HIFAR PHASE A DECOMMISSIONING PLAN

Public Consultation Version

November 2021

Project Name: HIFAR Decommissioning Project (Phase A)

Decommissioning Project ID: D00041

Engineering		**Document No:** ACS248144			
		Document Title: HIFAR Phase A Decommissioning Plan			
REVISION SHEET		**Job No:** D00041			
Revision Letter	**Description of Revision**	Print name, date and sign or initial			
		Prepared	**Checked/ Reviewed**	**Approved**	**Agreed**
Rev 0	Original Issue	Content removed due to security reasons	Content removed due to security reasons	Content removed due to security reasons	Content removed due to security reasons

Notes:

1. Revision shall be verified in accordance with the Quality Plan for the job.
2. Revision to be agreed by the Client where relevant.

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Introduction

HIFAR was shut down on 30 Jan 2007, and a Possess or Control (PorC) licence (F0184) issued on 15 Sep 2008.

A 2005 options study (1) for HIFAR recommended its decommissioning be completed in three stages:

1. De-fuel, removal of the heavy water inventory etc.
2. Characterisation.
3. Final dismantlement.

One option was a deferred dismantlement strategy of 30 years, however given that decreases in radiation levels would be modest beyond 10 years post shut down, the study recommended early decommissioning. This would meet with international best practice, would ensure knowledge retention of HIFAR within the operations and decommissioning teams, and would respect previously made public commitments.

1.1.1 Characterisation

A project to characterise HIFAR, under the PorC licence, was initiated in Nov 2014 and completed in Aug 2019. The results of this were published in the Report on the Characterisation of HIFAR (ACS187819) which has been used extensively in the planning for this decommissioning and dismantlement (D&D) project.

1.1.2 Decommission and Dismantlement

This plan is for the Phase A D&D of HIFAR which will be split into Phase A-I, A-II and A-III and will require three submissions including the decommissioning licence application and two requests for approval under Section 63 of the ARPANS Regulation 2018 (4). These submissions will consist of:

1. **Decommissioning Licence Application Phase A-I**: D&D of the Utilisation equipment, Neutron beam instruments and Irradiation rig support equipment;
2. **Section 63 Phase A-II:** D&D of the main reactor ancillary circuits; and
3. **Section 63 Phase A-III:** D&D of the items stored in the No.1 Storage block.

As the section 63 submissions for phase A-II and A-III will each require their own respective safety assessments; this plan only includes the summaries of the safety assessments for phase A-I which can be found in section 9.

This approach is commensurate with the level of safety analysis, decommissioning planning, documentation and associated risks.

1.1.3 Reactor Block

The D&D of the reactor block is not in the scope of the current project or of this decommissioning plan. This will be undertaken at a later stage and will be dependent on the build schedule of the Australian National Radioactive Waste Management Facility (NRWMF).

1.2 Purpose

The purpose of this plan is to describe the Phase A D&D of HIFAR focusing on the safety measures to protect staff, the public and the environment. This decommissioning plan will be submitted to ARPANSA as part of the decommissioning safety analysis which includes a safety analysis report (SAR) (ACS248156) and eight other documents which go into depth about the effective control of HIFAR during D&D activities. These plans are:

1. Schedule.
2. Effective Control Plan.
3. Safety Management Plan.
4. Radiation Protection Plan.
5. Waste Management Plan.
6. Security Plan.
7. Emergency Plan.
8. Environment Protection Plan.

1.3 Audience

The intended audience for this plan is:

- HIFAR Phase-A Decommissioning Project Team
- HIFAR License Nominee
- HIFAR Licensing Officer
- ANSTO Chief Nuclear Officer.
- ANSTO Safety and Reliability Assurance (SRA)
- ARPANSA

2 FACILITY DESCRIPTION

The High Flux Australian Reactor (HIFAR) research reactor was a 10 MW heavy water moderated and cooled reactor, of the DIDO class. Initially, it used highly enriched uranium as fuel, but later was converted to use low enriched uranium. HIFAR went critical for the first time on 26 January 1958. It was a multi-purpose nuclear reactor used for research; production of radioactive isotopes for Australian nuclear medicine and industry; materials testing; neutron beam experiments, and for silicon irradiation. HIFAR was permanently shut down 10:25 am on 30 Jan 2007, after 49 years of operation, when it was replaced by the OPAL reactor which was commissioned in 2006.

The following section provides information about HIFAR, and a description of the more important extant systems/circuits when they were operational.

2.1 Location and Description of the Site and Facility

HIFAR is situated on the ANSTO Lucas Heights Campus, which is located on Commonwealth land in the suburb of Lucas Heights some 35 – 40 km southwest of the centre of Sydney. An aerial image of the campus can be found in Appendix B: . A floor plan of HIFAR showing its various levels can be seen in Appendix E: and a site plan of HIFAR showing the buildings within the HIFAR facility is shown in Appendix F: .

2.1.1 DIDO Class Reactors

HIFAR was one of the six DIDO class reactors. The others are:

DMTR[1], Dounreay, Scotland.

DIDO, Harwell, England.

PLUTO[2], Harwell, England.

FRJ-2, Jülich Research Centre, Germany.

DR-3, Risø National Laboratory, Denmark.

A 3D diagram of the HIFAR Reactor Block and D_2O plant room is shown in Figure 1.

Content removed due to security reasons

1 Dounreay Materials Testing Reactor.

2 PLUTO and DIDO reactors are essentially of the same design.

Figure 1 3D DIAGRAM OF HIFAR SHOWING THE REACTOR BLOCK ABOVE THE D2O PLANT ROOM

2.1.2 Design and Construction

The principal consultants for the design and construction of HIFAR were Head Wrightson Processes Ltd (HWP). HWP had also built five similar DIDO class reactors all of which are now shutdown and at different stages of decommissioning.

2.2 Principal Characteristics

The principal characteristics of HIFAR are summarised in Table 1, with a schematic diagram showing the reactor containment building in Figure 2.

Table 1 PRINCIPAL CHARACTERISTICS OF HIFAR

Item	Detail
Reactor Type	DIDO
Faces	10
Height (Base to top of concrete)	5.0 m
Height (Base to top of Top Plate)	6.0 m
Height of reactor top above ground	11 m
Diameter (face to face)	6.7 m
Facilities – Horizontal	30
Facilities – Vertical	28
Mass	974 tonnes
Fuel Element Positions	25
Full thickness of Biological Shield	1.527 m
Fuel	Initially highly enriched uranium, by 2007 HIFAR was using a low enriched uranium (19.6% enriched) core
Moderator/Coolant	10.1 tonnes D_2O
Secondary Cooling	H2O via cooling towers associated pumps, pipework etc.
Coolant Temperature	50º C
Full Power	10 MW
Maximum Thermal Flux	1.4x1014 N/cm2/sec

Item	Detail
Control Absorbers	Europium and Cadmium
Applications	Materials testing, medical isotope production, silicon and other isotope irradiation
Built	1954 – 1958
First Criticality	26th January 1958 (Australia Day)
Commenced Routine Operations	1960 at 10 MW
Shutdown	30 Jan 2007
Number of Major Shutdowns	13
No Operating Days	13,631
Total Megawatt Days	136,310
Last Operations Programme	585

Content removed due to security reasons

Figure 2 SCHEMATIC DIAGRAM OF THE REACTOR CONTAINMENT BUILDING AND CONTENTS (ACS052079)

2.2.1 Systems/Circuits

While operational HIFAR used a hierarchical naming structure of systems/circuits. For example, the primary cooling system was designated the '01 circuit' and was usually referred to as 'Primary Cooling (01) Circuit'.

The Characterisation Project team used these systems/circuits as a foundation for the development of characterisation groups forming the basis of HIFAR's characterisation (ACS187819).

2.2.2 The HIFAR Facility

The various items contained in HIFAR are tabled in Table 2. For clarity, this table splits the items into those that will be dismantled in the current project HIFAR Phase A Decommissioning (herein referred to as Phase A) and then later, in the second phase, Phase B.

Table 2 ITEMS CONTAINED IN HIFAR

HIFAR Items to be Dismantled in Phase A	HIFAR Items to be dismantled in Phase B
Items stored in No.1 Storage Block.	Reactor:
Primary Cooling (01) Circuit.	• Reactor Aluminium Tank.
Blanket Gas (Helium) (02) Circuit.	• Graphite reflector.
Secondary Cooling (04) Circuit.	• Reactor Steel Tank.
Shield Cooling (05) Circuit.	• Biological shield.
Rig Cooling System (06) Circuit.	• Reactor Steel Structure.
Emergency Cooling (014) Circuit.	• Irradiation facilities.
Storage Block Cooling (017) Circuit.	• Thermal column.
Neutron beam instruments:	• Ion chambers.
• AUSANS (Australian Small Angle Neutron Scattering) Neutron Beam Instrument.	Installed rigs.
• Medium and High-Resolution Powder Diffractometer.	Ventilation System:
• Neutron Reflectometer.	• Normal Ventilation (07 and 08) System.
• Triple Axis Spectrometer.	• Active Ventilation (30) System.
• Long Wavelength Polarisation Spectrometer Instrument (LONGPOL).	• Standby Active Ventilation (09) System.
• Medium Resolution Single-Crystal Diffractometer Instrument.	Reactor Containment Building, Building 15.
Flasks (Fuel Flasks and Silicon Transfer Flasks)	Ancillary buildings.
Rig support equipment.	Soil, trenches, and trench contents.

HIFAR Items to be Dismantled in Phase A	HIFAR Items to be dismantled in Phase B
Silicon Storage Blocks.	Flasks (Remaining flasks)
Control Room.	
Fuel Assembly Station (FAS).	
General Utilisation Equipment.	

2.3 HIFAR Facility Radiological Characterisations and Surveys

The report on the Characterisation of HIFAR (ACS187819) includes a characterisation of all areas within HIFAR sufficient to develop risk informed Decommissioning Execution Plans (DEP). Contamination surveys and dose assessments, along with the historical records of surveys performed during the operational life of HIFAR, provide the project with sufficient evidence for the release of systems, structures, and components (SSC). See Section 5.1 for further details.

