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HIFAR Facility Licence Application Part C

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HIFAR FACILITY SAFETY ANALYSIS REPORT FOR THE POSSESS AND CONTROL PERIOD

(rev. 0)

Prepared By

Australian Nuclear Science and Technology Organisation

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EXECUTIVE SUMMARY

This Safety Analysis Report examines the safety of the HIFAR Facility during the period that the Possess or Control licence remains in force. This period is known as the Possess and Control period. It includes ongoing maintenance and upkeep of the facility, dismantling and removal of redundant[1] facilities and equipment outside the Reactor Building as well as dismantling, screening/clearance and removal of non-active and low activity equipment within the Reactor Building. It also includes installation of replacement systems, such as electrical power supplies, air conditioning and fire detection.

Given that the fuel elements and D_2O have been removed from the Reactor Building, the vast bulk of the hazards have also been removed. There are no criticality issues. What remains is a building that contains a number of active items that emit radiation and some tritium.

The former Engineered Safety Provisions (safety systems) for HIFAR (which were crucial during operation) are either not required at all, or now protect against only minor hazards affecting staff in the building at the time. In the event of a failure of the ventilation system, lighting or another system, there are no tasks that will take place that cannot be readily suspended until the services are restored. Furthermore, failure of the safety support systems will not produce immediate risks to personnel inside or outside the Reactor Building.

The location is secure, being inside the Lucas Heights Science and Technology Centre (LHSTC) fenced area and having electronic access control.

The major activities that are planned to occur during the period that the Possess or Control period remains in force include:

- Installation of a new power supply and removal of the old power supply, including backup generators, switchboards and cabling;
- Installation of new fire detection system and removal of the old system;
- Installation of new air conditioning system and removal of the old space conditioning system;
- Replacement of the air lock doors with lightweight doors suitable as fire exits;
- Reduction in security requirements for entering the Reactor Building;
- Installation of additional shielding on Reactor Top Plate and blocking beam lines;
- Removal of the cooling towers and ponds;
- Removal of the Emergency Control Room;
- Removal of the AUSANS system;
- Removal of pneumatic conveyor systems, including the “bridge” connection to Building 23;
- Removal of control room instruments and rig controls;
- Removal of the Containment Isolation System;
- Removal water cooling and treatment system for Storage Block No. 1;
- Removal of the secondary cooling circuit;
- Removal of redundant steel structures; and
- Removal of HIFAR protection signal system.

Each project undertaken during the Possess and Control period will be assessed using the ANSTO Risk Assessment protocols. This requires that an assessment is made to identify hazards and hazardous scenarios and assess the associated risks to ensure that the control measures are adequate. For most projects this will involve preparation of a SAC submission, but some very minor projects may be assessed using Safe Working Method Statements or similar, in accordance with the OHSE Safety Approvals System.

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[1] Active usually means radioactive in this document

Where the projects are subject to ARPANS Regulation 51 provisions, a submission will be made to ARPANSA. Projects that are subject to ARPANS Regulation 52 will be reported quarterly in accordance with that Regulation.

There will be no dismantling activities associated with the reactor block, Storage Block No. 1, the plant room or the 01 or 02 circuits during the Possess and Control period. Furthermore, no dismantling will be undertaken that will generate sizeable quantities of radioactive waste.

In addition to the preliminary dismantling and refurbishment activities to be undertaken, ANSTO will also undertake characterisation of the nuclide inventory in the HIFAR Facility, including the reactor and Storage Block No. 1. A preliminary report and plan [1] will be prepared shortly early in the period of the Possess and Control licence, while the full characterisation report will be produced during the period that the Possess or Control licence remains in force and submitted as part of the decommissioning licence application.

The operating history of HIFAR shows that the doses to personnel during normal operations and during major shutdowns can be managed effectively. The monthly doses to personnel undertaking the preliminary dismantling and refurbishment projects are expected to be less than the doses received during major shutdowns.

The review of decommissioning reports from DIDO and PLUTO in the UK shows that the HIFAR Facility can safely undergo preliminary dismantling followed by a period of Safe Enclosure prior to final dismantling.

The systems used at ANSTO to manage occupational safety, radiation doses and control modifications to equipment and facilities are appropriate for the activities to be undertaken in the Possess and Control period including the preliminary dismantling and refurbishment projects. The existing site emergency arrangements and the specific HIFAR emergency procedures are appropriate for the hazards and risks present.

The systems developed for management of waste that will be produced during the preliminary dismantling and refurbishment phase are able to ensure that all waste will be accurately classified and records kept of the disposal route. There will be very minor quantities of liquid waste produced and the only significant airborne waste will be tritium gas released over time from the graphite reflector as well as Tritium vapour released from the drained 01 circuit and the 02 circuit. The tritium gas and vapour will be extracted, filtered to remove any particulates and discharged through the stack 15A on the top of Building 15. The emission of tritium is expected to be well below the current notification levels set by ARPANSA. The notification levels correspond to the ALARA dose objective when emitted for all nuclides from all stacks on the LHSTC site.

The safety analysis identified the Reference Accident for the facility to be the accidental removal of the shield plug for the most active component in Storage Block No. 1. The consequences of this accident would result in significant vertical radiation shine plus minor radiation exposure to people located on the ground or in buildings outside the Reactor Building. Thus the hazard classification for the HIFAR Facility is F1: “No potential for significant consequences outside the facility” [2].

The analysis shows that the overall concept for preliminary dismantling and refurbishment can be undertaken without undue risks to people or the environment. The ANSTO Safety Approval process and the safety management systems are appropriate to manage each of the individual activities to be undertaken during the Possess and Control period.

CONTENTS

GLOSSARY

The acronyms and terms included in this glossary have predominantly been taken from the HIFAR Definitions document [3].

ACRONYMS

ALARA	As Low As Reasonably Achievable
ALI	Annual Limit of Intake
ANSTO	Australian Nuclear Science and Technology Organisation
APR	Auxiliary Plant Room
ARI	ANSTO Radiopharmaceuticals and Industrials
ARPANS Act	Australian Radiation Protection and Nuclear Safety Act 1998
ARPANS Regulations	Australian Radiation Protection and Nuclear Safety Regulations 1999
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
ASNO	Australian Safeguards and Non-Proliferation Office
AUSANS	Australian Small Angle Neutron Scatterer
B	Building, e.g., B15, B40
CCA	Coarse Control Arm
CIS	Containment Isolation System
DPR	D_2O Plant Room
DAC	Derived Air Concentration
DAS	Data Acquisition System
DL	Dose Limit
DP	Differential Pressure (gauge)
DU	Depleted Uranium
ECCS	Emergency Core Cooling System
ECR	Emergency Control Room
EPD	Electronic Personal Dosimeters
EPR	Experimental Plant Room
EPSS	Electrical Power Supply System
FIP	Fire Indicator Panel
FMAH	Fuel Management and Active Handling Section
HIFAR	High Flux Australian Reactor
HSD	HIFAR Safety Document
ILW	Intermediate Level Waste
LHSTC	Lucas Heights Science and Technology Centre
LLW	Low Level Waste
OHSE	Occupational Health, Safety and Environment
OLC	Operational Limits and Conditions
PAL	Personnel Air Lock

RAT	Reactor Aluminium Tank
RCR	Reactor Control Room
RPS	Reactor Protection System
RST	Reactor Steel Tank
SAC	Safety Assessment Committee
SB1	Storage Block No. 1
SCADA	Supervisory Control and Data Acquisition
SCC	Site Control Centre (B53)
SCS	Space Conditioner System
SMA	Safety Monitoring Assemblies
SOSS	Site Operations Safety Supervisor
SWMS	Safe Work Method Statement
SWP	Safe Working Permit
TLD	Thermoluminescent Dosimeter
TSFM	Technical Services and Facilities Management
VAL	Vehicle Air Lock
VESDA	Very Early Smoke Detection and Alarm
WO	Waste Operations (section within Safety and Radiation Services)

TERMS

Active

Active usually refers to radioactive in this document, with some exceptions that refer to non-passive protection systems.

Abnormal Occurrences

Events that could cause, or have the potential to cause, deviations from normal operations that may have an adverse effect on the safety of the facility.

Acceptance Criteria

Acceptance criteria include ALARA levels, dose limits for radiation workers, contractors and the general public and release limits into the environment. They also include the annual effective dose equivalent limits, as set out in the ARPANS Regulations that must not be exceeded during normal operation and following accidents.

Accident Conditions

Abnormal occurrences that could lead to the exposure of operating personnel or members of the public to ionising radiation in excess of the acceptance criteria if the relevant protective features, including operator intervention, do not function in accordance with the design intent.

Controlled Facilities

Those facilities identified by the ARPANS Act as being controlled facilities and thus subject to the Act and its associated Regulations. See the definition in ARPANS Act.

Deferred dismantling

The strategy in which parts of a facility containing radioactive contaminants are either processed or placed in such a condition that they can be safely stored and maintained until they can subsequently be decontaminated and/or dismantled to levels that permit the facility to be released for unrestricted use or with restrictions imposed by the regulatory body [14].

Facility Officer

Are nominated by the General Manager/Institute Head to be responsible for the safe operation and maintenance of a Controlled Facility in accordance with the ANSTO Safety Management System, the licensing conditions placed on it by ARPANSA and any other relevant standards and legislation. Facility Officers are responsible for ensuring that the internal safety documentation relating to the operation of the facility is maintained and reviewed as necessary.

Fuel Management and Active Handling

The Fuel Management and Active Handling team (FMAH) manage the movements of new and spent fuel elements on site as well as working on active materials in the B41 hot cells.

Nominee

The officer taking overall responsibility for the facility as defined in Section 5.2 of ANSTO Safety Directive 2.1 - "Safety Review and Approval System".

Limits and conditions

A set of rules which set forth parameter limits, the functional capability and the performance levels of equipment and personnel approved by the regulatory body for the safe operation of the facility.

Possess and Control period

The period for which a Possess or Control licence remains in force.

Protective Systems

Those systems provided to protect the facility against identified hazards. They generally include the fire protection system and the security access system.

Safe Enclosure

A strategy in which a facility is placed into a safe condition and in which decontamination and dismantling are delayed for a period of some years (known as the safe enclosure period).

Safe Operating Envelope

The envelope of operating conditions within which it is safe to operate the plant. The boundaries of the safe operating envelope are the Limits and conditions.

Safety Analysis Report

Presents the “safety case” for a facility in a single document and documents the safety assessment. It is a living document that is subject to continuous revision throughout the life of the facility.

Safety Case

The complete “case” for the safety of the facility. The Safety Case includes the Safety Analysis Report together with all the referenced material, all drawings, procedures, instructions, hazard identification studies, facility logs, safety analyses, training records, training programs, training material, and any other records kept that may have a bearing on the safety of the facility.

SAR Coordinator

The SRS officer allocated to that facility in order to facilitate the preparation of the SAR and coordinate its safety assessment.

1. INTRODUCTION

1.1 BACKGROUND

HIFAR, the High Flux Australian Reactor has reached the end of its operational life and was shutdown on 30 January 2007. ANSTO has adopted a strategy of deferred decommissioning. To undertake this, some preliminary dismantling of inactive systems and the refurbishment of some other systems is required. This will be followed by a period of Safe Enclosure with ongoing maintenance, surveillance and control.

A Possess or Control licence is sought to cover the preliminary dismantling, refurbishment of systems appropriate for the Safe Enclosure period and ongoing maintenance and control throughout the remainder of the Safe Enclosure period.

This Safety Analysis Report assesses the proposed safety systems and procedures for the period that this licence remains in force. It describes the safety management during this period and examines the activities to be undertaken in the facility against relevant criteria and assesses the risk to the public, the workforce and to the environment.

1.2 REPORT STRUCTURE

Section 1 (this introduction) describes the document purpose, scope, and limits. A brief overview of the role of the facility and its interfaces with other facilities is also included. Section 2 outlines the site characteristics and Section 3 provides a description of the facility. Section 4 details the major activities to be undertaken during the Possess and Control period and outlines the philosophy for the overall plan; Section 5 reviews the relevant operating experience of the facility. Section 6 examines reports from other sites that have been decommissioned or are in Safe Enclosure and Section 7 reviews the safety management system for the facility. Section 8 considers the management of wastes arising from operations of the facility. Section 9 provides estimates of the doses to the operators that will occur during this phase of the plan. Section 10 assesses the risk to the operators, the public and the environment of the facility and demonstrates the acceptability of the proposed activities.

1.3 PURPOSE/ OBJECTIVES

This Safety Analysis Report, which summarises and references safety management documentation and safety analysis, has been prepared to provide the management of the facility with information necessary to assess the safety of the facility during the period that this licence remains in force.

This Safety Analysis Report forms one part of an application to the ARPANSA for a licence authorising ANSTO to Possess and Control the facility. Through the ARPANSA licensing process, ARPANSA is requested to approve the overall preliminary dismantling, refurbishment and storage plan, based on the assessments performed and information provided in this Safety Analysis Report and other supporting documentation.

1.4 SCOPE

This subsection specifies the limits of the document, defines what is (and what is not) covered by the Safety Analysis Report, includes plant boundary limits, and defines the interface responsibility for transfers of process materials between this facility and other facilities on site.

This report is for the period that this licence remains in force. This report includes the preliminary dismantling of items from the HIFAR Facility, both within and outside the Reactor Building and refurbishment of systems including installation of new lighting and ventilation systems and also includes the period of Safe Enclosure to allow for some decay of radionuclides to occur. This report does not include the final dismantling activities such as removal of the HIFAR Facility reactor block, 01 and 02 circuits, plant room, storage block No. 1 and the Reactor Building. These will be undertaken in a decommissioning phase to be undertaken under a licence following the Possess and Control phase.

This Safety Analysis Report covers all ANSTO activities related to the HIFAR Facility. Furthermore, this SAR covers all aspects of safety because it is the prime document for demonstration of safety through the ANSTO internal safety assessment and approval process, in addition to being a supporting document for licensing purposes.

Areas covered by this Safety Analysis Report are:

- The Reactor Building including
  - The Reactor Block
  - No. 1 Storage Block (SB1)
  - All other equipment within the Reactor Building
  - The active and standby ventilation systems
- The Emergency Control Room (ECR)
- The Auxiliary Plant Room (APR)
- The cooling towers
- The Electrical Power Supply System (EPSS)
- Water supply and treatment facility associated with the facility,
- Compressed air supply,
- Hydraulic systems,
- Connections to liquid waste delay tanks,
- Solid waste collection locations, and
- Maintenance areas in B17 and B42 and associate storage areas.

This facility SAR covers facility specific information. General information common to the ANSTO Lucas Heights site is contained in Site Description and Arrangements (ANSTO 2001).

The following facilities and operations are NOT included in this Safety Analysis Report:

- Movements of material outside the facility, where responsibility is transferred to another group on site,
- B41 activities and equipment, including Storage Block No. 2,
- Activities associated with final closure that were undertaken under the operating licence,
- Activities after the change in state of the HIFAR Facility from Possess and Control period to final decommissioning,
- The overall site waste management issue of spent fuel. Waste arising from the facility is limited to waste generated within the facility itself, for example, used ion exchange resin from the demineralisation circuit.

1.5 INTERFACES

This section identifies interfaces between this facility and other activities. For the sake of simplicity, the interfaces have been defined at the edge of buildings wherever possible. This enables the physical interfaces to be clearly defined. The interfaces have been grouped into organisational interfaces, equipment interfaces, facility interfaces and service interfaces.

Organisational interfaces:

- Activities in the Reactor Building, including No 1 Storage Block are under the direct control of Technical Services and Facilities Management.
- The active waste storage and treatment operations are undertaken by Waste Operations (WO). Once material is transferred from the HIFAR Facility and accepted by WO personnel, it is no longer the subject of this SAR.

- The storage and cropping ponds in B41 and B23C are under the control of Fuel Management and Active Handling (FMAH). Once material is transferred from the HIFAR Facility and accepted by FMAH personnel it is no longer the subject of this SAR.
- Safety and Radiation Services provides specialist dosimetry expertise and health physics support.

Equipment interfaces:

- The various flasks that were used in the operations of HIFAR, predominantly for fuel handling, will be included in this SAR when under the control of the HIFAR Facility management.
- The retrievable bin waste flasks (drawing A0E 63760 section A-A) are used for the transfer of waste items out of the HIFAR Facility to other storage or treatment facilities. When under the control of the HIFAR Facility personnel, the retrievable bin waste flasks are included in the SAR.
- Items of equipment may be removed from the HIFAR Facility during preliminary dismantling and refurbishment and stored on site before being recycled or sold. While they are under the control of the HIFAR Facility, they are included in this SAR.
- The outside of the VAL and the personnel airlocks are the primary equipment interfaces to the Reactor Building.

Facility interfaces:

- The HIFAR Facility Vehicle Air Lock provides an interface between the HIFAR Facility and B41 facilities.
- The designated solid waste collection point in the General Storage Area of B41 provides an interface between the HIFAR Facility and Waste Management.
- The liquid waste interface is at the end of the lines that flow to the north delay tank located to the north of the Reactor Building and the end of the lines that flow to the south delay tank located beside the emergency control room.
- The sewerage system interface is where the pipes leave the Reactor Building.
- The services' interfaces to the facility, such as water, are located where the pipelines enter the Reactor Building.

Service interfaces:

- Electrical power supply is provided from dedicated systems, including distribution boards and emergency supply diesel generators. The electrical interface is at connection at the substation.
- A compressed air supply is provided using two compressors in the Auxiliary Plant Room. In addition, there is a connection to the site compressed air supply.
- Liquid waste from the facility flows to the delay tanks located to the north and south of the Reactor Building.
- Solid waste is categorised and contained in appropriate containers and then stored in designated areas before being collected by Waste Operations.

