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Safety Analysis Report of the Intermediate Level Waste Capacity Increase Facility (Siting Licence Stage)

C01056

Executive Summary

Australian society benefits from the radiopharmaceuticals produced at ANSTO and the nuclear research undertaken by the organisation. The production of radiopharmaceuticals and research activities result in the generation of radioactive waste. ANSTO has a responsibility to safely and effectively manage the radioactive waste generated through these processes.

Based on current projections of remote handled solid waste (RHSW) production at ANSTO Lucas Heights, existing storage facilities will be at full capacity from 2027 for certain waste streams. Therefore, an additional facility is required to ensure that ANSTO is able to safely store and manage all RHSW produced on site until a time where it is able to be transported to the National Radioactive Waste Management Facility (NRWMF) for interim storage.

This facility Safety Analysis Report (SAR) has been prepared to demonstrate good safety practices and provides information intended to facilitate ANSTO safety approval and regulatory approval by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) for the siting licence application. This document gives facility specific information and should be read in conjunction with the site SAR document which gives the general ANSTO site information.

A preliminary risk assessment has been conducted for the proposed Intermediate Level Waste Capacity Increase (ILWCI) facility as part of the siting licence application to ARPANSA. The purpose of the risk assessment at this early stage in the project, based on the information available, is to ensure that a safety-led design process is adopted, in accordance with regulatory requirements and international best practice. This HAZID (hazard identification) study used a qualitative, systematic technique, similar to that of a HAZOP (hazard and operability) study to identify and examine all reasonably possible hazards associated with the proposed process.

The preliminary risk assessment has highlighted one scenario with a credible catastrophic radiological impact and high inherent risk. This is for an operator falling into an open pit. Recommendations have been made and this scenario will be further assessed in subsequent applications to determine the adequacy of controls and to ensure that this risk is as low as reasonably achievable (ALARA). All other scenarios with radiological consequences have been assessed as low or very low. Some industrial hazards such as traffic accidents, slips, trips and falls, crush injuries, and working at heights have been assessed with medium risks.

The safety analysis of abnormal events shows that there are no credible accidents that can affect the safety of the public, and hence the facility is categorised as an F1 facility. There are credible events and accidents that could cause damage to plant and equipment resulting in contamination and exposure events. However, the likelihood of these events is acceptable, and the consequences are able to be managed effectively. Alarm and protection systems allow abnormal and emergency situations to be detected and action taken to mitigate the situation.

The design of the facility and its intended operations have been examined in this document and compared against relevant standards and criteria. These comparisons have indicated that the facility design is adequate for its intended purpose. The safety management systems that will be used to control operations within the facility have been described and shown to provide appropriate levels of control. This SAR shows that the design of this facility and its intended operations are such that it can be operated and maintained safely and within dose limits and does not pose issues for ultimate decommissioning. In addition, a siting stage evaluation was performed, and the Site Characteristics and Site Related Design Bases report concluded that the site was generally suitable.

This report is to be submitted as part of the siting licence application to ARPANSA and is reflective of the current design stage. This SAR will become more detailed as the project proceeds and will be reviewed, updated and resubmitted with each subsequent licence application.

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1. Introduction

Australian society benefits from the radiopharmaceuticals produced at ANSTO and the nuclear research undertaken by the organisation. The production of radiopharmaceuticals and research activities result in the generation of radioactive waste. ANSTO has a responsibility to safely and effectively manage the radioactive waste generated through these processes.

The ANSTO Lucas Heights campus currently stores remote handled solid waste (RHSW) and due to the recent opening of the ANSTO Nuclear Medicine (ANM) facility and the future commencement of operation of the SyMo facility, the production of RHSW is predicted to increase. With this increase, forecasting shows that the current RHSW storage facilities at ANSTO Lucas Heights will reach full capacity from 2027 for certain waste streams. Therefore, it is vital that an additional facility be constructed to meet storage demands until a time when the waste can be transported to the National Radioactive Waste Management Facility (NRWMF).

The proposed Intermediate Level Waste Capacity Increase (ILWCI) facility will be used for the storage of waste only. It will be similar in operation to the current RHSW storage facility ([redacted]) that has been operating at ANSTO Lucas Heights since 1959.

This Safety Analysis Report (SAR) only addresses the processes and operations within the proposed ILWCI facility and not the associated facilities and processes related to RHSW management.

1.1. Style

This facility SAR follows the format developed by ANSTO which is based on the International Atomic Energy Agency (IAEA) guidelines for the preparation of the SAR [1]. This report is a factual and objective description of the facility, its intended operations and the identified hazards and controls. It is developed to be informative and readable, and to maximise utility to all relevant stakeholders.

1.2. Purpose / Objectives

As per the ARPANS Regulation 2018, this SAR is "as complete as possible" at the Siting Licence Application stage of the ILWCI Project. The aim of this document is to demonstrate that the proposed ILWCI facility will be capable of safe and effective siting and future operations in compliance with all relevant safety regulations and requirements of the regulatory authorities Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), Comcare and the Environmental Protection Agency (EPA) throughout all phases of its life cycle.

This is a living document that will be revised and developed as the facility changes during its lifetime. Revision of this document is subject to change management processes including assessment and approval as required by ANSTO and its regulators.

1.3. Facility Overview

The proposed facility will be used to store RHSW from various ANSTO activities including Filter cups generated in the ANM Mo-99 process which are welded into storage vessels and stored in tubes. Miscellaneous RHSW including SyMo cans placed in aluminium retrievable bins (ARBs) will be stored in engineered pits. These wastes will be stored in this facility until they are moved to the NRWMF for interim storage.

The proposed ILWCI facility shall be a purpose-built single-level store similar to the existing [redacted] The facility will be located in the Waste Management Precinct (WMP) near the existing [redacted] in the South East corner of the Lucas Heights site, as shown in Figure 1. The building will have a steel portal framed building superstructure, with a fully braced roof and end bays supported on concrete piled footings. The building exterior is clad in precast concrete panels and lightweight steel. The roof is clad with steel sheeting. Within the building are subfloor in-situ concrete storage vaults in over-excavated rock, supported directly on rock. The facility concept site plan is shown in Figure 2.

The facility's physical layout will be detailed further in Chapter 4. Details on the facility safety features can be found in Chapters 3 and 4.3.

Figure 1 - WMP at Lucas Heights [2]

[redacted]

Figure 2 - ILWCI Facility Concept Site Plan [2]

1.4. Scope

The scope of this SAR covers all of the activities taking place in the proposed ILWCI facility. It should be read in conjunction with the site SAR document [3] which provides general information common to the ANSTO Lucas Heights site.

This SAR includes consideration of:

- Hazards arising from operational activities;
- Natural hazards including seismic; and
- Human induced hazards.

This SAR is a living document and will be periodically reviewed and revised to reflect facility design and management changes throughout its lifecycle. Revision of this SAR is subject to change management processes including assessment and approval as required by ANSTO and ARPANSA.

Activities and equipment associated with the management of RHSW performed in other licenced facilities and that are not covered by this SAR are:

- Collection of filter cups in ANM;
- Encapsulation of filter cups into storage vessels in [redacted];
- Treatment of intermediate level liquid waste in the SyMo facility;
- Collection of RHSW from ANM, [redacted], [redacted]; and
- Filter Cup verification testing in [redacted].

The general purpose (GP) flask and retrievable waste flask will be considered in this SAR as they directly interface with the future ILWCI facility.

This report is to be submitted as part of the siting licence application to ARPANSA and is reflective of the current design stage. This report will become more detailed as the project progresses and will be reviewed, updated, and resubmitted with each subsequent licence application.

1.5. Interfaces

The RHSW that is to be stored in the ILWCI facility is generated and managed at multiple facilities around the Lucas Heights campus. This includes, but is not limited to ANM, [redacted], [redacted], SyMo and OPAL.

The handover point to WMS from the facility generating the waste will generally be once the waste is tied down on an ANSTO truck ready for transportation to the ILWCI storage facility. Each facility has their own facility SAR which addresses the requirements for preparation of the waste for storage and the interfaces with WMS.

The RHSW will be stored at the ILWCI facility until the NRWMF becomes available for interim storage of intermediate level waste (ILW). At that time, the RHSW/ILW will be packaged and/or processed as required and prepared for offsite transportation.

1.6. Comparison with other facilities

The proposed ILWCI facility will be similar in design and operation to the existing RHSW storage facility, [redacted]. [redacted] has been storing RHSW at ANSTO Lucas Heights since 1959. Supported by decades of operational experience, a review of Building [redacted] operations was conducted to determine areas for improvement for the current design. The following improvements are being considered for this stage of the design:

- Pit lids and plugs to be designed flush with floor to eliminate existing trip hazards;
- Demarked and dedicated walkway to reduce walking over pit lids and plugs;
- Building weatherproofing improved to prevent water coming in through louvres during heavy precipitation events;
- Security improvements including but not limited to a functional ‘[redacted]
- Drive-through truck bay makes manoeuvres easier and safer;
- Boom gate on truck exit for pedestrian safety;
- Built-in active ventilation system (AVS) (rather than retro-fit);
- Electronic data entry station to reduce/remove need for the physical tally boards for recording pit contents; and
- Water management practice to reduce likelihood of ingress – going back to over-excavating with conductivity probes. This prevents groundwater coming into contact with the storage tubes and causing corrosion.

1.7. Responsibilities

The Chief Executive Officer (CEO) of ANSTO, as the applicant to ARPANSA for the ILWCI facility licence, has appointed the General Manager, WMS as the Nominee of the ILWCI facility licence and delegates them the responsibility of overall compliance with the ARPANS Act and Regulations.

The Manager, Waste Operations (WO), reporting to the General Manager, Waste Management Services is responsible for making appropriate plans and arrangements, implementing effective controls for managing the prescribed facility, materials and provision of resources in line with the ARPANS Act and Regulations. The Manager, WO, also carries out the responsibilities of Facility Officer for safe operations and maintenance of the controlled facility within this unit as outlined in the WHS Accountabilities, Responsibilities and Actions AG 2362 [4].

The Licensing Officer, WMS is responsible for coordinating compliance with regulatory requirements in the controlled facility and dealings with controlled material and apparatus.

Responsibilities for the proposed ILWCI facility are shown in Table 1 below.

Table 1 - Responsibilities for the proposed ILWCI facility

Task	Responsibility
Safety	All personnel are responsible for safety, with coordination and monitoring provided by the ANSTO High Reliability Group that includes the Work Health and Safety (WHS) Adviser and the Health Physicist (HP). For any modification/upgrade to the facility, the ANSTO Safety and Reliability Assurance (SRA) process provides safety approvals.
Security	General Security is the responsibility of ANSTO Security and Safeguards.
Statutory and regulatory compliance	Licensing and Facility Officers, liaising with the ANSTO Regulatory Affairs Manager, who reports to the Chief Operating Officer (COO).
Resources	WMS Managers, liaising with ANSTO Human Resources.
Process Implementation	WMS Managers.
Daily operations	Supervisors, liaising with the WO Manager, Licensing and Facility Officers.
Management of Plans and Arrangements	The Nominee is responsible for the overall management of the plans and arrangements.
Maintaining control of the facility	The Nominee, Project Manager (during the project phase only) and WMS/WO Manager.

2. Site Description

2.1. Location

ANSTO Lucas Heights campus comprises approximately 600 ha of land and is located in the suburb of Lucas Heights, 35 km south-west of the Sydney CBD (central business district) on the dissected Woronora Plateau at an elevation of about 150 m Australian Height Datum (AHD). The site is approximately 2 km west of the Woronora River and 8 km south of the Georges River and is surrounded by bushland extending for several kilometres with no significant habitation in the north-west, west and south-west quadrants.

The ILWCI facility will be located within the boundary fence of the Lucas Heights site inside the WMP as shown in Figure 1 previously. The facility will be between existing [redacted] and will have road access from Dalton Avenue.

Further details can be found in the Site Characteristics and Site Related Design Bases Report [5].

2.2. Site characteristics

The following site characteristics for the proposed ILWCI facility have been detailed in full in the Site Characteristics and Site Related Design Bases Report [5].

2.2.1. Geology and seismicity

Initial geotechnical investigations were conducted in July 2019 to determine the suitability of the proposed site for the ILWCI facility. This investigation included drilling two core boreholes firstly to a depth of 1.1 metres using solid flight augering methods and then advancing the boreholes to a depth of 10 metres to obtain 50 mm diameter continuous core samples of the rock for identification and strength testing purposes [6].

This study confirmed that the site levels ranged from approximately 137 - 141 metres AHD. Filling/topsoil, which was typically silty sand with grass roots, was encountered to the depths of 0.1 - 0.35 meters followed by very low to low and medium strength fractured sandstone to depths of 1.89 - 3.7 metres overlying medium to high strength, slightly fractured unbroken sandstone [6]. Free groundwater was not observed during auger drilling to depths of up to 1.1 metres. Laboratory testing of the rock core confirmed that the Point Load Strength Index (Is50) values ranged from low to very high strength (0.1 MPa to 3.1 MPa).

The interpreted geotechnical model for the site comprised of loose to very loose topsoil and natural sands to approximately 1 metre over Hawkesbury Sandstone. In general, the sandstone comprised of 2 - 4 metres of highly weathered, fractured-slightly fractured, very low to medium strength rock. Below 4 metres the sandstone was more uniform being slightly fractured-unbroken, medium to high strength sandstone bedrock. It is expected that the groundwater table would be well below the proposed bulk excavation of the site.

Some suggestions for possible actions to be followed during construction have been made from the geotechnical assessors [6]. However, further surveys and assessments will be conducted prior to the commencement of any excavation activities.

The Lucas Heights campus is located on the sandstone Woronora Plateau in the Sydney Basin. The Australian Standard for Earthquake Loads (AS 1170.4, 2007) shows that the Sydney Basin lies in a low intensity seismic zone. While there are some features in the Sydney Basin indicative of past earthquake activity, the OPAL Siting Safety Assessment notes that no seismically active geological structures have been identified, and that there are no major fault lines within 35 km of the Lucas Heights campus [7]. A consolidated report published in 2001 also supported this finding [8].

The geotechnical report conducted in July 2019 for the proposed ILWCI facility site concluded that, in accordance with AS 1170-2007, a hazard factor of 0.08 and subsoil class of B_e is considered to be appropriate for the site [6].

Further details can be found in the Site Characteristics and Site Related Design Bases Report [5] in addition to the ANSTO Lucas Heights site SAR [3].

2.2.2. Meteorology

ANSTO operates a meteorology laboratory on the Lucas Heights site which has been recording data since 1968. The data captured includes wind speed, wind direction, temperature, and rainfall. The data for Lucas Heights is available on ANSTO's website and published by the Bureau of Meteorology on the Lucas Heights Weather Observations page [5]. Further details can be found in the ANSTO Lucas Heights site SAR [3].

