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Replacement Research Reactor Project

COMMISSIONING PLAN

Prepared By
Australian Nuclear Science and Technology Organisation

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

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1 PRELIMINARIES

1.1 DEFINITIONS

1. Audit: A documented activity performed to determine by investigation, examination and evaluation of objective evidence the adequacy of and adherence to established procedures, instructions, specifications, codes, standards, administrative or operational programmes and other applicable documents and the effectiveness of implementation.
2. Commissioning: The process during which the performance of reactor components and systems, having been constructed, is verified to be in accordance with design assumptions and meet operational requirements, occupational safety requirements and nuclear safety requirements; it includes both nuclear and non-nuclear tests.
3. Contract Performance Demonstration Test: A test performed to demonstrate that the plant fulfils the performance indicated in the CPAC.
4. Deficiencies: Term denoting either non-conformities or deviations.
5. Deviation: The document defined under the Commissioning QA Plan that identifies procedures that need to be revised or corrected.
6. Non-conformity: The document defined under the Commissioning QA Plan that identifies an item that does not meet the requirements or specifications.
7. Operational 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 ARPANSA for safe operation of the reactor facility.
8. Post-installation test: Individual component and equipment tests performed as part of the installation procedures.
9. Pre-commissioning test: A term used interchangeably and synonymously with Pre-operational test.
10. Pre-operational test: A system test performed once the construction and post installation tests have been finished, the term is synonymous with Pre-commissioning test.
11. Review: A systematic reassessment of the commissioning activities carried out at regular intervals and aimed at ensuring a high level of quality and safety throughout the commissioning phase.
12. Test: The set of measurements, examinations and/or observations carried out as part of the determination that a system, structure or component meets its design intent.
13. Verification: The process of determining whether the quality or performance of an item or activity is as stated, as intended or as required.

1.2 ACRONYMS

1. CG: Commissioning Group
2. CM: Commissioning Manager
3. COG: Construction Group
4. CP: Commissioning Plan
5. CPAC: Contract Performance Acceptance Criteria
6. CPDT: Contract Performance Demonstration Test
7. CQAP: Commissioning Quality Assurance Plan
8. CSRC: Commissioning Safety Review Committee
9. LHSTC: Lucas Heights Science and Technology Centre
10. MG: Management Group
11. OG: Operation Group
12. CLC: Commissioning Limit and Condition
13. QA: Quality Assurance
14. RRR: Replacement Research Reactor

2 COMMISSIONING OBJECTIVE AND GENERAL DESCRIPTION

2.1 INTRODUCTION

1. The initial tests of the RRR facility consist of a series of tests categorised as post-installation, pre-commissioning and commissioning tests. The post-installation tests commence with the completion of system/component installation and ends with system turn over for pre-commissioning test. The pre-commissioning test phase begins after completion of the post-installation tests of the systems and continues until the completion of systems tests. Pre-commissioning tests are run on individual systems, and are aimed to release the system as a stand alone unit. The commissioning test phase begins with final integration tests followed by fuel loading and terminates with the completion of the power ascension tests. Commissioning tests are aimed at demonstrating the performance of key safety systems and test the integration between the different systems.
2. Post-installation tests are run under the organisational, procedural and control framework of the Construction, Inspection and Test Plan.
3. Pre-commissioning tests are run under the organisational, procedural and control framework of the Pre-commissioning Test phase Plan.
4. This Replacement Research Reactor Commissioning Plan (CP) represents the top level RRR Project strategy and plan for:
   a) Organisation and management of the commissioning effort;
   b) Planning and scheduling of the commissioning;
   c) Successful testing and verification of the functional performance of the facility systems in accordance with the project schedule within budget and with the required quality standards; and
   d) Organisation and arrangements to carry out the Contract Performance Demonstration Tests (CPDT)
5. The CP gives the framework for all the activities needed to carry out the commissioning tasks from the end of the pre-commissioning test phase up to completion of power tests and the demonstration of the plant performance in accordance to the contract.
6. Although the commissioning goals are fulfilled at the end of stage C commissioning, this CP includes an additional stage where the CPDTs are executed. These tests are performed with the plant and the facility staff in accordance with the arrangements foreseen to operate the facility routinely. This stage covers the gap between the commissioning phase and the operation phase.
7. The CP gives a key to the list and scope of operative documents that will be used during the execution of commissioning.
8. The CP outlines the prerequisites that are necessary prior to the start of the commissioning phase and commissioning stages.