2.4 Site and Facility Operational History

2.4.1 HIFAR Licencing

HIFAR was operated by ANSTO under the ARPANSA issued Facility Licence FO0044-4A issued on 14 June 2001. This licence was replaced on 15 September 2008 by Facility Licence F0184, to Possess or Control (PorC) HIFAR. Broadly, Facility Licence F0184 allowed ANSTO to:

- Care and maintain HIFAR whereby a state of ‘safe enclosure’ is achieved.
- Characterise HIFAR to the extent approved by the CEO of ARPANSA.
- Dismantle components that are below exemption levels.

This decommissioning plan supports ANSTO’s application for Phase A of the HIFAR Decommissioning Project.

2.4.2 Post Shutdown Activities

Following HIFAR’s shutdown (30 January 2007), a program of closure works commenced. Within the first 12 months, the reactor fuel was fully unloaded, heavy water drained, control arms removed, and operational staffing ceased.

Additionally, the possess or control licence application identified 39 refurbishment and preliminary dismantling activities to be undertaken in HIFAR during the possess and control period (2).

3 DECOMMISSIONING STRATEGY

Prior proposals for the decommissioning of HIFAR identified a preferred option of a care and maintenance period comprising 30 years, followed by demolition of HIFAR to a green field site. The 30-year period for care and maintenance was based on reducing the radionuclide inventory and associated dose rates by radioactive decay prior to dismantlement. However, this type of approach was no longer favoured internationally and in a 2005 report, commissioned by ANSTO, dismantlement after a shorter period of decay was recommended as the preferred decommissioning strategy (1).

This prompt decommissioning approach reassures stakeholders that HIFAR will be dismantled safely avoiding on-going legacy issues and maximising the use of experienced staff in the D&D process.

Three stages of decommissioning were considered in the 2005 report:

- Stage 1 – Removal of the fuel, coolant (heavy water) and the cooling towers.
- Stage 2 – Possess and Control period during which characterisation and D&D planning could be performed.
- Stage 3 – Decommissioning of HIFAR.

The option of full decommissioning of HIFAR in Stage 3 was considered not to be viable in the immediate term, due to waste storage constraints caused by uncertainties around the development of the national waste repository.

After detailed characterisation and further consideration, Stage 3 decommissioning of HIFAR was divided into two separate phases - Phase A and Phase B with the option to return to a Possess or Control licence at the completion of Phase A.

3.1 Phase A D&D Strategy

Phase A will be split into 3 stages - Phase A-I, A-II and A-III. The first stage (Phase A-I) will see the removal of structures, systems and components peripheral to the reactor block or the reactor containment building (RCB). Approval for this will be requested under a decommissioning licence. Phase A-II and A-III will require further approval under Section 63 of the ARPANS regulations.

This strategy was adopted so that dismantlement of less radiologically challenging aspects of Phase A-I can commence without delay. Meanwhile, detailed planning required for Phase A-II and III which require section 63 submissions, due to higher activation levels, could occur concurrently with dismantlement work. This planning is currently being undertaken.

Table 3 differentiates those items to be dismantled under the decommissioning licence (Phase-A-I) and section 63 submissions (Phase A-II and Phase A-III).

Table 3 EQUIPMENT BEING DISMANTLED UNDER PHASE A-I, A-II and A-III

Phase A-I:	**Phase A-II:**	**Phase A-III:**
Neutron beam instruments: AUSANS (Australian Small Angle Neutron Scattering) Neutron Beam Instrument. Medium and High-Resolution Powder Diffractometer. Neutron Reflectometer. Triple Axis Spectrometer. Long Wavelength Polarisation Spectrometer Instrument (LONGPOL). Medium Resolution Single-Crystal Diffractometer Instrument. Flasks: Fuel Flasks Silicon Transfer Flasks Rig Support Equipment Silicon Storage Blocks Control Room	Primary Cooling (01) Circuit. Blanket Gas (Helium) (02) Circuit. Secondary Cooling (04) Circuit. Shield Cooling (05) Circuit. Rig Cooling System (06) Circuit Emergency Cooling (014) Circuit Storage Block Cooling (017) Circuit	Items stored in No.1 Storage Block

Fuel Assembly Station (FAS) General Utilisation Equipment		

3.2 Phase B D&D Strategy

Decommissioning of the reactor block and the remainder of HIFAR (Phase B) will be undertaken after approval of a second decommissioning licence application. This second application will take place at a later stage and will be dependent on additional government funding as well as the build schedule of the Australian National Radioactive Waste Management Facility (NRWMF).

3.3 Regulatory Plan

The HIFAR Phase-A regulatory plan (ACS270370) identifies the various documents and licencing stages for Phase-A. These can be seen in Appendix C: and Appendix D: .

3.4 Justification of Preferred Strategy

The justification for the decommissioning strategy of Phase A is predicated on several factors including:

- Retention and utilisation of knowledge gained during characterisation of HIFAR
- Realised reduction in radiological hazards
- Low risk of contamination or activation

This strategy also mitigates increased risks to the D&D process caused by:

- Loss of people with sufficient decommissioning experience
- Loss of knowledge of HIFAR in its current state
- Increased decommissioning difficulty (and associated cost) through degradation of systems and materials.

The strategy enables for a small project team who have sufficient decommissioning experience and knowledge of HIFAR to enable an agile project approach which can reflect, learn and adjust risk and safety management.

It is anticipated this strategy will also allow a degree of flexibility for regulator resources to conduct reviews, Q&A meetings and site inspections.

The utilisation equipment, circuits etc. do not exhibit any large radiological risk as they are mainly below exemption levels with only some of the items having minor contamination or minor activation. Therefore, this strategy is commensurate with the level of safety analysis, decommissioning planning and associated risks.

3.5 Regulatory Framework

Regulatory frameworks considered during the planning of HIFAR Decommissioning Phase A are described in this section.

3.5.1 International Atomic Energy Association (IAEA)

Much of the policy and principles administered by ARPANSA are derived from expertise from the IAEA. One of the objectives of the IAEA is to produce guides based on the International best practice in Nuclear Decommissioning which have been informative in the planning of HIFAR's decommissioning.

3.5.2 Australian Radiation Protection and Nuclear Safety Agency (ARPANSA).

ARPANSA is an independent government agency developed to identify, assess and communicate health, safety and environmental risks from radiation. They administer the Australian Radiation Protection and Nuclear Safety Act (3) and the Australian Radiation Protection and Nuclear Safety Regulations, (ARPANS) (4) and are the primary regulators of HIFAR.

3.5.3 Australian Safeguards and Non Proliferations Office (ASNO)

ASNO is an independent regulatory authority responsible for regulating all states and territories under the Nuclear Non-Proliferation (Safeguards) Act 1987 (5).

The principal object of this Act is to give effect to:

- Australia's obligations under the Non-Proliferations Treaty
- Australia's Comprehensive Safeguards Agreement and additional protocol with the IAEA, the Convention on the Physical Protection of Nuclear Material (and its 2005 amendment) (6); and
- Australia's agreements with various countries on the transfer of nuclear material, equipment and technology.

Commitments under these international treaties are managed through a system of permits issued by ASNO for the possession of nuclear material, equipment and technology.

3.5.4 Environment Protection and Biodiversity Conservation Act (EPBC)

The EPBC Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places — defined in the act as matters of national environmental significance.

The decommissioning of HIFAR is considered a ‘controlled action’ under subsection 22 of the EPBC Act (7). An EPBC referral will be submitted to the Department of Agriculture, Water and Environment. The decommissioning of HIFAR is contingent on receiving approval from the Minister.

3.5.5 NSW Waste Regulatory System

Wastes generated from decommissioning activities and which meet ANSTO ‘Free Release’ criteria will then be classified using the NSW EPA Waste Classification Guidelines. The applicable legislation to be followed for waste disposal will be the Protection of the Environment Operations Act 1997 and the Radiation Control Act 1990 (8, 9).

4 DECOMMISSIONING MANAGEMENT

ANSTO is suitably resourced and capable of maintaining effective control over all D&D activities required as part of the Phase A scope of work.

This plan will summarise the framework which ANSTO has deployed to ensure all applicable D&D requirements, as stipulated by the ARPANS Act 1999 and Regulation 2018, are complied with.

This decommissioning plan should be read in conjunction with the Effective Control Plan section of HIFAR Phase A Plans and Arrangements (ACS261210). This covers organisational systems and processes for the effective control of HIFAR including:

- Statutory and Regulatory Compliance
- Commitment of ANSTO Management
- Accountabilities and Responsibilities
- Organisational Resources
- Communication and Reporting
- Process Implementation
- Records and Documentation Control

4.1 Management System

The HIFAR Phase A project will be governed using the ANSTO's Capital Program Management Office (CPMO) Lifecycle Management Framework (ACS252467)

4.2 Safety Management

Safety management for Phase A will be conducted in compliance with the ANSTO Work Health & Safety Management System (WHSMS) which is made up of standards and guides that support ANSTO's Work Health & Safety and Environment (WHSE) Policy. The Safety Management Plan section of the HIFAR Phase A Plans and Arrangements (ACS261210) covers off the organisational systems and processes.

The project is committed to enabling a positive safety culture by:

- Conducting works in accordance with the Codes of Practice and standards listed in Appendix A: .
- Conducting workshops to identify the best decommissioning approach.
- Enabling collaboration with safety and radiation experts.
- Communication with the Danish DR3 project team – a sister DIDO reactor decommissioning project.
- Supporting a questioning attitude and involving all project team members.
- Providing relevant training and awareness for all personnel working on HIFAR decommissioning activities. Refer to HIFAR Decommissioning Training Plan (ACS260821)
- Utilising safety briefings, toolbox talks, safety inspections and use of the STAR (Stop, Think, Act, Review) principle all encourage a positive safety culture.
- Effective communication, consultation and cooperation. Refer to HIFAR Phase A Decommissioning Communication Plan (ACS270299).
- Involving internal/external risk assessment specialists.

To ensure all risks to the health and safety of ANSTO staff and the community are reduced as far as is reasonably practicable, the project will be committed to any requirements made from the Safety and Reliability Assurance (SRA) process.