2.2.3. Hydrology

An assessment of the proposed site for the ILWCI facility concluded that, based on the elevated topographic setting of the site, the regional groundwater table is expected to be well below the proposed maximum depth of excavation. Seepage arising from normal stormwater infiltration should, however, be expected along the top of the rock surface and along fractures in the rock, particularly after periods of wet weather. It is anticipated that during construction and operations the site will require perimeter drains connected to a sump and pump system. The basement will require permanent drainage below the floor slab to direct seepage to the stormwater drainage system [6]. Further details can be found in the Site Characteristics and Site Related Design Bases Report [5] in addition to the ANSTO Lucas Heights site SAR [3].

2.3. Surrounding land use

Details for surrounding land use can be found in the Site Characteristics and Site Related Design Bases Report [5] in addition to the ANSTO Lucas Heights site SAR [3].

2.4. Surrounding population distribution

Details on the surrounding population distribution can be found in the Site Characteristics and Site Related Design Bases Report [5] in addition to the ANSTO Lucas Heights site SAR [3].

2.5. Natural environment, land and water usage

Details on the natural environment, land and water usage can be found in the Site Characteristics and Site Related Design Bases Report [5] in addition to the ANSTO Lucas Heights site SAR [3].

2.6. Baseline radiological levels

Baseline radiological levels are background (~1 mSv/year) within the general vicinity of the ILWCI facility. For further information regarding baseline radiological levels on the Lucas Heights campus, refer to the Site Characteristics and Site Related Design Bases Report [5].

3. Design Safety Principles

This Chapter describes the design intent of the ILWCI facility in relation to safety objectives, in order to protect the public and ANSTO workers. It identifies and describes the safety objectives and general and specific design requirements of the facility.

3.1. General building(s)

The ILWCI facility is being designed in alignment with the current Australian Standards, Building Code of Australia (BCA) and ANSTO building code. It is also being designed with relevant IAEA Requirements and Guides for the storage of radioactive waste.

3.2. Codes and standards

All buildings, plant and equipment associated with the ILWCI facility are to be designed and constructed to the current standards. The building will be reviewed periodically throughout its lifetime to ensure that compliance with current codes and standards is maintained. Particularly with respect to electrical installations, ventilation systems, emergency exit signage and fire protection.

All new buildings and refurbishments are executed to the standards in the current Australian Building Code as a minimum and all new equipment must meet the relevant Australian Standards. The design related standards applicable to new work and equipment at ANSTO are detailed in Table 2.

Table 2 - Design related standards applicable to new work at ANSTO

Standard Number	Title
AS/NZS 1170 all parts including AS/NZS 1170.2 AS/NZS 1170.4	Minimum design loads on structures (SAA Loading Code) Structural design actions – Wind actions Earthquake loads
AS/NZS 1200	Pressure equipment
AS 1418 (Set)	Cranes, hoists, and winches
AS/NZS 1668, Part 2	The use of ventilation and air conditioning
AS 1670	Fire detection, warning, control, and intercom
AS/NZS 2293	Emergency escape lighting and exit signs for buildings
AS 2419, 2441, 2444, 2665	Standards relating to fire fighting and protection systems
AS/NZS 3013	Electrical installations
AS/NZS 3666	Air handling and water systems – microbial control
AS 3700	Masonry structures
AS 3959	Construction of buildings in bushfire prone areas
AS 4024	Safety of machinery
AS/NZS 2430	Classification of hazardous areas

3.3. Classification of structures, components, and systems

The ILWCI facility will be classified as a controlled facility on the ARPANSA licence.

The classification of structures, systems, and components (SSCs) relevant to radiological safety is based on AG 2494 Guidance on the Radiological Safety Categorisation of Structures, Systems and Components [9]. This guide is intended primarily for the radiological safety categorisation of items in facilities other than nuclear research reactors and as such is applicable to the buildings and plant associated with radioactive waste management in the WMP.

In summary, the categorisation for SSCs in terms of radiological safety is shown in Table 3.

Table 3 - Structures, Systems, and Components (SSCs) Categories

Category	Description
I	Item whose failure could lead to a radiological exposure exceeding 100 mSv (for occupationally exposed individuals) or 5 mSv (for a member of the public), taking into account other protective measures, with some degradation.
II	Items, other than category I items, whose failure could lead to radiological exposure exceeding 20 mSv (for occupationally exposed individuals) or 1 mSv (for a member of the public) taking into account other protective measures, with some degradation.
III	Any system, structure or component that is not allocated to Safety Category I or Safety Category II.

The SSCs will be classified according to this scheme in the safety assessments for each functional area. These may include equipment such as active ventilation systems, interlocks, fire detection/suppression systems, cranes, and radiation monitoring equipment.

WMS buildings, plant, and equipment (including SSCs categorised according to the method above) are scheduled for maintenance by the ANSTO Maintenance & Engineering (AME) group in accordance with the Service Level Agreement. Items of equipment (including some that may not be categorised as SSCs related to radiological safety) are classified according to their maintenance priority as essential (Category 1 maintenance compliance) due to their importance in the safe and uninterrupted operation of waste treatment processes. These include items such as lifting equipment, pumps, ventilation systems, transport flasks and specialised processing equipment as listed in the computerised maintenance management system - SAP. Radiation monitors are scheduled for calibration in the Waste Operations Calibration database at the required interval.

The Safety Assessment [10] identifies and classifies safety systems as critical controls or controls that support maintaining risks as low as reasonably achievable (ALARA) and support defence in depth. SSC categorisation for items in ILWCI will be undertaken at a future stage of the project.

3.4. Qualification of components

Formally qualified components within the facility will include items that are subject to special quality assurance during manufacture or installation in order to withstand demanding operational conditions. The facility crane is a qualified component that will be scheduled by AME for inspections, certification, and maintenance as required. Major plant equipment has been selected with the consideration of the suitability of materials to resist degradation from environmental factors and process conditions (e.g. pits and tubes designed for radiation resistance). These items meet the standards for the type of equipment (where specific standards exist) and are also scheduled for maintenance by AME according to the required frequency as indicated in SAP.

3.5. Design for radiological safety

The ANSTO requirements relating to radiological safety are discussed in AE 2310 Radiation Safety Standard [11]. The whole-body effective radiation exposure limit for workers is 20 mSv annually (averaged over 5 years) and 50 mSv in any one year. Radiological safety design is based on the assessment of the radiological classification (AG 2509 - Classification of Radiation and Contamination Areas [12]).

The RHSW pits and tubes shall be designed with heavy concrete shielding to minimise dose rates to operators. The existing shielded retrievable waste flasks and GP flask are designed to allow for safe transfer and transport of RHSW around the Lucas Heights site to the proposed storage facility.

3.6. Design for nuclear safety

The ANSTO requirements relating to nuclear safety are discussed in AE 2307 Nuclear Safety Standard [13].

The ILWCI facility will be assessed for criticality by a specialised ANSTO group called Nuclear Analysis. [redacted] in the storage vessels are such that there is no credible scenario in which criticality could occur.

3.7. Design for chemical safety

Chemicals or hazardous substances are handled and stored according to the specific Safety Data Sheet, ANSTO standards and guides (AS 2302 - Chemical Safety, AG 2441 – Storage of Chemicals Guide [14] and relevant Australian Standards (AS 2830 - Good Laboratory Practice, AS 2243 - Safety in Laboratories and AS 2982 - Laboratory Design and Construction).

Small amounts of acetone will be kept in the safety cabinet. These are to be used for minor decontamination purposes within the building.

Chemicals will be stored (based on volume and type) within the appropriate dangerous goods cabinet. Safety showers and eye wash stations are available in all areas where chemicals are handled on a regular basis.

3.8. Design for industrial safety

The codes and standards at the time of construction will be the basis for the industrial safety design for the facility. All mechanical and electrical equipment will be selected and installed to comply with the relevant Australian standards for industrial safety (see Table 2). The cranes will be selected as per AS 2550 (Set — 2008 Cranes hoists and winches) and will be scheduled on a preventative maintenance schedule.

Access to all confined spaces associated within the facility will be prevented under normal circumstances by use of physical barriers (gates, chains, railings). Confined spaces entry is subject to a risk assessment specific to the activity and is carried out according to AG 2401 - Confined Space Risk Assessment and Entry Process Guide [15]. All elevated/gantry walkways and platforms will have non-slip metal gratings and handrails to prevent falls.

The waste storage pits are to be covered with heavy cement blocks or plugs which will prevent accidental entry into the pits. The crane is to be used for lifting heavy items such as pit covers and transport flasks.

In addition, ANSTO will have the crane and other lifting devices validated and approved by the ANSTO Lifting Equipment Approvals Officer (LEAO) and the AVS by the ANSTO Active Ventilation Approvals Officer (AVAO).

3.9. Design for external events

The ANSTO site SAR document [3] addresses the suitability of the site and external events potentially affecting the site as a whole. The potential for hazards associated with external events to affect the facility has been assessed at the siting licence application stage. A siting stage evaluation was performed, and the Site Characteristics and Site Related Design Bases report [5] concluded that the site was generally suitable. The safety analyses for the external events are also summarised in Chapter 9. The design and construction of the facility will be undertaken according to the current Australian Standards (Table 3) and designed to meet AS/NZS 1170 (Structural Design Actions) Part 2 (Wind load) and Part 4 (Earthquake load).

3.10. Design for fire protection

The fire services design in the ILWCI facility will include automatic fire detection and alarm system, occupant warning system and portable hand-held fire extinguishers.

The design and performance of the automatic fire detection and alarm system shall be in accordance with AS 1670.1-2018 and Chapters 11.5.1 and 11.5.2 of the ANSTO Building Code. The system will include dedicated addressable-type Tyco manufacture MX Vigilant Series or compatible Fire Detection Control and Indicating Equipment (FDCIE) located within the entrance to the building. The FDCIE shall be networked with the existing fire alarm network on site and connected to the ANSTO Security Operations Centre (ASOC) via the site-wide fire alarm Ethernet system [2].

The design and performance of the occupant warning system shall be in accordance with AS 1670.1-2018 and Chapter 11.5.7 of the ANSTO Building Code. The system shall be integrated within the FDCIE. All controls and equipment will be continuously monitored for open or short circuit equipment failures, low battery level and similar items. Power supplies, batteries and zone amplifiers will be housed within the FDCIE [2].

Non-CFC type fire extinguishers shall be provided throughout the new building in accordance with AS 2444-2001 and Chapter 11.5.4 of the ANSTO Building Code. Fire hose reels shall be installed within 4 metres of each exit in accordance with BCA E 1.4 and AS 2441-2005. Fire hose reels are supplied by the domestic cold-water service via a backflow device is to be provided to the fire hose reels. All isolation valves on the domestic cold water supply must be lockable and in accordance with AS 2441 [2].

3.11. Design for decommissioning

The design of the ILWCI facility follows a 'whole-of-life' approach that will facilitate decommissioning of the structures and equipment. Whilst the final decision on the detailed decommissioning strategy will be made in the future, it is expected that decommissioning will leverage the skills and facility knowledge of operational personnel through a post operational clean out. CAD drawings of the facility, developed during the design process, including the pits, tubes, and ventilation system, will facilitate planning and execution of the dismantling process.

The key decommissioning objectives applied during development of the facility design have been to:

- Minimise active waste volumes;
- Maximise decontamination effectiveness; and
- Minimise decommissioning doses as far as reasonably practicable.

Due to the nature of the ILWCI facility, the decommissioning operations should not present significant technical challenges. It is considered that already proven techniques are readily available to dismantle this facility safely.

The main facility elements likely to be contaminated are:

- AVS equipment including ductwork, filter casing, AVS stack;
- Storage pit steel frames (a very minor level of contamination may be present);
- Below ground concrete inner wall of the storage holes and pits;
- Storage hole plugs and pit covers (only inner layers could be contaminated);
- ARBs;
- Conductivity probes and associated cables in the storage holes and/or pits;
- Lifting tools/gears such as hooks and slings (minor/negligible contamination); and
- Shielded flasks, i.e. GP or Retrievable Waste Flasks (if not reused in other facility).

The facility will have infrastructure for the management of effluent and the AVS available which could support decommissioning. In addition, various components can be deconstructed without invasive cutting and dismantling operators due to their modular nature. Radiation monitors are also present to support decommissioning.

4. Facility Description

This Chapter describes the buildings, plant, equipment, processes, associated hazards, and protection systems associated with the ILWCI facility.

4.1. Overview

The proposed facility will be used to store RHSW from various ANSTO activities including [redacted] cups generated in the ANM Mo-99 process which are welded into storage vessels and stored in tubes. Miscellaneous RHSW including SyMo cans placed in ARBs will be stored in engineered pits. These wastes will be stored in this facility until they are moved to the NRWMF for interim storage.

The proposed ILWCI facility shall be a purpose-built single-level store similar to the existing [redacted]. The facility will be located in the WMP near existing [redacted] in the South East corner of the Lucas Heights site as shown in Figure 1. The building will have a steel portal framed building superstructure, with a fully braced roof and end bays supported on concrete piled footings. The building exterior is clad in precast concrete panels and lightweight steel. The roof is clad with steel sheeting. Within the building are subfloor in-situ concrete storage vaults in over-excavated rock, supported directly on rock. The facility concept site plan is shown in Figure 2.

The following general plant and equipment will be associated with the ILWCI facility:

- Building gantry crane (15 t) and other lifting equipment (e.g. slings);
- GP flask (10.3 t);
- Shielded retrievable waste flask (6 t and 9 t);

- AVS; and
- Local Area Radiation Monitors.

4.2. Building and structures

The concept structural design proposed is a steel portal framed building superstructure, with a fully braced roof and end bays supported on concrete piled footings. The building exterior is clad in precast concrete panels and lightweight steel. The roof is clad with steel sheeting. Within the building are subfloor in-situ concrete storage vaults in over-excavated rock, supported directly on rock. The concept design of the facility can be seen in Figure 3 and Figure 4.

Sub-floor storage for [redacted] is within in-situ, reinforced concrete structures in over excavated rock. The base will be founded on shallow footings socketed into rock pending detailed geotechnical information, with approx. [redacted] within the excavation. Each vault will be divided into sub-vaults by minimum [redacted]

Steel beams, spanning between walls support the [redacted] tubes (filled), and a minimum [redacted], in-situ, high density concrete floor over. A grillage of steel members inside the vault is proposed to restrain the steel tubes laterally. Each vault tube will be sealed with a stepped steel plug.

ARB storage pits are also in-situ, reinforced concrete structures within the over excavated rock. The ARB storage pits are sub-divided by proprietary steel frames and have precast concrete lids capable of being removed and set down onto an adjacent pit by the 15 t overhead crane.

Figure 3 - Front view of the proposed ILWCI facility [2]

Figure 4 - Rear view of the proposed ILWCI facility [2]

4.3. Plant and equipment

4.3.1. Gantry Crane

The storage area will be serviced by a 15 t dangerous goods rated (DGR) overhead crane. The crane rails will be supported on steel corbels directly from the main building columns. The crane will be used for lifting flasks, shielded plugs/lids and other equipment around the facility.