2.2 APPROACH TO COMMISSIONING

1. Commissioning results in an operational system, i.e. all components tested and verified to be in accordance with their design intent, operating and maintenance procedures available and in place and the operation staff able to operate a fully operational reactor facility.
2. Commissioning phase is carried out to demonstrate that:
   a) The plant systems and subsystems operate together in an integrated manner in accordance with the design objective and meet the performance criteria regarding operational requirements, occupational safety requirements and nuclear safety requirements;
   b) The documentation is adequate for full facility operation, describing accurately the plant and procedures;
   c) Staff skills are appropriate to operate the plant in accordance within occupational health and safety requirements and regulatory requirements;
   d) The facility performs as designed;
   e) The plant interfaces appropriately with LHSTC related facilities;
   f) The measurable parameters for items performing safety functions comply with the intents of design as stated in the SAR; and
   g) The Contract Performance Demonstration Tests are run to demonstrate compliance with the Contract Performance Acceptance Criteria.
3. The commissioning phase will give an opportunity to ANSTO staff to obtain practical experience in the operation of equipment and systems.
4. The commissioning phase is identified in the RRRP Contract Master Schedule as one of the Project phases. The Commissioning phase is organised into several stages, each with its own objectives and specifications.
5. The commissioning is driven by an organisation composed of different groups, each with its defined objectives and responsibilities along the different commissioning stages. During the commissioning phase the responsibility for proper operation and maintenance of plant systems is gradually transferred from the Construction Group to the Operation Group.
6. The Commissioning arrangements are consistent with the guidelines and recommendations of:
   a) IAEA Safety Standards Series, “Commissioning of Research Reactors”, Draft Safety Guide, NS259 NS-G1 draft 4, March 1999 (ex Safety Series 35-G4, “Safety in the Commissioning of Research Reactors”).
   b) IAEA, 50-C/SG/Q12, Quality Assurance in Commissioning.

3 COMMISSIONING ORGANISATION AND RESPONSIBILITIES

1. The responsibilities and duties of all project participants are discussed in the RRR Management Plan. The specific responsibilities related to the commissioning are defined in this section.
2. The responsibilities and duties of the facility staff and LHSTC support groups for routine reactor operation during the CPDTs stage and beyond will be provided by procedure.

3.1 ORGANISATION FOR COMMISSIONING

1. To carry out the commissioning, a special organisation is established that is different from the one used for the other project phases. The organisation is based on several groups and managers that are responsible for driving and carrying out the commissioning activities. The groups are as follows: a Management Group (MG), a Commissioning Group (CG), a Construction Group (COG), an Operation Group (OG), the Commissioning Safety Review Committee (CSRC) and the Commissioning Quality Assurance Group (CQAG).
2. These groups are made up of staff of ANSTO, INVAP and its subcontractors who have been part of the project delivery from design to construction and installation, and are thus acquainted with the RRR design.
3. Commissioning of the facility will be overseen by the Management Group, which will be chaired by ANSTO's Project Manager.
4. The commissioning is organised in several stages as explained in Section 4. The commissioning functional chart for stage A is shown in Figure 1, whilst the functional chart for stages B1, B2 and C is shown in Figure 2, and the composition of the groups and teams is shown in Figure 3. The functional chart for the CPDT stage is shown in Figure 4.
5. For the CPDTs, the organisation is modified to become the definitive operational facility arrangements. In this way, the sub-structure from ANSTO that will manage the RRR will liase with INVAP in order to carry out the CPDTs.

3.2 FUNCTIONS AND RESPONSIBILITIES

3.2.1 Management Group

1. The Management Group will have the authority of the ANSTO Chief Executive and the INVAP CEO for the conduct of all activities associated with the commissioning program.
2. The Management Group shall include:

   a) the ANSTO RRR Project Manager,
   b) the INVAP Project Director,
   c) the INVAP Vice President, Nuclear Division
   d) the ANSTO Chief of Operations
   e) the ANSTO Manager Reactor Operations
   f) the ANSTO Director, Safety and Radiation Science,

