station, where it is set down standing upright. The shield doors on the Unloading Station are then closed. The process is similar for the MWTC except that these containers are transported to the facility in the vertical orientation.

The operators enter the shielded Unloading Station via an interlocked man access door and access the top of the Cask/MWTC to remove the Lid bolts. Once the lid bolts have been removed, the operators leave the shielded unloading bay. Access during subsequent lid removal and unloading operations is prevented by interlocks that prevent:

- Use of the OHC when the main shielded labyrinth doors are closed and the man access door is not locked
- Unlocking of the man access door when beta/gamma radiation monitors in the shielded Unloading Station detect high levels of radiation (i.e. when the Cask lid has been removed).

Once it has been confirmed that the Unloading Station shield doors are closed, the operators have left the shielded Unloading Station and the man access door has been locked (in accordance with the administrative controls), the Cask/MWTC lids are lifted remotely using the OHC and set down in a dedicated lay-down area. Measurements from the radiation monitors in the Unloading Station and visual inspection by the operators using CCTV are then used to confirm that the Cask/MWTC contains no unexpected material (e.g. fuel).

18.4.3.2.3 Unloading the Casks & MWTCs

A remotely operated OHC or power manipulator is used to grapple, lift and remove Control Rods and Cask Baskets from the Casks and MWTC Liners from the MWTCs. The Cask Baskets and the MWTC Liners have the same lifting features but a different grapple is used to lift the Control Rods. The OHC or power manipulator is then used to manoeuvre the items through a further shielded labyrinth door to the Solid ILW Buffer Storage Area where they are placed in a racking system.

Once the Cask/MWTC has been fully unloaded, it is reloaded with empty Cask Baskets / MWTC Liners from the Shielded Buffer Storage Area racks, again using the OHC or power manipulator. The Cask or MWTC is then re-lidded using the OHC. Once the shielded lid is confirmed to be in position and the dose rate readings form the beta/gamma monitors in the shielded Unloading Station are confirmed to be at an acceptable level, the operators can re-enter via the man access door and fasten the lid bolts. The Cask is then checked for external contamination, decontaminated (if necessary) and reloaded on to the transporter using the OHC for reuse.

18.4.3.2.4 Unloading in the Buffer Storage Area, Size Reduction and Packaging

The contents of the ILW Buffer Storage Area racking system can be viewed remotely by the operators using a CCTV camera. The OHC or power manipulator is used with purposely deigned grapples to recover either individual Control Rods or individual items from a Cask Basket or MWTC Liner stored in the racks. Control Rods are manoeuvred directly to the Control Rod size reduction and packaging station. Other items are first manoeuvred to the assay station, where beta/gamma dose rates are measured along the whole item length to ascertain, with the dose fingerprint of the item, whether it corresponds to ILW or LLW. The items transferred from the Fuel Pool include LPRM, SRNM, TIP and NSUs pre-cropped into approximately 4 metre lengths. The lower lengths of these components which operate outside and some distance below the bottom of the RPV during the operational life will correspond to LLW (rather than ILW). Following characterisation, the item is manoeuvred to the appropriate (ILW or LLW) size reduction and packaging station. An interlock on the OHC or power manipulator control system prevents movement to the LLW size reduction and packaging station if the dose rates measured at the assay station are above a specified level.

18.4.3.2.5 Control Rod Size Reduction and Packaging Station

At the Control Rod size reduction and packaging station, the control rod (which has a cruciform cross-section) is flattened by passing it through a hydraulic roller crusher. The flattened Control Rod is then cut into ~ 1.4 metre lengths using a Pinch and Shear cropper. The shearing is carried out directly over an open 3 m^3 Box, ensuring that any material that might be released during shearing fall directly into the box. Prior to each shearing operation, the lower section of the rod is clamped in a secondary grab/manipulator. This grab/manipulator is then used to lower the sheared length in manner that avoids damage to the box and in a position that ensures efficient waste packing.

18.4.3.2.6 ILW Size Reduction and Packaging Station

At the ILW size reduction and packaging station, non-control rod items that have been confirmed as ILW at the assay station are positioned over a 3 m^3 Box and then sheared using a Rotating Shear Cropper. Prior to each shearing operation, the lower section of the item is clamped in a secondary grab/manipulator. This grab/manipulator is then used to lower the sheared length in manner that avoids damage to the box and in a position that ensures efficient waste packing.