4.3.2. GP Flask

The GP flask (10.3 t) is constructed of steel and lead. The flask is currently used to transport the [redacted].

[redacted]

Figure 5 - General Purpose Flask

4.3.3. Shielded Retrievable Waste Flask (6 t and 9 t)

The retrievable waste flask (6 t and 9 t) is constructed out of steel and lead and shall be used in conjunction with the crane to transport and transfer the waste loaded aluminium bins of solid waste into (and out of) the retrievable storage pits. A winch system on the flask lifts or lowers the bins inside or and out of the flask and provides shielding during transport or transfer of wastes into (or out of) storage. The retrievable flask is transported on the back of a 10 t truck and used at various locations around ANSTO Lucas Heights for the collection of RHSW.

Figure 6 - Retrievable Waste Flask (6 t)

4.3.4. AVS

A primary exhaust system will serve the ARB pits [redacted] which will be connected to a high efficiency particulate air (HEPA) and carbon filtration unit, supported by routine stack discharge monitoring.

4.3.5. Radiation Monitoring System

There will be wall mounted area gamma monitors at the entry to the building which activate an audible alarm on detection of a dose rate above the set point. The number and location of these monitors will be finalised in the next revision of this SAR when the project progresses to the next licensing phase (Construction Licence).

4.4. Process Operations

4.4.1. Collection and Transport of RHSW

The RHSW will be packaged by the waste generators in stainless steel boxes or in plastic packaging, tins or directly according to WMS requirements. These waste items or packages will be placed into ARBs for collection by WMS personnel at a time and location agreed with the client. Each waste container that is transported is checked for surface dose rate by a Health Physics Surveyor (HPS) and a Waste Operations Service Request form is completed and signed by both the HPS and waste generator.

RHSW collected from Building [redacted] (Building [redacted], Building [redacted] and [redacted]) is transported within an ARB inside an 800 kg shielded red square castle (owned by ANSTO Health) to the Building [redacted] hot cells. The castle is placed inside Hot Cell 1 and the lid removed off the castle. The retrievable bin is then lifted from the castle and placed on the tunnel transfer trolley within the cell. The retrievable waste flask is located on a loading platform external to Hot Cell 1 ready to be loaded with a retrievable bin. The retrievable bin on the tunnel transfer trolley is moved out of the cell and located below the retrievable flask to be loaded. The retrievable bin is winched inside the retrievable waste flask which is then loaded onto a truck to be transported to the ILWCI facility.

RHSW from ANM, OPAL and SyMo will be picked up within ARBs directly from the hot cells. The retrievable waste flask is located above the hot cells and the retrievable bin is winched inside. The waste is then [redacted].

The transport of all RHSW is in accordance with AG 2515 Safe Movement and Transport of Radioactive Materials [16].

The ARBs transported within the retrievable waste flask will be lowered into the underground retrievable shielded storage pits in the ILWCI facility. The waste details and pit location will be recorded in a logbook and in SAP.

[redacted]

Collection of [redacted] from ANM:

One of the waste streams generated by the production of Mo-99 is composed of [redacted]. These are collected and transported from the ANM hot cells to the [redacted] hot cells within the [redacted]. The [redacted] is of lead and steel construction and has an inner cavity to house the outer and inner can required to transfer the filters. [redacted]. The flask is loaded with an outer and inner can and placed on top of the ANM hot cell. The inner stainless steel can is lowered into the cell and loaded with up to [redacted] cups. The outer aluminium can held within the flask has a built-in manual winch mechanism to facilitate lifting/lowering of the inner can. The flask has a manual winch to lift and lower the outer can and a mechanical counter to determine the outer can position. After the [redacted] for encapsulation of the [redacted] in a third containment vessel.

[redacted] encapsulation:

The loaded [redacted] and transferred onto the docking platform next to Hot Cell 1. The inner and outer cans are then unloaded from the [redacted] through the vertical posting port into the tunnel transfer trolley and delivered into Hot Cell 1 for the encapsulation process. The inner and outer cans are over-packed into a stainless steel storage vessel and the lid screwed on (using the lid screwing rig). This step includes placing a metal O-ring seal within the vessel. The lid is then welded at the junction with the body using the automated welding rig to fully encapsulate the [redacted]

[redacted] storage in the ILWCI facility:

The encapsulated [redacted] (within the storage vessel) are moved out of Hot Cell 1 on the tunnel transfer trolley and loaded through the vertical posting port into the GP flask which is mounted on the docking platform.

[redacted]. The GP flask is mounted over a designated storage tube (with shielding plug removed) and the storage vessel is then deposited into it. [redacted]

4.5. Hazards in the facility

This Chapter outlines the types of hazards that have been identified and the associated protection systems that have been incorporated within the design of the ILWCI facility.

The broad hazard types are nuclear, radiological, chemical, and industrial. These hazards are well known and have been successfully managed in the similar [redacted] facility and elsewhere on the ANSTO site. Chapter 9 of this SAR provides the methodology and results for the safety and risk assessment of identified fault sequences associated with these hazards and clearly identifies which protection system (barriers) have been included within the safety assessment and are therefore deemed to be important in ensuring that the facility and its operations are acceptably safe.

4.5.1. Nuclear hazards

[redacted].

4.5.2. Radiological hazards

Radiological hazards are due to potential radiation dose rates and contamination from the transfer and storage of RHSWs (e.g. airborne release of I-131 bearing RHSW). These hazards are managed by the use of heavy shielding (flasks or pit covers), the AVS, the use of approved procedures for waste movements (including contamination clearance of flasks), the use of appropriate personal protective equipment (PPE), and the use of radiation monitors to alert personnel to the radiation level.

From the HAZID process, the following hazard scenarios have been identified and will be discussed in more detail in Chapter 9:

- Vehicle accident;
- Flask lifted with the door open;
- Flask dropped due to crane failure;
- Waste package dropped during movement in ILWCI;
- Storage pit open for longer duration due to crane failure;
- Fall into an open pit;
- Pressurisation of [redacted] storage vessel;
- Failure of the pit AVS;
- Operator exposure to tritium;
- Dropped HEPA filter; and
- Water ingress in the storage pit and/or tubes.

4.5.3. Chemical and bio-hazards

Small amounts (~20 L) of chemicals (acetone and detergents) are used for minor decontamination of equipment (e.g., retrievable flask) and floor. Appropriate PPE is worn when working with these chemicals and they are stored in safety cabinets with current Safety Data Sheets (SDS).

There will be no biohazards in the future ILWCI facility.

4.5.4. Industrial hazards

From the HAZID process, the following conventional industrial hazard scenarios have been identified and will be discussed in more detail in Chapter 9:

- Fire in the ILWCI facility;
- Working at heights;
- Manual handling;
- Moving parts – with potential for crush and pinch injuries;
- Personal injury from truck in the truck bay; and
- Slips, trips and falls.

4.6. Protection Systems

4.6.1. Fire Alarm and Suppression

Refer to Chapter 3.10 for information regarding the fire and smoke detection, fire alarm, and fire suppression systems.

4.6.2. Instrumentation, alarm and control systems

Security systems, including swipe access, security cameras and alarms, will be installed in the ILWCI facility as per ANSTO security requirements. Further restricted access, and Australian Federal Police (AFP) surveillance will be implemented to increase safety of the stored radioactive waste. Swipe access to the facility will only be given to authorised personnel who have been trained and are competent to work in the classified radioactive area.

The AVS will be equipped with an alarm when the pressure differential elevates above a threshold value indicating that the HEPA or carbon filter is becoming fouled and requires changing.

Moisture detectors (conductivity probes) will be located in each of the pits. These will initiate a local alarm in the event of any water collecting in the pits. The floor of the pit will have a slight slope to capture the water in a sump, thereby, making the detection of the water in the pit easier and allowing any water collected to be pumped out.

The overhead gantry crane will be designed to interface with the existing flasks captive key interlocks. The 9 t retrievable waste and GP flask has a captive key interlock which will prevent the ILWCI building crane being operated whilst the flask doors are open.

Local radiation monitors will be installed throughout the facility with an alarm set point for elevated dose rates.

An uninterruptible power supply (UPS) will be installed in the facility to ensure consistent power to systems such as the AVS. A static UPS will be selected in accordance with AS 61000 and AS 62040.

Refer to Chapter 3.10 for information regarding the fire and smoke detection, fire alarm and fire suppression systems.

4.7. Designation of areas

The proposed ILWCI facility is anticipated to be free from surface contamination and accordingly, the area classification for contamination in the building is White. The radiation area classification of the proposed ILWCI facility will be Blue. This will be confirmed through later stages of the project.

4.8. Security and security arrangements

The ANSTO Lucas Heights campus has security arrangements in place with the 1.6 km bushland perimeter centred on the HIFAR reactor, the OPAL reactor and the security perimeter fence with site access controlled by the AFP. The ILWCI facility will have a security and access system, and normal card swipe access for staff and other security approved personnel. Further information is available in the ILWCI Siting Licence Security Management Plan [17] and the ANSTO Security Manual [18].

5. Safety Management

This Chapter outlines the general ANSTO safety management arrangements and, more importantly, the local specific arrangements relating to the ILWCI facility. It covers the ANSTO WMS current safety practices, considers their extent and implementation, and details where safety management responsibilities lie. This Chapter demonstrates that existing practices are well defined and acceptable in terms of safety and shows that effective feedback and review mechanisms are in place to facilitate continuous improvement. Further information is detailed in the ILWCI Siting Licence Safety Management Plan [19].

5.1. ANSTO safety policy

ANSTO has policies in place relating to all aspects of its operations. Work Health & Safety Policy (AB 0102) [20] states ANSTO's commitment to Work Health and Safety. In a similar manner, the Environment Policy (AB 7100) [21] states ANSTO's commitment to the environment and sustainability. Both policies outline ANSTO's actions to meet those commitments. Other policies, including those for security, quality, human resources and business, provide a comprehensive framework. These policies are periodically reviewed.

There are several measures in place to ensure that these policies are available and understood. They are provided to employees at induction and available on the ANSTO intranet which is accessible to all staff. There are regular staff forums held by the CEO and within the business units at which safety is discussed and emphasised and this reinforces the intent of the policy. Safety training programs further expand and explain the intent of the policy.

Supporting the WHS Policy are the radiation safety standards. AE 2310 Radiation Safety Standard [11] commits to the ALARA principle to optimise radiation protection and safety and outlines the ANSTO source related dose constraints. These constraints are below the required levels recommended by ARPANSA in Fundamentals for Protection against Ionising Radiation (2014) (Radiation Protection Series F-1), Code for Radiation Protection in Planned Exposure Situations (2020) (Radiation Protection Series C-1).

There are objectives for general safety performance and the key performance indicators are monitored as per AP 7486 Planning to Achieve WHS Targets and Objectives [22]. ANSTO also has an environmental monitoring program.

Operational and project documents are developed in accordance with the ISO 9001 certification and in conformance to the ANSTO project governance framework described in AG 2843 Project Management Methodology Handbook [23]. The ISO 45001 certified ANSTO WHS Management System and other policies are managed in accordance with ANSTO's ISO 9001 certified quality management systems and the ISO 14001 certified environmental management system. This ensures that there are procedures for document control and records management.

The effectiveness of these management systems is monitored and maintained by the audit programs required by the ISO certifications. These include both internal audits by ANSTO workers and external audits by the certifying organisation. Audit records are maintained, and non-conformances and corrective actions are managed through these processes.

5.2. Legal requirements

ANSTO is considered the 'person conducting a business or undertaking' for the purposes of the Work Health and Safety Act, (WHS Act, 2012), associated Regulations, and the Safety, Rehabilitation and Compensation Act (1988).

ANSTO is a controlled person for the purposes of the Australian Radiation Protection and Nuclear Safety Act (ARPANS Act, 1998) and associated regulations. Under this legislation, the proposed ILWCI facility constitutes a Controlled Facility (a Nuclear Installation) and therefore requires licensing at all stages of the facility life.

5.3. Organisational management structure

Refer to Chapter 1.7 for details about the responsibilities for the ILWCI facility. Figure 7 shows the Waste Management Services organisational structure.

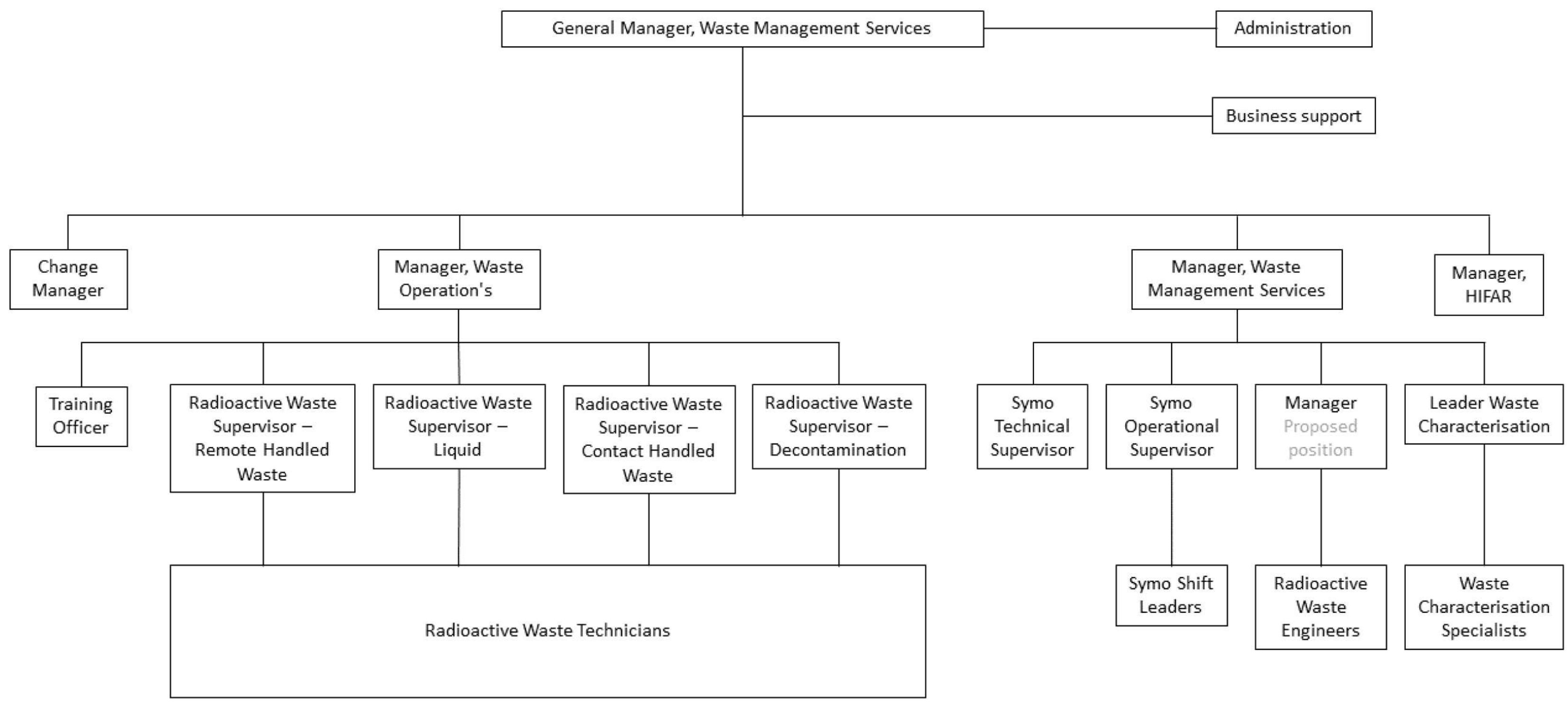

Figure 7 - Waste Management Services Organisational Structure

5.4. Facility management structure and responsibilities

The detailed management structure and control processes which are in place to safely manage the operation of the ILWCI facility are described in the ILWCI Siting Licence Effective Control Plan [24], which forms the controlled reference source for management structure and responsibility information. In addition, Chapter 1.7 outlines the responsibilities for the ILWCI facility complemented by Chapter 5.3 showing the organisational management structure.