3. Others may participate in the Management Group by invitation.

4. The principal role of the Management Group will be to provide necessary resources and support to the Commissioning Group and to provide strategic oversight.
5. The ANSTO RRR Project Manager represents ANSTO in administration of the contract throughout the commissioning.
6. The INVAP Vice President, Nuclear Division, and Project Director will provide the resources of INVAP and their various contractors and sub-contractors to fulfil the needs of the contract.
7. The ANSTO Chief of Operations provides the interface between the Project and ANSTO stakeholders.
8. The ANSTO Manager Reactor Operations ensures access to resources in reactor engineering, reactor physics and reactor operation required for commissioning and ongoing operation of the RRR.
9. The ANSTO Director, Safety and Radiation Science brings to the Management Group access to resources with knowledge in radiation protection, licensing and workplace safety.
10. The MG will have the following collective responsibilities:
    a) Appointing authorities and responsibilities for the commissioning groups;
    b) Reviewing the planning and execution of the commissioning;
    c) Authorising the starting of the commissioning stages;
    d) Establishing lines of communication, personal qualification and training requirements, and commissioning plan reviews;
    e) Managing the activities in the interface between participating groups;
    f) Ensuring the availability of an adequate number of properly trained, experienced, qualified and, where required, authorised personnel to carry out the commissioning activities;
    g) Ensuring that appropriate action is taken to correct any deficiencies identified during commissioning; and
    h) Ensuring that the resources necessary to carry out commissioning activities are available.

3.2.1.1 ANSTO RRR Project Manager

1. The ANSTO RRR Project Manager will be responsible for:
    a) Chairing the MG.
    b) Handling the interaction with the regulatory body (ARPANSA) through the Licence Nominee.
    c) Ensuring the conditions imposed by ARPANSA for the commissioning phase are observed and complied with.
    d) Overseeing compliance by ANSTO with its contractual obligations.
    e) Interacting with INVAP on any contractual issue that may arise in accordance with the responsibilities and obligations of the Contract.

3.2.1.2 INVAP Vice President, Nuclear Division

1. The INVAP Vice President, Nuclear Division, will have the responsibility to provide the resources and support from INVAP and subcontractors to carry out the commissioning in accordance with the Contractual obligations.

3.2.1.3 INVAP Project Director

1. INVAP's Project Director is the official spokesman for INVAP and will co-ordinate activities with ANSTO's RRR Project Manager.

3.2.1.4 ANSTO Chief of Operations

1. The ANSTO Chief of Operations will liase with ANSTO stakeholders.

3.2.1.5 ANSTO Manager Reactor Operations

1. The ANSTO Manager Reactor Operations will provide to the Management Group access to properly trained personnel with experience in operation of a nuclear research reactor.
2. He is responsible for the arrangements which will provide a period of parallel operation of the existing research reactor with the RRR to ensure continuity of a neutron irradiation service to ANSTO's stakeholders during commissioning and demonstration performance testing.
3. He is responsible for ensuring that sufficient appropriately trained personnel are available to carry out the commissioning activities.

3.2.1.6 ANSTO Director, Safety and Radiation Science

1. The ANSTO Director, Safety and Radiation Science will provide to the Management Group insight into international best practice on regulatory involvement in commissioning of nuclear facilities.
2. The Director S&RS will be responsible for provision of appropriate resources and advice in radiation monitoring and radiation protection to the commissioning teams.

3.2.2 Commissioning Group

1. The Commissioning Group is responsible to the Management Group for arranging commissioning of the RRR in accordance with the conditions of the contract and the licences issued by ARPANSA.
2. The Commissioning Group will consist of:
   - Commissioning Manager (INVAP)
   - RRR Project Engineering Manager (ANSTO)
   - Commissioning Reactor Manager (ANSTO)
3. The Commissioning Manager is responsible for planning, organising and management of all commissioning work, including preparation of the commissioning plan, the commissioning safety case, and the procedures and instructions for tests.
4. The RRR Project Engineering Manager will bring his technical knowledge and experience gained throughout the design and construction stages of the project and will identify ANSTO personnel from within the RRR project to participate in commissioning activities.

5. The Commissioning Reactor Manager is responsible for providing the resources of the operating organisation to witness cold commissioning activities and to support the hot commissioning. The Commissioning Reactor Manager is responsible for the safety of the facility under the terms of the operating licence.
6. The CG will organise the commissioning of systems and components.
7. The CG is responsible for:
   a) Interacting with the appropriate groups to establish, prior to the commissioning, commissioning test objectives, requirements, plans and acceptance criteria;
   b) Planning in advance commissioning tests and preparing the commissioning schedule, detailed time schedules and procedures which include sequencing, prerequisites for tests, review points, and manpower and equipment requirements;
   c) Monitoring the progress of the Commissioning phase; and
   d) Implementing procedures that ensure orderly transfer of responsibility from the COG to the OG for structures, systems and components, including identification of special precautions for partly installed or deficient systems.