18.4.3.2.7 LLW Size Reduction and Packaging Station

At the LLW size reduction and packaging station, non-control rod items that have been confirmed as LLW at the assay station are sheared using a Rotating Shear Cropper. The shearing is carried out directly over a LLW Transport Container and the sheared lengths are permitted to fall directly into this container.

18.4.3.2.8 Removing and Supplying New Packaging Containers

Once a 3 m^3 Box has been filled, it is moved by a conveyor system to the ILW Box Lidding Station. At this station, any residual voidage in the 3 m^3 Box is filled with sand, if required, (which is used as an inert filler) and a lid is then fitted and bolted into place remotely. The 3 m^3 Box is then moved on the conveyor system to a Decontamination Station where the external surfaces of the sealed 3 m^3 Box are then checked for contamination by swabbing and, if required, decontaminated. The 3 m^3 Box is then moved by the conveyor system to the Solid ILW Dispatch Bay. The ILW Cross Site Transporter is brought to the Solid ILW Dispatch Bay and the 3 m^3 Box is remotely handled into the ILW Cross Site Transporter using a OHC and removed from the ILW Treatment Facility for dispatch to the Interim ILW Store.

Empty 3 m^3 Boxes are delivered to the Solid ILW Dispatch Bay using the ILW Cross Site Transporter and these are moved to the Control Rod and ILW size reduction and packaging stations using the conveyor system (operating in reverse).

Once a LLW Transfer Container at the LLW size reduction and packaging station has been filled, it is re-lidded and swabbed to ensure it is clean. If contamination is found, it will be decontaminated prior to transfer to the Solid LLW Treatment Facility using a Fork Lift Truck. Empty LLW Transfer Containers are delivered to the LLW size reduction and packaging station by Fork Lift Truck.

18.4.3.3 Wet LLW Treatment Facility

This facility processes the following wastes;

- Bead resin (from LCW demineraliser, HCW demineraliser and CD)
- Concentrated waste (from HCW evaporator)
- Activated carbon (from LD system)

The Wet-solid LLW treatment facility is designed to condition and package waste in Third Height International Standardisation Organisation (THISO) containers in a form compatible with disposal at the LLWR. The facility is designed to have the capability and capacity to treat one years' worth of wet-solid LLW arisings within a period of three months. The volume of these wet-solid LLW arisings are given in [Ref-1].

The Wet LLW Treatment Facility is a self-contained multi-storey building. The building has a shielded enclosure containing the waste reception area, an unshielded cement powder handling area, a THISO container import/export area and an area for THISO container filling.

The Wet LLW Treatment Facility is connected to the Rw/B by a shielded and secondary contained transfer pipe duct.

The main equipment items in the Wet LLW Treatment Facility include: -

- OHC
- linear conveyor for THISO container
- MWTC handling equipment
- MWTC lid removal and fitting equipment
- Supernatant decant pump
- An LLW Process Tank
- A Wet LLW feed pump
- LLW Effluent Treatment system and associated discharge pump
- 200 litre Drum emptying system
- Cement grout preparation equipment (powder feeder, mixer, grout feed hopper and grout pump)
- NaOH dosing system
- THISO fitted with lost In-line Mixer
- Assorted shield gates
- Air compressor
- HVAC system

An overview of the Wet LLW treatment process is shown in Figure 18.4-1.

18.4.3.3.1 Transfer to Wet LLW Treatment Cell

Two types of wet LLW, Resins and Sludge are initially collected and stored in separate tanks in the main Rw/B (see Section 18.2.3.6 above). Motive water is used to transfer the Resins and Sludge wastes to the Wet LLW Treatment Cell and makes up the majority of the transfer volume. The two waste streams are

co-processed in batches, which are periodically transferred to the Process Tank in the Wet LLW Treatment Facility.

A third source of wet LLW is waste sludge and filter media transferred in 200 litre Drums from the Laundry Drains treatment system (see Section 18.2.3.4 above) and Granular Activated Carbon (GAC) that does not meet the LLWR WAC for incineration, which is also transferred in 200 litre Drums from the Laundry Drains treatment system via the Solid LLW Treatment facility (see Sections 18.2.3.4 and 18.4.3.1.1 above). The 200 litre drums containing these wastes are mechanically lifted above the Wet LLW Process Tank and then emptied into the tank following supernatant removal (see below) and mixed with the other wet LLW streams.