The CEO of ANSTO is the applicant to ARPANSA for the siting licence for the ILWCI facility. The responsibility for maintaining effective control of the facility and for ensuring compliance with the ARPANS legislation has been delegated to the Nominee, who is the General Manager, WMS.

Facility operations are controlled by the Manager, Waste Operations. This person has the main responsibilities regarding the safety of activities conducted within the facility and also assumes the role of the Nominated Facility Officer (Regulatory Compliance) and Authorised Officer (Security).

Reporting to the Manager, Waste Operations are the Radioactive Waste Supervisors, responsible for, collection, processing, and storage of radioactive waste. These officers have the responsibility to ensure that all people working in that area, on whichever project or activity, are aware of the particular hazards and the safety arrangements that apply to that area. Specific roles including Building Warden, Health and Safety representative and first aid officer will be assigned to support activities such as safety and emergencies.

The core responsibilities listed below are further discussed in the following Chapters:

- Training and authorisation of facility workers (Chapter 5.7.6).
- Maintaining the operating limits and conditions (Chapter 5.8).
- Controlling maintenance (Chapter 5.11).
- Special responsibilities in emergencies (Chapter 5.12).
- The control of modifications system (Chapter 5.13).
- Auditing (Chapter 5.17).

Details on ANSTO's policy, framework and processes involving delegations of authority can be found in AG 1682 ANSTO Delegations Manual [25].

5.5. Safety approval system

The safety approval system for the ANSTO site ensures that practices and proposals have been scrutinised by knowledgeable and multidisciplinary personnel within ANSTO but outside the direct operation of the facility. The main instrument of this system is the SRA. All new or changed activities with safety category A will require safety approval. More details on the WMS arrangements for managing changes related to safety can be seen in Chapter 5.13.

5.6. Quality assurance program

The activities that will take place within the ILWCI facility will conform to the Quality System requirements of ISO 9001. Refer to Chapter 5.7.3 for more details on the use of written procedures and the WMS Business Management System.

WMS collects and analyses various data from their activities to demonstrate the efficiency of waste management processes and systems, the compliance with regulatory requirements, and more importantly, the effective performance towards the WHS and Radiation Protection Plans. It is anticipated that, once operational, the ILWCI facility will produce and monitor the following types of data:

- Data from incident, accident or exceedance events;

- Data from observations, assessments or audits;
- Radiation data from radiation monitors, stack monitoring and personnel dosimetry;
- Inventory data of the stored RHSW; and
- Maintenance data for plant and equipment.

Further information on the processes to collect, record, and communicate this data is detailed in the ILWCI Siting Licence Safety Management Plan [19].

5.7. Control of normal operations

The details for all aspects of normal operations are referenced in the following Plans and Arrangements:

- Effective Control Plan [24]
- Safety Management Plan [19]
- Radiation Protection Plan [26]
- Radioactive Waste Plan [27]
- Security Management Plan [17]
- Emergency Plan [28]
- Environment Protection Plan [29]

This Chapter is complemented by Chapter 5.12 which covers abnormal events and emergency arrangements. Also, Chapter 9.2 and 9.3 will discuss any risks associated with normal operations and assess the safety of normal operations.

5.7.1. Overall responsibility

Refer to Chapters 1.7 and 5.4 for details about the responsibilities for the ILWCI facility.

5.7.2. Local control

Refer to Chapters 1.7 and 5.4 for details about the responsibilities for the ILWCI facility.

5.7.3. Use of written procedures

Specific procedures for the ILWCI facility will be documented in the WMS Business Management System. Both the ANSTO and WMS Business Management Systems have been designed to meet the requirements of ISO 9001 and ISO 14001. It is ANSTO policy that all processes are reviewed and documented to ensure that they are well understood, current and available for use.

Procedures and instructions are integrated across ANSTO and WMS, with associated processes cross referenced within documents for ease of use. During the course of documenting processes, associated activities are reviewed to ensure consistency between procedures. Document templates are used to ensure consistency of presentation of information in procedures and instructions for ease of reading by the end user.

All procedures are accessible to staff on ANSTO's intranet. The documents are controlled to ensure that only the latest revision is available to users. ANSTO documents are controlled by the ANSTO Management Controlled Document Process, AR 1041 [30]. Documents generated during both commissioning and operations will be controlled according to these processes. The processes ensure that documents are identified, created, reviewed, approved, and distributed to end users in a controlled manner.

The effectiveness of these management systems is monitored and maintained by the audit programs required by the ISO certifications. These include both internal audits by ANSTO staff and external audits by the certifying organisation. Audit records are maintained, and non-conformances and corrective actions are managed through these processes.

5.7.4. Permits to work

Formal permits to work, including Safe Work Permit, Safe Work Method Statements, Confined Space Clearances, Working from Heights, and Electrical Work Permits are applicable and must be completed before such hazardous activities are undertaken in the facility. Persons doing the work must sign the permit acknowledging that they understand its contents. The workers may be WMS staff, other ANSTO staff, or external contractors. If they are external contractors, then they must have completed the required training and extra supervision is provided by ANSTO staff.

5.7.5. Handing over of responsibilities

During short-term and long-term absences, including holidays and retirements, ANSTO has a mechanism for people to act within a role and assume its responsibilities for a defined period of time. In addition, ANSTO has a succession planning and talent management process to upskill staff for roles within the organisation to streamline the handover of responsibilities during personnel changes.

When the facility is being transitioned from the project into operations, a detailed handover process will be adopted in alignment with the practical completion of the facility and the commencement of commissioning.

5.7.6. Training and authorisation of workers

ANSTO has comprehensive processes which collectively ensure that potentially hazardous work is performed and supervised by properly trained, authorised, and qualified workers. This process is initiated by the recruitment process for employees and non-employees where the selection is based on approved selection criteria for the role. These criteria specify the qualifications, knowledge and experience required for the work to be performed.

The training requirements, training methods, and competency evaluation techniques for WMS personnel are documented in the Training in WMS procedure, P 6599 [31]. This includes instructions for training personnel in operations, radiation protection, and emergency procedures. This procedure is maintained by WMS management and they are responsible for ensuring that all personnel are fully trained and competent for their specific job functions.

During the training period, the area supervisor in the relevant area is responsible for:

- Providing constant supervision to trainees;
- Ensuring training is adequately delivered and evaluated; and
- Conducting a practical training evaluation based on operational procedures and work instructions including use of appropriate PPE.

Subsequent to a successful evaluation, the technician is certified as competent and authorised to perform specific functions to which their training relates.

Radiation Protection Services (RPS) workers play an important safety role in radiation areas and controlled facilities providing radiation monitoring and advice during commissioning, construction, operation, and maintenance of the facility. RPS workers must be demonstrably Suitably Qualified and Experienced Persons (SQEP) to fulfil their respective roles. HP are recruited with the necessary knowledge, skills and experience required to undertake the role of HP or are trained, deemed competent and authorised to act in this capacity within the ANSTO training framework. HPS are given comprehensive theoretical and practical training and must be deemed competent for all HPS training modules before they are authorised to undertake HPS functions at ANSTO.

The High Reliability group provide WHS related information, advice, assessments and training as well as developing, managing and maintaining the ANSTO WHS Management System. The Training and Development group, utilising the Learning Management System (LMS), support coordination and management of training onsite including inductions required for workers in consultation with business units and subject matter experts.

Workers employed as Contractor Supervisors who supervise high risk works as defined in AG 2454 Role of Contractor Supervisor [32] must have been formally nominated by their General Manager. In order to act in this capacity, the Contractor Supervisor must have completed the ANSTO Contractor Supervisor (C1 – High Risk) course and successfully completed the assessment of competence and any other course relevant to the work being undertaken by their contractors. This is to ensure a level of competency in critically reviewing risk assessments, management plans, and work being undertaken, e.g., Safe Work in Confined Spaces and Safe Work at Heights.

ANSTO workers that are required to do specialised tasks involved in facilities, laboratories, and projects are provided area-specific inductions and task-specific training (if this training has not previously been completed). High-risk work licences and SafeWork NSW tickets must be available for inspection at all times and recorded in the site training matrix and in the ANSTO LMS.

Building Managers and Area Supervisors additionally have responsibilities relating to authorising and/or stopping work within their designated areas. It is their responsibility to ensure that any work undertaken is performed by trained personnel and with the appropriate risk assessments completed. Each facility will also have a designated first aid officer who is responsible for maintaining the first aid equipment and administering first aid as appropriate.

Contractors involved in construction or maintenance work must hold all relevant licences, qualifications and have undertaken all ANSTO specific training required for site access prior to work commencing. Contractor qualifications are assessed through an independent external party (Smartek-Barrington's) prior to contractors being allowed to undertake activities on the ANSTO site. A risk assessment on the nature of the activities is completed at the procurement stage in conjunction with the ANSTO WHS Team. All task-specific training identified as part of planning, as detailed in the work-specific risk assessment (SWMES), or as part of the contract company training matrix must be sighted, current, recorded, and on site at all times.

Visitors entering construction work areas should hold a General Construction Induction Card and must be escorted by a representative of the Principal Contractor who will provide a local area induction and outline all required PPE required for entry. The full list of courses and the retraining period requirements is given in AG 2364 Work Health and Safety Training Needs Analysis [33].

5.8. Operating limits and conditions

Operational limits and conditions (OLCs) are instructions, procedures, or managerial limits that if breached could result in the facility presenting unsafe conditions. The limits are derived such that they give suitable flexibility in terms of operational parameters whilst maintaining an adequate safety margin beneath the acceptability criteria.

According to the safety categorisation of the safety-related items, if there are SSCs within the ILWCI facility which has items with Safety Category 1 or 2, OLCs will be required for the facility [34]. This will be reviewed in a future assessment at a later stage of the project.

5.8.1. Minimum Staffing levels

The proposed ILWCI building is to be used for the storage of waste only. No other activities will occur within the facility and it will remain unoccupied most of the time. Access will be restricted, and WMS staff will only enter the facility as required to store waste or complete inspections and house-keeping duties. During radioactive waste transfers, a minimum of two WMS staff members are required to effectively undertake ARB transfers and three WMS staff members for [redacted].

5.9. Radiation Protection Regime

The radiation protection regime is documented in the Radiation Protection Plan [26] for the ILWCI facility. The radiation protection measures during all phases of the facility fully comply with AE 2310 Radiation Safety Standard [11] of the ANSTO WHS Safety Management System. This plan describes the organisational arrangements, systems and processes for the control of exposure to ionising radiation during activities in the facility.

The plan highlights ANSTO's adoption of the principles of radiological protection such as justification of practice, optimisation of protection, dose limitations and defence in depth. In addition, it outlines radiological hazards and controls in the facility, the approach to the classification of the work areas, the development of local rules and procedures prior to operation and utilisation of PPE.

ANSTO's Radiation Protection Services (RPS) section is led by an appointed ANSTO Radiation Safety Officer (RSO) and will provide staff via a service level agreement to assist in all phases of the ILWCI facility project. This will include appointment of a Health Physicist (HP), also known as a Radiation Protection Advisor (RPA), and Health Physics Surveyors (HPS).

Radiation monitoring programs exist at ANSTO to collect information about radiological conditions in the workplace and the evaluation of this information (workplace and area monitoring). This, together with information on exposures to individuals (dosimetry results), assists in confirming that safe working practices and engineering standards have been successfully implemented and that the radiological hazards are under effective control. Training, record keeping, auditing and event reporting are all well-established within ANSTO and combined with all other components of the radiation protection regime mentioned above, provides adequate protection during all stages of the facility.

5.10. Management of Safety

ANSTO is committed to ensuring the health, safety and welfare for all workers, contractors, visitors, and members of the public. Central to this commitment is a proactive Work Health and Safety Management System (WHSMS) which supports ANSTO's Work Health and Safety and Environment policy [35]. The WHSMS provides a comprehensive system of policies, procedures and guides to assist ANSTO in meeting its strategic plans and legislative obligations. It utilises the defence in depth strategy and has several layers of protection for workers and the environment. The framework for the documentation is accessible to all staff via the staff intranet and uses ANSTO's Atom of Safety (Figure 8). This framework has been designed to allow for the unique nature of risks associated with ANSTO's operations and provides the required flexibility for the site whilst maintaining compliance with legislative obligations and ISO 45001 certification.

Figure 8: ANSTO's Atom of Safety WHSMS

All ANSTO safety standards, policies and practices are fully endorsed by the CEO of ANSTO and are subject to ongoing review and audit to ensure that they continue to adequately reflect the safety practices implemented at ANSTO and by WMS. Every document within the WHSMS is required to be formally reviewed at least every 3 years or as needed depending on changes to the overarching legislation and regulations.

Further details on the management of health and safety is described in the Safety Management Plan [19] for the ILWCI facility.

5.11. Control of inspection and maintenance activities

Asset management plans will be developed for the facility to define the examination, maintenance, inspection, and testing required for assets and components. Any assets critical to safety will be assigned to an asset owner/custodian and registered in the G 3233 WMS Asset Management Plan [36]. This document details the specific objectives and specifies the activities, programs, resources, responsibilities, time scales and specific measurable outcomes that are required for assets to achieve their set objectives. A maintenance strategy will be developed based on failure mode, effects and criticality analysis (FMECA) and reliability centred maintenance (RCM) principles that will relate the maintenance to plant failure modes.

The Asset Owner will be the Nominee for the licence, and the Radioactive Plant Engineers will be the Asset Custodians. The Facility Officer will be responsible for the safe operations and maintenance of the controlled facility. Inspection and maintenance activities may be undertaken using ANSTO staff or specialised contractors.

WMS buildings, plant, and equipment (including SSCs categorised according to the method above) are scheduled for maintenance by the ANSTO Maintenance & Engineering (AME) group in accordance with the Service Level Agreement. Items of equipment (including some that may not be categorised as SSCs related to radiological safety) are classified according to their maintenance priority as essential (Category 1 maintenance compliance) due to their importance in the safe and uninterrupted operation of waste treatment processes.