4.3 Organisational and Administrative Controls

ANSTO is comprised of highly trained personnel who are dedicated to the safe use of radiation for applications that benefit the community. ANSTO staff, who are required to use controlled apparatus or material or work around radiation, are required to attend mandatory radiation safety training regularly as part of their duties.

Radiation safety training includes information on how the ARPANS Act and the Regulations are applied at ANSTO. Additional training is provided to personnel who are required to take on more responsibilities as part of their work.

In collaboration with the Licence Nominee (ANSTO's Chief Engineer AME), the Phase A Project Manager will ensure ongoing compliance with the HIFAR licence and will be supported by Project Responsible Officers, who have been assigned to each segment of the project. Specific responsibilities are discussed in more detail in Section 4.4.

The organisational structure of the Phase A Decommissioning Project is charted in Figure 3.

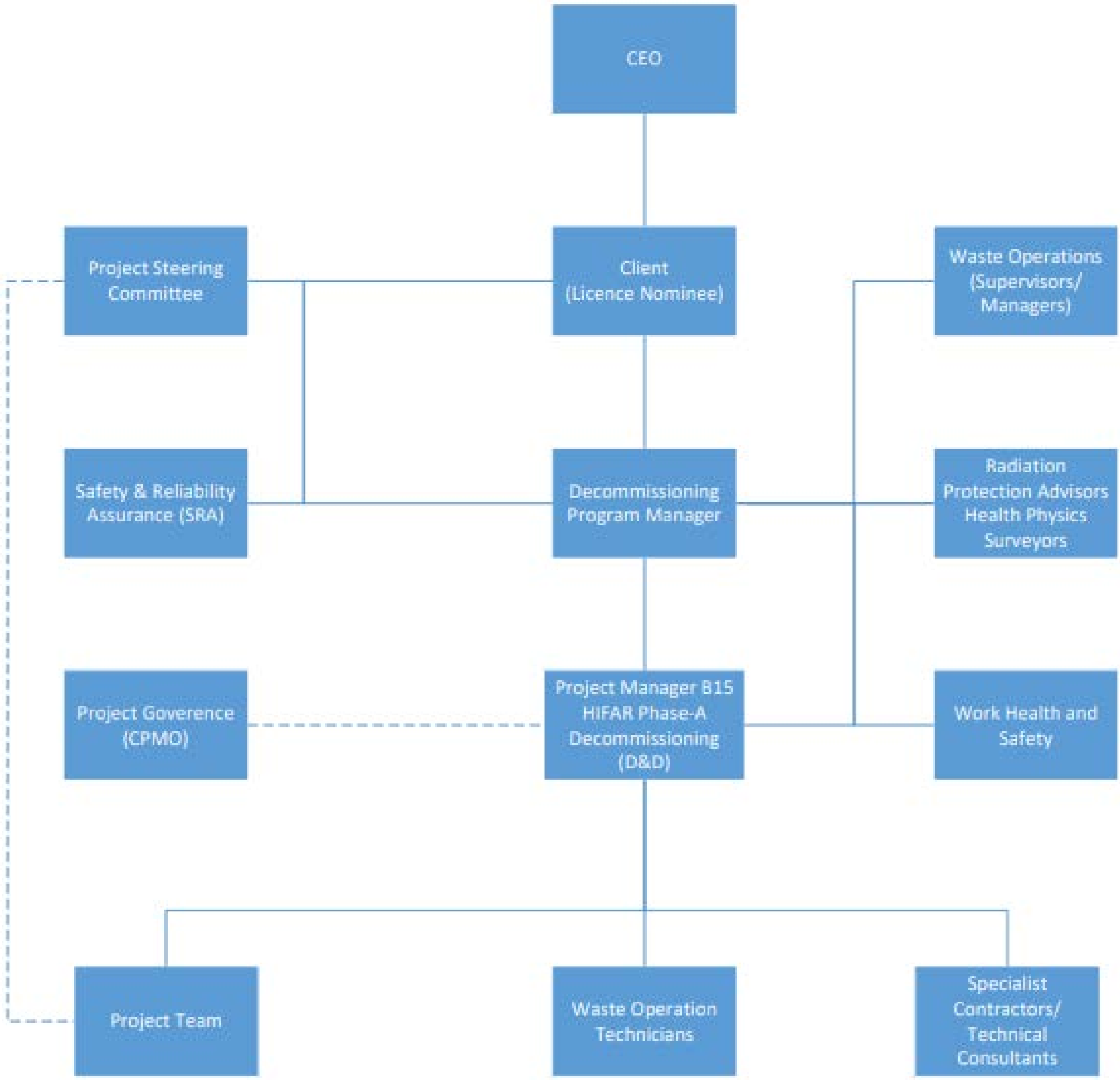


Figure 3 PROJECT ORGANISATIONAL GOVERNANCE STRUCTURE

4.4 Staffing, Qualification and Training

Most project team members, that have been integral to the previous HIFAR Characterisation Project, have accumulated a great deal of experience with the risks and hazards of HIFAR.

Several team members have decommissioning experience dating back to the MOATA reactor decommissioning project and some have obtained Decommissioning Certification from Argonne National Laboratory (ANL) and Oak Ridge Associated Universities (ORAU). (10)

The Project has a training service level agreement with ANSTO Waste Management Services. The training processes collectively ensure that potentially hazardous D&D activities are performed by and supervised by properly authorised and qualified workers.

All project team members will undergo a HIFAR induction process and specific training outlined in the HIFAR and General Decommissioning Training Plan (ACS260821) as well individual training in the ANSTO Learning Management System (LMS). Managers can view a person's training status in both the LMS and HIFAR Training Plan.

Radiation Protection Advisors (RPA) and Health Physics Surveyors (HPS) are recruited and provided with radiation training by ANSTO's Radiation Protection Services Division. Refresher courses are also offered.

Staff from WHS provide advice on conventional work health and safety and provide non-radiation safety training, including induction for workers and safety training for supervisory workers.

Contractors engaged by the project will be supervised by a nominated and approved ANSTO Contractor Supervisor proportional to the level of risk the contractors work poses. Project Contractor Supervisors must have identified and arranged for the contractors to complete mandatory site inductions, HIFAR induction and any specific training identified in the HIFAR Training Plan.

4.5 Project Management

The ANSTO Maintenance & Engineering (AME) group provides extensive project management experience as well as engineering design and manufacturing expertise.

4.5.1 Project, Program and Portfolio Management

Projects or Programs are managed and governed in accordance with the Project Management Policy (AB-0117) authored by ANSTO's Capital Project Management Office.

4.5.2 Design, Development and Manufacturing

Design and drafting resources are allocated to projects and programs based upon the demand and the longevity of a project or program.

The ANSTO Workshop is fully equipped with state-of-the-art machinery which can be utilised to manufacture equipment, tooling and support prototyping and testing efforts.

4.5.3 Systems Safety and Reliability

ANSTO's Systems Safety and Reliability department has safety specialists who conduct the detailed safety and risk assessments for project and operational activities.

4.5.4 Asset Management and Support Group

Assets are managed according to the 'ANSTO Strategic Asset Management Plan' (AG-6659) which includes the identification of an Asset Owner and Asset Manager for standalone plant & equipment assets and infrastructure assets. These roles and responsibilities are described in 'Asset Management Roles and Responsibilities' (ACS076722).

4.5.5 Decommissioning

Within the AME group, the AME Decommissioning Program have provided a project team to manage Phase A as well as the licence nominee (Chief Engineer AME) who ensure that licence conditions and other legal duties are complied with.

The Project Manager will ensure that all project personnel adhere to the approved plans and arrangements and other referenced documentation included as part of the HIFAR decommissioning licence application. In addition, the Project Manager will ensure that all decommissioning activities involving safeguarded material or associated items will be performed in accordance with the Nuclear Materials and Associated Items Project/Activity Management (P-1938).

4.6 Quality Management

The ANSTO Business Management System is managed in accordance with ANSTO's ISO 9001 certified quality management systems and/or the ISO 14001 certified environmental management system. Audits are conducted at least annually by the external certifying bodies for all certifications. These certifications assure there is an effective, standardised and continuously improving business management system in place.

All new activities or work involving hazards are risk assessed in accordance with ANSTO's 'WHS Risk Management Standard' (AE-2301). This document provides advice and tools in relation to hazard identification, consultation, risk mitigation and evaluation.

4.7 Documentation and Record Keeping

Phase A project records are maintained in accordance with ANSTO Records Management Process (AR-1477).

ANSTO maintains guides, procedures and work instructions directly related to the safety, security, and safeguards of the facilities. These documents are in relation to both the operational management of the facilities and the conduct of nuclear science and technology-based activities. The specific guides, procedures, and work instructions relevant to each facility are outlined in the business management system (BMS).

4.7.1 Document Management

Controlled documents are managed in accordance with the ANSTO Controlled Document Process (AR-1041) and are available to staff via the ANSTO intranet.

4.7.2 Additional Project Records

Working project documents are kept on the ANSTO network in a project directory and are regularly backed-up by ANSTO Information Services (IT).

In addition, the project has developed the HIFAR Component Tracking Management System (HCTMS) which has been setup in ANSTO's SAP system specifically to manage and track HIFAR's components, and to maintain data about their physical, radiological and location status. A definitive list of data points is listed below:

- General Data
  - ID Number
  - Description
  - Location
- Images
- Documents
  - Surveys
  - Certificates
  - Reports
- Characterisation Data
  - Characterisation Group
  - Physical
  - Radionuclides
  - Dose Rate
  - Waste Stream
  - Status
- Waste/package tracking

4.7.3 Incident Reporting Records

Records of incidents are generated by any individual who identifies an operational, quality, safety or security concern. This includes near hit, incident, accident, or abnormal occurrence according to

Safety Incident Response & Notification Process (AP-2372) and the ANSTO Incident Reporting Process (AR-6350).

4.8 Contractors Involvement

Contractors or agency staff will be used during the Phase A D&D process. Agency staff will undergo training in accordance with the HIFAR training plan (ACS260821). Contractors will undergo targeted training and will be under the supervision of an ANSTO contractor supervisor.