3.2.2.1 Responsibilities of the Commissioning Manager

1. Responsibilities of the CM are to:
   a) Prepare and update the Commissioning Plan and related documents;
   b) Approve the commissioning procedures and any update to them;
   c) Approve commissioning test results on behalf of INVAP;
   d) Organise the activities allocated for every stage, following the procedures presented in the operative documentation and integrating the actions of all the groups involved;
   e) Plan the activities to be carried out during the commissioning stages and the systematic and sequential progression of operations;
   f) Appoint the INVAP personnel to the commissioning teams;
   g) Ensure that the CP is carried out following the Commissioning QA Program;
   h) Establish lines of communication, personnel qualification and commissioning progress reviews;
   i) Verify that systems being commissioned have been successfully tested during the pre-commissioning test stage;
   j) Prepare a comprehensive commissioning report at the end of each commissioning stage, with input and support from other involved groups;
   k) Request authorisation to the MG to start every commissioning stage; and
   l) Liase with the COG.

3.2.2.2 Responsibilities of the RRR Project Engineering Manager

1. The RRR Project Engineering Manager will provide to the Management Group access to the ANSTO personnel who were involved in the identification of design and performance requirements, design reviews and inspection and testing activities during construction and installation.
2. He will provide acceptance on behalf of ANSTO for commissioning procedures and test results.
3. He will nominate ANSTO personnel from the Project Group to be included in the commissioning teams.

3.2.2.3 Responsibilities of the Commissioning Reactor Manager

1. The Commissioning Reactor Manager will provide to the Commissioning Group access to ANSTO personnel in the Operating Group who will be provisionally accredited to operate the reactor containing nuclear fuel.
2. The Commissioning Reactor Manager will be responsible for the safety of the facility and personnel under the terms of the ARPANSA Operating Licence and will have authority to terminate any commissioning test in breach of licence conditions or which threatens safety.
3. The Commissioning Reactor Manager has responsibilities regarding the handling of the Operation Group as explained in section 3.2.4.

3.2.3 Commissioning Teams

1. Commissioning teams will be formed to undertake planning, preparatory work and commissioning tests on reactor systems.
2. Membership of the teams will be determined by the Commissioning Group and will include personnel with knowledge and experience appropriate to the system to be commissioned and tests to be undertaken. The teams will include ANSTO and INVAP staff who have previously been involved in the detailed design and engineering activities, including the staff from both ANSTO and INVAP involved in the development and implementation of the Construction Inspection & Test Plan (CITP) throughout the design and installation stages of the project. Personnel from the Operation Group comprising operators and maintainers from INVAP and ANSTO will also be included in the Commissioning Teams to operate the systems. Other personnel from ANSTO and members of the Construction Group involved in the construction and installation will be included in Commissioning Teams as required.
3. The disciplines included in the commissioning teams may include as appropriate but not limited to:
   a) reactor processes,
   b) reactor systems,
   c) neutron sources,
   d) Instrumentation & Control,
   e) electrical,
   f) irradiation facilities,
   g) balance of plant, and
   h) safety.
4. INVAP personnel allocated to the Commissioning teams will provide support to the Commissioning Manager in ensuring compliance with INVAP responsibilities for Commissioning, including:

   a) Establishing, prior to the commissioning, commissioning tests objectives, requirements, plans and acceptance criteria;

b) Planning in advance commissioning tests and preparing the commissioning schedule, detailed time schedules and procedures which include sequencing, prerequisites for tests, review points, and manpower and equipment requirements;
c) Drafting commissioning test procedures;
d) Ensuring that the prerequisites for the commissioning tests are satisfied, and confirming that the written procedures are adequate;
e) Ensuring that the commissioning procedures comply with the appropriate radiological safety rules and regulations;
f) Conducting the commissioning tests;
g) Resolving difficulties during test execution
h) Issuing reports, filling test records, certificates and completion assurance documentation;
i) Withdrawing or removing procedures and equipment used during commissioning but not appropriate to plant operation.

5. INVAP is responsible for all commissioning of the Reactor Facility. Stage A commissioning will be undertaken by INVAP, with ANSTO personnel witnessing the activities. Stages B and C commissioning will be undertaken directly by ANSTO on documentation prepared co-jointly by ANSTO and INVAP, with INVAP providing guidance on the commissioning procedure and being present throughout.