1.6 HISTORY OF FACILITY

HIFAR first became critical in 1958 and commenced operation at 10 MW in 1960. The condition of the reactor has been reconfirmed to be acceptable at approximately four-yearly intervals in Major Shutdowns.

The operation of HIFAR for nearly 50 years together with the operation of HIFAR's sister reactors for an additional 150 reactor-years without a major accident supports the findings of the many safety analyses of the reactors that they can be operated safely. The operational history and the experience of ANSTO as the owner/operators supports the view that the reactors were soundly and conservatively designed, and safely operated. Of the incidents which have occurred, none are seen as a realistic progenitor of a major nuclear accident or significant contamination of the soil or groundwater. The operation of HIFAR has had no adverse effect on the health of operating staff, other ANSTO employees or members of the public.

Since 1972 the following changes to HIFAR and its operation have been made (only those relevant to the Possess and Control period are provided here):

Operational, organisational and administrative changes:

- Loading and unloading of Hollow Fuel Element rigs at power.

Significant plant modifications:

- An increase in the fuel loading to 170 g in each fuel element and a reduction to 60% enrichment.
- Introduction of fuel with 20% enrichment in 2004
- Several improvements to the Scavenge System, culminating in a fully automatic Emergency Core Cooling System.
- Upgrading of the Containment Isolation System (CIS), including the duplication and diversification of the Reactor Building closures.
- Installation of a Standby Active Ventilation System to facilitate testing of the CIS.
- Installation of a new duplicated and separated Emergency Power Supply System.
- Installation of a new double walled tank in the Storage Block for the storage of irradiated fuel.
- Seismic qualification and strengthening of critical plant and buildings.
- New neutronic instruments: Excess Flux Trip Channels and Log Period Channels to replace the Shut-Down Amplifiers, and Period Meters.
- Installation of AUSANS, a neutron collimator which penetrates the Reactor Building.
- Refurbishment of the SCS.
- Installation of ten silicon irradiation rigs in vertical graphite holes and associated storage and handling facilities.
- The provision of a security fence and surveillance system around the HIFAR area to increase protection against potential sabotage.
- Installation of new cooling towers.
- Repairs to leaking shield cooling coils on the Steel Tank.
- Replacement of combustible insulation within the Reactor Building.
- New (and much improved) helium system gas monitoring equipment.
- Improvements to the data acquisition system resulting in the installation of a DAS.
- Improvements to the RAT Flooding System.
- Upgrading of ECR including installation of post accident monitoring instrumentation.

1.7 RESPONSIBILITIES

The overall site management and devolution of authority is contained in the ANSTO LHSTC Safety Analysis Report - Site Description and Arrangements [7].

ANSTO, as the licence holder, has responsibility for the management of the HIFAR facility. The Executive Director of ANSTO has delegated responsibility for the safe management of HIFAR to the General Manager, Technical Services and Facility Management (TS&FM) Division (see Figure 1.1). The Operating Organisation for this phase with roles, responsibilities and lines communication of key personnel is described in detail in HIFAR Procedure NHP 1.2 – “Organisation, Responsibilities and Authority”. [4].

The General Manager, Technical Services and Facilities Management is the Licence Nominee for HIFAR and has overall responsibility for the maintenance of and safety of activities undertaken in

HIFAR at all times, consistent with ANSTO policies and general arrangements. The Nominee is delegated to make, amend or vary the application in the name of ANSTO, pursuant to paragraph 34(a) of the ARPANS Act 1998 and regulation 39 of the ARPANS Regulations 1999.

The General Manager, Technical Services and Facilities Management has delegated responsibility for implementing these Plans to the Facility Manager (see Figure 1.2). The Facility Manager is responsible for planning and managing resources to ensure the safety of activities undertaken in HIFAR and the effective maintenance and control of HIFAR (TSFM Procedure DHF 001 – "Quality Management Planning – De-fuelled HIFAR Facility" [5] and Procedure NHP 1.2 – "Organisation, Responsibilities and Authority". [6]

Figure 1.1 Organisational chart of ANSTO

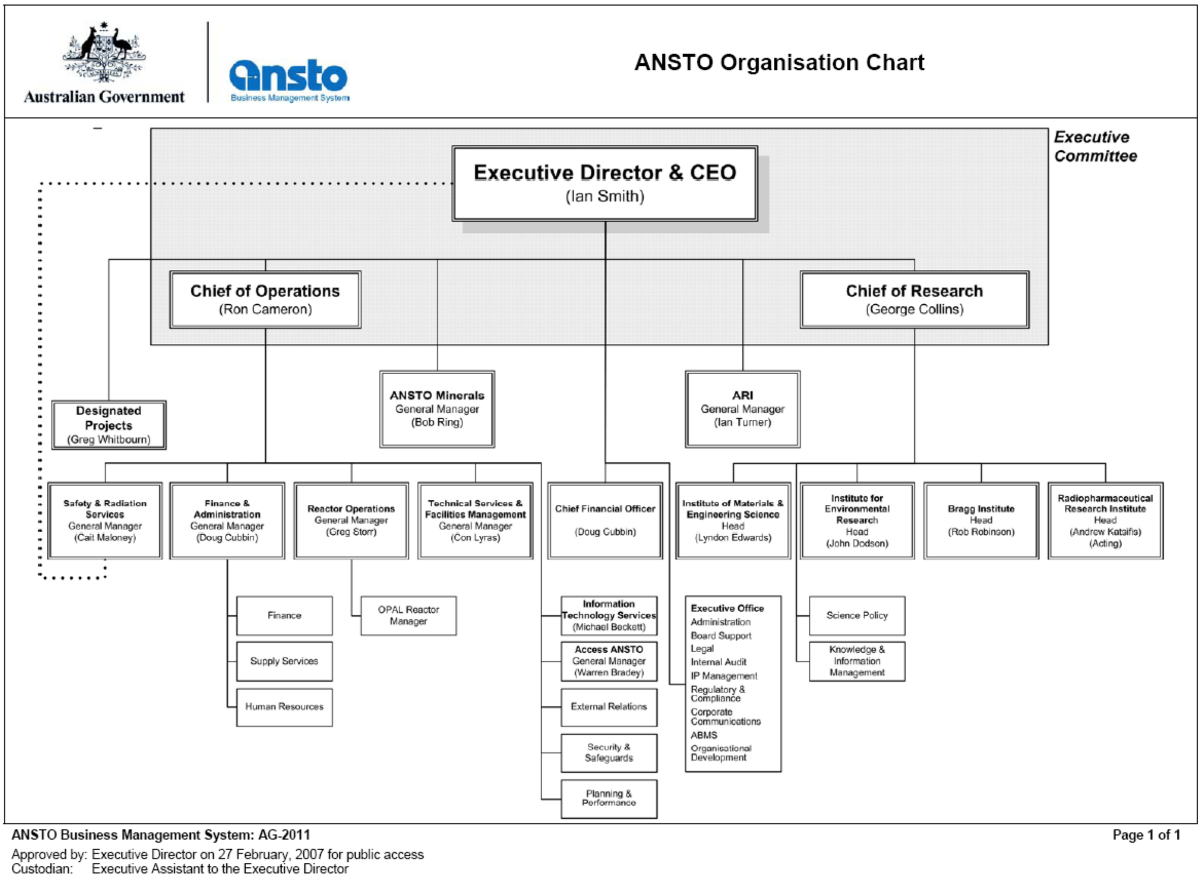
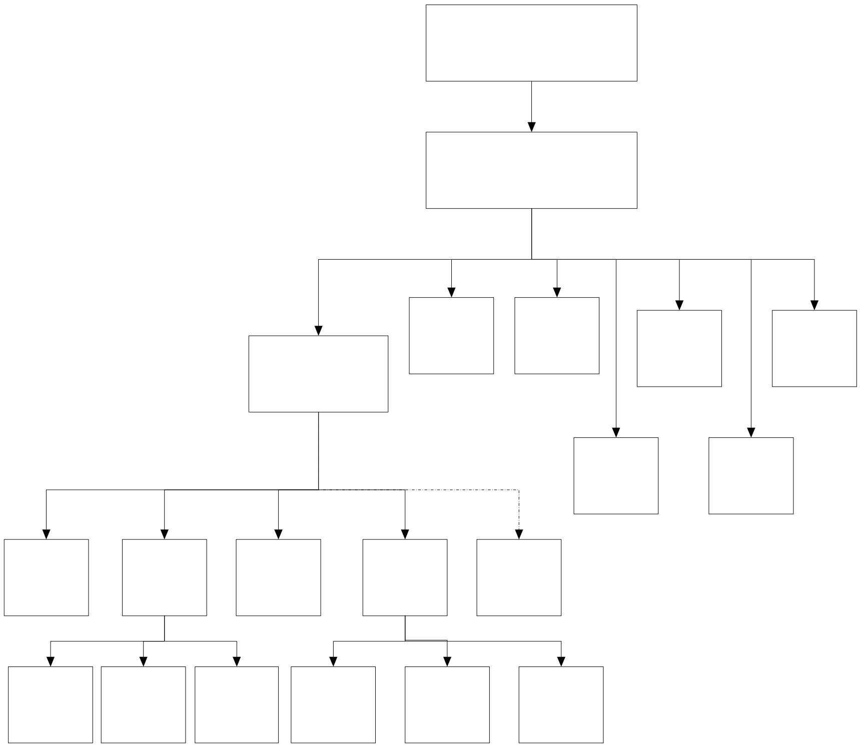


Figure 1.2 Organisational chart of the HIFAR Facility Management Structure



1.8 REGULATORY FRAMEWORK

ANSTO is responsible for the HIFAR Facility under the Australian Nuclear Science and Technology Organisation ACT (ANSTO ACT 1987).

ARPANSA regulates the licensing system for the HIFAR Facility, including the current operating licence, and the proposed Possess or Control licence under the ARPANS Act.

2. SITE DESCRIPTION

This section describes the site location, characteristics, and surrounding human environment and land use. The general ANSTO site characteristics are described in a separate document [7]. Information given in the following subsections applies to the HIFAR Facility.

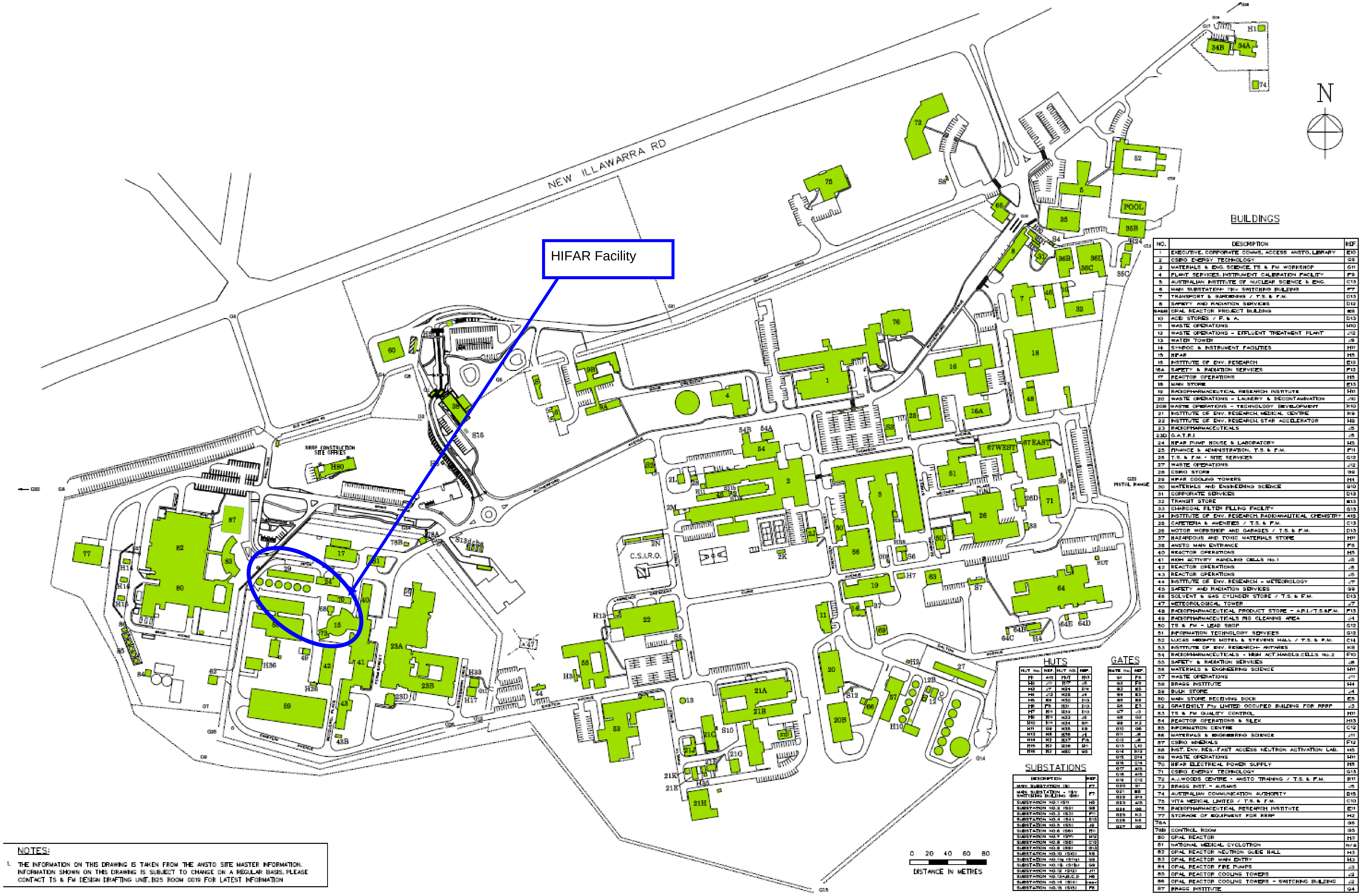
2.1 LOCATION

A brief description of the site location is provided in Section 2.1 of ANSTO LHSTC Safety Analysis Report- Site Description and Arrangements [7].

The HIFAR Facility is located within the HIFAR security area at the west end of the site, as shown in Figure 2.1. The other support structures for the HIFAR Facility, such as the cooling towers are also located within the HIFAR security area.

Vehicle access to the Reactor Building is via the vehicle air lock (VAL) which exits onto Fermi St. Personnel access to the Reactor Building is via two of the three personnel air locks.

Figure 2.1 Location of the HIFAR Facility at LHSTC



2.2 SITE CHARACTERISTICS

A detailed description on site characteristic including site geology, seismic characteristics, meteorology, hydrology is provided in Section 2.2 of ANSTO LHSTC Safety Analysis Report- Site Description and Arrangements [7] and the Safety Analysis Report for OPAL [8].

2.3 SURROUNDING LAND USE

A detailed description of the surrounding human environment and land use is furnished in Section 2.4 and 2.5 of ANSTO LHSTC Safety Analysis Report- Site Description and Arrangements [7].

As is seen in Figure 2.1 this facility is located immediately adjacent to B41 and has the Vehicle access via the north-west end of B41. Thus all movements of flasks and equipment into or out-of the HIFAR Facility travel through this accessway. The production facility for ARI is located immediately across Fermi Rd. Immediately to the north and connected to B41 is Building 40 predominantly containing offices and with access to the HIFAR Facility.

2.4 SURROUNDING POPULATION DISTRIBUTION

A description of the surrounding population to the LHSTC is provided in Section 2 of ANSTO LHSTC Safety Analysis Report - Site Description and Arrangements [7].

The closest approach a member of the general public may make to the Reactor Building and remain outside the perimeter fence is approximately 100 metres.

Approximately 75 staff routinely work in the ARI facility including office personnel. The number of staff working in the HIFAR Facility, Building 40 (predominantly offices), Building 41 (Hot Cells and active handling), Building 42 (predominantly offices) and Building 43 (the HIFAR Facility maintenance workshop) is yet to be determined and will be likely to fluctuate depending on various projects underway.

2.5 NATURAL ENVIRONMENT, LAND AND WATER USAGE

A description of the natural environment and associated land and water usage is provided in Section 2 of ANSTO LHSTC Safety Analysis Report - Site Description and Arrangements [7].

2.6 BASELINE RADIOLOGICAL LEVELS

A description of the baseline radiological levels in the area around the LHSTC is provided in ANSTO LHSTC Safety Analysis Report - Site Description and Arrangements [7].

2.7 SECURITY

The HIFAR Facility is located within the HIFAR fenced area on the LHSTC site. There are appropriate security systems for access to this area based on the types and quantities of nuclear and radioactive material. The Australian Federal police provide the guarding services in accordance with ANSTO's physical protection requirements. Since the removal of all fuel and D_2O from the Reactor Building, the security requirements have significantly reduced commensurate with the reduction in hazard and risk. The security risk posed by the facility will be reduced as there will be no fissile or strategic materials contained within it. Subject to security assessments and approvals and other conditions, it is proposed to take down the HIFAR fence, or reduce the footprint of the HIFAR fenced area. This is commensurate with the level of hazard present.

3. FACILITY DESCRIPTION

The facility description in this section must be read in conjunction with the proposed refurbishment and preliminary dismantling projects (see Section 4 of this SAR and Part E of the licence application).

The descriptive materials in the HDM [9] and HSD [10] were used for the base description but this was extended to include the changes to the facility following shutdown.

The facility's plant and equipment, safety related systems, hazardous materials handled and stored, and process and maintenance operations are described.