The responsibilities of contractor supervisors are outlined within 'Safe Management of Contractors' (AP-2303). Contractors will conduct all work in accordance with approved plans and execute their work safely. More information on contractor responsibilities is outlined in the Work Safety Handbook (AG-2451).

4.9 Decommissioning Schedule

Phase A has a detailed project schedule with the major milestones summarised in Table 4.

Table 4 PHASE-A PROJECT TIMELINE

Task	Estimate of Completion Date
Decommissioning Licence Preparation o Plans & Arrangements o Decommissioning Plan o SRA approval	Q4 2022
EPBC/PWC approvals	Q2 2023
Decommissioning Licence Approval o ARPANSA review o Public submission o Approval	Q4 2023
Work Completion o Neutron beam instruments o Irradiation rig equipment o Mezzanine platforms	Q2 2024
Main ancillary circuits - section 63 o Preparation/SRA Approval	Q2 2024

Task	Estimate of Completion Date
o ARPANSA approval	
Storage Block contents - section 63 o Preparation/SRA Approval o ARPANSA approval	Q4 2024
Work Completion o Main ancillary circuits o Storage block contents	Q4 2025
PorC application/approval (or Phase B Decommissioning Licence Application)	Q1 2026

4.10 Specific Decommissioning Issues

4.10.1 Communication

The HIFAR Decommissioning Communication Plan (ACS256407) creates a framework so stakeholders know the purpose, frequency and means for project updates. Additional communication will take place via toolbox talks, line management reporting, incident reporting processes and workplace health and safety committee meetings. This can be related, but not limited, to any change in policy, legislations and regulations, or customer requirements.

Regular communications are also held with stakeholders including Radiation Protection Services, Waste Management Services, ARPANSA etc.

4.10.2 Waste Acceptance Criteria

The disposal of Phase A waste will follow all statutory and regulatory requirements. Preliminary Waste Acceptance Criteria have been set for the NRWMF by the Australian Radioactive Waste Agency (ARWA) and are reproduced in Table 5. ANSTO will adopt these limits and classify the waste packages accordingly.

Table 5 RADIOACTIVITY LIMITS SPECIFIC TO EACH WASTE PACKAGE TYPE

WASTE TYPE	RADIOACTIVITY LIMITS	DOSE LIMITS
LLW	Radioactivity concentration not exceed 4,000 Bq/g alpha and 12,000 Bq/g beta/gamma emitting radionuclides. Total package limit is 4GBq alpha, or 12Bq for beta/gamma emitting radionuclides.	≤ 2 mSv/hr at package external surface, and ≤ 0.1 mSv/hr at 1 metres.
ILW	Radioactivity levels greater than that for LLW, and heat generation rate of less than 2 kW/m^3	ILW in dual-purpose storage / transport containers ≤2 mSv/hr at package external surface, and ≤0.1 mSv/hr at 1 metres. ILW in to be stored in shielded vaults can have ≤100 Sv/hr at external surface. These packages are transported in shielded transport containers and unloaded and emplaced at the NRWMF.
Safeguarded Materials	Packaged Safeguards material shall meet radiological property criteria for ILW	≤ 2 mSv/hr at package external surface, and ≤ 0.1 mSv/hr at 1 metre.

5 CONDUCT OF DECOMMISSIONING

The D&D of HIFAR will be the largest nuclear dismantlement project ever undertaken in Australia. Whilst not considered intrinsically, or mechanically difficult, the presence of radioactive material and the need to maintain public confidence throughout Phase A requires sound and safe conduct of all decommissioning activities.

5.1 Activated and Contaminated Structures, Systems and Components

HIFAR has a long history of radiological surveying and sampling, culminating in the recent characterisation of HIFAR which identified the majority of activated and contaminated structures, systems and components including an extensive characterisation report (ACS187819) which allowed for risk informed D&D planning.

5.1.1 Radiological Survey and Sampling Program

Characterisation of HIFAR was based on the US Multi-Agency Radiation Survey and Assessment of Materials and Equipment (MARSAME) (11) which uses a graded approach whereby components with the greatest potential for activity, according to historical surveys, receive the greatest characterisation effort, while components with less potential receive less attention.

Under the Marsame approach components were classified as either non-impacted (those that have no reasonable potential to contain radionuclide concentrations) or impacted (those that have a reasonable potential to contain radionuclide concentrations). Impacted components were then considered to be Class 1 (indicatively intermediate level waste), or Class 2 (indicatively low level waste) or Class 3 (indicatively very low level waste).

The following radiological characteristics were obtained through the characterisation process:

- Dose rates allowing dismantlement to be based on the ‘as low as reasonably achievable’ (ALARA) principle.
- Radionuclide inventory, in accordance with the National Radioactive Waste Management Facility (NRWMF) *Generic Waste Acceptance Criteria* (12), allowing waste to be transferred to the NRWMF licence, or free released.
- Activated (exposed to neutrons), and/or
- Tritium contaminated (exposed to the reactor’s heavy water (D_2O), and/or
- Contaminated (predominately Co-60)

From the characterisation results, a dose assessment was conducted on the Phase A-I work.

The details of the dose assessment is listed in the HIFAR Decommissioning Phase A-I Dose Assessment (ACS264019). This identifies a maximum collective dose of less than 3mSv and maximum individual dose of less than 1mSv.

Dose rates were calculated by the project RPA from characterisation data and anticipated task times. The dose rates used in the assessment for each SSC are summarised in Table 6.

Table 6: SSC dose rate summary

Dismantlement Task	Dose Rate (mSv/hr)
AUSANS	0.1
MRSCD	0.16
LONGPOL	0.27
TAS	0.05
Neutron Reflectometer	0.1
Uranium Assay Rig	0.1
Rig Equipment	0.1
Utilisation Equipment	
Silicon storage blocks	0.03
Fuel Flasks	0.1
Silicon Flasks	0.02

5.1.2 Plant Radiological Characterisation

Plant and equipment within HIFAR was characterised and documented in the Report on the Characterisation of HIFAR (ACS187819).

Most of the waste generated from Phase A will be solid waste. This waste will be further classified based on characterisation information during D&D activities and managed in accordance with the Waste Management Plan of the HIFAR Phase A Plans and Arrangements (ACS26121).

If required, additional characterisation will be undertaken to facilitate planning, dose optimisation, quantification of radionuclides, packaging, local interim storage, and national repository storage for final disposal.

5.2 D&D Techniques and Technologies

D&D techniques and technologies to be adopted are standard industrial and radiological practices which include:

- radiation survey instruments.
- manual cutting devices.
- rigging equipment.
- polar crane.
- hand tools.
- PPE; and
- dosimetry badges.

These are detailed in Decommissioning Execution Plan (DEP's) which also provide step by step dismantlement sequences for each SSC.

5.2.1 DEP's

DEP's define the D&D process including safety risks and controls, waste considerations and the disassembly sequence for each item of equipment to be decommissioned. Each DEP has involved detailed planning provided by WHS, radiological and HIFAR subject matter experts as well as other key members of the project team. It includes:

- Estimates on the hours to complete the task,
- Identification of equipment to be used and
- Documentation of the likely radiological hazards, allowing dose optimisation.

The DEP's for the Phase A-I work are listed below:

- Ausans (ACS248150)

- MRSCD (ACS248151)
- Longpol (ACS248155)
- TAS (ACS248153)
- MRPD (ACS248152)
- Neutron Reflectometer (ACS248154)
- X193 (ACS248148)
- Rigs (ACS248149)
- HIFAR Control Room (ACS256348)
- Fuel Assembly Station (ACS256345)
- Silicon Transfer Flasks (ACS256347)
- Silicon Storage Blocks (ACS261237)
- Fuel Element Transfer Flasks (N1 & N2) (ACS261236)

Every DEP has undergone radiological and WHS risk assessment conducted by ANSTO's Systems Safety & Reliability.

D&D techniques that follow industry standard practice are identified in table 7 and described further in section 5.2.2

Table 7 D&D techniques

DEP & SSC's	D&D Techniques						
	Manual dismantling	Thermal Cutting	Shearing	Nibbling	Cold cutting	Pipe cutting	Angle grinding
AUSANS (ACS248150)	Y						
MRSCD (ACS248151)	Y						
Longpol (ACS248155)	Y						
TAS (ACS248153)	Y	Y			Y		
MRPD (ACS248152)	Y						
Neutron Reflectometer (ACS248154)	Y						
X193 (ACS248148)	Y		Y	Y	Y	Y	Y
Rigs (ACS248149)	Y		Y	Y	Y	Y	Y
HIFAR Control Room (ACS256348)	Y		Y	Y	Y	Y	Y
Fuel Assembly Station (ACS256345)	Y						
Silicon Transfer Flasks (ACS256347)	Y		Y				
Silicon Storage Blocks (ACS261237)	Y		Y				
Fuel Element Transfer Flasks (N1 & N2) (ACS261236)	Y		Y				

5.2.2 D&D Techniques

5.2.2.1 Manual dismantling

Manual dismantling techniques will be used when deconstructing SSC's. This generally includes unbolting and removing of equipment using the following:

- Various Lifting Aids (general) e.g. lifting jib, lifting slings and chains etc.
- Handtools (general)
- Working table (platform/ station)
- Manipulation jig(s)
- HIFAR Polar Crane

5.2.2.2 Thermal Cutting

Thermal cutting techniques will be used on some of the SSC's, this will employ the following tools:

- Guide rail to prevent hot cutting through TAS DU shielding preventing the release of airborne contamination.
- Plasma cutting equipment which can be used on stainless steel and carbon steel items of varied thicknesses up to 25mm such as tanks and large pipe sections.
- Oxy-fuel cutting equipment which can be used on the D&D of carbon steel items of varied thicknesses up to 75mm such as beam instrument shielding or seized bolts.

5.2.2.3 Shearing and Nibbling

Shearing and nibbling techniques will be used on a variety of materials with thicknesses up to 16mm with hydraulic, pneumatic and electric shears and nibblers.

5.2.2.4 Cold Cutting, Pipe Cutting and Angle Grinding

Cold cutting techniques will be used on a variety of material types wall thicknesses and items with varied geometries. These include:

- Jig Saw or Circular Saw.
- Pipe cutters – used for metal pipes with wall sections up to 12mm. This equipment can either be mounted in a stationary unit or via a mobile device for in-situ cutting operation.