Maintenance items will be scheduled using ANSTO's computerised maintenance management system (SAP). Radiation monitoring equipment is calibrated periodically as scheduled in the Waste Operations Instrument Calibration Database.

5.12. Control of abnormal events and emergency arrangements

The potential abnormal occurrences/accidents have been identified in the hazard studies supporting the design as discussed in Chapters 9.4 and 9.5. The facility is designed to minimise the likelihood of occurrences and where possible, to provide for recovery. There are some local emergency arrangements that operate without assistance from the ANSTO site response teams. Emergency Response in WMS, P 6600 [37] is a sub-set of the ANSTO primary emergency plan and provides greater detail for WMS emergency response.

5.12.1. Incident reporting systems

All events and incidents are reported, monitored, and managed through ANSTO's Governance, Risk and Compliance (GRC) Cloud following the ANSTO Incident Management Process, AR-6350 [38]. The GRC Cloud is a fully integrated system that assists ANSTO in securely managing its assurance activities, by recording all information pertaining to the investigation of the incident including:

- Impact;
- Corrective/preventative actions;
- Any recommendations for improvement;
- Verification of the effectiveness of any actions; and
- Incident close out.

Records are securely maintained to provide adequate evidence of each investigation and any resulting action. The records are managed in accordance with ANSTO requirements and are readily retrievable for auditing purposes. Safety records are maintained in compliance with the ANSTO Records Management Process, AR 1477 [39] and the ANSTO Management System Controlled Document Process, AR 1041 [30]. These documents outline the appropriate storage locations, approvals, availability, retention periods and responsibilities for maintaining the records to ensure all regulatory and legal requirements are met.

To encourage reporting and communication of safety data, ANSTO adopts a transparent, no blame and full disclosure safety culture. The GRC reporting system simplifies the reporting process by reducing the number of forms that need to be completed and providing a user-friendly interface to allow easy and accessible reporting to all staff.

5.12.2. Learning from Experience (LfE)

The following, observations, assessments, and audits will be conducted at the ILWCI facility:

- Routine review of safety documentation as required under the ARPANS Regulations;
- Management system audits;
- Regular workplace safety inspections, as per AG 2432 [40];
- Regular housekeeping inspections, as per AG 2432 [40];
- External audits conducted for contractors working on the facility, as per WHSMS contractor compliance criteria, AF 1311 [41];

- Audits to identify discrepancies in actual conduct of operations compared to procedures;
- Safety surveys; and
- Risk assessments.

These processes will allow the General and Line Managers to identify and address hazards and to monitor implemented control measures and local procedures. Any areas or issues found to be unsatisfactory will undergo changes to bring them to a satisfactory level.

An inspection schedule will be prepared for the facility dictating the required frequency of inspections/audits based on the severity of the risks and the types of hazards involved. Reports generated from these processes will be entered into GRC with actions assigned as required and will be utilised to ensure learning and continuous improvement.

5.12.3. Emergency arrangements

The general ANSTO emergency arrangements are set out in the AS 2305 Emergency Planning Standard [42] and AG 5945 ANSTO Emergency Management Plan [43]. More facility specific details can be outlined in the ILWCI Siting Licence Emergency Management Plan [28].

The ANSTO site has 24-hour coverage by the Emergency Response Team (ERT) who responds first in an emergency. An Emergency Response Vehicle, equipped with a wide range of emergency equipment, is on stand-by. The ERT personnel are trained to respond to a wide variety of situations and carry out training exercises with emergency response organisations such as the Fire and Rescue NSW and Ambulance Service NSW.

The ANSTO Lucas Heights site has an ASOC that is staffed continuously. The ASOC functions as a communications centre for all emergency response situations.

In the future ILWCI facility, there will be a Building Warden and operations personnel trained to respond appropriately to any emergency. Evacuation plans in the building will show the designated muster points and name the Building Wardens.

The Area Supervisor is responsible for ensuring that local emergency arrangements are in place, that they are suitable for the sources used or stored in that location, and that all personnel involved are trained in their roles as described in AG 2952 Role of Area Supervisor [44]. The Building Warden is responsible for marshalling evacuees and securing the affected building as described in AG 2465 Role of Building Wardens [45]. There are trained deputies for this role. The HPS and HP have roles in radiation incidents as part of the ANSTO general emergency response arrangements.

New staff are given training in the emergency procedures during induction and on-going training occurs during the training exercises. If there is concern of contamination following a ventilation failure or fire, emergency response personnel entering wear appropriate PPE and respiratory protective equipment (RPE), which may include self-contained breathing apparatus.

5.13. Change Management

Whenever a change to the equipment, systems, processes, policies, or technology in the ILWCI facility are deemed to be required, a Change Management Plan, AF 6947 [46] should be completed. This form guides the initiating person/s to ensure that the objective of the change is clear and that all aspects have been adequately considered. In addition, the Change Management Checklist AF 6946 [47] should be used to provide clarity that all required steps have been undertaken and sufficient consideration has been made to safely implement any change. The checklist covers all phases of the change including design, planning, implementation, and review.

Further detail on the process can be found in the ILWCI Siting Licence Safety Management Plan [19].

5.14. Safeguards

[redacted]

5.15. Criticality control

The ILWCI facility will be assessed for criticality by a specialised ANSTO group called Nuclear Analysis. [redacted]

5.16. Control of contractors, tenants, and visitors

Arrangements are in place to ensure that all visitors to the facility are accompanied by an ANSTO staff member while in operational areas. The arrangements for controlling contractors' and visitors' access to the Lucas Heights campus and to the store are given in the ILWCI Siting Licence Effective Control Plan [24] and Security Plan [17].

5.17. Safety monitoring and review

Chapter 5.12.2 discusses the observations, assessments and audits that will be conducted at the ILWCI facility relevant to safety monitoring and review.

6. Waste Management

The waste management arrangements for the facility are outlined in the Waste Management Plan [27]. Further information can be found in the Lucas Heights site SAR document [3] which describes the site infrastructure and issues including the waste operations function.

6.1. Policy and Requirements

The ANSTO Radioactive Waste Management Policy [48] and Safe Management of Radioactive Waste Guide, AG 2517 [49] provide a framework for managing radioactive waste at ANSTO. This policy states that all radioactive waste at ANSTO will be managed in a manner that protects human health and the environment both now and into the future. Further information about the ANSTO waste policy and general requirements is outlined in the site SAR.

6.2. Airborne Discharges

During the siting phase of the facility there will be no radioactive airborne releases to the atmosphere. Once operational, the ILWCI facility will produce volatile radioactive wastes, gases, dust, or other airborne emissions which will be controlled through an AVS with a HEPA and carbon filtration unit, supported by continuous stack discharge monitoring. Notification levels and discharge limits/targets that apply for the facility will be defined further into the design process.

6.3. Solid Wastes

Solid wastes generated from the ILWCI facility will consist of small volumes of soft waste such as gloves, plastic sheeting, and wipes used in routine operational activities. There will be HEPA and carbon filters waste associated with the facility's ventilation system which will require routine changes periodically. All waste will be managed using existing WMS infrastructure, processes, and expertise.

The RHSW entering the facility for storage will be managed by SQEP trained in risk assessed instructions/procedures. All transfer procedures outline key characteristics of the waste and the package that must be documented prior to transport.

All arrangements in place align with the waste management philosophy of minimisation and the principle of ALARA.

6.4. Liquid Wastes

Small quantities of wastewater will be generated during operations from the safety shower, eye wash, and hand washing facilities which drain to the active B-line and are received at the effluent treatment plant. This liquid would then be discharged offsite in alignment with the Trade Waste Consent with Sydney Water Corporation. There may be small amounts of hydraulic oil which are uncontaminated and can be disposed of offsite following contamination clearance.

6.5. Baseline radiological levels

Information on measured environmental radiation at the Lucas Heights site and its vicinity is reported in the ANSTO annual environmental monitoring reports. These reports provide results of measured radioactivity and radiation levels for airborne emissions, low-level liquid effluent, and external radiation. All results are within the relevant discharge authorisations which also specify the standard or guideline (e.g., World Health Organization (WHO) Guidelines for Drinking Water Quality) against which compliance is assessed. ANSTO is committed to an ongoing monitoring programme for radioactivity in the environment and effluent discharges.

Baseline radiological levels are expected to be background (~1 mSv/year) within the general vicinity of the ILWCI facility. For further information regarding baseline radiological levels on the Lucas Heights campus, refer to the Site Characteristics and Site Related Design Bases Report [5]. More detailed analysis will be undertaken in future stages of the project.

7. Review of Operating Experience

Since this SAR relates to the new ILWCI facility, the most relevant and extensive operating experience is the operation of the current [redacted] facility and other WMS experience with RHSW. The Australian Atomic Energy Commission (AAEC)/ANSTO have been processing and storing RHSW since the 1950s.

7.1. Review of operations in WMS

WMS has continued to safely and effectively operate all processes associated with the management of ANSTO's radioactive waste as accredited under AS/NZS ISO 9001/2010. The Building [redacted] facility consistently operates within internal and regulatory safety limits, according to established procedures with minimal incidents and events.

All wastes disposed/discharged from the site have been shown to have met relevant exemption and/or discharge criteria. All wastes held on site are securely packaged and handled in such a way as to minimise radiation exposure to personnel or the environment.

Processes within WMS are well established with a long track record of efficient and safe performance. Major new operations are thoroughly tested and implemented following a rigorous commissioning process involving assessment by the SRA, with support of technical specialists and HPs. The infrastructure associated with the facility has been upgraded and operations have been improved and refined with operational experience.

Personnel are trained to the competency level required for the proficient performance of tasks and are supplied with the necessary equipment to safely carry out their work. Additional Work Health and Safety and Health Physics support is provided when required to ensure that all hazards are properly addressed and minimised.

7.2. Review of risk assessments in WMS

Risk assessments were carried out for the following WMS activities/facilities:

- Contact Handled Solid Waste
- Contact Handled Liquid Waste
- Remote Handled Solid Waste
- Intermediate Level Liquid Waste
- Nuclear Materials Store
- Radioactive Waste Sources Management
- Waste Services (decontamination and laundry services)
- Radioactive Waste Treatment & Conditioning - [redacted]

In summary, there were no unacceptably high risks associated with WMS activities and facilities with the majority of risks assessed as very low or low. It was ascertained that there were sufficient preventive controls (engineering and administrative) in place to effectively mitigate these risks according to the ALARA approach or otherwise recommendations were made to reduce the likelihood and/or consequences of the events.

7.3. Commissioning program

The building services to be installed in the facility will undergo testing and commissioning by the Principal Contractor in accordance with an approved plan which will be reviewed and authorised by ANSTO personnel.

The commissioning program will include cold and hot commissioning of the AVS system. The DGR building crane will also be tested and commissioned by the crane supplier in accordance with an approved commissioning plan. The commissioning activities will be witnessed and approved by the ANSTO LEAO. Dose rates measurements will be undertaken with a test source to validate the shielding structures. Frames, plugs and other structures and components will be fit tested to ensure that they are aligned to the appropriate tolerances. Functional testing with pits and tubes will be undertaken to ensure that containers can travel unimpeded. Building water tightness and water detection testing will also be undertaken.

A detailed commissioning program will be developed at a later stage in the project.

7.4. Commissioning reports

Following the testing and commissioning of the building at a later stage in the project, commissioning reports for different services and systems will be prepared.

7.5. History since commissioning

The facility has yet to be built therefore there is no history since commissioning.

7.6. Review of WMS radiological monitoring results

Radiological monitoring of the buildings and processes within WMS is carried out on an ongoing basis. Routine surveys have generally shown radiation and contamination levels to be within acceptable limits with any abnormal levels flagged and addressed to reduce the levels of radiation or contamination.

7.7. Dose uptake by the workforce - routine and abnormal

Within the past 5 years, the average annual dose received by staff is below the WMS local ALARA effective dose level of 2 mSv. The routine dose uptake for the workforce of the ILWCI is expected to be similar to the existing [redacted] for staff undertaking ARB and [redacted] transfers. The doses received by staff are monitored by ANSTO Dosimetry staff and reviewed by WMS and the HP to ensure that they are ALARA.

7.8. Waste quantities arising from operations and comparison with operational limits

The ILWCI facility is to be operated for the safe management, processing, and storage of radioactive wastes. Wastes generated as a result of the operations in the facility will include small volumes of contact handled and non-active liquids and soft solid waste (contact handled and 'white' waste) such as plastic sheeting, disposable PPE, cloths, and wipes. Waste generation will be minimised whilst ensuring that safety and contamination controls are not compromised. Wherever possible, non-radiological materials such as paper, cardboard and scrap metal are sent for recycling. Waste quantities will be similar to the existing [redacted] RHSW storage facility.

7.9. Description of Incidents and Accidents

There are no incidents or accidents to describe as the facility has not been constructed.

7.10. Description of Audits and Inspections

As the facility is not constructed or operational, there are currently no facility specific audits and inspections to describe. However, audits and inspections will be conducted as per WMS procedures and practices.

WMS schedule and conduct internal audits to determine the effectiveness of the Business Management System, to assess work health & safety and radiation protection practices, and to evaluate the compliance of its processes with relevant regulatory requirements. The planning and conducting of audits follow the ANSTO Management System Audit process and are carried out by trained auditors who are independent of the area being audited. Additional audits and inspections are carried out by other parties, including ARPANSA, the regulator of the Waste Operations facility licence, or the ISO 9001 and 14001 certification agency.

Audit findings have shown that processes, documentation, and training within WMS are effectively managed with only a few minor non-conformances and areas for improvement identified. All non-conformances are promptly addressed, and actions are taken to rectify the issues and their causes. Issues arising from audits, inspections, or events are collated and tracked through the ANSTO risk system.

8. Review of Plant Condition

The building, plant, and equipment are yet to be constructed/procured. The facility is intended to be designed fit for purpose and in alignment with current standards. This Chapter of the SAR will be detailed further at a later stage in the project.

9. Safety Analysis

This Chapter draws on the process information and the overview of hazards in Chapter 4. It goes further in giving a detailed description of the hazard identification and risk assessment process used and then making an assessment of the safety of the facility.

9.1. Hazard identification

A systematic hazard identification was performed to identify any credible hazardous scenarios that could arise during the proposed waste transfer activities. The hazard identification was performed using Checklist and 'What-if' analysis techniques.

This HAZID study used a qualitative, systematic technique, similar to that of a HAZOP study to identify and examine all reasonably possible hazards associated with the proposed process. A multi-disciplinary team attended a workshop and methodically considered each step in the process brainstorming using guidewords to identify all foreseeable hazards. The interaction of the team, each with different knowledge, experience, and backgrounds was essential to the success of the HAZID process. The functional expertise of the participants included project management, engineering, waste management, operations, radiation protection, and safety. The main objective was to identify any potential hazards that may influence the final design of the proposed components or process.