3.1 OVERVIEW

The HIFAR Facility comprises the reactor, which is within the Reactor Building as well as a number of pieces of equipment located outside the Reactor Building. These external facilities are:

- The auxiliary plant room,
- The secondary cooling pumps, cooling towers and piping,
- The electrical power supply system including emergency power generation and supply,
- The ventilation systems, including active and standby systems,
- The water treatment circuit for Storage Block No. 1,
- The AUSANS facility,
- The emergency control room

Within the Reactor Building are:

- The reactor block,
- The D_2O plant room,
- The control room,
- Storage block No. 1,
- Experimental rigs,
- Beam line equipment,
- The polar crane and other jib cranes,
- Secondary cooling pipework,
- Helium circuit pipework and vessels,
- Shield cooling pipework,
- Rigs cooling pipework, and
- Graphite gas circuit pipework.

Some of these items are planned to be refurbished or removed during the Possess and Control Period (see section 4.3).

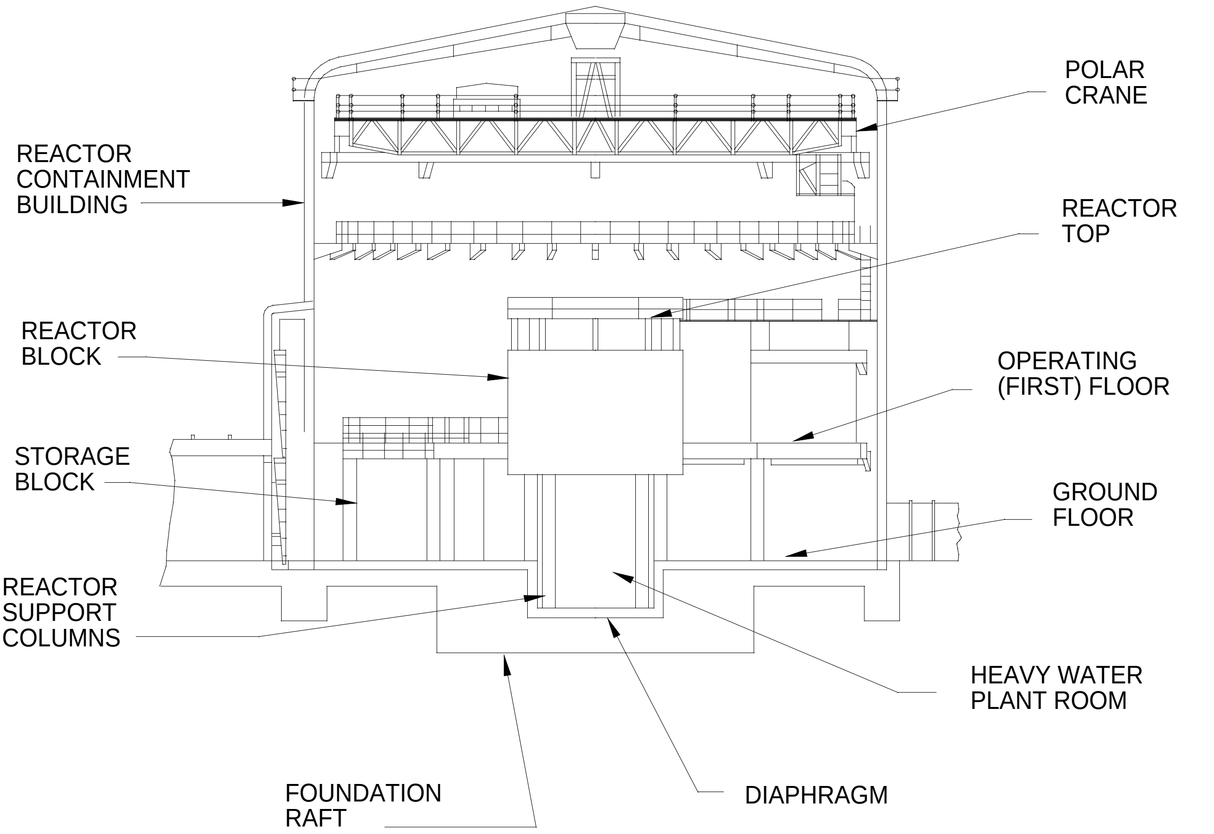
3.2 BUILDING AND STRUCTURES

The Reactor Building is the cylindrical steel dome-roofed structure housing the HIFAR Facility and much of its ancillary plant and experimental equipment. Access to the Reactor Building is via the Personnel Air Locks or the Vehicle Air Lock. All penetrations of the Reactor Building shell have closure devices that were required during the operational period of the Reactor. During the Possess and Control period, the air locks and containment closure devices will be disabled. The air locks will be replaced with normal security doors with access control locks. This approach is consistent with the level of hazard present and with good practice in safe egress in an emergency.

The purpose of the Reactor Building was to isolate radioactive material from the environment in the event of an accident involving the release of such material within the building. This function will no longer be required during the Possess and Control period.

The Reactor Building is a right circular cylinder 21 m in diameter and 21 m high with a low profile conical roof. The wall thickness is generally 21 mm thick.

Figure 3.1 Reactor Building and HIFAR Design



3.3 REACTOR BLOCK

The reactor block is located in the centre of the Reactor Building (Figure 3.2 and Figure 3.3) and comprises concrete shielding around a steel tank containing a graphite reflector. This surrounds the reactor aluminium tank (RAT) which contains the core. On the top of the reactor is a shield ring and top plate that provides shielding to personnel.

The experimental rigs occupy either the horizontal or vertical intrusions into the graphite reflector.

No activities are going to involve the reactor block during the Possess and Control period.

Figure 3.2 Reactor Details

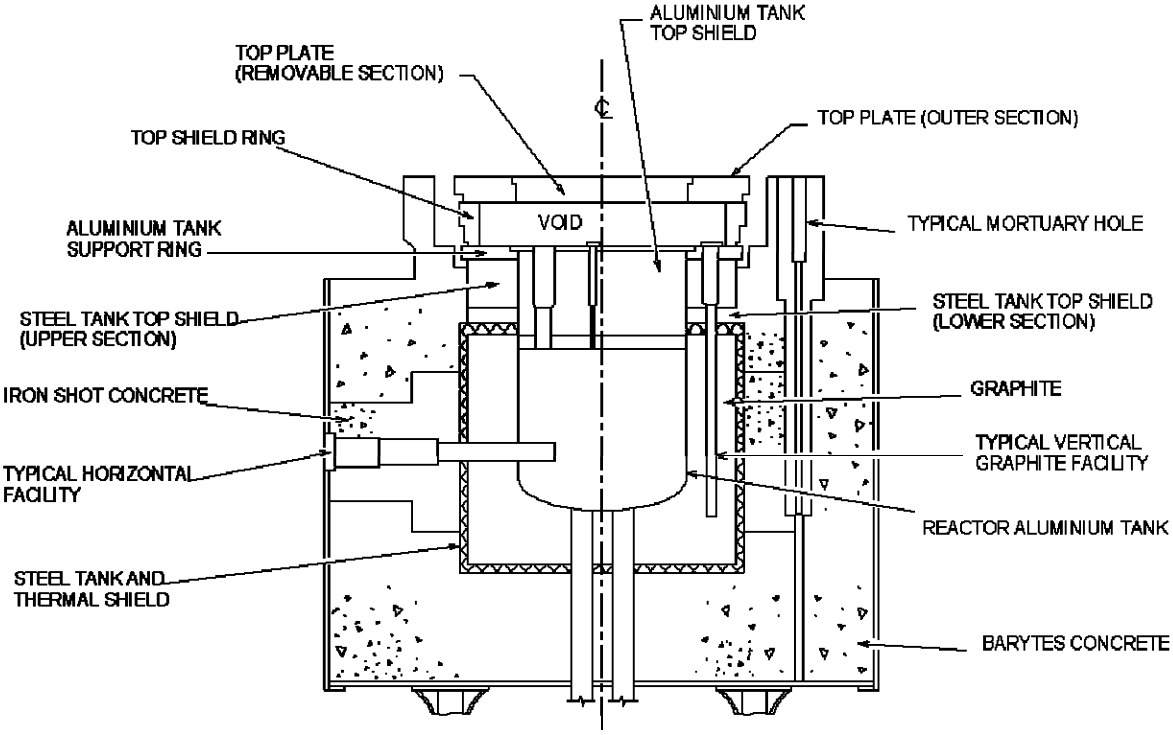
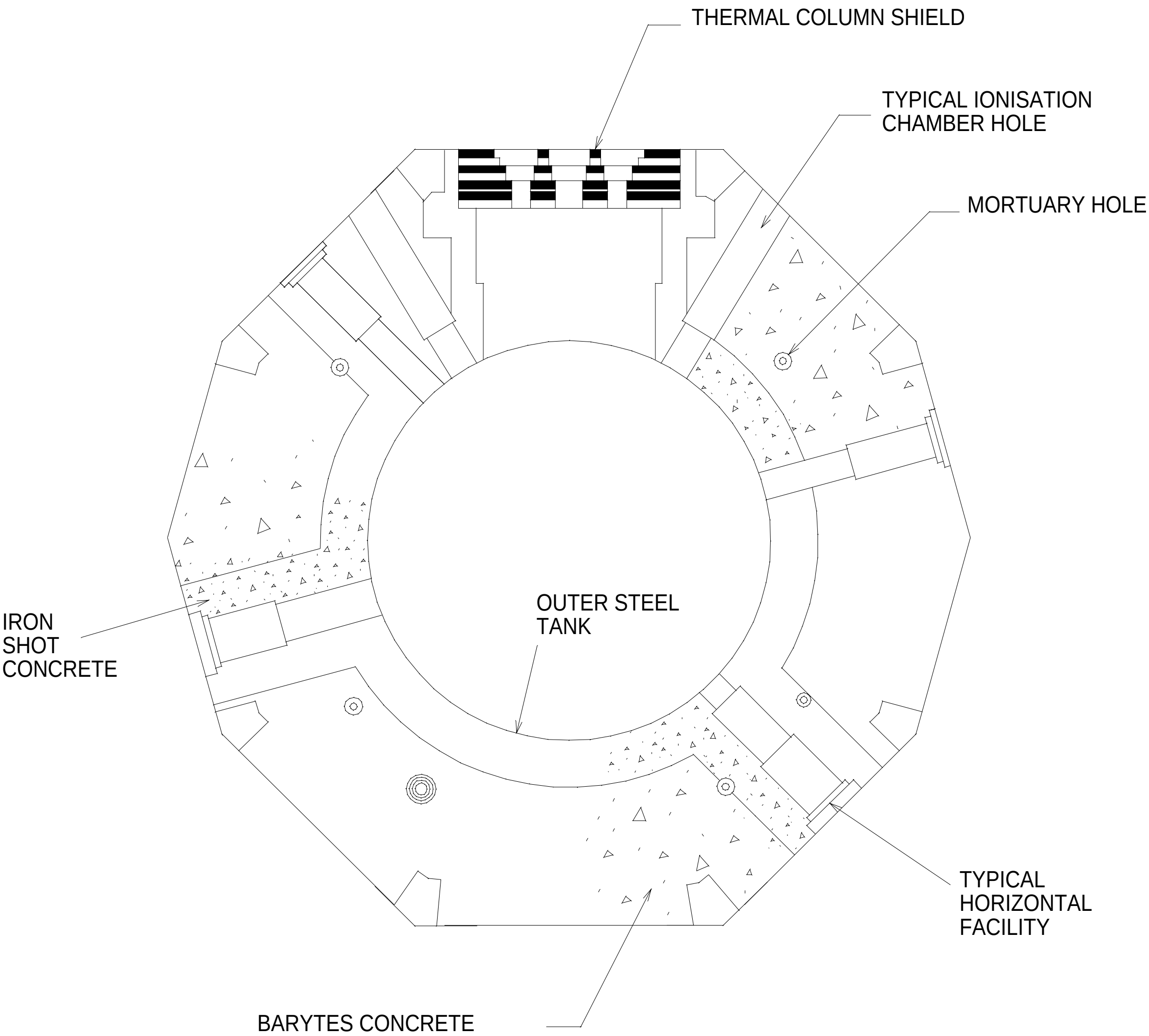


Figure 3.3 Sectional Plan of Reactor

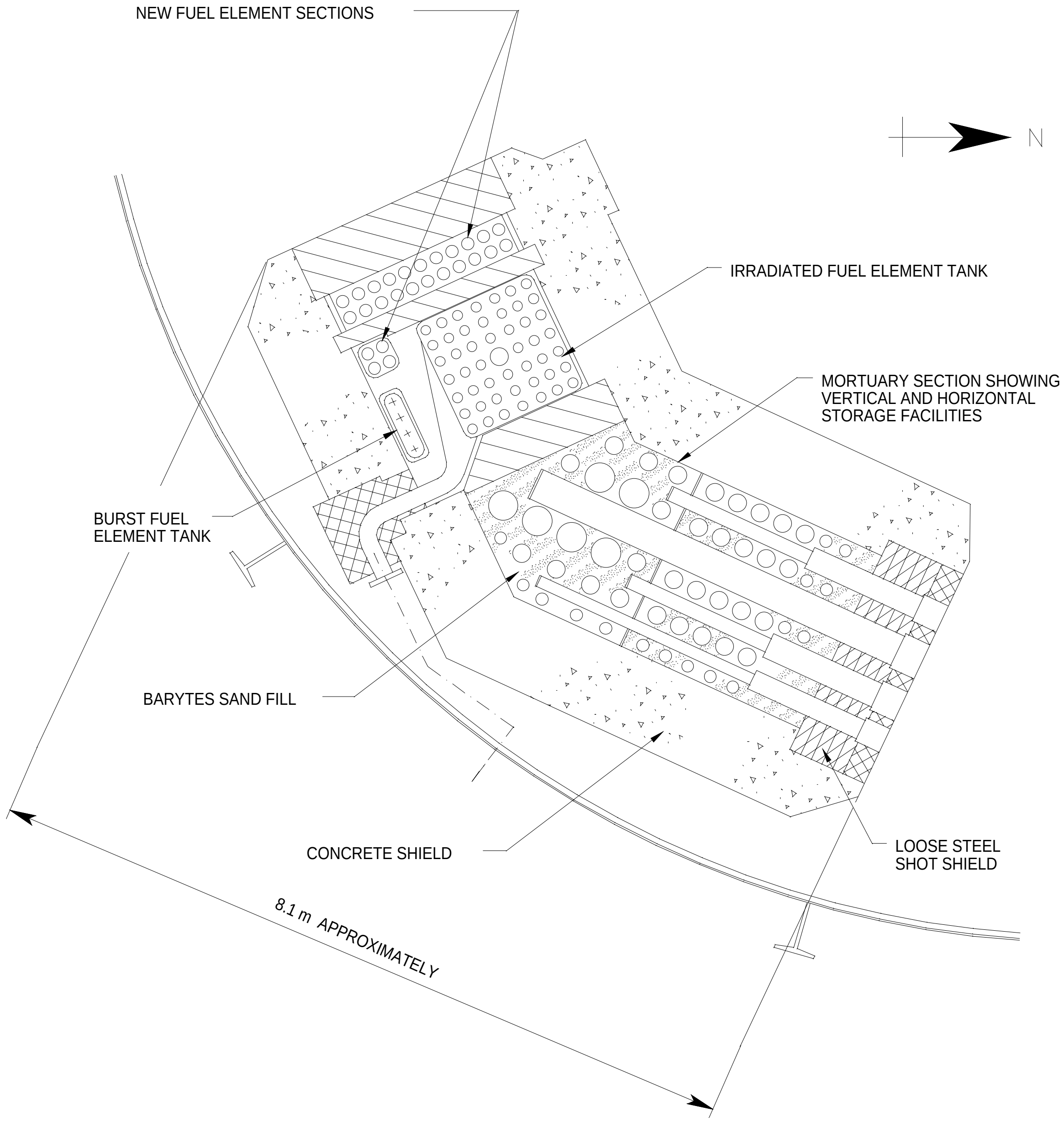


3.4 STORAGE BLOCK NO. 1

The No. 1 Storage Block (SB1) is on the ground floor (basement level) inside the Reactor Building beside the Vehicle Air Lock (Figure 3.4). It provides storage for vertical and horizontal irradiation facility plugs and rigs, and vertical storage for fuel element plugs, assemblies and liners. Access to the horizontal storage is from the ground floor. Access to the vertical storage is from the top of the block which is just below the level of the 5m floor.

Any items that are to remain in the Storage Block can be stored dry and do not require cooling. No activities during the preliminary dismantling and refurbishment involve the storage block except the removal of pipework, pumps and heat exchangers external to the storage block.