The following subsections cover preparation for treatment of the wet LLW.

18.4.3.3.2 Supernatant Removal (Resin and Sludge) and GAC Addition

Once a mixed batch of Resins and Sludge has be transferred to the Wet LLW Treatment Cell, the waste is allowed to settle in the LLW Process Tank and the supernatant is then removed using a Decant Pump with a retractable dip leg. The control system monitors the depth of the sludge bed and hindered settling zone and the end of the dip leg is positioned to maximise supernatant retrieval. After supernatant removal, wet LLW transferred from the Laundry Drains treatment system in 200 litre drums can be emptied from drums into the top of the Wet LLW Process Tank and mixed with the other wastes (see Section 18.4.3.3.1 above).

18.4.3.3.3 Supernatant Treatment

Decanted supernatant is transferred to the LLW Effluent Treatment Plant which is used to remove fine particulate and soluble species. The separated solids and soluble species are returned to the LLW Process Tank for incorporation in a subsequent encapsulation batch. Treated supernatant is transferred back to the main Rw/B.

18.4.3.3.4 Caustic Treatment of Ion-Exchange Resins

Following supernatant removal, a caustic solution is used to swell the ion-exchange resins prior to cement immobilisation. This prevents swelling post cement curing, which would compromise the integrity of the final waste package. The caustic solution is delivered to site in an IBC (International Bulk Container), which is positioned in a bunded area in the Chemical Storage Area. Caustic solution is transferred from the IBC to the LLW Process Tank via the metered Caustic Feed Pump. The LLW Process Tank is agitated until the caustic treatment is complete.

18.4.3.3.5 Grout Preparation

The exact cement grout formulation will be subject to optimisation trials. The pre-blended cement powder will be delivered in 2.5 tonne capacity IBCs that can be connected to the grout process equipment. The pre-blended cement powder is metered into the Mixer where it is wetted with chilled water (to limit the effects of the exothermic pozzolana reaction) to form a suitable grout product. The grout is transferred to a Wet Grout Hopper ready for transfer to the lost In-Line Mixer in the THISO container.

18.4.3.3.6 Wet LLW Immobilisation

Grout flow via the lost In-Line Mixer in the container is established and allowed to continue until the floor of the THISO container is covered in grout. Homogenised (using the agitator in the LLW Process Tank) LLW sludge is then introduced into the lost In-Line Mixer and well mixed Grout and LLW are transferred into the THISO container. When the THISO container has been filled to a pre-set depth, the flow of LLW is stopped but the flow of grout is allowed to continue so as to provide a layer of relatively clean grout capping off the

active mixture in the container. Once the container is full, the feed tanks are isolated and static lost In-Line Mixer is disconnected and dropped into the waste product. The contents of the THISO container are left to cure before the lid is fitted. The container is then subject to final Quality Assurance (QA) checks before being transferred to the LLW Marshalling Area, ready for dispatch off-site for disposal at the Low Level Waste Repository (LLWR).

18.4.3.4 Wet ILW Treatment Facility

This facility processes the following wastes;

- Powder resin & crud (from CUW filter demineraliser and FPC filter demineraliser)
- Sludge and crud (from CF and LCW filter)

The Wet-solid ILW treatment facility is designed to condition and package waste into $3m^3$ drums in a passively safe form compatible with NDA RWM requirements for ultimate disposal in the GDF. The volume of these wet-solid ILW arisings are given in [Ref-1].

The Wet ILW Treatment Facility is a self-contained multi-storey building. The building has a shielded enclosure containing the waste reception cells with three tanks, an unshielded cement powder handling area, an unshielded chemical storage area, Modular ILW Solidification equipment in a shielded cell and a 3 m^3 Drum import / export area also in a shielded cell.

The Wet ILW Treatment Facility is connected to the main Rw/B by a shielded and secondary contained transfer pipe duct.