From the HAZID process, the following radiological hazard scenarios have been identified:

- Vehicle accident;
- Flask lifted with the door open;
- Flask dropped due to crane failure;
- Waste package dropped during movement in ILWCI;
- Storage pit open for longer duration due to crane failure;
- Fall into an open pit;
- Pressurisation of [redacted] storage vessel;
- Failure of the pit AVS;
- Operator exposure to tritium;
- Dropped HEPA filter; and
- Water ingress in the storage pit and/or tubes.

The key non-radiological or conventional industrial hazards include:

- Vehicle accident;
- Fire in the ILWCI facility;
- Working at heights;
- Manual handling;
- Moving parts – with potential for crush and pinch injuries;
- Personal injury from the truck in the truck bay; and
- Slips, trips and falls.

9.2. Risk management

A risk assessment was carried out on the various hazardous scenarios identified during the HAZID workshop. The identified scenarios relating to the operation of the facility were analysed qualitatively or quantitatively to assess inherent and residual risks according to ANSTO WHS Management System, ANSTO Risk Analysis Matrix AG 2395 [50] and the application of engineering judgement.

Scenarios with radiological impact were analysed to assess the inherent risk, identify critical controls, and assess the residual risk. For scenarios where the inherent radiological impact was assessed to be minor or negligible or where the inherent risk was assessed to be low or very low, critical controls were not identified and the residual risk was not assessed further. Critical controls were not identified for WHS scenarios.

It should be noted that the facility is currently in the concept design phase. Therefore, the details provided in this risk assessment are preliminary. As the design progresses and more details become available, the risk assessment will be reviewed and updated to confirm that the assumptions made in this report remain valid and that the conclusions are unchanged. An updated risk assessment will be submitted as part of each subsequent licence application for the facility.

9.2.1. Hazard control

Hazard control measures refer to the operating strategies and procedures/instructions that are in place to control known hazards. These administrative measures are distinct from the hardware measures referred to in Chapter 9.2.2.

ANSTO has various operating strategies, procedures, and instructions that are in place to control known hazards in the ILWCI facility. ANSTO has comprehensive processes which collectively ensure that potentially hazardous work is performed by and supervised by properly trained, authorised, and qualified workers. This process is initiated by the recruitment process for employees and non-employees where the selection is based on the approved selection criteria for the role. These criteria include the qualifications, knowledge and experience appropriate for the work to be performed. Further information on training can be found in Chapter 5.7.6.

All procedures and work instructions are risk assessed to ensure that all operators are adequately informed of the hazards during all operational activities. In addition, the facility has low occupancy with personnel within the building only for operations, maintenance and housekeeping.

9.2.2. Protection and damage limitation systems

Protection and damage limitation systems refer to the equipment and instrumentation that are in place to control known hazards. These are distinct from the administrative measures referred to in Chapter 9.2.1.

Security systems, including swipe access, security cameras and alarms, will be installed in the ILWCI facility as per ANSTO security requirements. Further restricted access, and AFP surveillance will be implemented to increase safety of the stored radioactive waste. Swipe access to the facility will only be given to authorised personnel who have been trained and are competent to work in the classified radioactive area.

The AVS will be equipped with an alarm when the pressure differential elevates above a threshold value indicating that the HEPA or carbon filter is becoming fouled and requires changing.

Moisture detectors (conductivity probes) will be located in each of the pits. These will initiate a local alarm in the event of any water collecting in the pits. The floor of the pit will have a slight slope to capture the water in a sump, thereby, making the detection of the water in the pit easier and allowing any water collected to be pumped out.

The overhead gantry crane will be designed to interface with the existing flasks captive key interlocks. Each flask has a captive key interlock which will prevent the ILWCI building crane being operated whilst the flask doors are open.

Local radiation monitors will be installed throughout the facility with an alarm set point for elevated dose rates.

An uninterruptible power supply (UPS) will be installed in the facility to ensure consistent power to the AVS system and to facilitate a safe evacuation from the facility. A static UPS will be selected in accordance with AS 61000 and AS 62040.

Refer to Chapter 3.10 for information regarding the fire and smoke detection, fire alarm and fire suppression systems.

9.2.3. Optimisation

For those ILWCI activities that have been assessed and are deemed to be justified, their protection should be optimised so it represents the best level of protection that can be achieved under the prevailing circumstances. As such, ANSTO is committed to reducing the likelihood of incurring exposures, the number of people exposed, and the magnitude of their individual doses to ALARA, taking into account economic and societal factors. A detailed description of the principle of optimisation, the process followed, and the decision-making tools used for the optimisation of protection is provided in ANSTO Radiation Safety Standard, AE 2310 [11].

Optimisation of protection at ANSTO is an iterative process that involves:

- evaluation of the exposure situation, including any potential exposures (the framing of the process);
- selection of an appropriate value for the constraint or reference level;
- identification of the possible protection options;
- selection of the best option under the prevailing circumstances; and
- implementation of the selected option.

The optimisation principle is applied to various aspects of the ILWCI design and operations such as:

- Engineering design of interlocks on the flasks and crane;
- AVS;
- Radiation and contamination monitors;
- Limiting radiation exposure using the principles of distance, time and shielding;
- Delay and decay of short-lived isotopes;
- Administrative controls such as trainings and procedures;
- Supply and maintenance of suitable equipment;
- Supply of PPE;
- Effective work planning to minimise doses received by staff member to ALARA;
- Appropriate characterisation and monitoring to ensure that the discharge of gaseous radioactive waste, if applicable, is within the discharge authorisation limit; and
- Development of emergency plans to mitigate the consequence of significant releases of radioactive waste to the environment.

9.3. Safety analysis for normal operation

WMS has demonstrated a sound track record with regard to the safe and effective management of all waste at Lucas Heights. The ILWCI facility is similar in design and operational philosophy to the existing [redacted] which ANSTO has utilised to successfully and safely manage RHSW for decades. The proposed facility will be managed and regularly reviewed to ensure that all regulatory, legal, safeguards, safety, and environmental requirements are complied with at all times in the management of radioactive waste.

Radiological monitoring of the buildings and processes within WMS is carried out on an ongoing basis. Routine surveys have generally shown radiation and contamination levels to be within acceptable limits with any abnormal levels flagged and followed up to reduce the levels of radiation or contamination. The routine dose uptake for the workforce of the ILWCI is expected to be similar to the existing [redacted] undertaking ARB and [redacted] transfers. The doses received by staff are monitored by ANSTO Dosimetry staff and reviewed by facility management and the HP to ensure that they are ALARA.

The ILWCI facility will be sited in alignment with ANSTO WHS management systems, standards, and practices, which are consistent with accepted radiation and work health and safety practices in Australia. A set of plans and arrangements have been prepared for the siting phase of the facility.

Once operational, the ILWCI facility will produce volatile radioactive wastes, gases, dust, or other airborne emissions which will be controlled through an AVS with a carbon filtration unit, supported by routine stack discharge monitoring. Notification levels and discharge limits/targets that apply for the facility will be defined further into the design process.

Small quantities of wastewater will be generated during operations from the safety shower, eye wash, and hand washing facilities which drain to the active B-line and are received at the effluent treatment plant. This liquid would then be discharged off site in alignment with the Trade Waste Consent with Sydney Water Corporation.

The combined effects of direct radiation and of releases of radioactive material from the facility do not result in offsite doses that exceed authorised limits to the public.

9.4. Safety analysis for internal abnormal events

This Chapter draws together the key outcomes of the hazard identification work and safety assessment processes described in Chapter 9.1 and relating to radiological safety. The key outcomes of industrial safety are presented in Chapter 9.8.

Table 4 summarises the results of the risk assessment for scenarios with radiological consequences. Further details on the detailed assessment of each accident type and the proposed barriers in place to prevent or mitigate the outcomes can be found in the Preliminary Safety Assessment for the ILWCI facility (Siting Licence) [10].

Table 4 - Summary of risk assessment for scenarios with radiological consequences

Scenario	Consequence	Inherent Impact	Inherent Likelihood	Inherent Risk	Residual Impact	Residual Likelihood	Residual Risk
Vehicle accident during cross-site transportation of RHSW	**Whole body dose** (GP Flask)	**Severe** (100-1000 mSv)	**Extremely Unlikely** (10^{-6} to 10^{-5} p.a.)	**Low**	**Severe** (100-1000 mSv)	**Not Credible** ($<10^{-6}$ p.a.)	**Not Assessed**
		Catastrophic (>1000 mSv)	**Not Credible** ($<10^{-6}$ p.a.)	**Not Assessed**	**Catastrophic** (>1000 mSv)	**Not Credible** ($<10^{-6}$ p.a.)	**Not Assessed**
	Whole body dose (Retrievable Waste Flask)	**Moderate** (1-20 mSv)	**Highly Unlikely** (10^{-5} to 10^{-4} p.a.)	**Very Low**	**Moderate** (1-20 mSv)	**Extremely Unlikely** (10^{-6} to 10^{-5} p.a.)	**Very Low**
		Severe (100-1000 mSv)	**Extremely Unlikely** (10^{-6} to 10^{-5} p.a.)	**Low**	**Severe** (100-1000 mSv)	**Not Credible** ($<10^{-6}$ p.a.)	**Not Assessed**

Scenario	Consequence	Inherent Impact	Inherent Likelihood	Inherent Risk	Residual Impact	Residual Likelihood	Residual Risk
	Physical injury	**Severe** (Death/ permanent injury)	**Highly Unlikely** (10^{-5} to 10^{-4} p.a.)	**Medium**	**Severe** (Death/ permanent injury)	**Highly Unlikely** (10^{-5} to 10^{-4} p.a.)	**Medium**
Flask lifted with door open	**Whole body dose** (Up to 5 minutes exposure)	**Moderate** (1-20 mSv)	**Very Likely** (0.1 to 1 p.a.)	**Medium**	**Moderate** (1-20 mSv)	**Very Unlikely** (10^{-4} to 10^{-3} p.a.)	**Low**
Flask dropped due to crane failure	**Whole body dose** (GP flask)	**Severe** (100-1000 mSv)	**Unlikely** (10^{-3} to 0.01 p.a.)	**High**	**Severe** (100-1000 mSv)	**Extremely Unlikely** (10^{-6} to 10^{-5} p.a.)	**Low**
		Catastrophic (>1000 mSv)	**Very Unlikely** (10^{-4} to 10^{-3} p.a.)	**High**	**Catastrophic** (>1000 mSv)	**Not Credible** (<10^{-6} p.a.)	**Not Assessed**
	Whole body dose (Retrievable Waste flask)	**Moderate** (1-20 mSv)	**Likely** (0.01 to 0.1 p.a.)	**Medium**	**Moderate** (1-20 mSv)	**Highly Unlikely** (10^{-5} to 10^{-4} p.a.)	**Very Low**
		Severe (100-1000 mSv)	**Unlikely** (10^{-3} to 0.01 p.a.)	**High**	**Severe** (100-1000 mSv)	**Extremely Unlikely** (10^{-6} to 10^{-5} p.a.)	**Low**
	Physical injury	**Severe** (Death/permanent injury)	**Unlikely** (10^{-3} to 0.01 p.a.)	**High**	**Severe** (Death/permanent injury)	**Highly Unlikely** (10^{-5} to 10^{-4} p.a.)	**Medium**
Waste package dropped during movement in ILWCI	**Whole body dose** (during recovery)	**Minor** (0.1-1 mSv)	**Likely** (0.01-0.1 p.a.)	**Low**	**Minor** (0.1-1mSv)	**Likely** (0.01-0.1 p.a.)	**Low**
	Operational Delay	**Moderate** (<1 month)	**Likely** (0.01-0.1 p.a.)	**Medium**	**Moderate** (<1 month)	**Likely** (0.01-0.1 p.a.)	**Medium**
Storage pit open for longer duration due to crane failure	**Whole body dose** (during recovery)	**Moderate** (1-20 mSv)	**Likely** (0.01 to 0.1 p.a.)	**Medium**	**Minor** (0.1-1 mSv)	**Likely** (0.01 to 0.1 p.a.)	**Low**
Fall into open pit	**Whole Body Dose**	**Catastrophic** (>1 Sv)	**Very Unlikely** (10^{-4} to 10^{-3} p.a.)	**High**	**Catastrophic** (>1 Sv)	**Very Unlikely** (10^{-4} to 10^{-3} p.a.)	**High**
	Physical Injury	**Severe** (serious injury or death)	**Very Unlikely** (10^{-4} to 10^{-3} p.a.)	**Medium**	**Severe** (serious injury or death)	**Very Unlikely** (10^{-4} to 10^{-3} p.a.)	**Medium**
Pressurisation of a storage vessel tertiary can	**Whole Body Dose** (during recovery)	**Minor** (0.1-1 mSv)	**Unlikely** (10^{-3} to 0.01 p.a.)	**Very Low**	**Minor** (0.1-1 mSv)	**Unlikely** (10^{-3} to 0.01 p.a.)	**Very Low**
	Operational delay	**Moderate** (<1 month)	**Unlikely** (10^{-3} to 0.01 p.a.)	**Low**	**Moderate** (<1 month)	**Unlikely** (10^{-3} to 0.01 p.a.)	**Low**
Failure of the pit AVS	**Inhalation dose**	**Negligible** (<0.1 mSv)	**Likely** (0.01–0.1 p.a.)	**Very Low**	**Negligible** (<0.1 mSv)	**Likely** (0.01–0.1 p.a.)	**Very Low**
Operator exposure to tritium	**Inhalation dose** (Tritium)	**Minor** (0.1-1 mSv)	**Unlikely** (10^{-3} to 0.01 p.a.)	**Very Low**	**Minor** (0.1-1 mSv)	**Unlikely** (10^{-3} to 0.01 p.a.)	**Very Low**
Dropped HEPA filter	**Inhalation dose**	**Minor** (0.1-1 mSv)	**Unlikely** (10^{-3} to 0.01 p.a.)	**Very Low**	**Minor** (0.1-1 mSv)	**Unlikely** (10^{-3} to 0.01 p.a.)	**Very Low**
Water ingress in the storage pit and / or tubes	**Active material released to the environment** (Internal leak)	**Moderate** (discharge to environment >10 L of H400-420 material OR>1000 L of other material)	**Very Unlikely** (10^{-4} to 10^{-3} p.a.)	**Low**	**Moderate** (discharge to environment >10 L of H400-420 material OR>1000 L of other material)	**Extremely Unlikely** (10^{-6} to 10^{-5} p.a.)	**Very Low**
	Active material released to the environment (Leaching into pit)		**Extremely Unlikely** (10^{-6} to 10^{-5} p.a.)	**Very Low**		**Not Credible** (<10^{-6} p.a.)	**Not Assessed**

A reference accident assessment [51] was undertaken for the ILWCI facility to examine the potential radiological impacts of any credible accident scenarios and determine whether these impacts could affect members of the public, occupants of the ANSTO Lucas Heights site, or only the people within the facility and if so, to what extent. The following accident scenarios were examined:

- Flask dropped during loading or unloading;
- Unintentional release of waste from flask during waste transfer;
- Flask lifted with door open;
- Fall into an open storage pit;
- Radioactive material escaping through storage pits; and
- Fire.