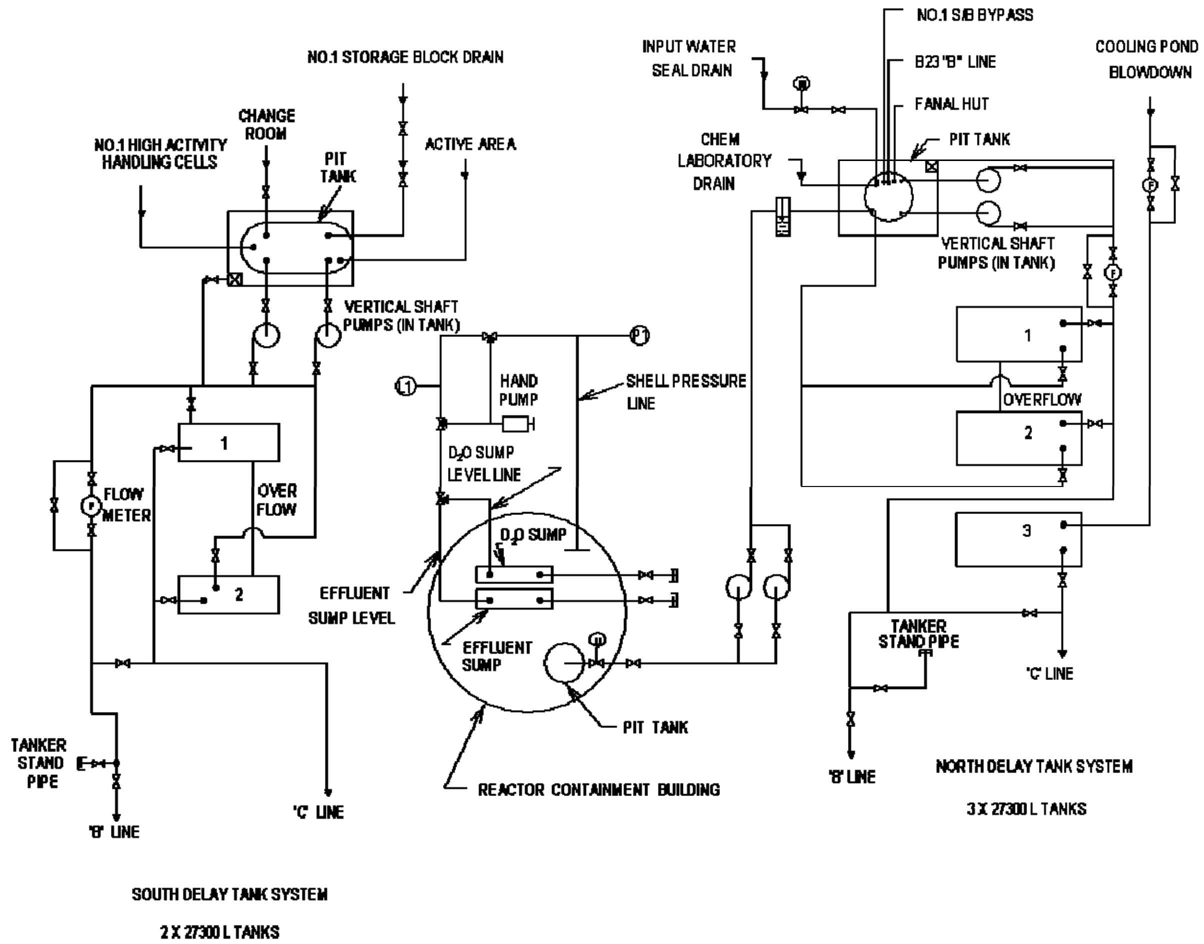
Figure 3.4 Storage Block No. 1 Design



3.5 WASTEWATER SYSTEM

The wastewater from the HIFAR Facility is directed to one of two delay tank systems (Figure 3.5). These delay tanks will still be maintained following the shutdown of the reactor. However, very little active liquid waste is anticipated (see section 8). The Delay Tanks are part of the Waste Operations Licence.

Figure 3.5 Wastewater Flows



3.6 VENTILATION SYSTEM

The normal ventilation system (Figure 3.6) was designed to:

- Provide an acceptable rate of air changes (one per hour) for personal comfort and removal of heat, odours etc, and to produce some degree of air conditioning.
- Prevent a build up of contamination within the ventilated space.

There are two sub-systems, the normal input and the normal extract. Normally, both sub-systems are operating but they can be operated independently, if required.

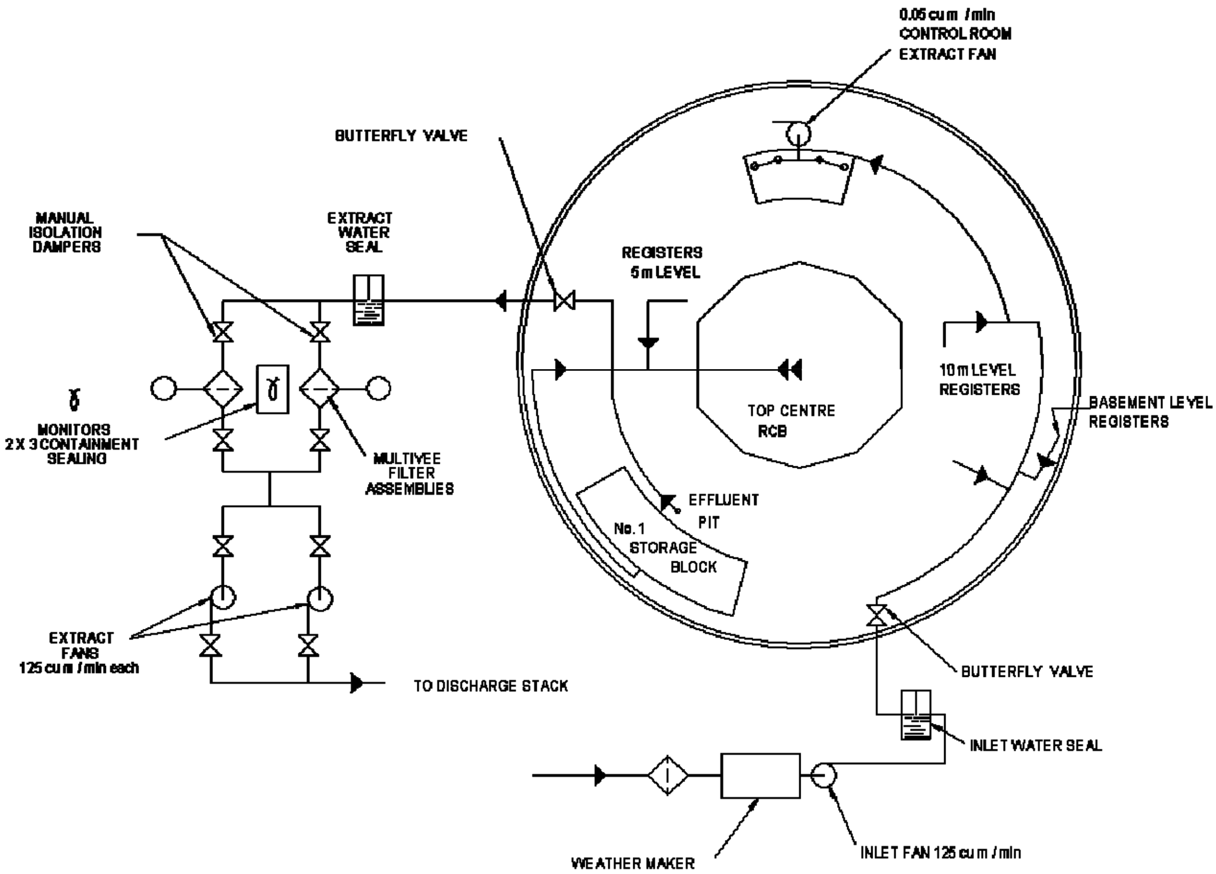
In the normal input system, air is brought in by a centrifugal fan through a bank of filters, which trap particulate matter. The air is then passed through an air conditioning unit where the temperature is and humidity are controlled before entering the Reactor Building.

The normal extract system has two centrifugal fans, each of 125 m^3/min. capacity, and two separate assemblies of multivee filters which trap particulate matter. Normally, one fan and one filter assembly is used (with the second fan and filter assembly on standby) but both fans can be operated simultaneously if required. The extracted air passes through the filters before discharge to atmosphere from the top of the Reactor Building.

On each filter assembly, there are two gamma monitors with low and high level alarms that function in coincidence as part of the HIFAR Facility protection system.

This system will be simplified as part of the activities to be undertaken during the period that this licence remains in force.

Figure 3.6 Ventilation System Design

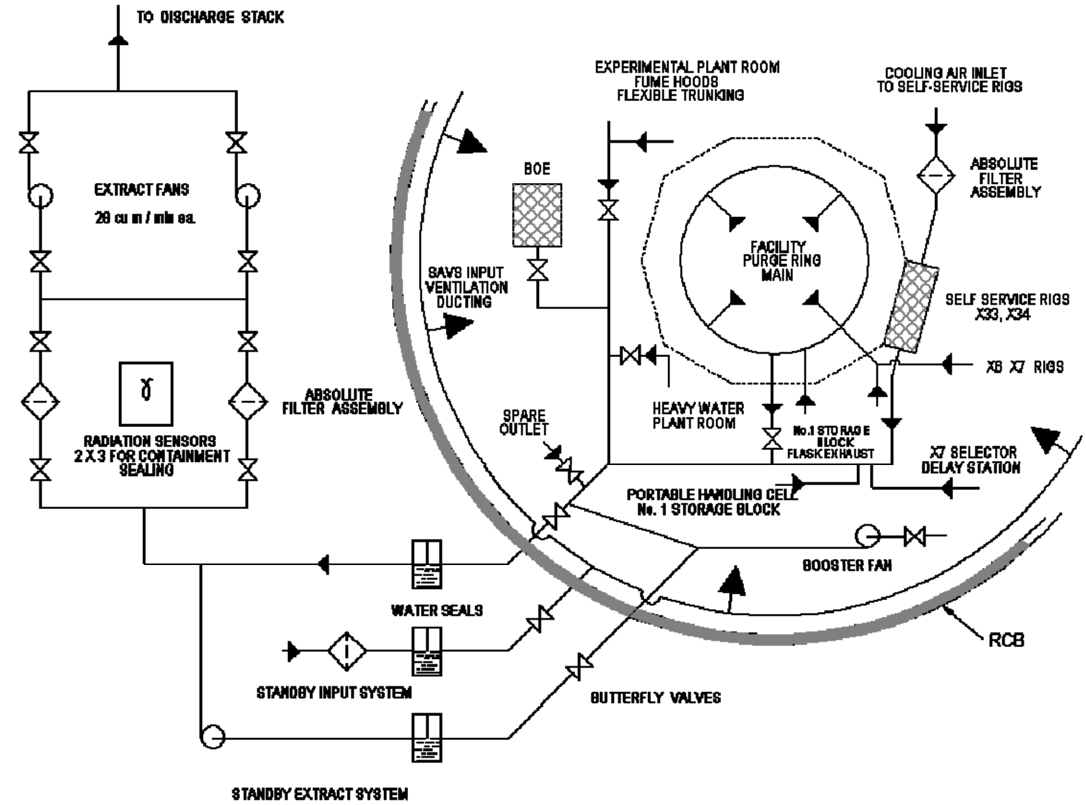


The active ventilation system (Figure 3.7) was designed to extract air and gases from particular rigs, including the silicon irradiation facilities, the heavy water and experimental plant rooms and other areas in the Reactor Building where contamination may have originated during normal operations. The extract fans are Sturtevant centrifugal compressor fans of 28 m^3/min. capacity at 3.6 kPa. The extracted air and gases are passed through Vokes absolute filters before discharge to atmosphere through the stack at the top of the Reactor Building. The filters trap 99.9% of particulate matter larger than 0.5 micron.

Following the final shutdown of HIFAR, the active ventilation system will continue to collect any tritium evolved from the graphite reflector or other components of the HIFAR Facility and expel it through the discharge stack on the top of the Reactor Building.

The details of these systems are provided here for information and are not intended to be a specification for the facility during the Possess and Control period.

Figure 3.7 Active Ventilation Extraction Design



3.7 OTHER SYSTEMS

3.7.1 Lighting

In the Reactor Building, normal lighting is provided to meet the Australian Standard for plant rooms, with enhanced lighting to meet the Standard for switchboards in appropriate areas and supplementary lights for special tasks.

Lighting is by flood lights suspended from the ceiling to give general illumination to the reactor top and 5m floor, supplemented by fluorescent tube lights in the reactor gallery, control room and under the mezzanine floors. Ground floor lighting is by fluorescent tube lights.

Emergency lighting is provided by battery-backed fluorescent tube units distributed throughout the Reactor Building.

The lighting system will be refurbished following final shutdown, extending into the Possess and Control period.

3.7.2 Cranes

The Reactor Building Polar Crane has a Safe Working Load (SWL) of 20.5 tonnes and is used for all heavy lifting operations within the Reactor Building, subject to accessibility. The handling flasks, top plate and shielding were lifted frequently during routine operations and all of these items are close to the SWL of the crane. This affects the frequency and rigour of maintenance inspection and servicing.

The crane may be operated from a cab suspended from the bridge, or by remote control. The drive motors operate on 415 V AC power from the line supply. Routine maintenance includes mechanical and electrical inspections monthly, quarterly, annually and bi-annually [11]. The crane operators also perform pre-operational checks [12].

The frequency of the routine maintenance activities on the crane will be reviewed during the preliminary dismantling and refurbishment based on the number and load of operations.

3.8 PERSONNEL SAFETY SYSTEMS

There are three systems which assist in the management of personnel safety in the Reactor Building. These systems will be refurbished during the Possess and Control period.

- The ventilation system
- The radiation monitoring system, and
- The fire detection system.

3.8.1 Ventilation

The ventilation system is described in detail in section 3.6. During the period that this licence remains in force, the system will be simplified to a supply of air-conditioned air for personnel comfort and to minimise corrosion; and an extraction system to collect and remove any tritium.

The extraction system passes air through filters to capture any dust or active particles before being exhausted to the atmosphere.

If the ventilation system fails, there is no immediate risk to personnel inside the Reactor Building. Alarms will sound and the personnel will evacuate the Reactor Building until the ventilation system is restored.

3.8.2 Containment

The containment function is no longer necessary as there is no potential for significant releases of active gas or particulates within the Reactor Building that need to be contained.

3.8.3 Radiation Monitoring

This section describes the instruments and systems that measure high radiation or radioactivity in the HIFAR Facility area and warn or alarm if levels are high. The radiation monitors will be refurbished and may be relocated during the Possess and Control period to reflect the change in hazards. Further details of the current arrangement are given in the HIFAR Descriptive Manual [9].

The instruments described here are:-

- Area radiation monitoring system.
- Beam radiation monitors.
- Portable radiation monitors.
- Tritium monitor.

Radiation monitors are installed to measure and display gamma radiation levels in the Reactor Building. They incorporate visual warnings and visual and audible alarms. Each channel consists of a detector/transmitter, local display unit and a main amplifier. They are connected to the HIFAR instrumentation power supply.

The detectors are distributed strategically within the building. A unit beside each detector displays the local radiation level and incorporates a radiation warning light and visual and audible high radiation alarms.

The main amplifier panel displays the radiation levels and incorporates visual high radiation warnings and alarms. The monitors also initiate alarms of high radiation with set points for the warning at 100µSv/h and alarm at 1000 µSv/hr.

Gamma radiation monitors were used to monitor radiation from the reactor beams. These monitors are mounted on the building walls opposite the horizontal facilities. They provide a local visual and audible alarm when the radiation at the detector exceeds the set point of 1 mSv/hr.

Gamma alarms are provided in areas with high intermittent radiation to give a local display of radiation fields. They also provide visual and audible alarms of high radiation. In the current configuration they are mounted on stands on the reactor top, the No 1 Storage Block, in the D_2O plant room, in the Experimental Plant Room and in the area of the isotope self service rigs, reactor face 6. They are connected to convenient power supply service outlets. Radiation is displayed and visual and optional audible alarm is given.

There are two gas monitors installed at the HIFAR Facility. They are calibrated for tritium or gamma radiation, but they are used here to measure tritium. These monitor the building atmosphere as an aid to heavy water leak detection. One of these monitors can be valved to sample the heavy water plant room and the reactor top void if appropriate. The units incorporate a local audible alarm.

The locations and number of all of these monitors are subject to change to suit the Possess and Control period.

3.8.4 Fire Detection and Protection

Currently, there are 15 smoke detectors in the Auxiliary Plant Room with one in the battery room. Within the Reactor Building, there are eight fire zones. There are VESDA alarms in the control room and under the top level walkway. In addition, there are smoke detectors covering the top level of the building, the underside of the mezzanine walkway and in the ventilation system ductwork. There is also a flame detector that monitors the vehicle area.

The fire detection system for the Reactor Building and the Auxiliary Plant Room will be refurbished during the Possess and Control period.

3.8.5 Review of Plant Condition

The plant condition has been acceptable for operation of the HIFAR reactor. The cranes have been maintained in accordance with the maintenance schedules and were extensively refurbished 8 years ago [13]. However, for the period before final decommissioning, some limitations in the electrical power supply and ventilation systems have been identified and therefore these systems will be refurbished.

3.8.6 Shutdown systems

Since there will be no actual operations of this facility during the period that this licence remains in force, there are no shutdown systems proposed. There are alarms that will alert personnel in the event of high radiation levels, fire or ventilation failure but there will be no automatic shutdown of any systems.

If a high electrical power use is detected, circuit breakers will act to interrupt the power flow. This is not considered a shutdown system and is considered in section 10.

3.8.7 Criticality alarm systems

As there will be no fissile material contained within the Reactor Building, criticality is not possible and thus there will be no criticality alarm.

3.9 OTHER BUILDINGS AND EQUIPMENT

This section lists and briefly describes other equipment, buildings and ancillaries associated with the facility.

HIFAR Auxiliary Plant Room

Connected to the Bld 15 and Bld 41 exterior walls is the APR which houses HIFAR plant and equipment like the three space conditioning sub-systems, the two HIFAR air compressors and air receiver, the vehicle airlock hydraulics power pack, the old HIFAR battery room, HIFAR Operator office, the Bld 15 pressurisation blower and ducting plus HIFAR electrical cabling and electrical penetrations through the Bld 15 wall. The three SCS evaporative condensers and two additional compressed air receivers are located just outside the APR.

Building 24

This building houses the HIFAR secondary circuit pump room, the old chemical dosing system and the HIFAR chemistry laboratory, offices and store rooms which are currently being converted into an OPAL irradiation target preparation facility. Adjacent to Bld 24 are the north delay tanks and pit which are required to remain in service to cater for ARI and Bld 41 requirements.