3.2.4 Construction Group

1. The COG function will be to provide support to commissioning tests and to plant equipment operations.
2. During the commissioning phases of the project, personnel from INVAP and from its subcontractors under overall supervision of INVAP will be on site as members of the COG to provide consultation regarding to systems, equipment characteristics and their initial settings.
3. The COG is responsible for:
   a) Ensuring that the installation of systems and subsystem components has been completed in accordance with design requirements and specifications, and that they are maintained in such a way as to prevent deterioration before being handed over to the OG;
   b) Providing test certificates, as-built documentation, or records highlighting design changes and deviations that may have been approved and implemented during the construction phase;
   c) Transferring the responsibility and knowledge on the installed systems to the OG;
   d) Correcting deficiencies identified during commissioning;
   e) Correcting non-conformances from construction and installation phase and revise documentation if necessary;
   f) Assisting the CG in formulating test objectives and acceptance criteria, in evaluating test results, in correcting non-conformance and in revising documentation as necessary;
   g) Assisting the CG and OG during the execution of commissioning activities; and

h) Maintaining the equipment necessary to carry out commissioning activities, including the calibration of such equipment.

3.2.5 Operation Group

1. The Operation Group (OG) function will be to operate the facility in accordance with the applicable plant documentation and commissioning procedures and requirements.
2. The OG shall consist of ANSTO and INVAP personnel who have been trained in their respective roles as part of the comprehensive training program to be undertaken.
3. The ANSTO personnel will be drawn in large part from Reactor Operations and will be trained in accordance with the procedures and operating instructions developed under the Commissioning Plan ("the Plan).
4. INVAP representatives from the Operation Group will:
    a) participate in development of the Plan,
    b) operate the systems during Stage A Commissioning, and
    c) provide guidance and oversight to ANSTO operators during commissioning Stage B and Stage C.
5. ANSTO representatives from the Operation Group shall:
    a) participate in the development of the Plan,
    b) witness the Stage A Commissioning, and
    c) operate all systems in accordance with the operating procedures during Stages B1, B2 & C Commissioning, during the conduct of the Contract Performance Demonstration Tests, and ultimately during routine operation..
6. ANSTO personnel will operate the Reactor Facility following commissioning, performance demonstration and hand over to ANSTO as an operating facility during and after the initial support period provided by INVAP.
7. During Stage A, the group will be managed by an INVAP representative with the active participation of the Commissioning Reactor Manager. From stage B onwards, the group will be headed by the Commissioning Reactor Manager, who will be responsible for nuclear and conventional safety issues. INVAP will provide support.
8. The personnel will be accredited by the Commissioning Reactor Manager as appropriate, taking into consideration the training received during the previous project stages (stated in the Training Plan). Accreditation will be required from stage B onwards.
9. The OG will be responsible during the commissioning phase for:
    a) Operating all systems in accordance with procedures indicated in the plant documentation, and gaining experience in the operation of the facility,
    b) Carrying out necessary maintenance activities on items transferred from the custody of the COG to the OG;
    c) Satisfying itself that the systems being received comply with the design and safety requirements, and accepting responsibility for the transferred systems; and
    d) Assisting the Commissioning Group in any way necessary to accomplish the commissioning goals.

3.2.6 Commissioning Safety Review Committee

1. The Commissioning Safety Review Committee (CSRC) will consider nuclear and radiation safety implications of all Quality Audit reports during the hot commissioning phase of the project.
2. The CSRC will also be responsible for reviewing the safety implications of proposed hot commissioning tests.
3. The CSRC shall have the responsibility of making recommendations to the Management Group and the Commissioning Group on proposed tests, based on safety considerations, and reporting to the Management Group.
4. The CSRC will have the following membership:

CHAIR:	ANSTO Director, Safety & Radiation Science
	ANSTO RRRP Safety & Licensing Manager
	ANSTO SAR Responsible Officer
	INVAP Safety Analyst
	INVAP Design Representative

5. In addition, the CSRC will consult outside experts for specific support as required.
6. The responsibilities of the CSRC include recommending to the MG the suspension of any portion of the CP and/or halting facility operations on the basis of safety considerations.