All credible reference accident scenarios present a radiation risk to operators inside the facility only. The bounding case being for someone who has fallen inside a storage pit for which the potential actions are explained in Chapter 11.6. There are no credible reference accidents that could present risk of harm to persons outside of the facility. Therefore, the ILWCI facility will be safe with respect to offsite effects and is classified as an F1 hazard category installation with no potential for significant consequences outside of the facility.

9.5. Safety analysis for external events

The ANSTO site SAR document addresses the suitability of the site and external events potentially affecting the site as a whole. The potential for hazards associated with external events to affect the facility has been assessed at the siting licence application stage. A siting stage evaluation was performed, and the report Site Characteristics and Site Related Design Bases report [5] concluded that the site was generally suitable.

9.5.1. Loss of (offsite) power

During the event that there is loss of offsite power, the UPS will activate allowing the AVS to continue operating and prevent the accumulation of iodine in the facility. The UPS will operate for a duration long enough for operators to vacate the facility.

9.5.2. Earthquake

The ILWCI storage tubes will be located underground and as such, both the tubes and cans are subject to possible damage in a seismic event. As the tubes are dry, the immediate consequences of a seismic event are not expected to be severe as the contents of the tertiary cans are expected to remain contained. Damage to the storage tubes however could lead to difficulties in recovery of the cans or to the ingress of water into the storage tubes. The building occupancy is very low and therefore, it is unlikely that someone could be inside the building at the time of such an extreme event and suffer a significant injury.

9.5.3. High winds

The ILWCI facility will be designed and constructed in accordance the requirements set out in the Australian Standards AS 1170.2. The building occupancy is very low and therefore, it is unlikely that someone could be inside the building at the time of such an extreme event and suffer a significant injury.

9.5.4. Flooding

There is no specific issue of water inundation of the ILWCI facility due to a regional flooding event. A localised flooding event due to a damage of the water supply pipework inside the building could be a possibility. There are no significant safety issues associated with flooding.

9.5.5. Lightning strike

According to the Lightning Protection standard (AS/NZS 1768:2007), between six and ten people are killed by lightning in Australia each year. Such incidence of fatalities is applicable mostly for persons staying outdoors at the time of the lighting strike.

In the event of a lightning strike to ILWCI, it is very unlikely that a person inside the building would suffer serious injury or fatality, or that it would cause any significant radiological consequence.

The most likely consequence of a lightning strike is damage to computers and other electronic equipment.

9.5.6. Aircraft crash

All civil and military aircraft are prohibited from entering the restricted airspace above the Lucas Heights campus unless a prior air traffic clearance has been obtained. It was estimated that the likelihood of the crash of a commercial jet or a general aviation aircraft on OPAL as 1.1×10^{-8} per year using the DOE method [5]. This is an extremely low likelihood event and therefore, for the ILWCI facility, the potential hazard of an aircraft crash does not need to be assessed further.

9.5.7. External fire

The location of the Lucas Heights campus is such that local bushfires can be expected every 8 to 12 years. These fires have the potential to burn to the site boundary. The fire intensity and duration is dependent on weather conditions, including the wind direction and strength, temperature, and humidity. Generally, the site is on relatively flat ground with sparse vegetation which would reduce the intensity of fires reaching the boundary. Hazard reduction by 'burning-off' is normally undertaken annually external to the site perimeter fence to minimise fuel loads and therefore the potential bush-fire intensity in proximity to nearby structures on the site. Burning off is also sometimes undertaken inside the fenced area. Building Wardens will perform pre-season annual bush fire inspections and complete a check list [52] to identify any preventative actions to be taken in line with the ANSTO Emergency Management Plan [43].

The site emergency response team along with the NSW Fire and Rescue and/or the Rural Fire Service (with base stations at Heathcote, Illawong, and Menai) would respond to a bush fire scenario at the Lucas Heights Campus. The buildings are away from the vegetation and there are access roads outside of the fence, which is expected to provide a safe separation from the facilities/buildings.

9.5.8. Transport accidents

The only bulk hazardous substances regularly transported along roads near the Lucas Heights campus are petrol and diesel. The road transport of explosives is by a route away from the site. The OPAL Siting Safety Assessment (RRP-SL-02) [7] reports on an analysis of possible transport accidents at the nearest road (New Illawarra Road) and the nearest railway line (approximately 3000 metres away). The analysis generally concluded that these events presented a low risk to the Lucas Heights campus and hence the future ILWCI facility at ANSTO. No further assessment is required.

9.5.9. Industrial activities

The inventories of hazardous materials used in industrial activities near the Lucas Heights campus are very small. A review of the list of sites for the storage of dangerous goods licensed under the NSW Dangerous Goods Act, 1975 within an 8 km radius of the Lucas Heights has revealed that there are no sites that handle large quantities of hazardous materials. Therefore, there are no major issues in relation to the industrial activities for the ILWCI facility.

9.5.10. Military activities

According to a report estimating the shelling frequency of HIFAR or the research reactor replacement [52], the chance of shelling a building on Lucas Heights campus was shown to be not credible and therefore is not assessed for the ILWCI facility.

9.6. Analysis of environmental impact

The proposed ILWCI facility is a solid radioactive waste storage facility that will be constructed within ANSTO's existing operational area and therefore its footprint will not impact the wildlife habitat of the buffer zone surrounding ANSTO. Within the facility, there will be no process operations that would generate volatile radioactive wastes, gases, dusts, or other airborne emissions in significant quantities. To monitor any airborne emissions from the facility, a stack monitoring system will be fitted to the AVS.

Given the lack of discharges/emissions, operation of the ILWCI facility will not change the existing level of radiological protection of wildlife at ANSTO. The most recent assessment of potential radiological impacts to wildlife is detailed in the ANM Environmental Protection Plan, Q-50323 [53]. This assessment considered both airborne emissions and liquid discharge pathways and conservatively evaluated ANSTO's cumulative potential discharges. The evaluation is summarised as follows:

The assessment used methods from international best practice as laid out by the ARPANSA Guide: Radiation Protection of the Environment, which is consistent with current approaches set forth by the International Commission on Radiological Protection (ICRP) and the IAEA. The screening evaluations considered exposure to a range of terrestrial organisms in the buffer zone from stack emissions via the air pathway, and, to a range of marine organisms near the ocean outlet at Potter Point, New South Wales via the liquid effluent pathway. Dose assessments were performed using the ERICA tool with radioactivity concentrations for air and water determined from data collected during routine monitoring of stack emissions and effluent releases at ANSTO. Concentration values along air and water pathways were overestimated, consistent with an approach of using conservative assumptions in this screening assessment.

In summary, despite using overestimates for radioactivity concentrations associated with ANSTO's emissions, results indicate potential risk quotients that are below standard benchmarks for all organisms and all pathways considered. Dose rates to organisms were determined to be below the lowest benchmark for potential harmful effects (10 $\mu Gy\ hr^{-1}$). These results are consistent with previous studies in determining no significant impacts from ANSTO effluents. Therefore, potential radioactivity releases from the ANM Facility are unlikely to impact local wildlife. Although projected dose rates are low, the release of low levels of radionuclides in air and water discharges indicates the need for ongoing monitoring and periodic re-evaluation.

In addition, ANSTO is also ISO 14001 accredited with an effective environmental management system.

9.7. Assessment of operating limits and conditions

The classification of SSCs relevant to radiological safety is based on AG 2494 Guidance on the Radiological Safety Categorisation of Structures, Systems and Components [34]. This guide is intended primarily for the radiological safety categorisation of items in facilities other than nuclear research reactors and as such is applicable to the buildings and plant associated with radioactive waste management in the WMP.

According to the safety categorisation, if there are SSCs within the ILWCI facility which have items with Safety Category 1 or 2, OLCs will be required for the facility. This will be reviewed in a future safety assessment at a later stage of the project.

More information on SSCs and OLCs can be found in Chapters 3.3 and 5.8 respectively.

9.8. Work, health and safety

ANSTO is committed to ensuring the health, safety, and welfare for all workers, contractors, visitors, and members of the public. Central to this commitment is a proactive WHSMS which supports ANSTO's Work Health and Safety and Environment policy [35]. The WHSMS provides a comprehensive system of policies, procedures and guides to assist ANSTO in meeting its strategic plans and legislative obligations. Further information is discussed in Chapter 5.10 and further elaborated in the ILWCI Siting Licence Safety Management Plan [19].

Scenarios with non-radiological consequences have been detailed and identified as part of the HAZID process in the safety assessment. The results of this assessment can be seen in Table 5. Further assessment into WHS issues will be conducted in later phases of the project.

Table 5 - Summary of risk assessment for scenarios with non-radiological consequences

Scenario	Consequence		Likelihood	Risk
Traffic accident	**Physical injury**	**Severe** (Death / permanent injury)	**Highly Unlikely** (10^{-5} to 10^{-4} p.a.)	**Medium**
Flask dropped due to crane failure	**Physical injury**	**Severe** (Death / permanent injury)	**Highly Unlikely** (10^{-5} to 10^{-4} p.a.)	**Medium**
Fire in the ILWCI facility	**Plant damage**	**Moderate** Plant damage (<1 month)	**Very Unlikely** (10^{-4} - 10^{-3} p.a.)	**Low**
Slips, trips and falls	**Physical injury**	**Severe** (Death / permanent injury)	**Very Unlikely** (10^{-4} to 10^{-3} p.a.)	**Medium**
		Moderate (Lost time injury)	**Unlikely** (10^{-3} to 0.01 p.a.)	**Low**
Manual handling	**Physical injury**	**Moderate** (Lost time injury)	**Unlikely** (10^{-3} to 0.01 p.a.)	**Low**
Working at heights	**Physical injury**	**Severe** (death/ permanent injury)	**Very Unlikely** (10^{-4} to 10^{-5} p.a.)	**Medium**
		Major (Serious injury)	**Unlikely** (10^{-3} to 0.01 p.a.)	**Medium**
Moving parts- crush/ pinch injuries	**Physical injury**	**Major** (Serious injury)	**Very Unlikely** (10^{-4} to 10^{-3} p.a.)	**Medium**
Person injured by truck in the truck bay	**Physical injury**	**Major** (Serious injury)	**Very Unlikely** (10^{-4} to 10^{-3} p.a.)	**Medium**

9.9. Safety Analysis Summary

A preliminary risk assessment has been conducted for the proposed ILWCI facility. The purpose of the risk assessment at this early stage in the project is to ensure that a safety-led design process is adopted, in accordance with regulatory requirements and international best practice. The risks considered have been assessed by considering the current design intention and information available at the time of the siting licence application.

The preliminary risk assessment has highlighted one scenario with a catastrophic radiological impact and high inherent risk. This is for an operator falling into an open pit. Recommendations have been made and this scenario will be further assessed in subsequent applications to determine the adequacy of controls and to ensure that this risk is ALARA. All other scenarios with radiological consequences have been assessed as low or very low with two scenarios with a medium residual risk for the consequences of physical injury and plant damage. Some industrial hazards such as slips, trips and falls, working at heights and crush injuries have been assessed as medium risks.

Six critical controls were identified for various scenarios in the safety assessment to reduce the risk and are detailed in the Appendix. Other controls also complement these controls in mitigating the risk.

There are no credible reference accidents that could present risk of harm to persons outside of the facility. Therefore, the ILWCI facility will be safe with respect to offsite effects and is classified as an F1 hazard category installation with no potential for significant consequences outside of the facility.

The radiological risks to the population from external accident conditions, including those that may require mitigation measures, are acceptably low and in accordance with national requirements. This facility will be designed to meet the safety objectives, and the appropriate external events, codes, standards, and design methods have been considered in the design.

The ILWCI facility will be sited in line with ANSTO WHS Management Systems standards and practices, which are consistent with accepted radiation and work health and safety practices in Australia.

10. Decommissioning

10.1. Decommissioning strategy

At the end of the operational phase of the facility, a decommissioning strategy will be prepared in compliance with the relevant regulatory requirements [54]. The preferred and likely option for decommissioning the facility would be 'immediate dismantling' as stipulated in IAEA guides [55, 56]. Whilst the final decision on the detailed decommissioning strategy will be made in the future, it is expected that decommissioning will leverage the skills and facility knowledge of operational personnel through a post operational clean out.

The design of the ILWCI facility follows a 'whole-of-life' cycle approach that will facilitate decommissioning of the structures and equipment. Table 6 provides a description of the main items that may be potentially contaminated at the end of the life of the facility. At the time of decommissioning, the facility will be characterised to understand the level of contamination. Each system, component and material will likely have a tailored decontamination and dismantling strategy.

Table 6 – Potentially contaminated material/waste

System	Components	Material	Waste
[redacted]	Storage tubes plugs	Concrete and/or steel	To be determined (TBD) prior to closure of the facility.
	Concrete – storage tubes	Concrete – a thin inner layer of the tubes could be contaminated.	TBD prior to closure of the facility.
Storage pits	Steel frames	Stainless steel	TBD prior to closure of the facility.
	Pit covers	Concrete with carbon steel rebar and lifting lug	TBD prior to closure of the facility.
Pit AVS	Ductwork	Stainless steel	TBD prior to closure of the facility.
	Exhaust fans	Stainless steel	TBD prior to closure of the facility.
	Filter housing	Stainless steel	TBD prior to closure of the facility.
General Purpose Flask and Waste Retrievable Flask	Flask liners	Stainless steel	TBD prior to closure of the facility.
	Flask body	Lead encased in structural steel	TBD prior to closure of the facility.
Other wastes - decontamination of plant equipment	Various. To be confirmed prior to decommissioning.	Various. To be characterised prior to decommissioning.	TBD prior to closure of the facility.

10.2. Decommissioning waste

At the time of decommissioning, the facility will be characterised to understand the level of contamination. Each system, component, and material will likely have a tailored decontamination and dismantling strategy. At that time, the volumes and characteristics of the waste will be better understood.

All packaged waste ([redacted] ARB) will be removed from the facility prior to decommissioning. An understanding of the characteristics of this waste (radiological and chemical) can be used to inform decommissioning. The radionuclides present will be mixed fission products.

Decommissioning waste will be managed through existing processing and storage pathways at ANSTO. The disposal route for the wastes generated is dependent on the availability of disposal facilities at the time of decommissioning.

11. Conclusions

11.1. Acceptability of site location & design

On the basis of the site characteristics information and the specific site-related design basis considerations, it is concluded that the proposed site for the storage facility, within the Lucas Heights site, does not have any negative features which cannot be overcome by the high standard and quality of engineering design and construction which are required by ANSTO.

The radiological risks to the population from accident conditions, including those that may require mitigation measures, are acceptably low and in accordance with national requirements. This facility will be designed to meet the safety objectives, and the appropriate external events, codes, standards, and design methods have been considered in the design.