Building 29

B29 is the HIFAR secondary circuit cooling pond, roof, 6 off cooling towers and the new automatic pond dosing system, chemical tank farm and awning.

HIFAR Emergency Control Room

This is a thick-walled concrete bunker attached to Bld 41, adjacent to the south delay tanks and pit which will remain in service. The ECR contains HIFAR related emergency equipment and plant controls. Attached to the ECR is a ventilation plant room and underground services trench to Bld 15 and Bld 70.

Building 42

The ground floor houses offices and amenities, the HIFAR/OPAL instrumentation workshop and a spare parts and radioactive sources store room for HIFAR/OPAL. Also on the ground floor is a storage compactus for HIFAR records. The main bay area is serviced by a gantry crane.

The first floor houses offices and amenities, the HIFAR maintenance computer, HIFAR records storage, the Health Physics offices and counting laboratory, and the Bld 42 PAL and access tunnel to Bld 15.

Building 68

B68 is the Fast Access Neutron Activation Laboratory (FANAL) which used the X176 rig and a pneumatic conveyor system between Bld 15 and Bld 68 for irradiation of various samples. Previously also used for Police forensic work.

Building 70

B70 is the HIFAR electrical power supply building consisting of duplicated rooms for A and B systems housing the two diesel generator sets and electrical switchboards, UPS equipment, batteries, rectifiers and inverters. Connected by trenches to Sub-Station No.1 and Bld 15 and the ECR. External to Bld 70 are the two diesel fuel tanks as well as the 3rd diesel/generator set and separate fuel tank.

Building 73 (located on 1st floor, above the HIFAR AVS Plant Room)

B73 was constructed directly above the HIFAR AVS plant room and houses the Australian Small Angle Neutron Scattering (AUSANS) equipment which was being operated by Bragg Institute. The beam instrument has a direct connection through the Bld 15 wall to the X213 Collimator, located in-pile in the reactor block.

The AUSANS room is serviced by a small mono-rail hoist and a separate staircase.

HIFAR AVS Plant Room

This room houses the HIFAR active ventilation system fans and filters. It is also used by S&RS to monitor the HIFAR stack discharges on a weekly basis.

Some of these items are planned to be refurbished or removed during the Possess and Control Period (see section 4.3).

3.10 CLASSIFICATION OF AREAS

The classification of areas in HIFAR changes to suit the movement of materials and equipment and changes to the activity levels in the areas, in accordance with ANSTO OHSE Guide AG2509 – *Radiation Safety – Radiation and Contamination Control*.

The Area Supervisor determines the classifications in consultation with radiation protection advisers. The designations are indicated by signs and labels as well as on notice boards.

There are three classification levels as shown in the following table (also taken from AG2509).

Table 3.1 Classification Levels for Radiation and Contamination Areas

Radiological Area Colour Code	Potential Radiation Exposure Levels (individual, effective mSv per year)	Removable Surface Contamination Levels (averaged over 2000 h per year)	Potential Airborne Contamination Levels (averaged over 2000 h per year)
RED	6 to 20	0.3 to 1 DL	0.3 to 1 DAC
BLUE	1 to 6	0.05 to 0.3 DL	0.05 to 0.3 DAC
WHITE	< 1	< 0.05 DL	< 0.05 DAC

The anticipated classifications (for contamination and radiation respectively) during the Possess and Control period are as follows:

- Reactor Building in general: white, white
- No.1 Storage Block: initially blue, red but may later be able to be reclassified.
- D_2O Plant Room: white, red possibly reducing to white blue

The following exceptions will apply in particular situations:

- The white contamination classifications for the D_2O Plant Room and Experimental Plant Room will apply once the any decontamination work has been undertaken and the white classification confirmed by HP clearance.
- The Control Room roof may from time to time need to be used to temporarily store reactor top plate and ring. During such periods, the control room roof will become blue red.
- The Experimental Plant Room because of its shielding may be temporarily used to store active items. During such periods, the classification will need to be reassessed.

For the HIFAR support facilities outside the Reactor Building they are not classified, except where specific tasks are being undertaken.

Local contamination control (white plastic sheeting *etc*) may be required for specific activities to be undertaken, and in addition, local dust control may be required for sample gathering (for inventory characterisation).

4. OVERALL PLAN

4.1 CHOICE OF STRATEGY

Deferred dismantling is one of three internationally accepted decommissioning strategies and is the strategy chosen for HIFAR [14]. This option allows processing and removal of some radioactive materials from the facility after the end of operations and before final dismantling. [14 s1.6, s8.3]

Deferred dismantling is sometimes called “safe enclosure”.

The choice of deferred dismantling was based on the minimisation of radiation doses for people involved in the decommissioning activities. During the Possess and Control period, redundant equipment will be dismantled and removed from within the Reactor Building and the support services can be removed from the site outside the Building. At this time new simpler systems will be installed to provide the necessary services. Deferred dismantling requires the installation of the new services to maintain the equipment and safety systems during the Possess and Control period.

Once the redundant equipment is removed and the new systems are installed, sample gathering work will be undertaken to characterise the inventory of active materials in detail [1]. This work will be used to plan the final decommissioning. This sampling will be used to support other characterisation activities (*eg* modelling and extrapolation of characterisation at similar facilities).

For more details on the rationale for the strategy, see Part A of this licence application.

4.2 DEFENCE IN DEPTH

The principal defence in depth protection systems for the HIFAR Facility in the Possess and Control period are the following:

1. The most active material will be contained within the Reactor Block structure or SB1. This provides adequate shielding for people who are within the Reactor Building.
2. The Reactor Building, although not a sealed building, provides an additional barrier. Any radiation from equipment inside the Reactor Building is attenuated by distance provided by the Reactor Building and any potential contamination that occurs inside the Reactor Building is contained within the Reactor Building.
3. The HIFAR secured area and the general site security provide additional barriers to people approaching the Reactor Building.
4. Local contamination and dust control when undertaking activities that might generate some contamination.
5. Active Ventilation system to keep tritium levels in the building within acceptable levels.

These five defences provide protection against accidental radioactivity doses being received by personnel.

4.3 DESCRIPTION OF PLANNED ACTIVITIES

This summarises the overall plan as it affects the Possess and Control period. The refurbishment activities are described below, followed by the dismantling projects. The order of the preliminary dismantling and refurbishment activities has not been finalised at this time.

The activities to be undertaken under the possess or control licence will be directed at achieving and maintaining a state of safe enclosure of the HIFAR facility. Such a state of safe enclosure will properly have regard not only to radiological safety but also to occupational health and safety and to the protection of the environment from radiological and non-radiological hazards. These planned refurbishment and preliminary dismantling activities are consistent with international best practice [see for example reference 24 section 6.3].

In addition to these activities, it is anticipated that some equipment (such as flasks) will be decontaminated, and set aside within the facility for possible reuse either in the facility or in another location.

4.3.1 Refurbishment Projects

The list of refurbishment projects is given below with some details of the scope of the tasks. Further details of each project are given in Part E of the licence application.

E0910 – Refurbish Electrical Power System

E0914 – Refurbish Active Ventilation System

E0916 – Refurbish HVAC System

E0917 – Refurbish Security System

E0920 – Refurbish Access System

E0927 – Refurbish Monitoring System

E0933 – Refurbish Communication System

E0934 – Refurbish Lighting System

E0948 – Refurbish Fire Alarm System

E0963 – Refurbish Instrumentation

E0972 – Install Shielding for the reactor block and No. 1Storage Block

4.3.2 Preliminary Dismantling Projects

The proposed preliminary dismantling projects involve all non-radioactive items that are not needed for the safety or utility of the facility during the period whilst the Possess or Control licence remains in force. Such dismantling will reduce fire hazards within and outside the reactor building, and address concerns about possible health and environmental hazards posed by redundant systems located outside the reactor building. Consistent with international practice, it is not proposed to undertake any dismantling of structures containing significant levels of radioactivity during the period of safe enclosure.

This philosophy was adopted for two main reasons (1) to allow a period of decay to take place of the radioactive material to thus reducing the potential volumes of each category of radioactive waste generated in the decommissioning period which will begin after Safe Enclosure and (2) not to generate any significant quantities of radioactive waste prior to the establishment of the Commonwealth Radioactive Waste Management Facility.

Some projects, upon more detailed assessment may prove to have large items of equipment with contamination that is not practicable to remove and in this case, those projects may be delayed until decommissioning commences.

The proposed projects are listed below. Indicative descriptions are provided in Part E of the Licence Application together with a brief justification for each project. Detailed descriptions of each of these projects will be developed and included in the Safe Work Method Statement or SAC submission (and regulatory submissions/reports where appropriate) for each project.

E0902 – Remove Cooling Towers, Pond/Pipework - external to the Reactor Building

E0918 – Remove Miscellaneous Items from the Reactor Building

E0919 – Removal of 3V8 Gasholder and Helium Circuit to the Graphite Space

E0922 – Remove Fuel Element Assembly Station

E0923 – Remove HIFAR 06 Circuit (Rigs Cooling)

E0931 – Remove No.1 Storage Block Cooling System - external to Reactor Building

E0932 – Remove HIFAR ECCS

E0939 – Remove HIFAR Protection Signal System

E0940 – Remove HIFAR Demineralised Water System

E0941 – Remove B23 Isotope Conveyor & Rigs Cooling System

E0942 – Remove B68 Isotope Conveyor & Rig Cooling System

E0943 – Remove Rig Consoles & Gas Mixing System

E0944 – Remove Out-of-Pile Silicon Irradiation Facilities

E0946 – Remove Redundant HIFAR Steel Structures

E0949 – Remove HIFAR CIS

E0950 – Remove D_2O Plant Room Flooding System

E0951 – Remove Non-Active Parts of the Primary Helium Circuit

E0953 – Remove HIFAR Area Buildings

E0958 – Remove Secondary Cooling Circuit – internal to the Reactor Building

E0960 – Remove Shield Cooling Circuit

E0961 – Remove Redundant Water Supply Circuits

E0962 – Remove Redundant HIFAR Area Cranes

E0968 – Remove HIFAR SCS

E0969 – Remove ECR Internal Equipment

4.4 PROJECT SAFETY REVIEW AND ASSESSMENT

Each project undertaken during the Possess and Control period will be assessed using the ANSTO Risk Assessment protocols. This requires that an assessment is made to identify hazards and hazardous scenarios, and assess the associated risks to ensure that the control measures are adequate. For most projects this will involve preparation of a SAC submission, but some very minor projects may be assessed using Safe Work Method Statements, in accordance with the OHSE Safety Approvals System (see sections 7.5 and 7.9). Some projects will require prior approval by ARPANSA under Regulation 51 while others may require quarterly reporting under regulation 52.

4.5 CHARACTERISATION OF THE NUCLIDE INVENTORY

A preliminary assessment plan for the nuclide inventory in the reactor block and SB1 has been prepared [1]. The purpose of the characterisation plan is to provide a preliminary guide and overview of the planning, organisation and work required to determine the amounts of radioactivity remaining in those parts of the HIFAR Facility that are to be dismantled as part of decommissioning.

The plan therefore includes the reactor block, the plant rooms, all reactor circuits, systems and equipment, beam and beam instrument shielding, the No.1 Storage Block, all other areas inside the Reactor Building, the plant and work areas outside the Reactor Building as well as selected buildings in the area.

The plan describes the characterisation work, which comprises the following steps:

- Review of historical information,
- Calculation methods,
- Preparation of the sampling and analysis plan based on an appropriate statistical approach,
- Performance of in-situ measurements and analysis,
- Performance of sampling and analysis of those samples (where required to add confidence to the other characterisation measures),
- Review and evaluation of data obtained, and
- Comparison of calculated results and measured data.

The nuclide and item inventory in the HIFAR Facility and in SB1 will be assessed in two phases: a preliminary assessment will be undertaken during Transition, followed by a detailed assessment during the 10 year waiting period.

The detailed assessment will occur after the redundant non-active equipment has been removed from the Reactor Building. This delay in undertaking the survey will ensure the activity being measured is the longer-life isotopes. In addition, the removal of redundant equipment will increase the space available for the characterisation activities, which may include taking samples as well as measurements.

Radiation dose measurements were taken inside the RAT of the PLUTO and DIDO reactors in 1992 [15, 16]. This showed that the significant nuclides were ^{60}Co, ^{55}Fe, ^{63}Ni, ^{133}Ba, ^{133m}Cd, and ^{154}Eu. The total activities in DIDO and PLUTO were measured to be 1.6 x 10^{14} Bq and the highest specific activities were in the RAT and top shield, the horizontal tubes, header plates, fuel element nozzles and the bottom disc of the top shield. This information from DIDO and PLUTO will be used to assist in the measurements of the inventory in the HIFAR Facility.

4.6 BASELINE ENVIRONMENTAL SURVEY

Prior to OPAL coming on line, an aerial gamma and soil sampling program was undertaken in July 2002 to provide a radiological footprint for the site [17]. This provides a baseline that will assist in assessing the effectiveness of the plan activities in preventing contamination of the local area.

4.7 MAINTENANCE OF EQUIPMENT FOR FINAL DECOMMISSIONING

The polar crane will be required during the removal of redundant equipment from the Reactor Building but will then remain unused until the final dismantling activities. The crane will therefore be maintained as necessary during the preliminary dismantling and refurbishment activities and then will be given preventative maintenance during the rest of the Possess and Control period to ensure that they will be available for the final dismantling activities.

The polar crane isolation switch will be locked open during the Safe Enclosure period to ensure that it cannot be used to remove shielding during that time.

5. REVIEW OF OPERATING EXPERIENCE

5.1 REVIEW OF PLANT RADIOLOGICAL MONITORING RESULTS

Abnormal plant radiological monitoring results in a Abnormal Occurrence Report or Operating Occurrence Report. These are discussed under section 5.3

5.2 DOSE UPTAKE BY THE WORKFORCE - ROUTINE AND ABNORMAL

The last two major shutdowns occurred in 2004 and in 2000. The shutdown in 2000 was similar to the activities that occurred during the final shutdown of HIFAR in 2007 and could be expected to be an upper limit on the possible doses arising out of activities to be undertaken during the Possess and Control period.

The tasks that were undertaken in the 2000 shutdown included removal of all fuel and draining of the D_2O from the reactor. The shutdown in 2004 did not drain the D_2O from the RAT.

In the 2000 shutdown, all external doses were controlled within the individual dose constraint of 0.9 mSv/ month [18]. This constraint was imposed by ANSTO Safety Assessment Committee. The tasks that resulted in the highest doses will not be undertaken during the Possess and Control period and so the doses received per month expected to be below 6.91 person-mSv (collective) and 0.08mSv (average) which correspond to the doses received in the third month of that shutdown.

The management systems for demonstrating that doses are ALARA include the use of electronic dosimeters as well as TLD badges. Extremity measurements will also be made where potentially high doses could be received by the hands. In addition, if any individual approaches a dose of 1.5 mSv, future work of that individual will be reviewed to minimise overall dose. Such reviews took place on five staff members in the 2000 MSD, resulting is a number of people being re-deployed to manage received doses.

Doses during the activities that will occur during the Possess and Control period are expected to be lower than operating dose rates and are able to be effectively managed using the existing dose management systems.

5.3 DESCRIPTION OF INCIDENTS AND ACCIDENTS

A review of annual licensee reports to ARPANSA in relation to HIFAR between July 2001 and June 2006 and the quarterly reports to ARPANSA between July 2006 and March 2007 show that there were only two significant contamination incidents that occurred during that period.

AOR 975 involved a spill of D_2O which, after cleanup and evaporation leaves no active residue. This review shows that from July 2001 until the end of March 2007, no significant contamination has occurred in Building 15. AOR 985 involved an internal leak leading to a partial draining of the RAT without release within the building.

In addition, a review of near-misses between 1 January 2000 and late March 2007 shows that the near misses that have involved contamination were minor and were able to be recovered.

The potential for any more significant incidents was considered through an analysis of the Annual Reports to ARPANSA for the period July 2001 to June 2006 and the Quarterly Reports to ARPANSA for the period July 2006 to March 2007. These show that there were no only two potentially significant contamination incidents that occurred during that period.

This review shows that during the period from July 2001 until the end of March 2007, no significant contamination has occurred in Building 15 and no significant near misses involving contamination occurred in Building 15.

6. REVIEW OF OTHER DECOMMISSIONING EXPERIENCE

The decommissioning experience from the DIDO and PLUTO reactors was reviewed to determine whether there are any particular hazards or lessons for dismantling and refurbishment activities or eventual decommissioning the HIFAR Facility.

A brief review of another decommissioning report was also undertaken.

6.1 DIDO/PLUTO DECOMMISSIONING REPORTS

The DIDO and PLUTO reactors were of very similar design to HIFAR. These reactors were shutdown in 1990 and brought to a state of safe enclosure during the years following. The experience obtained during those activities is relevant to the planning for the decommissioning of the HIFAR Facility.

A review of the post closure activities undertaken at DIDO and PLUTO show that the strategy adopted for HIFAR is comparable [19, summary p6]. As with the strategy adopted for HIFAR, the UK experience was based on the balance between adequate decay and retention of knowledge. The delay enabled a considerable quantity of ILW to be downgraded in category. Furthermore, as with the Australian situation, a disposal facility or long term store for ILW was not available at the time.

The approach to end shift coverage and reduce staff at HIFAR once the reactor is defuelled and drained of D_2O is consistent with the approach at DIDO and PLUTO [19, p7].