3.2.7 Commissioning Quality Assurance Group

1. The Commissioning Quality Assurance Group (CQAG) will be headed by the Commissioning QA Manager (INVAP). The Commissioning QA Manager will report directly to the Management Group.
2. The group will consist of quality assurance personnel from ANSTO and INVAP.
3. The CQAG will assist the Commissioning Manager:
   a) in the implementation of the Commissioning Quality Plan (see section 9),
   b) in providing overview and advice in relation to the preparation of the commissioning procedures contained in the Plan, and
   c) In monitoring commissioning activities for conformance with the Commissioning Quality Plan.
4. The CQAG will be responsible for the internal audit of the Plan throughout all stages of its development. The Commissioning QA Manager shall also ensure that, in conjunction with the Management Group, external audits are also conducted during the development and implementation of the Plan.
5. The CQAG will be responsible for:
   a) Preparation of the Commissioning Quality Assurance Plan (see section 9);
   b) Assisting the CM and the MG in the implementation and enforcement of the Commissioning Quality Assurance Plan and other general procedures;

c) Co-ordinating inspections of implementation of the CP;
d) Maintaining and updating the CP documentation, including test records,
e) Auditing commissioning activities, and
f) Maintaining suitable test and calibration records of the equipment and tools being commissioned;

3.2.8 Safety and Licensing Manager

1. The ANSTO RRR Safety and Licensing Manager will be the communications interface between the Commissioning Group and ARPANSA in regard to regulatory matters associated with the approval to perform commissioning. It should be noted that all formal communications between ARPANSA and ANSTO in respect to RRR commissioning will be routed through the Management Group.

3.3 FUNCTIONS AND RESPONSIBILITIES DURING THE CPDT PHASE

1. During the CPDTs, the organisation will be as per the Chart shown in Figure 4. The functions and responsibilities will be the ones assigned for the Reactor Facility operation phase plus part of the previous commissioning organisation, with the following modifications:
   a) The OG is responsible for the operation, configuration and maintenance of the Reactor Facility.
   b) The OG will receive from the CG requests to perform CPDT activities together with the resources needed to carry them out (e.g. specific human resources, tools and equipment).
   c) It is the OG's responsibility to confirm that the planing of the CPDTs is consistent with operation and maintenance activities.
   d) The OG will receive from ANSTO all the required support to perform other activities not related to the CPDT.
   e) The INVAP Project Director and the ANSTO Project Manager will handle any commercial issues between ANSTO and INVAP regarding CPDT results and progress.
   f) The CG will execute the CPDTs, whilst the OG will be required to operate the required systems according to procedures provided by the CG.
   g) The Facility Safety Review Committee will handle all the safety issues, replacing the CSRC.
   h) The QA group will integrate both the commissioning QA procedures and operation QA procedures in a "migration" to routine operation.

3.4 ANSTO INVOLVEMENT IN THE COMMISSIONING ACTIVITIES

1. Previous sections on the commissioning organisation indicate the participation of ANSTO personnel in the commissioning.
2. ANSTO is responsible for obtaining the necessary permits and authorisations from ARPANSA for the facility as well as for the staff, as needed. To this end, INVAP will provide support in preparing documentation, training and analysis.
3. ANSTO will review the commissioning plans and procedures.

4. ANSTO will provide progressively during stages A, B and C a sufficient number of provisionally accredited operators to permit two-shift operation to the OG. During the CPDTs, long runs are foreseen, and additional staff will be necessary. The required staff involves technicians and engineers to operate and maintain the facility in accordance with the requirements of the Operating Licence,
5. Radiation protection services and health physics support will be provided by ANSTO.
6. The commissioning activities provide an opportunity for further training of ANSTO personnel on the operation of the reactor systems.

3.5 PARALLEL OPERATION WITH HIFAR

1. The optimum level of participation and involvement of ANSTO staff in the commissioning of the new facility will be carefully determined to cope with the parallel operation with HIFAR.
2. During this period, staffing levels for both reactors will be sufficient to ensure that they comply with requirements.

3.6 HAND-OVER OF THE FACILITY

1. Systems will be handed over to ANSTO gradually following completion of the precommissioning test of each system.
2. ANSTO's Project Manager and INVAP's Project Director will jointly agree the hand-over sequence. A preliminary general sequence for hand-over is the following:
   a) buildings
   b) auxiliary services
   c) reactor cooling systems
   d) nuclear systems
   e) I&C systems
   f) radioisotope production facilities
   g) neutron beam facilities
3. The hand-over of each system will be formalised in a hand-over document. This document will state that hand-over was carried out according to the technical specifications and/or specific procedures for the given system, which will be identified.
4. The System Pre-Commissioning Test Release Certificates (STRC's), as defined in the CITP, will be used to facilitate the hand-over of systems to ANSTO. The STRC's are signed-off by INVAP and ANSTO upon successful completion of pre-commissioning testing of a system.