In summary, this site was selected because of the following features:

- Existing nuclear site with the adequate security infrastructure with site access controlled by the AFP;
- Existing infrastructure including power, water supply, waste services, and communications;
- Existing staff with expertise in radiation protection, maintenance and engineering, asset management, waste management, and emergency response capabilities; and
- An established environmental monitoring program.

11.2. Acceptability of normal operations

WMS has demonstrated a sound track record with regard to the safe and effective management of all waste at Lucas Heights. The ILWCI facility is similar in design and operational philosophy to the existing [redacted] which ANSTO has utilised to successfully and safely managed RHSW for decades. The proposed facility will be managed and regularly reviewed to ensure that all regulatory, legal, safeguards, safety and environmental requirements are complied with at all times in the management of radioactive waste.

The ILWCI facility will be sited in line with ANSTO WHS Management Systems standards and practices, which are consistent with accepted radiation and work health and safety practices in Australia. A set of Plans and Arrangements have been prepared to support the siting licence application requirements.

11.3. Acceptability of residual risk associated with abnormal operation

Chapter 9.4 detailed the safety analysis for internal abnormal events. The preliminary risk assessment has highlighted one scenario with a catastrophic radiological impact and high inherent risk. This is for an operator falling into an open pit. Recommendations have been made and this scenario will be further assessed in subsequent applications to determine the adequacy of controls and to ensure that this risk is ALARA. All other scenarios with radiological consequences have been assessed as low or very low with two scenarios with a medium residual risk for the consequences of physical injury and plant damage. Some industrial hazards such as slips, trips and falls, working at heights and crush injuries have been assessed as medium risks.

The safety analysis of abnormal events shows that there are no credible accidents that can affect the safety of the public, and hence the facility is categorised as an F1 facility. There are credible events and accidents that could cause damage to plant and equipment resulting in contamination and exposure events. However, the likelihood of these events is acceptable, and the consequences are able to be managed effectively. Alarm and protection systems allow abnormal and emergency situations to be detected and action taken to mitigate the situation.

Chapter 9.5 detailed the safety analysis for potential for hazards associated with external events. A siting stage evaluation was performed, and the report Site Characteristics and Site Related Design Bases document [5] concluded that the site was generally suitable.

11.4. Emergency arrangements, procedures and exercises

The main local emergency arrangement is the requirement to make safe and evacuate the building under some circumstances. Based on the earlier discussions in Chapter 5.12, Chapter 9 on safety analysis and Chapter 11.2 above, the facility is well equipped with detection and protection systems, trained personnel and is well supported by the ANSTO emergency personnel and procedures.

11.5. Maintenance, inspection and testing of safety related items

Asset management plans will be developed for the facility to define the examination, maintenance, inspection and testing required for assets and components. Any assets critical to safety will be assigned to an asset owner/custodian and registered in the WMS Asset Management Plan, G 3233 [36].

Waste Management Services buildings, plant and equipment are scheduled for maintenance by the ANSTO Maintenance & Engineering (AME) group in accordance with the Service Level Agreement. Items of equipment (including some that may not be categorised as SSCs related to radiological safety) are classified according to their maintenance priority as essential (Category 1 maintenance compliance) due to their importance in the safe and uninterrupted operation of waste treatment processes.

Maintenance items will be scheduled using ANSTO's computerised maintenance management system (SAP). Radiation monitoring equipment are calibrated annually as scheduled in the Waste Operations Instrument Calibration Database.

These systems will ensure that the maintenance, inspection, and testing of safety-related items will be implemented within the required frequencies to ensure that all items are functioning in their intended role in the overall safety system.

11.6. Action plan

The safety assessment identified the following recommendations for consideration:

- **R1:** A recovery plan should be developed for the scenario of a crane failure at a time when the storage pit shielding is compromised. This could include provisions such as spare shielding plugs and the required equipment to lift these into place when the crane is not available.
- **R2:** A rescue plan for a person falling inside of a pit should be developed and any required equipment made available in the ILWCI facility. This will act to reduce the time of exposure and therefore the impact. Rescue personnel and/ or ERT must be briefed on the details of the rescue plan as per the Worker Safety Handbook.
- **R3:** Investigation should be undertaken into the inclusion of anchor points within the ILWCI facility so that a restraint harness is available if operators or maintenance staff are required to go within 2 metres of an open pit. This will reduce the likelihood of an event.

- **R4:** A temporary barricade should be erected during a waste transfer to create a physical exclusion zone around the open pit. This will reduce the likelihood of an operator falling into the open hole and help to ensure all personnel remain at a safe distance. The design for this proposed control shall be further investigated and developed prior to the construction licence risk assessment being submitted.

A disposition memorandum of the risk assessment recommendations was prepared by WMS. This can be found in Appendix B with a response to each recommendation.

The risk assessment will be reviewed and further developed as the facility proceeds through construction, and operational licence applications when more details become available. In addition, according to the safety categorisation of the safety-related items, if there are SSCs within the ILWCI facility which have items with Safety Category 1 or 2, OLCs will be required for the facility. This will be reviewed in a future assessment at a later stage of the project.

11.7. Justification for continued operations

Australian society benefits from the radiopharmaceuticals produced at ANSTO and the nuclear research undertaken by the organisation. The production of radiopharmaceuticals and research activities results in the generation of radioactive waste. ANSTO has a responsibility to safely and effectively manage the radioactive waste generated through these processes.

WMS has demonstrated a sound track record over many years with regard to the safe and effective management of all waste at Lucas Heights. The proposed facility will be managed and regularly reviewed to ensure that all regulatory, legal, safeguards, safety and environmental requirements are complied with at all times in the management of radioactive waste. Radiation dose and contamination exposure to personnel is within acceptable limits for radiation workers as evidenced by personal dosimetry and routine surveys of WMS. Therefore, the proposed ILWCI facility is justified as an appropriate storage facility for RHSW at Lucas Heights until such time as the NRWMF becomes available for interim storage.

A preliminary risk assessment has been conducted for the proposed ILWCI facility as part of the siting licence application to ARPANSA. The purpose of the risk assessment at this early stage in the project is to ensure that a safety-led design process is adopted, in accordance with regulatory requirements and international best practice.

The risks considered have been assessed by considering the current design intention and information available at the time of the siting licence application. The risk assessment will be reviewed and further developed as the facility proceeds through future licence applications when more details become available.

11.8. Facility hazard categorisation

The bounding accident, for radiological exposure to operators within the facility, was assessed to be an operator falling into an open storage pit resulting in a catastrophic dose (>1 Sv). No credible reference accident scenarios were identified with the potential for significant consequences to those outside of the facility or the ANSTO Lucas Heights site. Therefore, the ILWCI facility will be safe with respect to offsite effects and is classified as an F1 hazard category installation with no potential for significant consequences outside of the facility.

12. References

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13. Glossary

AAEC	Australian Atomic Energy Commission
AFP	Australian Federal Police
AHD	Australian Height Datum
ALARA	As Low As Reasonable Achievable
AME	ANSTO Maintenance and Engineering
ANM	ANSTO Nuclear Medicine
ANSTO	Australia Nuclear Science and Technology Organisation
ARB	Aluminium Retrievable Bin
ARPANSA	Australia Radiation Protection and Nuclear Safety Agency
ASOC	ANSTO Security Operations Centre
AVAO	Active Ventilation Approvals Officer
AVS	Active Ventilation System
BCA	Building Code of Australia
CAD	Computer-aided Design
CBD	Central Business District
CEO	Chief Executive Officer
COO	Chief Operating Officer
DGR	Dangerous Goods Rated
EPA	Environmental Protection Agency
ERT	Emergency Response Team
FDCIE	Fire Detection Control and Indicating Equipment
FMECA	Failure Mode, Effects & Criticality Analysis
GP	General Purpose
GRC	Governance, Risk and Compliance
HAZID	Hazard Identification Study
HAZOP	Hazard and Operability Study
HEPA	High Efficiency Particulate Air
HP	Health Physicist
HPS	Health Physics Surveyor
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
ILW	Intermediate Level Waste

ILWCI	Intermediate Level Waste Capacity Increase
LEAO	Lifting Equipment Approvals Officer
LfE	Learning from Experience
LMS	Learning Management System
NRWMF	National Radioactive Waste Management Facility
OLC	Operating Limits and Conditions
OPAL	Open Pool Australian Light Waste Reactor
PPE	Personal Protection Equipment
RCM	Reliability Centred Maintenance
RHSW	Remote Handled Solid Waste
RPE	Respiratory Protection Equipment
RPS	Radiation Protection Services
SAA	Standards Association of Australia
SAR	Safety Analysis Report
SDS	Safety Data Sheet
SQEP	Suitably Qualified and Experienced Persons
SRA	Safety and Reliability Assurance
SSC	Structures, Systems and Components
[redacted]	[redacted]
SV	Storage Vessel
SWMES	Safety Work Method and Environmental Statement
TBC	To Be Confirmed
TBD	To Be Determined
UPS	Uninterruptible Power Supply
WHO	World Health Organization
WHS	Work Health and Safety
WHSMS	Work Health and Safety Management System
WMP	Waste Management Precinct
WMS	Waste Management Services
WO	Waste Operations

14. Drawings List

The following is a list of all the figures throughout this Safety Analysis Report.

All relevant drawings related to the concept design can be found in the Jacobs report 'ANSTO ILWCI Concept Design (30%) Report Rev 3 (IA222700)' [2]. These drawings relate to the architectural, structural civil, mechanical services, electrical, security, fire and hydraulic aspects of the facility.

Appendix A - Critical Controls

ID	Critical Control	Main Safety Functions	Relevant Scenarios	Control Type	Safety Category	Control Description	Claimed Impact Reduction	Claimed Likelihood Reduction/ Failure Rate	Monitoring and Surveillance	Comment
CC-01	Robust design of waste flask	To prevent significant damage to shielding during a collision.	7.1.1	Engineering Mitigative	TBC in alignment with AG 2494	Adequate shielding and design features to prevent release of material during an impact or collision event.	N/A	0.1	Routine inspection and maintenance on the flask.	N/A
CC-02	Flask captive key interlocks	Prevent lifting the flask when the door is open.	7.1.2	Engineering Preventative	TBC in alignment with AG 2494	Each flask has a captive key interlock which will prevent the ILWCI building crane being operated whilst the flask doors are open.	N/A	0.01	Functional testing at every transfer (key cannot be removed early when flask door is open).	N/A
CC-03	Procedure for flask operations	To prevent the omission of closing the door prior to lifting the flask.	7.1.2	Administrative Preventative	TBC in alignment with AG 2494	A procedure for the proposed facility will be developed and staff will be trained to ensure that the flask door is closed prior to performing a lift.	N/A	$3x10^{-3}$	Trained operators and regular reviews of the procedure.	N/A
CC-04	DGR certified crane	Additional features to improve the reliability of the crane.	7.1.3	Engineering Preventative	TBC in alignment with AG 2494	The overhead crane in the ILWCI facility will be DGR certified and meet AS1418 standards with adequate safety factors for crane components, and additional safety features. These features will include dual ropes and over-speed emergency brakes. The crane will undergo regular preventative maintenance, inspections and testing as per the manufacturer's requirements.	N/A	$1x10^{-6}$	Routine inspection and maintenance of the crane.	N/A

ID	Critical Control	Main Safety Functions	Relevant Scenarios	Control Type	Safety Category	Control Description	Claimed Impact Reduction	Claimed Likelihood Reduction/ Failure Rate	Monitoring and Surveillance	Comment
CC-05	Recovery Plan for crane failure	Ensure minimal exposure time to the open pit and ensure that appropriate steps can be taken to restore shielding in a safe and timely manner for maintenance on the crane.	7.1.5	Administrative Mitigative	TBC in alignment with AG 2494	Prior to commissioning, a plan shall be developed detailing the recovery plan for crane failure with storage pit open. This plan should identify the procedure, equipment and PPE required to restore shielding in the ILWCI in a safe and timely manner to reduce any exposure to recovery staff. Only once shielding is restored should maintenance staff enter the building to work on the failed crane.	1-20 mSv to 0.1-1 mSv	N/A	Trained operators and regular reviews of the procedure.	N/A
CC-06	Moisture detectors	Prevent environmental leaching from the pits.	7.1.11	Engineering Mitigative	TBC in alignment with AG 2494	Moisture detectors (conductivity probes) will be located in each of the pits. These will initiate a local alarm in the event of any water collecting in the pits. The floor of the pit will have a slight slope to capture the water in a sump, thereby, making the detection of the water in the pit easier and allowing any water collected to be pumped out.	N/A	0.02	Routine functional testing.	N/A

Appendix B – Disposition of Risk Assessment Recommendations

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MEMORANDUM

To	[redacted]	Date	24/3/2021
From		Ref/File No.	ANSTO/T/TN/2020-14
Subject	Disposition of risk assessment recommendations		

For the siting of the new radioactive waste storage facility, a safety assessment of the facility was conducted which generated several recommendations.

Please find below disposition to the recommendations made in Safety Assessment ANSTO/T/TN/2020-14 rev 0.

#	Recommendation	Response	Status
1	A structural integrity assessment, using engineering methods such as FEA modelling, should be conducted on the GP and retrievable waste flasks (6 t and 9 t) shielding to confirm the probability of failure during an impact such as a traffic collision during transportation of active waste or a flask drop.	Agreed. There is a plan for doing a model of the drop of flasks and this will span two years. Start has been with the SUF Flask, and these flasks will be done following that work.	Other Flasks underway – will be done within 2 years.
2	A recovery plan should be developed for the scenario of a crane failure at a time when the storage pit shielding is compromised. This could include provisions such as spare shielding plugs and the required equipment to lift these into place when the crane is not available.	Agreed. A recovery plan will be developed for crane failure scenario.	Not yet started
3	A rescue plan for a person falling inside of a pit should be developed and any required equipment made available in the ILWCI facility. This will act to reduce the time of exposure and therefore the impact. Rescue personnel and/ or ERT must be briefed on the details of the rescue plan as per the Worker Safety Handbook.	Agreed. A rescue plan will be developed with Emergency Operations Manager and ERT.	Not yet started
4	Investigation should be undertaken into the inclusion of anchor points within the ILWCI facility so that a restraint harness is available if operators or maintenance staff are required to go within 2 metres of an open pit. This will reduce the likelihood of an event.	Agreed. Will investigate whether anchor points can be incorporated into the building. Will investigate which	Not yet started

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		scenarios need to work around an open pit.	
5	A temporary barricade should be erected during a waste transfer to create a physical exclusion zone around the open pit. This will reduce the likelihood of an operator falling into the open hole and help to ensure all personnel remain at a safe distance. The design for this proposed control shall be further investigated and developed prior to the construction licence risk assessment being submitted.	Agreed. The intention is to have a permanent barrier around the pits and to have all people outside the barrier whenever the pit is uncovered.	Concept designs have been drafted.

[redacted]