The majority of the radioactive content resulted from neutron irradiation, particularly in the components adjacent to the core i.e. the RAT, the Steel Tank and the nearby shielding. There was, however, a considerable amount of contamination particularly in the primary circuit. Contamination was greater in DIDO, where a cobalt sample developed a leak during the final year of operation and resulted in considerable levels of ^{60}Co being present in the D_2O.

The major nuclide of the radioactive inventory was ^{60}Co and resulted from traces of cobalt present in the aluminium and steel in the reactor structures. Other nuclides such as various nickel isotopes and ^{14}C are of particular significance in the long term.

Although the neutron flux at any particular point in the reactor was not known to a high degree of accuracy, the radioactive content could be calculated with adequate precision for decommissioning purposes using available data [19, p25]. This conclusion supports the approach taken for HIFAR that sample gathering is only required to support and validate the modelling.

This experience suggests that the contamination is likely to be restricted to the primary circuit, the reactor and the experimental rigs. This is expected to be the situation at the HIFAR Facility and none of these items is being dismantled during the Possess and Control period.

The DIDO and PLUTO experiences also demonstrated that the hazards were greatly reduced by the post-closure activities and a lesson was that significant resources were wasted in producing a safety case that was overly elaborate [19, p28].

The decision to replace the ventilation plant for the HIFAR Facility with a smaller, modern, purpose-built plant is also consistent with the experience at DIDO and PLUTO [19, p29].

The DIDO and PLUTO experience also indicates that even though systems to be removed in preliminary dismantling are expected to be clean, it is important to check all equipment and material and only treat it as clean once it has been cleared [19, pp31-33].

The experience from DIDO and PLUTO also suggest that the facility categorisation of HIFAR for ARPANSA (hazard category F1) is appropriate [19, p42].

In developing any new procedures and guidance for the preliminary dismantling and refurbishment of HIFAR, ANSTO will take into account the experience of the DIDO and PLUTO cases.

Generally the experience from DIDO and PLUTO is that the inventory estimates are pessimistic. The estimates of inventory from HIFAR will be reviewed during the detailed characterisation study that will be undertaken to ensure that they are not overly optimistic or pessimistic.

The DIDO and PLUTO experience is consistent with ANSTO's expectation that the secondary cooling system is free from activity and will be able to be disposed of as clean waste [19, p53].

The DIDO and PLUTO experiences provide valuable estimates of radioactive waste for decommissioning and these will be used as the basis for characterisation. The total quantities of waste are able to be managed.

The management of monitoring of people, vehicles and equipment is known to be an intensive task and resources are being planned to manage this effectively [19, p107]. The ANSTO vehicle gate monitor is expected to assist in this regard by helping to prevent inadvertent removal of active material.

The experience from DIDO and PLUTO suggests that discharges to the environment will be low. Stack discharges were controlled by extract filters. The discharge of tritium was well within the limits [19, p112]. This is in line with the experience from the 2000 Major Shutdown and with the anticipated releases following final shutdown.

The management of initial opening of pipes, vessels and other enclosed spaces will be assessed during the SWMS for each task based on the experience from DIDO and PLUTO, although this may be more applicable to decommissioning.

6.2 OTHER RELEVANT DECOMMISSIONING REPORTS

Another similar design reactor was the DR3 reactor at RISØ National Laboratory, Roskilde, Denmark [20].

The plan for the shutdown is similar to that planned for the HIFAR Facility, consisting of the following overall steps:

- Final shutdown of reactor,
- Removal of fuel and D_2O
- Removal of non-active items
- Dormancy for a period (10-30 years)
- Final dismantling

This program is in line with the program planned for the HIFAR Facility.

7. SAFETY MANAGEMENT

This section briefly outlines the safety management system that applies to all facilities on the Lucas Heights site and more importantly to the local specific arrangements relating to the facility. It covers the facility's safety practices, their extent and implementation, and details where safety management responsibilities lie. This section demonstrates that existing practices are well defined and acceptable in terms of safety, and that effective feedback and review mechanisms are in place to facilitate continual improvement.

For further information, see the eight plans and arrangements for managing safety (Part B of the Licence Application).

7.1 LEGAL REQUIREMENTS FOR SAFETY

Operations at ANSTO are subject to the following Acts passed by the Federal Government:

- The Australian Nuclear Science and Technology Organisation Act
- The Environmental Protection (Nuclear Codes) Act
- The Occupational Health and Safety (Commonwealth Employment) Act
- The Australian Radiation Protection and Nuclear Safety Act.

From these Acts and Regulations flow the requirements for ANSTO to operate in a safe manner.

ARPANSA have prepared a number of guides on safety management, which have been consulted during the development of the ANSTO safety management system.

7.2 ANSTO OHSE STANDARD

ANSTO safety management arrangements and procedures cover all activities and dealings under its control. These arrangements and procedures protect human health and the environment, and promote continual improvement in safe working practices in the workplace. This commitment is in accordance with ANSTO strategic policy, as set out in the ANSTO Health, Safety and Environment Policy (APOL 2.1). APOL 2.1 also commits ANSTO to values such as safety and environmental awareness being integral to, and a priority in, all operations.

Implementation of the HIFAR Facility safety management arrangements and other local (HIFAR) procedures is in accordance with the ANSTO Safety Management System. The system is detailed in various "ANSTO OHSE Standards and Practices" which are disseminated to all staff. The OHSE Standards [21] are issued by the Executive Director whilst the OHSE Practices are set by custodian divisions with specialist knowledge. These arrangements inform staff of health and safety requirements for compliance, as necessary. The Safety Management System ensures that hazards are identified and their risk is managed so that all activities are conducted safely by providing a framework for:

- Minimising the likelihood of incidents or accidents;
- Managing radiation protection and occupational health and safety;
- Protecting human health and the environment; and
- Promoting a positive safety culture

This regime gives assurance that all operations continue to be conducted safely and in a manner that is consistent with regulatory commitments.

The applicable arrangements and procedures are discussed below under the following Sections/Sub-sections.

7.3 ANSTO OHSE PRACTICES

All issued Safety Practices are applicable to activities taking place within the HIFAR Facility. Particularly relevant documents to the work of the facility are:

Occupational Health

- Occupational health, safety and environmental (OHSE) responsibilities guide (AG2362)
- Event response process guide (AG2372)
- Safety training guide (AG2363)
- Safety and security arrangements at LHSTC guide (AG2382)
- Prevention and management of fatigue guide (AG2477)

Radiation and Contamination Control

- Derived air concentrations of common radionuclides guide.(AG2508)
- Radiation area classification and contamination areas guide (AG2509)
- Entry and exit from classified radiation areas guide (AG2510)
- Clothing to be worn in classified radiation areas guide (AG2511)
- Clothing change procedures when entering or leaving classified areas guide (AG2512)
- Clearance of radiation classified or radioactive contamination guide (AG2514)
- Contamination clearance levels guide (AG2513)
- Personal dosimetry guide (AG2521)
- Medical surveillance requirements guide (AG2479)
- ALARA Assessment (Guide) (AG2505)
- Risk Assessment and ALARA Cost-benefit Analysis (AG2506)
- Safe Management of Licensable Sources (Guide) (AG2471)

Radiation Safety – Safe Movement and transport of radioactive material

- Safe movement and transport of radioactive materials guide (AG2515)

Radiation Safety – Management of Radioactive Waste

- Safe management of radioactive waste guide(AG2515), Solid(AG2518), Liquid(AG2519)and Airborne(AG2520)

Manual Handling

- Manual handling risk management process flowchart (AG2341)
- Risk Assessment Matrix (AG2395)
- Manual Handling Risk Management Process (Checklist) (AG2467)

Electrical Safety

- Electrical safety rules guide (AG2101)
- Isolation of systems plant equipment guide (AG2409)
- Isolation tagging of systems guide (AG2410)

Contractor Safety

- Contractors access to site guide (AG2448)
- Process for contractors safety management guide (AG2453)

Chemical Safety

- Chemical risk management process guide (AG2435)
- Storage of chemicals guide (AG2441)
- Guidance for chemical risk assessment – SAC submission guide (AG2439)

- Laboratory safety – fume cupboards and recirculating fume cabinets risk management process guide (AG2443)
- Compressed and liquefied gases and flammable liquids guide (AG2444)
- Chemical waste disposal guide (AG2445)

Risk Management

- Hazard identification and risk assessment process guide(AG2329)
- Confined space risk assessment and entry process guide (AG2401)
- Excavation work and penetration to buildings process guide (AG2403)
- Fall prevention guide (AG2406)
- Persons Working Outside of Normal Hours (AF2538)
- Safe working permit guide (AG2408)

Nuclear and criticality safety are not relevant to the HIFAR facility during the possess and control period.

In addition to the general nature of the above documents, the requirements of both safety and quality have given rise to a comprehensive set of procedures and work instructions for this facility.

7.4 ORGANISATIONAL MANAGEMENT STRUCTURE

Figure 1.1 gives the ANSTO Management structure. Figure 1.2 gives the management structure relevant to the facility. Preliminary dismantling and refurbishment activities within the HIFAR Facility are the responsibility of the Project Leader and the Project Manager.

These individuals are appointed by the General Manager and have significant responsibilities in regard to safety of activities within their areas of control.

7.5 SAFETY APPROVAL SYSTEM

The safety approval system for the site oversees all the activities to ensure that practices and proposals have been scrutinised by knowledgeable personnel within ANSTO but outside the direct operation of the facility. The visible embodiment of this system is the use of SAC approvals for site activities.

SAC approval is being sought for the Possess and Control period for the HIFAR Facility. This SAR is being used to support an application to SAC and to ARPANSA for Possess and Control approval.

Each project undertaken during the Possess and Control period will be assessed using the ANSTO Risk Assessment protocols. This requires that an assessment is made to identify hazards and hazardous scenarios, assess the associated risks ensure that the control measures are adequate. For most projects this will involve preparation of a SAC submission, but some very minor projects may be assessed using Safe Working Method Statements or similar, in accordance with the OHSE Safety Approvals System.

In addition, where the projects are subject to ARPANS Regulation 51 provisions, a submission will be made to ARPANSA. These two systems will ensure that the planned projects can be undertaken safely. Projects that are subject to ARPANS Regulation 52 will be reported quarterly in accordance with that Regulation.

7.6 QUALITY ASSURANCE PROGRAM

The activities that will take place within the HIFAR Facility during the Possess and Control period will conform to the HIFAR Quality Management System which is accredited to ISO 9001/2000. These quality systems impose a set of requirements on the facility and its operation, the staff and the documentation of most activities within the facility.

7.7 ENVIRONMENTAL MANAGEMENT

The activities that will take place within the HIFAR Facility during the Possess and Control period will conform to the HIFAR Quality Management System which in turn conforms to the ANSTO Business

Management System (ABMS). The ABMS is accredited to ISO 14001:2004. These systems impose a set of requirements on the facility and its operation, the staff and the documentation of most activities within the facility. For further information, see the Environmental Management Plan (Part B(7) of this licence application.

7.8 RADIATION PROTECTION REGIME

OHSE Radiation Safety Standard [22] give details of the overall ANSTO radiation protection regime. The application to the facility staff is summarised below. Further details are provided in the Radiation Protection Plan which is Part B(3) of this licence application.

7.8.1 Personnel External Dosimetry

All staff working on preliminary dismantling and refurbishment activities in the Reactor Building will be radiation workers and the wearing of personal dosimeters in the Building is mandatory. The dosimeters are changed monthly and the doses made available to all affected staff. Management also reviews the doses received. The Dosimetry Service in Safety and Radiation Services provides this service and maintains records under a Service Level Agreement. Staff may also wear Electronic Personal Dosimeters (EPD) to provide an immediate indication of any dose received and specific tasks may require an EPD to be worn.

7.8.2 Personnel Internal Dosimetry

All preliminary dismantling and refurbishment staff will have a whole body monitor count as required by AG-2521.. The Dosimetry Service in Safety and Radiation Services provides this service and maintains records under a Service Level Agreement.

7.8.3 Facility Radiation and Contamination Surveys

Safety and Radiation Services staff conduct regular surveys of the Reactor Building on behalf of the HIFAR Facility. The area where work has been and will be undertaken is checked for radiation levels and contamination levels. Safety and Radiation Services staff have knowledge of the location of higher activity levels within the facility and the potential for elevated radiation or contamination levels so certain areas will receive greater attention than others.

The results of the surveys are given, in writing, to the Facility Manager who arranges for any necessary action needed as a result of the survey.

7.8.4 Contamination management

At the personnel entry to the Reactor Building is a detector that will alert personnel to the presence of contamination on their skin or clothing.

7.9 CONTROL OF MODIFICATIONS

Each project of the preliminary dismantling and refurbishment plan and any sample gathering project will be managed in accordance with HIFAR project management procedures. These procedures implement the ANSTO OHSE standards and practices in relation to the control and categorisation of activities (which includes modifications).

7.9.1 Overall responsibility

The General Manager has overall responsibility for the operation of the facility. Below that level, preliminary dismantling and refurbishment activities within the Reactor Building are the responsibility of the Project Manager.

7.9.2 Local control

The Project Manager has overall responsibility for preliminary dismantling and refurbishment. Day to day management of site personnel and contractors is provided by the Facility Manager.

7.9.3 Use of written procedures

The activities undertaken during the preliminary dismantling and refurbishment are generally non-routine. Many of the activities will be undertaken once only. Thus there are no standard operating procedures for these activities.

Each of the preliminary dismantling and refurbishment activities will be managed through the use of a Safe Work Method Statement (SWMS) undertaken for the specific tasks to be done. These SWMSs will be written by the team undertaking the work, reviewed by the Facility Manager and retained for quality assurance review.

Entry and exit from the Reactor Building will be governed by procedures/instructions and will include a requirement (amongst other things) to have Health Physics coverage on first entry for the day. This latter restriction may be lifted after the Radiation Monitoring system is refurbished.

7.9.4 Human factors consideration and Safety Culture

The human factors consideration during the preliminary dismantling and refurbishment will include work-load assessments, the potential for people to make mistakes and ergonomic aspects associated with manual handling. Wherever feasible, lifting will be undertaken by mechanical aids.

HIFAR management, through the safety management system encourages ongoing minimisation of safety risk and the implementation of appropriate safe behaviour. Activities at HIFAR are undertaken under the guidance of the HIFAR management in accordance with the documented procedures within the QMS. Personnel are trained and assessed for their specialist skills and, are encouraged to take responsibility for ownership of safety. Open communication and use of the Safety Review Meetings enable staff to report safety concerns and contribute to effective solutions. Human factors analysis and task analyses are an integral part of the safety management system.

AS 2310 - ANSTO OHSE Standard - Radiation Safety commits ANSTO to enabling a positive safety culture that guides the attitudes and behaviour of all individuals in the realisation of the radiation protection objectives. To achieve this, ANSTO ensures sound management practices; good engineering and laboratory practices; attention to quality assurance, training and qualification of personnel; implementation of a comprehensive safety assessment, monitoring and review system; and feedback from lessons learned.

7.9.5 Hazard identification and Screening

Once the hazards are identified, the consequences are considered to assess whether a more in-depth analysis is required. For the proposed projects, it is expected that the potential consequences will not warrant significant analysis. During the SWMS and preparation of the work permit, the hazards associated with chemicals, electricity, working at heights, confined spaces, high voltage, heavy lifts, as well as radiation will be specifically considered.

7.9.6 Scenario identification

The hazardous scenarios requiring additional analysis will be described in sufficient detail to allow the reader to understand the context of the hazard. The hazard analysis will include both radiological and industrial hazards. This may be an important issue for areas that also store hazardous chemicals, or where the radioactive sources are also toxic or chemically hazardous, or for other toxic materials, electrical hazards or industrial hazards.

7.9.7 Risk controls

The OHSE System requires that risk controls be applied according to the hierarchy of controls where practicable (that is, attempting first to eliminate hazards, then substitute, isolate from people, engineer the risks out, then lastly apply personal protective equipment). Whilst it is preferable to use the higher controls, PPE often supplements the higher barriers and is a required good practice for some activities. During the preliminary dismantling and refurbishment projects, the use of PPE will assist in reduction of injuries to personnel. In addition, the presence of radiation alarms, ventilation alarms and fire alarms will alert personnel and facilitate their evacuation to safety.

7.9.8 ALARA

Doses will be minimised during the preliminary dismantling and refurbishment activities through the use of Safe Work Method Statements (SWMSs). The minimisation of dose is an important feature of the SWMSs that will be undertaken when dismantling equipment that may possibly have some activity within it.

In addition, the doses actually received by personnel will be monitored to ensure that unexpectedly high doses are not received. If higher than expected doses are received, an investigation will be undertaken to determine the causes and develop reduction strategies.

7.9.9 Permits to work

A formal Work Permit must be completed before any non-routine activity is undertaken in the facility. This will include virtually all the preliminary dismantling and refurbishment. The area supervisor of the area in which the work is to take place completes this form and the person(s) doing the work must sign the permit acknowledging they understand its contents. The SWMS will be undertaken as part of the completion of the work permit. The worker(s) may be ANSTO staff or external contractors but if they are external contractors then they must have completed ANSTO Contractor Training and extra supervision by ANSTO staff is required.

Important information provided by the permit includes:

- Time during which the work can proceed;
- Area in which the work is permitted;
- Radiological and conventional hazards that may be encountered in the area;
- Requirement to wear protective clothing and overshoes;
- Any special restrictions on the use of flames or generation of sparks.

If the workers are ANSTO employees who are not normally active area workers or are outside contractors, operations staff supply them with audible personal dosimeters, if required, explain the protocols appropriate to the area classification and on departure, they must check workers and equipment for radioactive contamination and record the reading of the personal dosimeter.