- Angle grinders – battery, pneumatically or electrically powered.

5.2.2.5 Services

In support of the deconstruction techniques the follow services are available for use:

- *Compressed Air*

The RCB has a compressed air system that will be used for some operational cutting equipment and supply air for D&D activities. The compressed air system can also supply breathing air from filtered air stations.

- *Active Ventilation*

Activities within the RCB will utilise a continuously operating active ventilation system. Localised extraction hoods will assist in negating the spread of particulates and potential gaseous fumes and can be connected to the RCB active ventilation system where required. Additionally specialist, mobile fume extraction equipment will incorporate HEPA filters in series and will exhaust to or be directly connected to the active ventilation system by flexible ducting.

- *Breathing Air*

For D&D activities, (such as hot cutting) that require an air-mask/hood, filtered air will be supplied by either battery operated air hoods or the RCB's breathing air stations and will be used when deemed appropriate by operators, WHS or HPS/RPA's

- *HIFAR Polar Crane*

The HIFAR Polar Crane will be used for lifting and moving items within the RCB. The crane may be operated from a cab suspended from the bridge, or by remote pendant control.

5.2.3 Deconstruction and Decontamination Area

During decommissioning, areas will be configured within the RCB to facilitate the surveying, size reduction and decontamination of components. The areas will be designated as a Deconstruction Area or Decontamination Area depending on the principal work to be undertaken there.

5.2.3.1 Deconstruction Area (DA)

When required, a deconstruction area will be configured to facilitate the safe and ergonomic deconstruction of larger components. This area will be accessible by the polar crane, sufficiently monitored by the HIFAR ARM system and will be supplied with the required safety equipment and tools.

5.2.3.2 Decontamination Area (DCA)

A decontamination area will be set up within the RCB to facilitate the decontamination of items using the WMS instruction In Situ Decontamination (I-6418). This area will be serviced by the polar crane, breathing air stations, active ventilation, water supply and the B-line.

5.3 Ground, Surface Water and Subsurface Soil and Sediment

Phase A will only see the removal of peripheral plant and equipment within the RCB. The D&D activities of this phase are not expected to affect any ground, surface water, subsurface soil or sediment.

5.4 Decommissioning Release Criteria

The Waste Management Plan of the HIFAR Phase A Plans and Arrangements (ACS261210) outlines the resources, methods, and capabilities employed to ensure that all radioactive waste uncovered during Phase A D&D is managed in accordance with state and federal legislation.

Waste which does not meet 'Free Release' criteria will undergo further characterisation to identify its radiological characteristics for long term storage.

Secondary liquid waste generated during D&D activities will be processed and managed by ANSTO Waste Management Services.

5.5 Surveillance and Maintenance

The following surveillance and maintenance activities will continue to be performed and records of such activities will be kept:

- Maintenance of appropriate systems for physical protection commensurate with the risk entailed.
- Monitoring, surveillance and inspection, commensurate with the level of hazard as mentioned in the Safety Analysis Report supporting Phase A.
- Maintenance of essential equipment, such as equipment for ventilation, mechanical handling and monitoring.
- Maintenance of HIFAR and the barriers and/or containment structure; and
- Maintenance of records about the surveillance and maintenance activities performed.

5.6 Components Exempt from Schedule 1 Part 1 of the Regulations

In line with the DEPs and additional safety documents, the process to dispose of components exempt from licence will be:

- Undertake D&D activity (where the component is fixed or attached) without removing from HIFAR
- Surveyance of component by HPS.
- Complete further characterisation to identify if the component is exempt from Schedule 1 Part 1 of the Regulations
- Obtain a Radioactive Clearance Certificate (AF-2357)
- Obtain final clearance and disposal
- Dispose of the item from the RCB
- Update HCTMS
- Include components disposed of in the next quarterly report to ARPANSA.

5.7 Components of Phase A

The scope of Phase A is restricted to the components identified in Table 3. For a full description of their operational purpose, physical attributes and characterisation details refer to the HIFAR Characterisation Report (ACS187819).

6 WASTE MANAGEMENT PROGRAM

6.1 Identification of Waste Streams

Waste streams for HIFAR Phase A have been identified in the HIFAR Characterisation Project (ACS187819) according to their radiological inventory, composition and material makeup. These are described in the following sections.

6.2 Solid Radioactive Waste

Most of the waste generated from Phase A D&D will be solid waste. The Waste Management section of the HIFAR Safety Analysis Review (ACS248256) provides an overview of the expected volumes of LLW, ILW and Free Release solid waste with the total amount for each classification tabled in Table 8.

Table 8 TOTAL PACKAGED WASTE VOLUMES FROM PHASE A D&D ACTIVITIES

Total Volume	Packaged ILW (m^3)	Packaged LLW (m^3)	Free Release Waste (m^3)
HIFAR Phase A Decommissioning	Redacted	Redacted	Redacted

6.3 Liquid Radioactive Waste

All liquid waste will be dealt with in accordance with ANSTO WMS liquid waste procedures (P-6547) and will be discharged to the appropriate waste line or collected in suitable vessels for treatment at the waste operations facilities.

Most radioactive liquid wastes generated during decontamination activities is expected to be classified as low level.

During Phase A-II decommissioning activities, some very minor quantities of tritiated heavy water are expected to be found scattered through the primary cooling system (01 Circuit). A preliminary estimate of this liquid waste puts this to be 30L which would account for < 7 TBq of activity. Airborne releases of tritiated heavy water will be monitored locally using portable tritium monitors and at the facility level using the HIFAR stack monitoring system. The RCB internal air quality is monitored for tritium and particulates via a dedicated Tritium monitor.

6.4 Gaseous Waste

The HIFAR Characterisation Project identified minor tritium contamination within certain system circuits of HIFAR (ACS187819).

It is currently planned that tritium decontamination methods, such as heating within an environmental furnace or decontaminated via aqueous transfer will be assessed by ARPANSA under the planned future section 63 (Phase A-II) submission

If the environmental furnace method is chosen, tritium gas and tritiated water vapour will be extracted and will be routed to HIFAR's RCB active ventilation system as a planned release.

Tritium decontamination via aqueous transfer will be treated as secondary liquid waste, which can be measured, collected and dealt with in a controlled manner.

During D&D activities, plasma cutting techniques may be employed. Any fume generated from this technique will be filtered and ventilated via local extract into HIFARs existing active ventilation system.

6.5 Hazardous (Non-Radiological) Waste

Hazardous materials such as lead, lead based paints and other toxic heavy metal-based paints are known to have been used on surface finishes of many components. These will be disposed of at a purpose-built facility in accordance with NSW EPA requirements.

6.6 Clearance

Clearance of waste at ANSTO is divided into three main categories based on their physical form and emitted dose rate. Waste categorisations relevant to Phase A are contained in the HIFAR Phase A Plans and Arrangements (ACS261210) and are summarised below:

- Free Release waste – waste that meets the criteria for exemption or clearance (activity concentration and activities of radionuclides)
- Contact Handled radioactive solid waste – radioactive solid waste that is above the exemption levels and has a radiation contact dose **below** 2 mSv/hr.
- Remote Handled radioactive solid waste - radioactive solid waste that is above the exemption levels and has a radiation contact dose **above** 2 mSv/hr.

7 COST ESTIMATE

Content removed due to security reasons

7.1 Phased Funding

After discussing various options, in October 2018 the HIFAR Characterisation Project Team outlined the option of dismantling HIFAR in two phases with Phase A starting in 2020 and the future Phase B being completed in 2029.

The project recommended the multi-phased funding shown in Table 9.

Table 9 PROPOSAL FOR MULTI-PHASED FUNDING DECOMMISSIONING

Funding	Stage		Estimated Cost (inc Contingency)	Estimated Duration	Years
Phase A	1	Planning, DLA application and regulation 63 submissions	Redacted	2 years	2020
	2	Dismantling plant and equipment	Redacted	4 years	2026
		Phase A Cost Sub Total	Redacted		
Phase B	3	Planning and licencing for reactor block	Redacted	1.5 years	2026
	4	Dismantlement and waste packaging reactor block	Redacted	3.0 years	2029
	5	Remediation and licence handback	Redacted	0.5 year	2030
		Phase B Cost Sub Total	Redacted		
		Total	Redacted		

The Phase A project is well funded, with its estimate of REDACTED being derived from the IAEA CERREX-D costing model and approved by the ANSTO Board (14).

8 RADIATION PROTECTION

The planning for radiation protection during Phase A has been documented in the Radiation Protection Plan section of the HIFAR Phase A Plans and Arrangements (ACS261210). Key to this document are the primary principles of radiation protection, which are:

- Justification of Practice.
- Optimisation of Protection
- Dose Limitation.
- Defense in depth
- Safety culture (appropriate classification, PPE, monitoring programs)

These principles are discussed in detail in the HIFAR Phase A Radiation Protection Plan and have been drawn primarily from ANSTO's radiation protection documentation Radiation Safety Standard (AE-2310) and Radiation Safety Best Practice guide (AG-6288).

8.1 Local Expertise

ANSTO has an internal radiation protection service that is available to provide timely local expertise. Within the service are Radiation Protection Advisors (RPA) who will advise the project manager and team on radiation protection issues, safe working practices, relevant standards and the optimisation of operational radiation protection measures. They will also advise Health Physics Surveyors on areas of the worksite that require radiation monitoring surveys.

9 SAFETY ASSESSMENT

In all stages of Phase A, the workers, the public and the environment must be protected from hazards resulting from decommissioning activities.

9.1 Identification of Hazards and Initiating Events

Using the ANSTO's Safety Assurance Screening' form (AF-2322) it was determined that a safety control evaluation was required. This evaluation was conducted in accordance with ANSTO's 'Safety and Reliability Assurance (SRA) Process' (AP-1094).