The main equipment items in the Wet ILW Treatment Facility include:

- Davit Crane for unloading new 3 m^3 Drums
- OHC for handling 3 m^3 Drums
- MWTC handling equipment
- MWTC lid removal and fitting equipment
- Supernatant decant pump
- Two off ILW Resin Batch Tanks
- One off ILW Crud Batch Tank
- Three off Wet ILW feed pumps
- ILW Effluent Treatment Plant and associated discharge pump
- Pre-blended cement grout preparation equipment (powder feeder, mixer, grout feed hopper and grout pump)
- Pre-blended cement powder feed system
- NaOH dosing system
- Modular ILW Solidification Equipment
- Assorted shield gates
- Air compressor
- HVAC system

An overview of the Wet ILW treatment process is shown in Figure 18.4-2.

18.4.3.4.1 Wet ILW Receipt

Two types of Wet ILW, Cruds and Spent Powdered Resin, are initially collected and stored in separate tanks in the main Rw/B. Batches of each waste type are transferred periodically into the process tanks in the Wet ILW Treatment Cell. The two waste forms are treated differently and so separate process tanks are used: a Crud Batch Tank and two Resin Batch Tanks (used simultaneously). Motive water is used to transfer the wet wastes and makes up the majority of the transfer volume.

18.4.3.4.2 Supernatant Removal

Following transfer to Cruds Batch Tank the Cruds are allowed to undergo a hindered settling process over a few hours resulting in the formation of a sludge layer, a hindered settling zone and a dilute supernatant. The supernatant is then removed using a Decant Pump with a retractable dip leg. The control system monitors the depth of the sludge bed and hindered settling zone and the end of the dip leg is positioned to maximise supernatant retrieval.

The same process is used to decant supernatant from the batches of powdered resin transferred to the Resin Batch Tanks, though in this case the solid content settles out more quickly.

Decanted supernatant (from both the Cruds Batch Tank and the Resin Batch Tanks) is treated to remove fine particulate and soluble species. The separated solids and soluble species are then returned to the Cruds Batch Tank for incorporation in a subsequent encapsulation batch. Treated supernatant is transferred back to the Rw/B.

18.4.3.4.3 Caustic Treatment of Resins

A caustic solution is used to swell the Powdered Resins prior to cement immobilisation. This prevents the Powdered Resins from swelling post cement curing, which would compromise the integrity of the final waste package. The caustic solution is delivered to site in an IBC (Intermediate Bulk Container), which is positioned within a bund in the Chemical Storage Area. Caustic solution is transferred from the IBC to the Resin Batch Tank via the metered Caustic Feed Pump. The Resin Batch Tank is agitated until the caustic treatment is complete.

18.4.3.4.4 Cruds Addition to Resins

Once the Resins have been dewatered and treated by addition of caustic solution, the solids content of the waste is too high for cement immobilisation. Dewatered Cruds (which still form a dilute solution) are therefore transferred to the Resin Batch Tank containing the treated resin using the Cruds Transfer Pump, so as to increase the overall moisture content. If insufficient dewatered Cruds are available, recycled water from the main Rw/B is added instead to achieve the desired water content. Incorporation/mixing of the dewatered Cruds with the Resins waste stream minimises the number of waste packages produced.

18.4.3.4.5 Wet ILW Immobilisation

The Resin and Crud mixture is then immobilised in cement in modular ILW solidification equipment which is operated remotely from a control panel. A new container (e.g. $3m^3$ drum) is positioned inside a Secondary Containment Vessel (SCV) at the Drum Loading Station. The drum is then moved to the Un-lidding Station, where the drum lid and associated bolts are removed automatically. The open drum is then positioned under the Waste Addition and Mixing Head (WAMH), which is lowered into position and engaged with the top of the drum in preparation for filling.

The Resin and Crud mixture in the Resin Batch Tank is then agitated and a fixed volume is transferred into the drum via a small metering vessel (which ensures the drum cannot be overfilled) ready for in drum mixing with the cement powders.

18.4.3.4.6 Immobilisation in Cement

The exact cement grout formulation will be subject to optimisation trials.