7.9.10 Handing over of responsibilities

The status of any incomplete work at the end of each day will be recorded on the work permit to ensure that the work is not assumed to be complete. These permits will be reviewed when preparing the following permits to ensure that the status of the work is well understood by the personnel undertaking the preliminary dismantling and refurbishment.

7.9.11 Training and authorisation of staff

7.9.11.1 Safety Training

All new employees undergo safety induction training. Staff undertaking more important safety-related functions such as that of Contract Supervisor or Area Supervisor attend the relevant training courses.

7.9.11.2 Work Training

The training and authorisation of staff is a requirement of the Quality System. Training is normally on-the-job training supported by the strongly emphasised use of written SWMSs.

7.9.12 Minimum staffing level

There will not be any general minimum staffing level for the preliminary dismantling and refurbishment activities. However, each activity will be considered during the SWMS and work permit preparation to ensure that the appropriate numbers of trained personnel are present.

7.9.13 Control of contractors and visitors

The control of the safety of contractors and visitors to the site as a whole is described in OHSE Contractor Safety Standard. This includes induction and ensuring awareness of the specific hazards present in and around the HIFAR Facility.

Visitors to the facility must be accompanied at all times within the facility by a staff member and must comply with all safety requirements.

7.9.14 Safety monitoring and review

The safety monitoring for the project will include assessment of the doses received by personnel, analysis of any accidents that occur and analysis of near misses. In addition, the emission of tritium will be monitored to ensure it is being managed effectively.

The condition of the safety equipment for the building will be reviewed to ensure that it is being maintained adequately.

HIFAR management holds a regular Safety Review meeting attended by HIFAR Line Managers and independent specialists. The Safety Review meeting ensures that all activities to be undertaken during the Possess and Control period will be coordinated and have the necessary safety assessments.

7.10 LIMITS AND CONDITIONS

Although the concept of Operational Limits and Conditions is not usually applied to shutdown defuelled reactors, [see for example 23, 24, 25, 26], it is expected that the OLCs that applied during the operational period of the reactor be reviewed for their applicability to the post-closure period and that only those relevant to that period be kept, so as to remove unnecessary impediments to ongoing activities [27].

The existing OLCs for the facility were reviewed as part of the development of the PorC licence application. This review concluded that the only limits that should remain are as shown in Table 7.1. Note that these required some revision; slight changes in title and new LC numbers are shown in that table).

The IAEA Safety Series 45 document also recommends consideration of whether “any new applicable criteria” [27 p. 24] should be defined. The tasks and projects that will be undertaken during the preliminary dismantling and refurbishment in the Reactor Building are encompassed by the maintenance activities that have been undertaken during the lifetime of HIFAR. Numerous items of equipment have been removed and replaced during major shutdowns of HIFAR. In addition, refurbishment projects have been undertaken at various times during the lifetime of HIFAR. As the range of tasks and projects are not significantly different to the range of tasks during specific periods of the operational period of HIFAR, no additional limits and conditions are required.

It is also important to recognise that not all aspects of safety management of a facility are subject to limits and conditions. The focus of limits and conditions is on “an envelope of parameters, developed by the operating organisation, which will protect the reactor, the staff, the general public and the environment from undue exposure if they are not exceeded” [28]. Many administrative controls, such as the permit-to-work and modification control are not governed by parameters and thus are not included in limits and conditions.

The cross reference between the earlier OLCs and the replacement LCs is listed in Table 7.1 below. The full text of each of the LCs is contained in Part E of the Licence Application#.

Table 7.1 Cross Reference of HIFAR OLCs to HIFAR Facility LCs

HIFAR OLC during the operational period	Relevance to Possess and Control Period	Proposed HIFAR Facility LC
4.3.4 Radiation Monitoring Instrumentation 4.3.4.1 - RCB Installed Area Radiation Monitors 4.3.4.3 - Detection of Tritium and Fission Product Gases	Radiation monitoring equipment inside the Reactor Building is still important to safety and prevention of excessive doses to personnel.	3.1.1 Radiation Monitoring Instrumentation 3.1.1.1 Reactor Building Installed Area Radiation Monitors 3.1.1.2 Detection of Tritium
4.13.2 Rig Handling Requirements	Potentially during the Possess and Control period, it may be necessary to move an item out of SB1 (e.g. to the B41 hot cells). If so, this OLC will be relevant for this movement.	3.2.1 Rig Handling Requirements.

HIFAR OLC during the operational period	Relevance to Possess and Control Period	Proposed HIFAR Facility LC
4.15 Radioactive Discharges 4.15.2 Airborne Discharges	4.15.2 will still be relevant as tritium will be released during the Possess and Control period. In addition, there is the potential for dust to be generated during the preliminary dismantling.	3.3.1. Airborne Discharges.
4.17 Radiological Hazards 4.17.1 Air Activity In The RCB	4.17.1 focuses on the acceptable level of tritium in the Reactor Building and thus will be relevant during the Possess and Control period.	3.4.1 Air Activity in the Reactor Building.
4.21 Hazardous Materials	There still may be a need to bring in hazardous material into the Reactor Building that could cause damage to the shielding of the material in the core or SB1.	3.5 Hazardous Materials

7.11 CONTROL OF INSPECTION AND MAINTENANCE ACTIVITIES

The maintenance of the safety systems, including the fire detectors, radiation monitors and active ventilation system will be detailed in a schedule to ensure that they are operational and in calibration.

The cranes that are retained will be maintained at appropriate intervals based on the usage and the need to ensure operation is possible at the end of the Possess and Control period.

The security doors and fire extinguishers will be maintained in the usual fashion as is done on the rest of the site.

7.12 CONTROL OF ABNORMAL EVENTS AND EMERGENCY ARRANGEMENTS

7.12.1 Event reporting systems

All abnormal events in the facility must be reported in accordance with the OHSE Management – Event Reporting AG 2375 Investigating Events (Guide). Such events include:

- All events arising from the operation and use of ANSTO's Controlled Apparatus, Controlled Material, including radioactive material, and Controlled Facilities.
- All accidents and incidents, whether work related, sustained whilst undertaking an endorsed sporting activity during an approved break, or during travel to and from work.
- All events of likely interest to either members of the public or external parties.
- All events that have the potential to reflect on ANSTO's position in the local community or more generally.

The event response system emphasises and facilitates learning from errors and requires that incidents are investigated, corrective actions implemented, and that lessons are learned from the incident.

HIFAR Procedure, NHP 9.2.26 is consistent with the ANSTO event response system that is outlined in AG 2375. NHP 9.2.26 (*Abnormal Occurrence Reports and Operating Occurrence Reports*) is used to identify, assess and categorise events and recommend appropriate corrective actions, if required, to prevent recurrence. The categorisation is done generally in accordance with the International Nuclear Event Scale (INES) [29], as applicable. The procedure has provisions for recording the events, analysing the root cause, recommending corrective/preventive actions and also providing requirements and guidance for reporting an event to the line management (and others within ANSTO) and ARPANSA based on the severity of the event.

NHP 9.2.26 has provisions for notifying ARPANSA within statutory timeframes, depending on the kind of event. Reports are made on all HIFAR events and anomalies, whatever the cause. These reports are investigated thoroughly by trained personnel.

Data collected from events and routine logs is reviewed regularly and trended for the purpose of identifying performance changes and possible need for corrective actions. Furthermore, such information is taken into account when planning future activities.

7.12.2 Emergency arrangements

ANSTO Site emergency arrangements are currently in existence to address any emergency at the LHSTC site [30, 31.]. This Response Plan identifies responsibilities of the Site Emergency Organisation and the Emergency Services Organisations in responding to accidents and incidents at the LHSTC. Response to the on-site component of any accident or incident is dealt with in this Plan together with the support from ANSTO to the Emergency Services Organisations if off-site radiological advice, technical assistance and monitoring are required.

The Response Plan was developed to ensure that there are arrangements in place to manage all hazards, minimise injuries to persons, minimise loss of life and/or property, minimise the environmental impact of any incident, prevent or minimise the spread of any on-site incident to off-site and restore LHSTC to normal operations in a timely and orderly manner.

In addition to the above site arrangements, there are local facility-specific emergency procedures [32] within the HIFAR QMS.

There is 24-hour coverage by the Site Operations Safety Supervisor who responds first in an emergency. An Emergency Response Vehicle, equipped with a wide range of emergency equipment, is on stand-by. The SOSS (Site Operations Safety Supervisor) personnel are trained to respond to a wide variety of situations and carry out training exercises with emergency response organisations such as the Fire Brigade and Ambulance Rescue.

Building 15 will be incorporated into the regular program of building evacuation exercises on site. The Building Warden (Manager HIFAR Facility) and Deputy Warden (HIFAR Facility Site Supervisor) for B15 will manage any evacuation from the building [33]. Evacuation plans in each building show the designated muster points and Building Wardens. New staff are given training in the emergency procedures during induction and ongoing training occurs during the training exercises.

Because of possible contamination of the air following a ventilation failure or fire, there is a requirement under site operations procedures that emergency response personnel entering the Reactor Building must wear self-contained breathing apparatus.

7.13 SAFEGUARDS

Safeguards requirements are necessary to control the physical security of nuclear material and prevent theft or loss. These requirements are defined in the Nuclear Non-Proliferation Treaty. Safeguards requirements related to the presence of nuclear grade graphite and DU are required and thus, inspection from ASNO and the IAEA may occur during the Possess and Control period.

7.14 CRITICALITY CONTROL

There are no criticality issues relevant to HIFAR.

7.15 CONTROL OF TOXIC & HAZARDOUS MATERIALS (ASBESTOS, ETC)

There are few toxic and hazardous materials in the HIFAR Facility. The diesel for the emergency generators and the lubricating oils are a combustible liquids but are not toxic. The main material of concern is asbestos as it is known to be in the Reactor Building.

A preliminary assessment of the locations of asbestos within the Reactor Building has been undertaken [34]. This has identified only a few areas where there is asbestos:

1. Basement - White floor tiles behind No. 1 storage vault
2. 5 metre level - Wall behind sink in kitchenette
3. Mezzanine - Grey floor tiles around rig technician desk

However, the assessment could not be undertaken in great detail as the reactor was operational. Following final shutdown, areas likely to contain asbestos, such as gaskets and insulating materials will be investigated for the presence of asbestos as part of the individual projects.

It is also expected that the neoprene diaphragms in the gasholders are reinforced with woven asbestos fibres.

Where asbestos is found, it will be labelled to ensure that it is not inadvertently disturbed during the dismantling and refurbishment. This labelling may take the form of spray painting, wrapping with coloured tape or similar, which will ensure that people working in the vicinity know that there is asbestos present.

Preliminary dismantling and refurbishment activities that include a section that contains asbestos, the procedure for removal of asbestos will be incorporated into the dismantling and refurbishment procedures for that section.

Any asbestos that is removed will be bagged appropriately, labelled and stored in a designated location for asbestos material by personnel qualified for the task. When a significant quantity of asbestos has been collected it will be disposed off site to a designated land fill facility. The SWMS for tasks that are undertaken in areas where asbestos may be present will include the methods to ensure that exposure does not occur.

7.16 CONTROL OF ELECTRICAL HAZARDS

The potential for a live electrical system to be inadvertently contacted during the preliminary dismantling and refurbishment process is controlled through the provision of a new electrical supply to the Reactor Building. This system will be labelled clearly at many points along its route.

The existing electrical supply will be completely disconnected from the substation, the generators and battery backup supplies before cabling is removed. The SWMS for each task will consider the potential for a live connection to the equipment.

The existing site procedures will be used for installing, changing over and maintaining the new power supply system. These procedures include SWPs, SWMS, danger tags and a number of Standards and Regulations to control electrical hazards. There are various techniques for dismantling obsolete electrical systems, including "earthing guns" which fire nails thru wires to connect them to earth. This reduces the risk that a circuit has not been isolated.

7.17 CONTROL OF PHYSICAL HAZARDS

The potential for heavy items to cause crush injuries during movement and lifting is recognised as a significant potential for injury.

All crane lifts will be undertaken by licensed crane operators. All chains and slings will be inspected at appropriate intervals and following any damage to ensure that they are maintained in good condition.

The SWMS for each task will consider the potential for crush and drop injuries and ensure that appropriate controls are instituted.

The ANSTO guidelines on working at heights and other hazards will also be considered during the preparation of the SWMS and will be followed during the preliminary dismantling and refurbishment.

8. WASTE MANAGEMENT

This section outlines the waste management arrangements for HIFAR. This should be read in conjunction with the Radioactive Waste Management Plan for HIFAR, in Part B(4) of the licence application.

8.1 POLICY AND REQUIREMENTS

The ANSTO Radioactive Waste Management Policy (APOL 2.2) should be consulted for the overall site discharge limits and general waste handling. ANSTO complies with appropriate codes in the handling, management and disposal of radioactive waste. ANSTO is certified to ISO14001 and is committed to regularly assessing the types and quantities of waste being generated, and evaluating and implementing improved ways of operating to bring about reductions where possible. This occurs, for example, through the Safety Assessment process which includes an assessment of waste generation of each proposed activity.

ANSTO's Radioactive Waste Management policy is consistent with international and national codes and these are implemented through ANSTO OHSE Standards and Guides.

8.2 AIRBORNE DISCHARGES

During the initial dismantling and refurbishment activities, the majority of the tritium will be released as tritiated water from the from the drained internal surfaces of the primary cooling and helium circuits (01 and 02 circuits) as well as from small pockets of trapped D_2O liquid until it evaporates away.

In addition, some minor release of tritium gas can be expected from the graphite space where it is present as tritiated hydrogen gas. This gas has a very much larger permitted ALI than tritiated water because it is not as readily absorbed as water. The existing stack monitors are not capable of detecting tritium gas released from the graphite space.

The ventilation system for the Building 15 will extract air from the reactor block to ensure that tritium does not build up in the atmosphere inside the Building. This gas stream will flow through the active extract filters to remove solid materials before it is released from the vent on the top of the building. The activity emitted from the stack is measured and reported to facility management, and included in quarterly reports to ARPANSA.

Tritium vapour will continue to be released from the dry 01 and 02 circuits for some considerable time and the experience of the 2000 major shutdown is relevant in considering the quantities of tritium that are likely to be released following the draining of the D_2O from the 01 circuit.

The total tritium content of air discharged from HIFAR stacks between 1/2/2000 and 2/5/2000 was 9696 GBq (14 weeks). This included the highest weekly discharge of 4217 GBq for the week when the 01 circuit valve servicing, DP cell maintenance, heat exchanger inspections / maintenance and D_2O Pump maintenance were performed and the levels of tritiated water in air were measurable and at times up to hundreds of DAC[2]. The total value of 9696 GBq was less than half the major shutdown notification level of 20,000 GBq per quarter [18].

Since there are no fuel elements or D_2O inside the Reactor Building, the generation of ^{41}Ar and other activation gases and vapours has already ceased.

8.3 SOLID WASTES

The overall processes relating to the generation of solid waste during Possess and Control period will be as follows:

1. The equipment to be dismantled will be identified.
2. Routine inspection of the accessible areas will be undertaken to confirm that there is no contamination on the equipment.
3. The equipment will be dismantled. When interior areas of piping become accessible, they will be routinely checked for contamination inside.
4. The dismantled equipment will be examined to confirm that the material is not contaminated.
5. It will be labelled and details recorded.
6. It will be relocated to a suitable designated area outside the facility.
7. Items that can be re-used on site (such as lead shielding) will be sent to the store or directly to other site locations for re-use.
8. Items that are recyclable will be collected and sent for recycling.
9. Items that are not recyclable will be collected and sent to landfill.

If contamination is found on the equipment, it will be labelled as such, segregated from other wastes and then examined in more detail to determine the level of contamination and whether it will be decontaminated or classified as active waste. For some projects with large items (bulk or weight), if

[2] 1DAC of tritiated water = 463 kBq/m^3 $\cong$ 12.5 μCi/ m^3

the initial contamination assessment indicates it cannot feasibly be decontaminated then the project may be re-evaluated.

Any active items will be stored in the EPR (inside B15) until the disposal or storage route is confirmed. Any larger items that cannot be easily reduced is size may be stored in B27 following consultation with Waste Operations.

Using the experience from DIDO and PLUTO and applying it to the HIFAR case, taking into account those items which will not be removed during the Possess and Control period, it is estimated that approximately 0.5 tonne of solid waste could be generated [19 p104, 35]. In the UK this would have been classified as very low level waste. In Australia, this would be classified as low level waste, or may even be exempt.

8.4 LIQUID WASTES

Small quantities of liquid discharges may be generated from preliminary dismantling activities (e.g. from decontamination work) and discharged to the “B” or “C” lines subject to the limits specified in ANSTO OHSE AG 2519 Safe Management of Radioactive Waste - Liquid Wastes (Guide). Discharge to the sewer will be in accordance with Trade Waste Agreement limits set with Sydney Water and monitored by ARPANSA.

The liquid waste from the preliminary dismantling and refurbishment will include water from SB1 and cooling towers, refrigerant from the space conditioning system, oils from equipment and diesel from generators.

The aqueous wastes are all anticipated to be non-active and will be discharged into the site water treatment system. The rate of discharge will be determined in discussions with WO to ensure that it is not excessive.

The (non-active) refrigerant from the space conditioning system will be collected by licensed personnel to ensure that the refrigerants are not released to the atmosphere.

Oils, also non-active, will be drained from the equipment and sent to an oil recycling company.

The diesel from the storage tanks for the diesel generators will be pumped out into a tanker and then transferred to other diesel storage tanks for re-use on site.