During the evaluation, workshops were conducted on each of the DEP's to identify and document hazards and risks associated with the Phase A-I work. Safety assessments were conducted by ANSTO's Safety Systems and Reliability (SS&R) team in accordance with 'WHS Hazard Identification and Risk Assessment Guide' (AG-2390) and the associated 'Risk Analysis Matrix' (AG-2395) and looked at the following criteria:

- Safety during normal operations (planned radiological exposures & controls)
- Identified internal initiators leading to exposures
- Identified external initiators leading to exposures

A summary of the safety assessments for Phase A-I work are provided in Table 10:

Table 10 Summary of Safety Assessments

D&D Equipment	Safety Assessment	Summary
AUSANS	ANSTO/T/TN/ 2021-08 rev 0, October 2021 (ACS248162)	Dismantling and decommissioning of AUSANS beam instrument involves the dismantling of 21 interlocking blocks which formed the main shielding of the instrument. Shielding materials include lead, steel, borated paraffin wax, and borated rubber sheets. Other equipment to be removed include a rotating beam selector, collimator rig, monochromator, and a detector vessel.

		Identified potential safety hazards due to decommissioning activities are asbestos exposure, manual handling, electrical hazards, dropping of detector vessel and working at heights. These risks have been assessed as medium and all radiological events are low or very low. Dismantlement will be undertaken using various techniques/methods such as polar crane, exclusion zones, barricades, SWMES, dose monitoring and radiation monitoring on the active extract
MRSCD	ANSTO/T/TN/ 2021-09 rev 0, October 21 (ACS248163)	Dismantling and decommissioning of the MRSCD involves the dismantlement of the biological shield (principally consisting of three interlocking shield blocks and integrated plugs) and residual internal brackets which are constructed from steel, lead, and borated paraffin wax. Identified potential safety hazards due to decommissioning activities are exposure to asbestos, manual handling, electrical hazard and working at heights. These risks have been assessed as medium and all radiological events are low or very low. Dismantlement will be undertaken using various techniques/methods such as hand tools, polar crane, exclusion zones, barricades, SWMES, dose monitoring and radiation monitoring on the active extract
LONGPOL	ANSTO/T/TN/ 2021-12 rev 0 October 21, (ACS248167)	Dismantling and decommissioning of LONGPOL involves the dismantlement of the biological shield (principally consisting of four interlocking shield blocks and integrated plugs) and residual internal brackets. These components are constructed from steel, lead, and borated paraffin wax. Identified potential safety hazards due to decommissioning activities are exposure to asbestos, manual handling, electrical hazard and working at heights. These risks have been assessed as medium and all radiological events are low or very low.

		Dismantlement will be undertaken using various techniques/methods such as hand tools, polar crane, exclusion zones, barricades, SWMES, dose monitoring and radiation monitoring on the active extract.
TAS	ANSTO/T/TN/ 2021-10 rev 0, November 21 (ACS248165)	Dismantling and decommissioning of TAS involves the dismantlement of the biological shield (principally consisting of upper and lower interlocking shield blocks), monochromator plug, dummy collimator plug, axis drive rail and residual internal brackets. residual internal brackets. These components are constructed from steel, lead, borated paraffin wax, borated rubber sheets, and depleted uranium (DU). Identified potential safety hazards due to decommissioning activities are manual handling, electrical hazard, working at heights, slips, trips and falls, and physical injury during cold cutting and airborne DU inhalation. These risks have been assessed as medium and all radiological events are low or very low. Dismantlement will be undertaken using various techniques/methods such as hand tools, cold cutting, polar crane, exclusion zones, barricades, SWMES, dose monitoring and radiation monitoring on the active extract.
MRPD	ANSTO/T/TN/ 2021-13 rev 0 October 21, (ACS248164)	Dismantling and decommissioning of the MRPD involves the dismantlement of the biological shield (principally consisting of interlocking shield blocks and integrated plugs) and residual internal brackets which are constructed from steel, lead, and borated paraffin wax. Identified potential safety hazards due to decommissioning activities are manual handling, electrical hazard and working at heights. These risks have been assessed as medium and all radiological events are low or very low. Dismantlement will be undertaken using various techniques/methods such as hand tools, polar crane, exclusion

		zones, barricades, SWMES, dose monitoring and radiation monitoring on the active extract.
Neutron Reflectometer	ANSTO/T/TN/2021-11 rev 0 November 21, (ACS248166)	Dismantling and decommissioning of the Neutron Reflectometer involves the dismantlement of the biological shield (principally consisting of shield blocks, lead blocks, lead shot and integrated plugs) and residual internal brackets. These components are constructed from steel, lead, and borated paraffin wax. Identified potential safety hazards due to decommissioning activities are asbestos exposure, manual handling, electrical hazard and working at heights. These risks have been assessed as medium and all radiological events are low or very low. Dismantlement will be undertaken using various techniques/methods such as hand tools, polar crane, exclusion zones, barricades, SWMES, dose monitoring and radiation monitoring on the active extract
Uranium Analysis Rig	ANSTO/T/TN/2021-14 rev 0, November 21 (ACS248160)	Dismantling and decommissioning of the Uranium Analysis Rig involves the dismantlement of the biological shielding and sample transport tubing, measuring station, loading station and contamination filtration system. These components are constructed from steel, paraffin wax and lead. Identified potential safety hazards due to decommissioning activities are electrical hazard, working at heights, manual handling and slips, trips and falls. These risks have been assessed as medium and all radiological events are low or very low. Dismantlement will be undertaken using various techniques/methods such as hand tools, polar crane, exclusion zones, barricades, SWMES, dose monitoring and radiation monitoring on the active extract.

Rig Support Equipment	ANSTO/T/TN/ 2021-31 rev 0 November 21, (ACS248161)	Dismantling and decommissioning of the rig support equipment involves the dismantlement of the various control panels, loading stations, unloading stations, piping, active ventilation fans and ducting, delay stations, biological shielding, valves, and field instruments. These components are constructed of various materials including polymers, steal, lead and copper. Identified potential safety hazards due to decommissioning activities are electrical hazard, working at heights, manual handling, slips and trips and falls. These risks have been assessed as medium and all radiological scenarios are low inherent risks. Dismantlement will be undertaken using various techniques/methods such as hand tools, polar crane, exclusion zones, barricades, SWMES, dose monitoring and radiation monitoring on the active extract
Utilisation Equipment	ANSTO/T/TN/ 2021-32 rev 0 October 21 (ACS261238)	Dismantling and decommissioning of the utilisation equipment involves the dismantlement of the fuel element transfer flasks, fuel assembly station, silicon storage blocks, transfer flasks and the reactor control room. These items are constructed of various materials including polymers, steal, lead and copper. Identified potential safety hazards due to decommissioning activities are dropped load, manual handling, electrical hazard and working at heights. These risks have been assessed as medium and all radiological events are low or very low. Dismantlement will be undertaken using various techniques/methods such as hand tools, polar crane, exclusion zones, barricades, SWMES, dose monitoring and radiation monitoring on the active extract

9.2 Evaluation of Public Exposure During Decommissioning

The Decommissioning of HIFAR will have no adverse effect on the health of operating staff, other ANSTO employees or members of the public.

An evaluation of potential public exposure during decommissioning shows there are no credible events that could affect the safety of the public. There are, however, credible events that could affect the safety of personnel. With controls in place the residual risk of these events have been judged to be medium or lower.

9.3 Evaluation of Potential Exposures

As part of the risk assessments, potential exposures to both industrial and radiological hazards were considered and are described in the following sections.

9.3.1 Exposures to Industrial Hazards

Several hazardous scenarios have been identified and risk assessed. The bulk of the risks associated with Phase A work are industrial in nature.

The risks due to industrial hazard exposures are considered tolerable as these risks are controlled by good safety practice and procedures. Some of the potential industrial hazard exposures include but are not limited to:

- Exposure to asbestos.
- Dropping load while conducting lifting activities using the polar crane due to rope failure or mechanical fault:
    - During lifting the instrument and ancillaries.
    - During walkways floor lifting task.
- Manual handling, sprain injuries or strain due to lifting of heavy items or repeated actions or fatigue.
- Eye injury from power tools.
- Electric shock/ electrocution due to faulty tools and equipment.
- Electrocution due to damage to unknown electrical cables in the TAS instrument during dismantling.
- Exposure to high frequency noise due to use of dismantling equipment.
- Fall from heights

- Injury due to slip trip or fall caused by obstructions in the path or while using staircase to access the RCB.
- Seismic activity during equipment and instruments shielding removal.
- Burns from hot cutting activities.

9.3.2 Exposure to Radiological Hazard

A summary of some of the potential radiological risk during Phase A-I work are identified below. The analysis indicates that when controls are in place the risks are low to very low. There is potential for exposure with:

- Collimated gamma radiation when performing dismantling activities of equipment (TAS and AUSANS), from an open collimator shutter. However, the risk assessment identified that with appropriate administrative controls to ensure the shutter remains closed; the residual risk is considered low.
- Gamma radiation during removal and separation of the cup assembly from the FET Flask; if workers don't realise the presence of radiation while removing and separating the cup assembly. The residual risk from this work is considered low as there are radiation controls in place including: HPS, EPD's, and area radiation monitors to alert workers in the area.
- Contamination if it becomes airborne. However, with appropriate PPE, air sampling, health physics monitoring the residual risk is considered low.
- Radiological particles released during cutting activities. It has, however, been assessed that with controls such as positive pressure PPE, local ventilation, air sampling and health physics monitoring the residual risk is considered low.

10 ENVIRONMENTAL IMPACT ASSESSMENT

ANSTO's Environmental Policy (AB-7100) outlines the importance of meeting the highest environmental protection standards. This is demonstrated in ANSTO's achievement and commitment to ISO 14001, the international standard for designing and implementing an environmental management system. This certification is implemented by ANSTO's Environmental Monitoring Group a key part of which is the Environmental Monitoring Program which looks after important programs such as:

- ANSTO's stack monitoring system
- Environmental gamma monitoring system

- Soil, groundwater & stormwater monitoring
- Weather monitoring
- Analytical services (gross alpha/ beta, tritium and gamma activity in environmental samples)

Further to this, ANSTO collaborates and shares information openly with the public and regulatory authorities such as

- NSW Environmental Protection Authority (NSW EPA)
- Australian Radiation Protection and Nuclear Safety Agency (ARPANSA).
- Sydney Water Corporation

In accordance with the EPBC Act 1999 (7) the HIFAR Project has undertaken a self-assessment of the potential impact of HIFAR Phase A decommissioning to the environment. Due to the containment systems currently in place and the limited amount of waste that will be produced, preliminary self-assessment indicates the environmental impact from decommissioning of HIFAR will be very low and is unlikely to require any further environmental assessment and controls.