Cement powder premixed in the correct ratio is delivered to site in an IBC. A screw conveyor is used to deliver the powders directly from the IBC to the drum in the modular ILW solidification equipment. The Resins and Cruds mixture is agitated using a lost-paddle in-drum mixer as the cement powder is added to

ensure that the powder is drawn into the bulk mixture. The flow of cement is stopped once the drum is filled to a pre-set level and the lost paddle is then released into the cement/waste mixture. After the waste matrix has set, a liquid cement grout is made up and pumped in to the 3 m^3 drum to provide an inactive cap on top of the waste mixture. The 3 m^3 drum is then left for a further period for the cement cap to cure, before being moved to the Drum Lidding Station, where the drum lid and lid bolts are automatically fitted. Finally the 3 m^3 drum is moved to the Swabbing Station to confirm it is free from contamination and then to the Unloading Station.

Should a problem occur during the 3 m^3 drum filling and cementation process, a fault recovery process is available which involves moving the 3 m^3 drum to a safe shielded position (the Unloading Station), thus allowing operator access to the plant under low dose conditions to carry out repair/breakdown maintenance on the waste mixing and filling systems. Additional fault recovery processes can be used to remove raw waste from the drum, or over-pack the drum in the SCV allowing it to be exported out of the plant to the ILW Store's quarantine storage area, see Section 18.4.3.5 below.

18.4.3.4.7 Transfer of 3 m^3 Drums to the On-Site Interim ILW Store

The ILW Cross Site Transporter is brought to the Modular ILW Solidification Equipment Drum Un-Loading Station. The filled 3 m^3 Drum is remotely lifted onto the cross site transporter and then transferred to the Interim ILW Store. The ILW Cross Site Transporter can also transport a drum that has been over-packed in the SCV.

18.4.3.5 Interim ILW Store

The Interim ILW Store is a heavily shielded, self-contained multi-storey building. The building incorporates a shielded enclosure, which contains the waste reception area, assay and remediation cells, and a main store area. The Interim ILW Store is a stand-alone self-supporting facility.

The Store is designed to hold all of the processed ILW generated in the operating lifetime of the ABWR, i.e. 60 years. The store is designed to provide conditions that will minimise as far as reasonably practical any degradation of the packaged wastes by corrosion or similar processes during the period of interim on-site storage (up to 100 years).

The main equipment items in the Interim ILW Store include:

- OHC for handling 3 m^3 Drums & 3 m^3 Boxes
- Shield gates
- HVAC system

18.4.3.5.1 Reception and Positioning of ILW in the Interim ILW Store

The ILW Cross Site Transporter is used to carry filled ILW packages from the Wet ILW Treatment Facility (3 m^3 Drums) and the Solid ILW Treatment Facility (3 m^3 Boxes) to the on-site Interim ILW Store. The ILW Cross Site Transporter docks with the ILW Store import / export bay so as to provide adequate shielding during the unloading process.

A remotely operated ILW Store Over Head Crane (OHC) is used to lift the filled ILW packages from ILW Cross Site Transporter. The grapple used by the ILW Store OHC meets the requirements stipulated by the Radioactive Waste Management Limited (RWM) for the handling of both 3 m^3 Boxes and 3 m^3 Drums. The OHC is then used to move the ILW packages to the Inspection Bay where the unique identifier on the waste package is read and recorded and appropriate visual inspection QA checks are performed. If any non-conformance is found, or if the package was declared as a non-conforming package at the waste

conditioning plant (e.g. because a problem occurred during waste processing), the package is transferred to the Quarantine Storage Area in the ILW Store using the OHC.

Packages which pass the QA check are moved using the OHC to the appropriate (Drum or Box) storage area where they are stacked. The final stacked position of each package is recorded along with the unique identifier for that package.

18.4.3.5.2 Inspection during Interim Storage on Site

Periodically selected packages are retrieved from stored array and moved back to the Inspection Bay using the ILW Store OHC. The original QA visual inspection checks on the packages are then repeated (e.g. to pick up any signs of corrosion, impact damage etc.) in order to demonstrate their continued integrity and compliance with the Waste Acceptance Criteria (WAC) of the Geological Disposal Facility (GDF).

18.4.3.5.3 Assay and Dispatch of Waste Packages from the ILW Store to the GDF

When dispatch of ILW packages from the ILW Store to the GDF is authorised, the Transporter will arrive on site and will be positioned in the Import / Export Bay of the ILW Store and opened ready to receive a waste package.