There may be small quantities of active liquid waste generated through testing and decontamination of equipment with very slight contamination. The quantity of this waste is expected to be low, in line with the experience of DIDO/PLUTO perhaps as much as $1.6m^3$ [19 p 104]. Any equipment with significant contamination will be stored for the final dismantling phase of the HIFAR Facility.

8.5 RECORDS

All the equipment removed from within the Reactor Building or where there could be contamination (e.g. pneumatic transfer lines) will be tagged. This tag will include the location where the equipment was removed from, what the equipment was and the results of the activity assessment.

The ultimate destination of the equipment will be recorded as the equipment leaves site or is sent for interim storage on-site. A detailed database structure has been developed for this management of material flow [36].

9. DOSE ESTIMATES

During the Possess and Control period, doses received by staff are anticipated to be very low.

Outside the Reactor Building, there are no significant doses likely to be received by people removing the cooling towers, etc. The only potential for doses are through the removal of the AUSANS beam line and the pneumatic conveyor pipes. Exposures will be managed through the normal radiation protection regime used in the management of maintenance on these items of equipment.

Within the Reactor Building, the intention is to remove redundant equipment in a white, white classified area. Thus the dose estimates from the routine activities is anticipated to be very low due to the background radiation level.

There is the potential for higher doses to be received if a mistake is made and shielding is removed or an active piece of equipment is removed. The assessment of such accidents is considered in section 10.

The estimates of doses received are likely to be lower than those experienced during the last major shutdown (see section 5.2). These dose rates were consistent with operating dose rates and showed that they were within the ANSTO site limits.

Each project being undertaken in the preliminary dismantling and refurbishment will be subject to SAC review, which will include scrutiny of the potential for excessive doses.

In summary, the dose rates received by people undertaking the preliminary dismantling and refurbishment projects is expected to be no more than the dose rates receive by HIFAR operators during normal operations; and will most likely be significantly lower.

10. SAFETY ANALYSIS

This section discusses the hazards present in the facility and the risk controls and strategies used to manage those hazards.

The internal and external events that could potentially expose those hazards are also discussed. Since the facility is largely static except for the planned activities (such as preliminary dismantling and refurbishment), the possible internal events would be associated with those activities. These activities are similar to the sorts of activities that have been undertaken when the reactor was operational (during major shutdowns for example) and were managed through the HIFAR project management processes. For the facility in this period, the associated risks are largely occupational with some radiological. The arrangements for this period are based on the arrangements that were current when HIFAR was operational.

The possible external events that were acceptable when HIFAR was operating, pose a negligible risk to the facility in this period.

10.1 HAZARD IDENTIFICATION

The hazards associated with the facility are listed below. These are general hazards and are not specified in detail. The individual SAC submissions will examine the hazards in more detail. However, it is appropriate to undertake a high level assessment of the likely hazards that will be associated with the preliminary dismantling and refurbishment activities.

- radiation hazards through unshielding a piece of active equipment,
- radiation hazards through contamination
- radiation hazards through tritium release from the graphite
- asbestos exposure
- mechanical hazards involved in the movement of heavy equipment
- fire
- toxic or asphyxiant gases
- electrical hazards

10.2 RISK MANAGEMENT

The hazards listed above will be managed through various mechanisms described below. The controls listed are the general administrative controls to manage the activities of people undertaking the dismantling or refurbishment, as well as the instrumented controls: radiation detectors, ventilation failure alarms and fire detectors.

Table 10.1 Hazard Management

Hazard	Causes	Consequences	Controls
radiation hazards through unshielding a piece of active equipment,	Inadvertent action during dismantling or refurbishment; or activity in unexpected location	Radiation exposure to people in the vicinity	Work Permits; SWMS, health physics surveys, area radiation monitors and alarms, TLD badges
radiation hazards through contamination	Inadvertent action during dismantling or refurbishment; or activity in unexpected location; vacuum filter bag rupture Waste containing activity moved out of Reactor Building without detection	Radiation exposure to people involved and potential spread of contamination	Work Permits; SWMS, health physics surveys, radiation scanners at entry and exit points; TLD badges, waste scanning; clearance certificates;
radiation hazards through tritium release from the graphite	Failure of ventilation system or disconnection of ventilation piping	Radiation exposure to people in the vicinity	Work Permits; SWMS, area tritium detectors and alarms, whole body monitoring, ventilation failure alarms, evacuation procedures, drills
asbestos exposure	Inadvertent generation of asbestos dust during removal of equipment	Potential cancer to people exposed	Identification surveys, marking, bagging, work permits, SWMS.
mechanical hazards involved in the movement of heavy equipment	Failure of lifting equipment or incorrect lifting procedures; inadequate supporting of equipment during dismantling	Crush injuries to people involved Potential loss of shielding	Work permits, SWMS, licensed crane drivers, equipment and sling inspections
fire	Dismantling activity such as grinding or oxy-acetylene cutting igniting combustible or flammable materials.	Injuries due to smoke inhalation and burns	Work permits, SWMS, fire detectors, fire extinguishers, minimal fire load, housekeeping, evacuation procedures, drills
toxic or asphyxiant gases	Toxic gas or nitrogen building up in the Reactor Building or a smaller volume	Potential asphyxiation of people present	Toxic gases not intended for use in the Reactor Building. Limited quantities of nitrogen used in the Reactor Building. Work permits, SWMS.
electrical hazards	Dismantling or other work on a live electrical system	Electrocution or electric shock	Work permits, SWMS, licensed electricians.

The facility is relatively free of contamination on external surfaces of equipment, walls, etc. The ventilation system HEPA filters generally have very low levels of activity. The facility contains a minimal fire load which will be lessened by the preliminary dismantling, as pumps, compressors etc and their associated lubricants are removed. Therefore, it is not credible that fire could cause a radiological release. Fire is essentially an occupational safety issue, and the prime response to a fire is to evacuate the facility.

10.3 REFERENCE ACCIDENT

The hazards listed above were examined along with the hazard analysis contained in the HSD [10] to determine the Reference Accident for the HIFAR Facility.

Of the five accident types listed in the HSD only two were seen as credible during the Possess and Control period. These are:

1. A shield plug could be lifted from SB1, allowing radiation shine from the port of the storage block. (based on 7.6.12 in the HSD).
2. A severe earthquake (section 7.8.1 of the HSD) could cause damage to SB1 resulting in loss of shielding or could cause shielding of the horizontal beam lines to be displaced.
3. A severe earthquake could cause failure of the reactor block support columns leading in the worst case to the reactor block dislodging from the support columns.

Both of the credible accident scenarios are considered below to determine the reference accident for this SAR.

<u>Lifting of a shield plug</u>

There are both horizontal and vertical storage facilities in SB1. The horizontal storage holes have some active materials such as collimators and activated stainless steel. The vertical storage holes contain the more highly active items such as CCAs although these will be relocated to the reactor for storage.

As the horizontal flask is unavailable, the shield plugs for the horizontal holes could only be removed using jacking screws or other powered devices. Due to the difficulty of removing the shield plugs and the lower activity of the contents, the higher risk is associated with the vertical storage holes.

The activity of the CCAs that were recently removed from the reactor following final shutdown is significant. The activity was estimated to be of the order of 1000 Sv/h at contact [37]. Thus, the radiation shine that would be emitted from the storage hole would be significant. However, such radiation would be directed in a vertical direction.

The CCAs are gradually being moved to B42 hot cells and the blades removed. The blades will become waste and will be managed under the Waste Operations Licence. The CCAs minus the blades will be moved back into the Reactor Block, because the plugs provide useful shielding. Some of these movements may continue after issue of the Possess and Control licence that is being sought. For this reason, this accident scenario remains in consideration.

<u>Earthquake</u>

The SB1 has been assessed to ground motions up to 0.23g. This level of ground motion is expected to occur on average once in 30,000 years [10 p12 of Section 7.8]. An earthquake could cause an item to fall on the storage block or displace shield materials placed in front of a beam line. However, because the storage block is constructed of massive concrete, it will resist damage from any falling object and any damage is likely to result in only slight loss of shielding. In addition, the beam lines from the reactor all contain shutters within the reactor block that greatly attenuate radiation shine from the beam lines.

The Reactor Block and support columns have been assessed to ground motions up to 0.23g but have been shown to have a high level of confidence to survive much higher ground motions. Failure of the columns could, in the worst case, cause the reactor block to topple but major structural failure of the block itself is not credible.

Therefore, neither of these possible earthquake events are considered bounding.

<u>Reference accident</u>

Based on the descriptions of the potential accidents in the facility, the reference accident is determined to be lifting of a shield plug from a storage hole in SB1 that contains the most active item (a recently removed CCA).

This reference accident holds some similarities with the abnormal occurrence in 1992 when operators accidentally started pulling out an irradiated fuel element using the ragged end flask [38] [39]. Although contact dose rates from a CCA blade could be as high as 1000 Sv/h at contact [37], experience from the 1992 event showed that the crane operator responded quickly and correctly, and actual doses received by staff nearby were at most 3.0 mSv.

The consequences of such a reference accident is significant radiation levels in a vertical direction above the storage block hole with some lesser radiation scattered in all directions. Based on the incident in 1992, where the three operators in the vicinity received a radiation dose but no-one outside the Reactor Building received a significant dose, the consequences of the Reference Accident are assessed to result in potentially significant doses to people inside the Reactor Building but very low to people outside the Reactor Building.

10.4 SAFETY ANALYSIS FOR INTERNAL ABNORMAL EVENTS

The management systems and instrumented alarms listed in Table 10.1 above are considered able to manage the risks associated with the preliminary dismantling and refurbishment. In particular, the SAC assessments, work permits and SWMSs, coupled with the use of licensed electricians and licensed crane drivers provides the ability to ensure that the hazards are managed.

However, it is essential that each of these administrative systems be followed closely to ensure that the specific hazards of each task are identified and appropriate measures be put in place to manage the risk to a low level.

Where a piece of equipment being dismantled is likely to contain some contamination or activity, a dose assessment must be made prior to the dismantling to ensure that the dose received is ALARA.

For the reference accident scenario, there are numerous protection systems that will act to prevent such an occurrence:

1. There are no planned movements of items out of SB1 during the Possess and Control period (although the final movements of the CCAs may continue for a short period into the Possess and Control period).
2. Additional shielding will be placed above SB1 to reduce background radiation levels.
3. The permit to work system and SWMS systems will reduce the risk that a person undertakes an incorrect task.
4. Only licensed crane drivers, familiar with the hazards within the Reactor Building, will operate the polar crane.
5. Supervisors will be present during the dismantling activities to ensure that personnel only undertake the tasks using correct procedures.
6. The area radiation alarms will detect any increase in radiation level and alert personnel to evacuate the building.

10.5 SAFETY ANALYSIS FOR EXTERNAL EVENTS

The external accidents include bushfire, earthquake, artillery impact, aircraft strike and industrial accident. Each of these accidents were analysed in the HSD [10] and the risk shown to be extremely low for the operational reactor. These events were considered to pose an acceptable level of risk when the reactor was operating. In the Possess and Control period, the risks posed by these external are considered to be negligible.

The location of the new reactor building (OPAL) is more than 100 m distant from the Reactor Building. The SAR for OPAL [8] shows that the risk to other facilities on site is sufficiently low.

10.6 ANALYSIS OF ENVIRONMENTAL IMPACT

The preliminary dismantling and refurbishment projects will result in significant quantities of solid waste materials. Some of the dismantled materials, such as lead shielding, will be reused on site, some is being stored for preservation of museum exhibits and some, such as steel piping and copper wiring, will be able to be recycled. Virtually all of the rest of the waste material will be non-active waste able to be sent to landfill. Only very small quantities of waste is expected to have activity requiring it to be stored on site.

Notwithstanding this, the analysis of environmental impact will be considered in the SAC submissions for each of the projects.

10.7 ASSESSMENT OF LIMITS AND CONDITIONS

The OLCs used during the operations of HIFAR were reviewed for applicability as limiting conditions during the Possess and Control period. Of the original OLCs, only five were found to be applicable during the Possess and Control period. These related to the detection and alarming on excessive gamma radiation, detection and alarming on excessive tritium concentrations in the Reactor Building, detection of excessive airborne releases from the Reactor Building, specific requirements on any movements from SB1 and requirements for entry of hazardous materials into the Reactor Building.

The significant decrease in number of LCs is considered appropriate due to the great decrease in the hazards of the HIFAR Facility. The radiological hazards associated with the HIFAR Facility are very low and are controlled through the LCs that relate to gamma radiation and tritium concentration in the Reactor Building. The environmental risk is controlled through the LC on airborne discharge limits.

The other management systems that manage the risks of the hazardous events listed in Table 10.1, such as work permit systems and licensing of crane drivers are not controlled by process parameters and thus are not properly the subject of Limits and Conditions.

10.8 OCCUPATIONAL HEALTH AND SAFETY

Occupational Health and Safety issues will be managed through use of the same systems as are used over the rest of the site. The nature of the preliminary dismantling and refurbishment projects will require the movement of large and heavy items. The use of work permits, SWMS and supervision are considered sufficient to reduce the risk to an acceptable level.

10.9 FACILITY HAZARD CATEGORISATION

The consequences of the reference accident, the accidental lifting of the shield plug for the most active item in SB1 are shown in section 0 to result in doses that are very unlikely to cause significant injuries to a person outside the building.

This leads to the hazard categorisation of the HIFAR Facility as F1 “No potential for significant consequences outside the facility” [2].

10.10 SUMMARY

The hazards that are presented by the HIFAR Facility are significantly lower than existed when HIFAR was operating. There are no criticality or nuclear hazards because all fuel and D_2O have been removed from the Reactor Building. The major hazards that exist are industrial hazards associated with moving heavy objects and radiological hazards associated with inadvertent removal of shielding from the reactor or items stored in SB1.

The consequences of the Reference Accident (lifting a shield plug from SB1) are potentially significant to people located in the Reactor Building, particularly people above the storage block hole. However, there are a number of layers of protection against such an accident. These include the administrative controls of work permits, SWMSs and licensed crane drivers as well as the presence of additional radiation shielding above SB1 and radiation detection alarms and emergency procedures.

The Limits and Conditions for the HIFAR Facility are based on the HIFAR OLCs but with significant changes to account for the reduction in risk. The LCs address the issues of radiation levels in the

Reactor Building, the prevention of contamination leaving the Reactor Building and the measurement and removal of tritium that is evolved from the graphite.

11. CONCLUSIONS

Once the fuel elements and D_2O are removed from the Reactor Building, the vast bulk of the hazards are also removed. There are no criticality issues and only limited Safeguards issues relating to the presence of nuclear grade graphite.

The former Engineered Safety Provisions (safety systems) for HIFAR (which were crucial during operation) are either not required at all, or now protect against only minor hazards affecting staff in the reactor building at the time. In the event of a failure of the ventilation system, lighting or another system, there are no tasks that will take place that cannot be readily suspended until the services are restored. Furthermore, failure of the safety support systems will not produce immediate risks to personnel inside or outside the Reactor Building.

The location is secure, being inside the HIFAR fenced area and the personnel who have operated and maintained the reactor will be available to assist in the preliminary dismantling and refurbishment.

Each project undertaken during the Possess and Control period will be assessed using the ANSTO Risk Assessment protocols. This requires that an assessment is made to identify hazards and hazardous scenarios and assess the associated risks to ensure that the control measures are adequate. For most projects this will involve preparation of a SAC submission, but some very minor projects may be assessed using Safe Working Method Statements or similar, in accordance with the OHSE Safety Approvals System.

Where the projects are subject to ARPANS Regulation 51 provisions, a submission will be made to ARPANSA. Projects that are subject to ARPANS Regulation 52 will be reported quarterly in accordance with that Regulation.

There will be no dismantling activities associated with the reactor block, Storage Block No. 1, the plant room or the 01 or 02 circuits during the Possess and Control period. Furthermore, no dismantling will be undertaken that will generate sizeable quantities of radioactive waste.

The operating history of HIFAR shows that the doses to personnel during normal operations and during major shutdowns can be managed effectively. The monthly doses to personnel undertaking the preliminary dismantling and refurbishment projects are expected to be less than the doses received during major shutdowns.

The review of decommissioning reports from DIDO and PLUTO in the UK show that the HIFAR Facility can safely undergo preliminary dismantling followed by a period of Safe Enclosure prior to final dismantling.

The systems used at ANSTO to manage occupational safety, radiation doses and control modifications to equipment and facilities are appropriate for the preliminary dismantling and refurbishment of the HIFAR Facility systems. The existing site procedures and limits on radiation dose are appropriate for managing the hazards associated with the dismantling and refurbishment, as are the emergency arrangements.

The systems developed for management of waste that will be produced during the preliminary dismantling and refurbishment phase are able to ensure that all waste will be accurately classified and records kept of the disposal route. There will be very minor quantities of liquid waste produced and the only significant airborne waste will be tritium released over time from the graphite reflector. The tritium vapour will be extracted, filtered to remove any particulates and discharged through the current vent on the top of the Reactor Building. The emission of tritium is expected to be below the notification limits set by ARPANSA.

The safety analysis identified the Reference Accident for the facility to be the accidental removal of the shield plug for the most active component in Storage Block No. 1. The consequences of this accident would result in significant vertical radiation shine plus minor radiation exposure to people located on the ground or in buildings outside the HIFAR Facility. Thus the hazard classification for the HIFAR Facility is F1: “No potential for significant consequences outside the facility” [2].

The analysis shows that the overall concept for preliminary dismantling and refurbishment can be undertaken without undue risks to people or the environment. The SAC and ARPANSA Approval Processes and the safety management systems are appropriate to manage each of the individual activities to be undertaken during the Possess and Control period.

12. ACKNOWLEDGMENTS

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