The self-assessment will be submitted to Department of Agriculture Water and Environment (DAWE) for their review to determine if further action is required i.e (Environmental Impact Statement EIS).

11 EMERGENCY PLANNING

Details of the Emergency arrangements are covered off in the Emergency Planning Section of the HIFAR Phase A Plans and Arrangements. (ACS261210)

The Emergency Plan covers:

- ANSTO's Organisational Emergency Plans
- Local Emergency Plans relevant to HIFAR
- Emergency Procedures, and
- Emergency Preparedness

12 PHYSICAL PROTECTION AND SAFEGUARDS

HIFAR's physical protection measures and safeguards are commensurate with the associated threat level. These protections and safeguards remain largely unchanged since it's time as an operating reactor.

12.1 Physical Protection

ANSTO's Lucas Height's campus is a secure facility with entry and exit controlled by the AFP.

Content removed due to security reasons

12.2 Security Plans an Arrangements

The measures taken to ensure physical protection are documented in the Security Plan of the HIFAR Phase A Plans and Arrangements (ACS261210). These plans provide instructions for the management of security-related risk at HIFAR, taking into consideration: regulatory compliance requirements, the Australian Government's Protective Security Policy Framework, administrative and physical controls and barriers to ensure that control is not relinquished or improperly transferred.

12.3 Nuclear Material and Safeguard

Shortly after the reactor was permanently shutdown in 2007, the reactor fuel was fully unloaded, heavy water drained and, coarse control arms removed. The items remaining in HIFAR that are registered as safe guarded materials are:

- Content removed due to security reasons
- Content removed due to security reasons

13 SUMMARY

This plan describes the Phase A decommissioning of HIFAR which will be split into Phase A-I, A-II and A-III.

This will require three submissions including the decommissioning licence application and two requests for approval under Section 63 of the ARPANS Regulation 2018 (4):

1. **Licence application Phase A-I**: D&D of the Utilisation equipment, Neutron beam instrument and Irradiation rig support equipment.
2. **Section 63 Phase A-II**: D&D of the main reactor ancillary circuits.
3. **Section 63 Phase A-III:** D&D of the items stored in the No.1 Storage block

As the section 63 submissions for phase A-II and A-III will each require their own respective safety assessments; this plan only includes the summaries of safety assessments for phase A-I which can be found in section 9.

This decommissioning plan has been produced in accordance with ARPANSA Regulatory Guide for Decommissioning Controlled Facilities. (13)

14 DEFINITIONS

Term	Meaning
AME	ANSTO Maintenance and Engineering
ANSTO Chief Nuclear Officer.	The Chief Nuclear Officer group aims to work collaboratively to support ANSTO's strategy and the underpinning operational imperatives for safety, security, sustainability, accountability, diversity and inclusion and governance, to allow the benefits of ANSTO's activities to be realised in a safe and compliant manner.)
ARPANS	Australian Radiation Protection and Nuclear Safety Regulations
AUSANS	Australian Small Angle Neutron Scattering Instrument
B-line	The B-line is part of the Lucas Heights wastewater system that pipes liquid from active drains in laboratories where radioactive materials are routinely handled.
Controlled Apparatus	A Controlled apparatus (ionising) is an apparatus that produces ionising radiation when energised or that would, if assembled or repaired, be capable of producing ionising radiation when energised; or an apparatus that produces ionising radiation because it contains radioactive material.
Controlled Material	Controlled material means any natural or artificial material, whether in solid or liquid form, or in the form of a gas or vapour, which emits ionising radiation spontaneously.
Characterisation Group	A group of HIFAR components that have relatively homogenous attributes and share a common radiological history.
Co-60	Cobalt-60
D&D	Decommissioning and Dismantlement
D2O	Deuterium oxide
DEP	Decommissioning Execution Plans
DIDO class	Class of nuclear reactors that used deuterium oxide as primary coolant and neutron

Term	Meaning
EPD	Electronic Personal Dosimeter
Exempt	Short for Exempt Dealings which have nine stipulations in the ARPANS 2018 Regulations (15)
Facility Officer	Accountable for the budget and outcomes of a project
FAS	Fuel Assembly Station
FETF	Fuel Element Transfer Flask
Free Release	The process of exemption or clearance, used to classify waste as “Free Release Waste”
Free Release Waste	Waste that meets the criteria for exemption or clearance (activity concentration and activities of radionuclides)
HCTMS	HIFAR Component Tracking Management System
HIFAR	High Flux Australian Reactor
HIFAR Licence Nominee	A Nominee is identified under the licence to ensure an appropriate delegation of the authority and responsibility and thus ensure that licence conditions and other legal duties are complied with. The Nominee appoints a Licensing Officer and Facility Officer (for a facility) and provides oversight and management of regulatory compliance
HIFAR Licensing Officer	The Licensing Officer (LO) carries out tasks as outlined in the Plans and Arrangements for the specific LO role as appropriate.
HIFAR Phase-A Project Team	Group of staff with varying roles tasked with delivering HIFAR Phase A project
HWP	Head Wrightson Processes
IAEA	International Atomic Energy Agency
ILW	Intermediate Level Waste
LLW	Low Level Waste
LONGPOL	Long Wavelength Polarisation Spectrometer Instrument
MRPD	Medium Resolution Particle Diffractometer

Term	Meaning
MRSCD	Medium Resolution Single Crystal Diffractometer
NRWMF	National Radioactive Waste Management Facility
OPAL	Open Pool Australian Light water Reactor
Options study	Review of possible options to consider before making a decision
PorC	Possess or Control
Project Manager	Accountable for the budget and outcomes of a project
Project Responsible Officer	Accountable for the delivery of the project
RCB	Reactor Containment Building
Residual risk	The assessed risk level once controls are in place
Safe enclosure	Term to describe a prolonged period (usually years) between routine operations or leading to decommissioning of the facility
Section 63	Request for approval to make a change with significant implications for safety
SAR	Safety Analysis Report
SRA	ANSTO Safety and Reliability Assurance
TAS	Triple Axis Spectrometer

15 REFERENCES

1.	Hart et al. *Options Study for The Decommissioning Of HIFAR,* May 2005. Available from (ACS270320)
2.	ANSTO. Activities to be Undertaken in the HIFAR Facility During the Possess and Control Period (HIFAR Facility Licence Application Part E. Document ANSTO/06/749/5), rev 1. February 2008. Available from: ACS100993
3.	Commonwealth. *Australian Radiation Protection and Nuclear Safety Act,* https://www.legislation.gov.au/Details/C2016C00977, 1998
4.	Commonwealth. *Australian Radiation Protection and Nuclear Safety Regulations* , https://www.legislation.gov.au/Series/F2018L01694, 2018
5.	Commonwealth. *Nuclear Non-Proliferation (Safeguards) Act*, https://www.legislation.gov.au/Details/C2012C00394 1987
6.	IAEA. *Convention on the Physical Protection of Nuclear Material, Convention on the Physical Protection of Nuclear Material*, 2005
7.	Commonwealth. *Environment Protection and Biodiversity Conservation Act*, subsection 22, https://www.legislation.gov.au/Details/C2014C00506 1999
8.	NSW. *Protection of the Environment Operations Act* No 156, https://legislation.nsw.gov.au/view/html/inforce/current/act-1997-156 1997
9.	NSW. *Radiation Control Act* , https://legislation.nsw.gov.au/view/whole/html/inforce/current/act-1990-013#:~:1990
10.	Argonne National Laboratory (ANL) and Oak Ridge Associated Universities (ORAU)Decommissioning Certification Program, https://www.orau.org/ptp/decomcert/index.htm, n.d
11.	Marsame. Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual (MARSAME), Supp. 1, EPA 402-R-09-001, DOE/HS-000, https://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1575/supplement1/sr1575s1.pdf Jan 2009
12.	Commonwealth. Dept Industry Innovation and Science Preliminary Safety and Waste Acceptance Report of the National Radioactive Waste Management Facility. https://www.industry.gov.au/sites/default/files/2019-09/nrwmf-preliminary-safety-and-waste-acceptance-report.pdf July 2018

13.	ARPANSA Regulatory Services, REGULATORY GUIDE: Decommissioning of Controlled Facilities, https://www.arpansa.gov.au/sites/default/files/draft_for_stakeholder_comment_-_reg_guide_decommissioning_of_controlled_facilities.pdf n.d
14.	CERREX-D2_Cost Estimation for Research Reactors in Excel; IAEA project DACCORD-2
15.	*ARPANS Regulations 2018* (Cth) pt V div 2. https://www.legislation.gov.au/Details/F2021C00746

Appendix A: Codes of Practice, Procedures and Guides

NSW Govt Codes of Practice

a)	Safework NSW Code of Practise Construction Work, https://www.safework.nsw.gov.au/__data/assets/pdf_file/0014/52151/Construction-work-COP.pdf, August 2019
b)	Safework NSW, Code of Practice Hazardous Manual Task, https://www.safework.nsw.gov.au/__data/assets/pdf_file/0020/50078/Hazardous-manual-tasks-COP.pdf, May 2022
c)	Safework NSW, Code of Practise How-to-manage-and-control-asbestos-in-the-workplace https://www.safework.nsw.gov.au/__data/assets/pdf_file/0014/50081/How-to-manage-and-control-asbestos-in-the-workplace-COP.pdf Aug 2019
d)	Safework NSW, Code of Practise How-to-manage-work-health-and-safety-risks https://www.safework.nsw.gov.au/__data/assets/pdf_file/0012/50070/How-to-manage-work-health-and-safety-risks-COP.pdf Aug 2019
e)	Safework NSW, Code of Practice Managing-electrical-risks-in-the-workplace https://www.safework.nsw.gov.au/__data/assets/pdf_file/0010/50230/Managing-electrical-risks-in-the-workplace-COP.pdf Aug 2019
f)	Safework NSW Code of Practice, Managing-the-risk-of-falls-at-workplaces, https://www.safework.nsw.gov.au/__data/assets/pdf_file/0018/50076/Managing-the-risk-of-falls-at-workplaces-COP.pdf Aug 2019
g)	Safework NSW, Code of Practise Managing-the-risks-of-plant-in-the-workplace https://www.safework.nsw.gov.au/__data/assets/pdf_file/0019/52156/Managing-the-risks-of-plant-in-the-workplace-COP.pdf Aug 2019
h)	Safework NSW Code of Practise Work-health-and-safety-consultation,-cooperation-and-coordination, https://www.safework.nsw.gov.au/__data/assets/pdf_file/0013/50071/Work-health-and-safety-consultation,-cooperation-and-coordination-COP.pdf Aug 2019