A selected waste package will be moved using the OHC to the Export Assay Bay. In the Export Assay Bay the waste package will have its unique identifier number recorded, be weighed and assayed for compliance with the WAC for the GDF. Once the assay and data recording has been completed, the waste package will be lowered into the Standard Waste Transport Container (SWTC) using the OHC. The SWTC will then be sealed and authorised to leave the ILW Store for the GDF. This process will be repeated until the ILW Store is empty.

18.4.3.6 LLW Marshalling Area

Following final QA checking in either the Wet LLW Treatment Facility or Solid LLW Treatment Facility, packaged LLW and VLLW are moved (using a Fork Lift Truck) to segregated bays in the LLW Marshalling Area to await collection for shipment to the appropriate disposal facility.

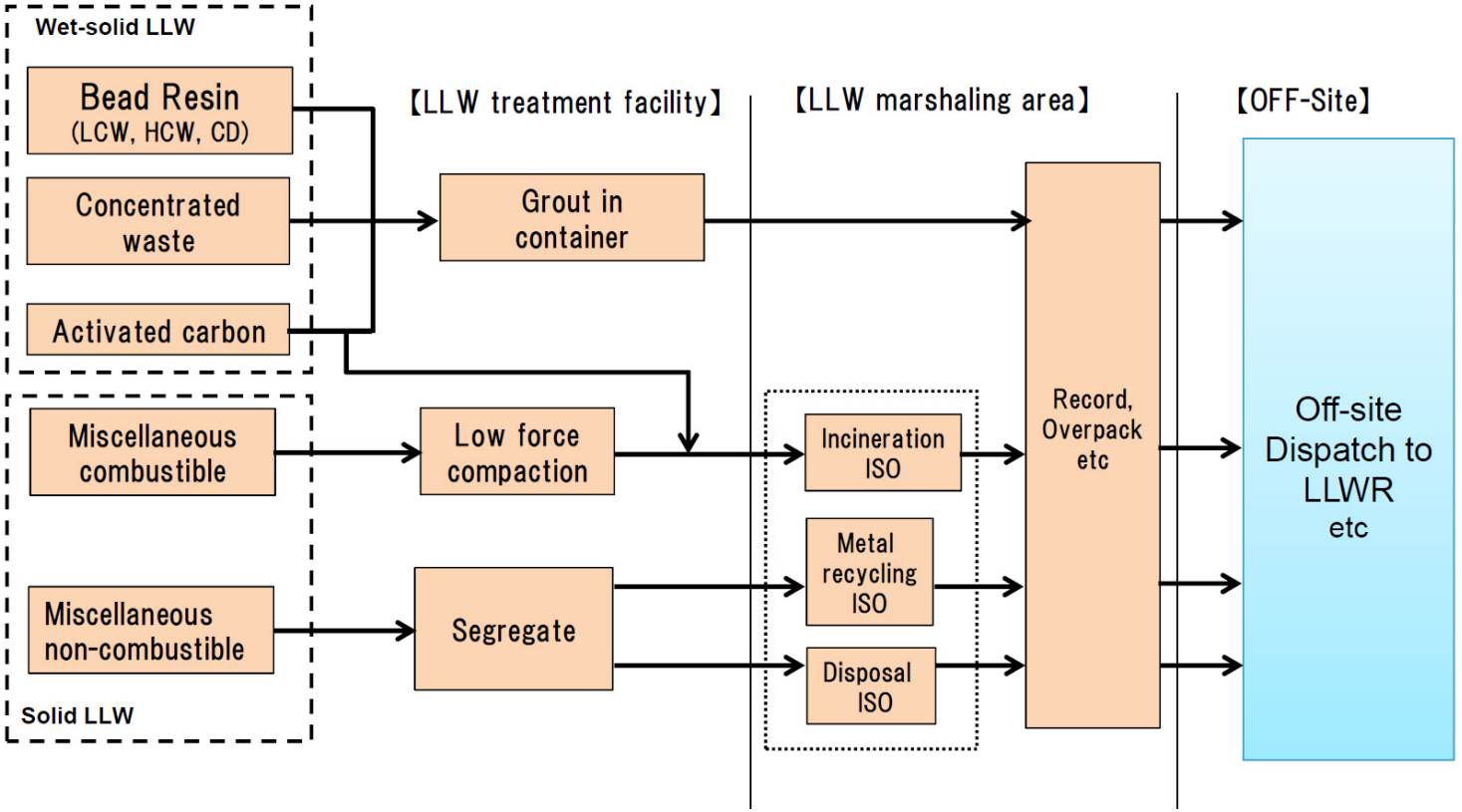

Figure 18.4-1 : Process Block Diagram Low Level Waste Processes

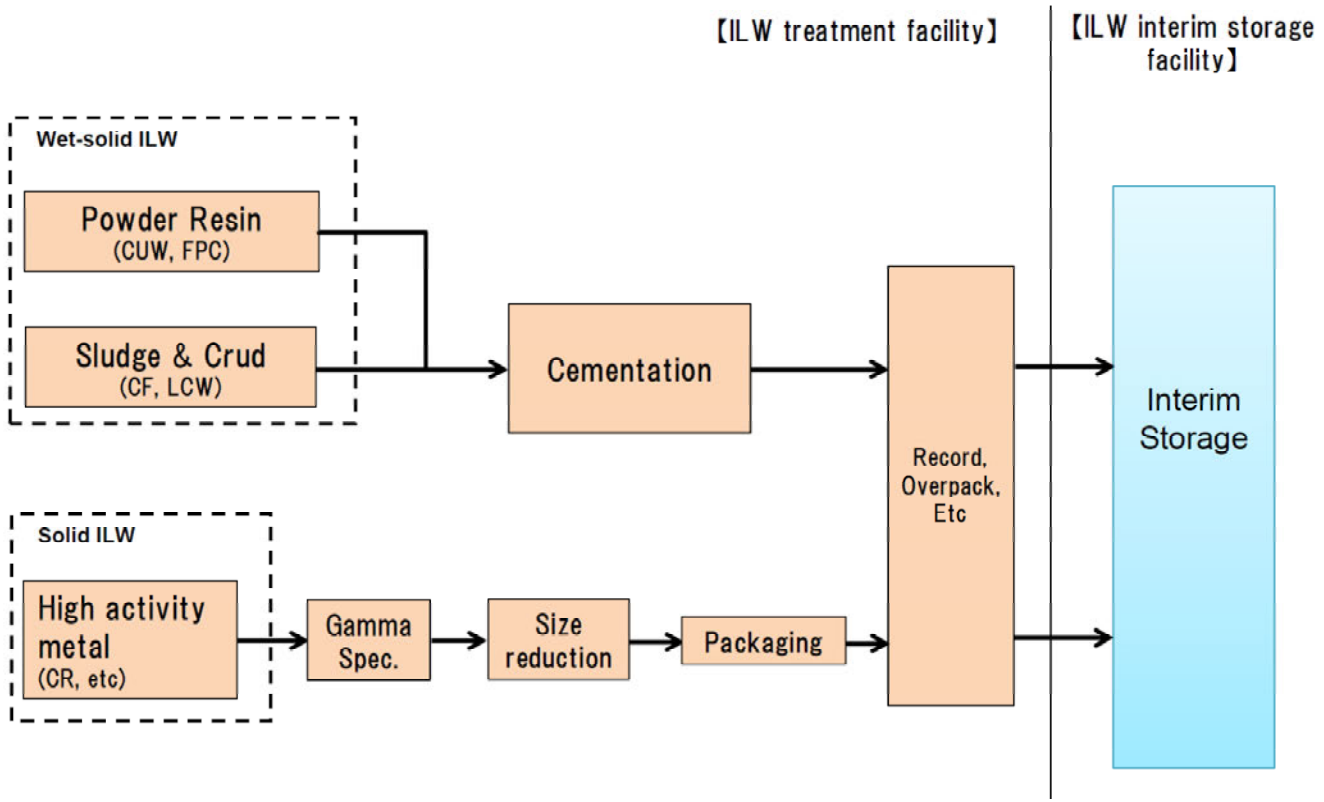

Figure 18.4-2 : Process Block Diagram Intermediate Level Waste Processes

18.4.4 References

[Ref-1] "Radioactive Waste Management Arrangements" (GA91-9901-0022-00001; WE-GD-0001, Rev. D)