ANSTO Procedures and guides

i)	ANSTO, AG6685 – Construction Safety, https://staff.ansto.gov.au/cs/groups/anstoall/@ctrldoc/documents/controlled_doc/mdaw/mdgx/~edisp/acs081510.pdf Feb 2016
j)	ANSTO, AG2467 – Risk Management of hazardous manual tasks, https://staff.ansto.gov.au/cs/groups/anstoall/@ctrldoc/documents/controlled_doc/mdaw/mdyw/~edisp/acs060575.pdf July 2019
k)	ANSTO, AP-2522, Risk Management of Asbestos (Asbestos Management Plan), https://staff.ansto.gov.au/cs/groups/anstoall/@ctrldoc/documents/controlled_doc/mdaw/mdyw/~edisp/acs060516.pdf June 2019
l)	ANSTO, AG-2058 Work Health and Safety Training Handboo khttps://staff.ansto.gov.au/cs/groups/anstoall/@ctrldoc/documents/controlled_doc/mdaw/mdyw/~edisp/acs060450.pdf Sept 2018

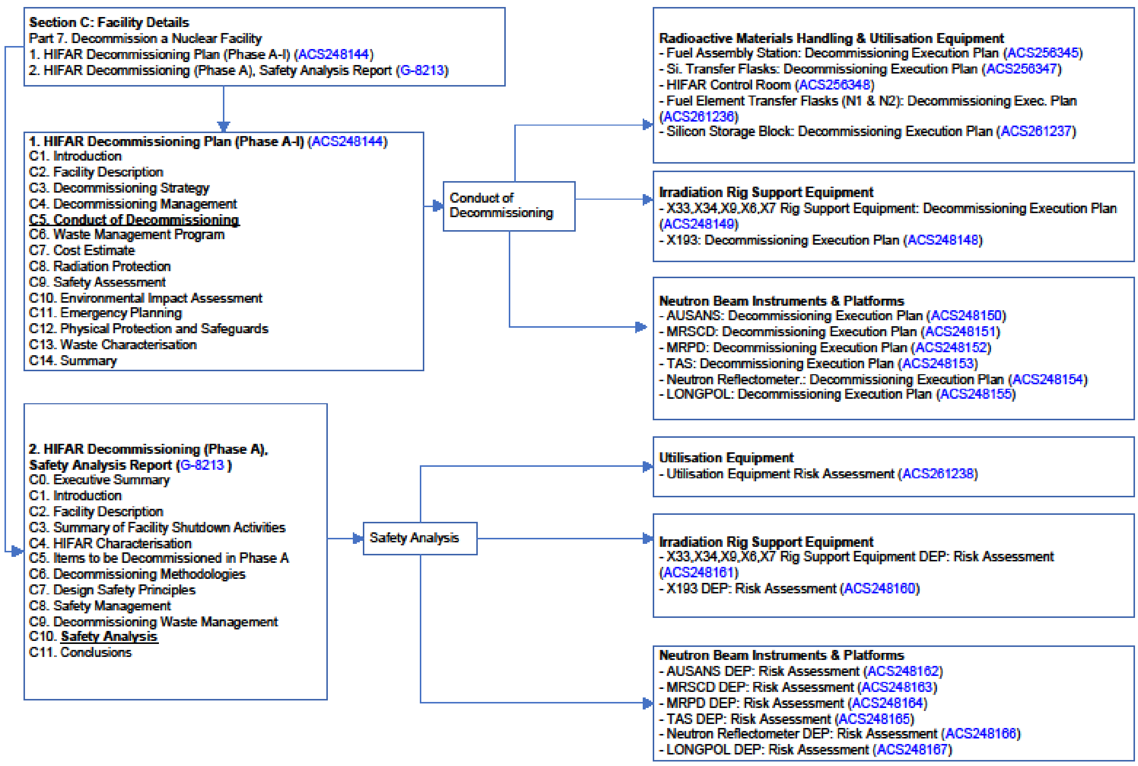
m)	ANSTO, AG-2304 Electrical Safety Guide https://staff.ansto.gov.au/cs/groups/anstoall/@ctrldoc/documents/controlled_doc/mdaw/mdyw/~edisp/acs060530.pdf Feb 2020
n)	ANSTO AG2406 – Safe Work at Heights, https://staff.ansto.gov.au/cs/groups/anstoall/@ctrldoc/documents/controlled_doc/mdaw/mdyw/~edisp/acs060589.pdf Sept 2021
o)	ANSTO, AG-2493, Plant Risk Management Process, https://staff.ansto.gov.au/cs/groups/anstoall/@ctrldoc/documents/controlled_doc/mdaw/mdyw/~edisp/acs060614.pdf
p)	ANSTO, AB-0002, Work Health, Safety Community & Environment Policy http://cdn.ansto.gov.au/acs/ACS265399/Latest/Web, June 2021
q)	ANSTO, AE-2310, Radiation Safety Standard, http://cdn.ansto.gov.au/acs/ACS060620/Latest/Web, Sept 2021
r)	ANSTO, AG-6288, Radiation Safety Best Practice guide, https://staff.ansto.gov.au/cs/groups/anstoall/@ctrldoc/documents/controlled_doc/mdaw/mdyy/~edisp/acs062317.pdf April 2019

Appendix B: Lucas Heights Campus Aerial Image

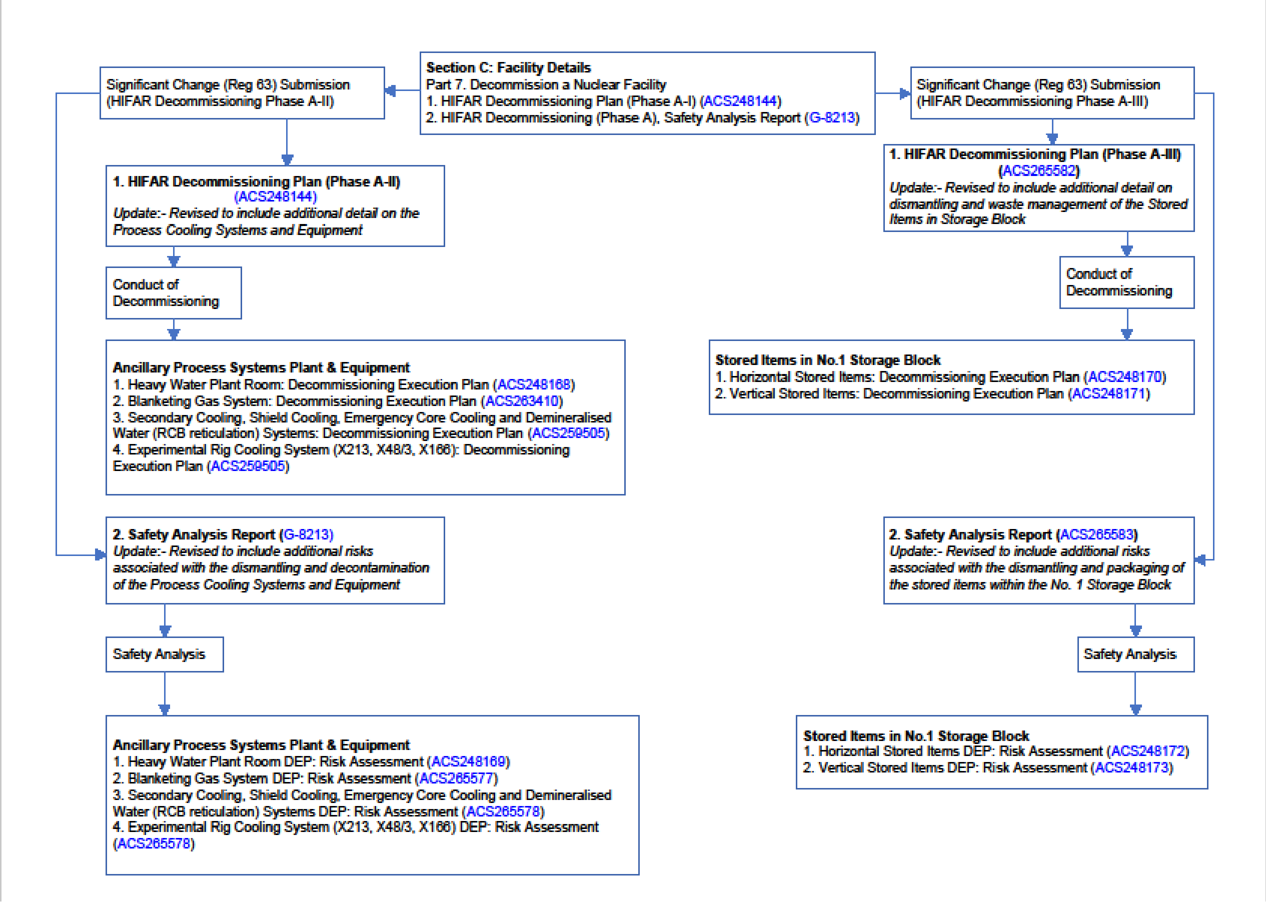
Lucas Heights Campus Aerial Image

Content removed due to security reasons

Appendix C: Facility Licence Overview of Phase A-I Submission



Appendix D: Section 63 Overview of Phase A-II & Phase A-III Submissions



Appendix E: HIFAR Floor Plans

Content removed due to security reasons

Appendix F: Location of HIFAR Building

LOCATION OF HIFAR BUILDINGS

Content removed due to security reasons