Figure 1: RRR Project Commissioning Functional Organisation Chart – Stage A

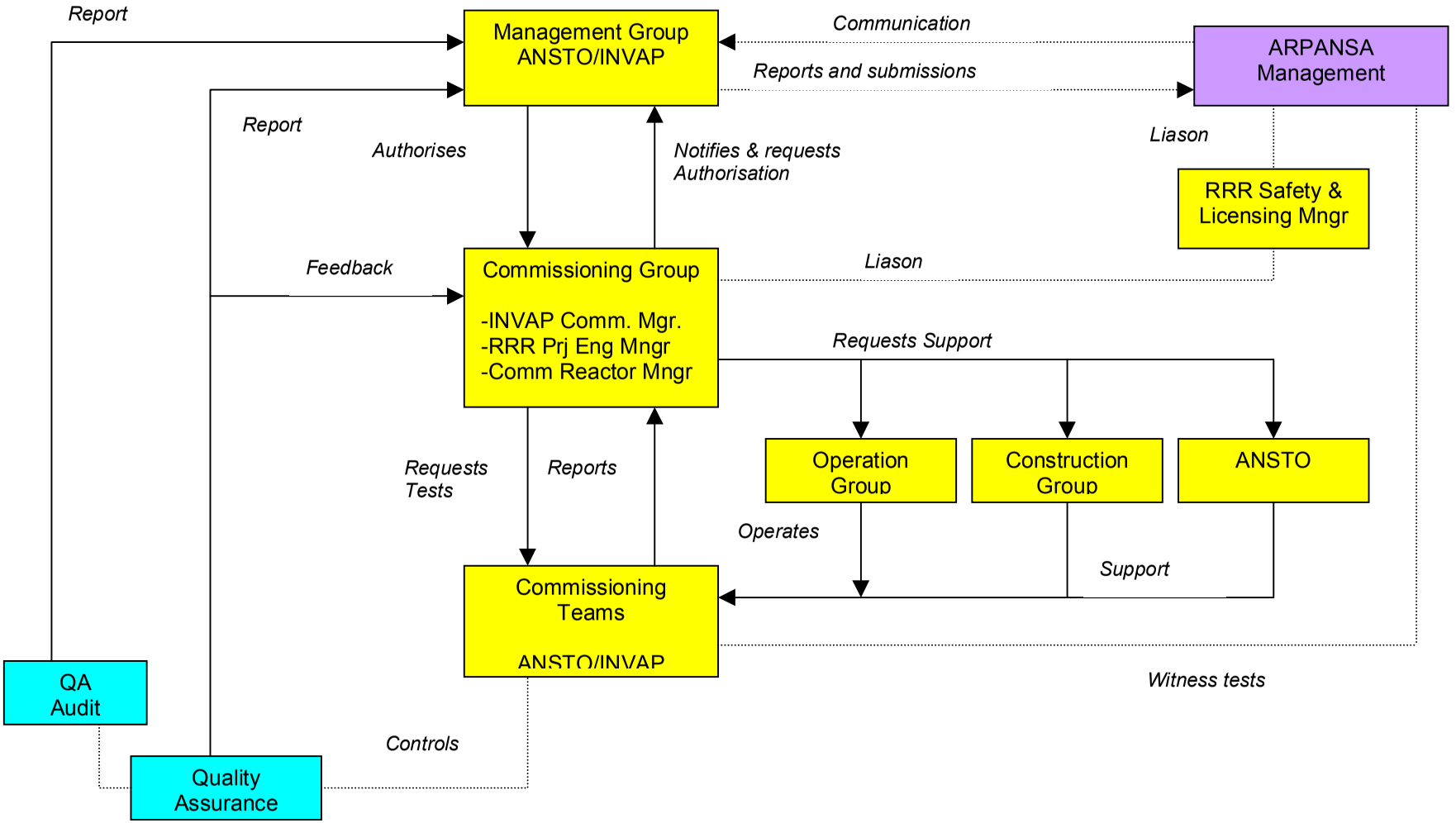


Figure 2: RRR Project Commissioning Functional Organisation Chart – Stages B1, B2 and C

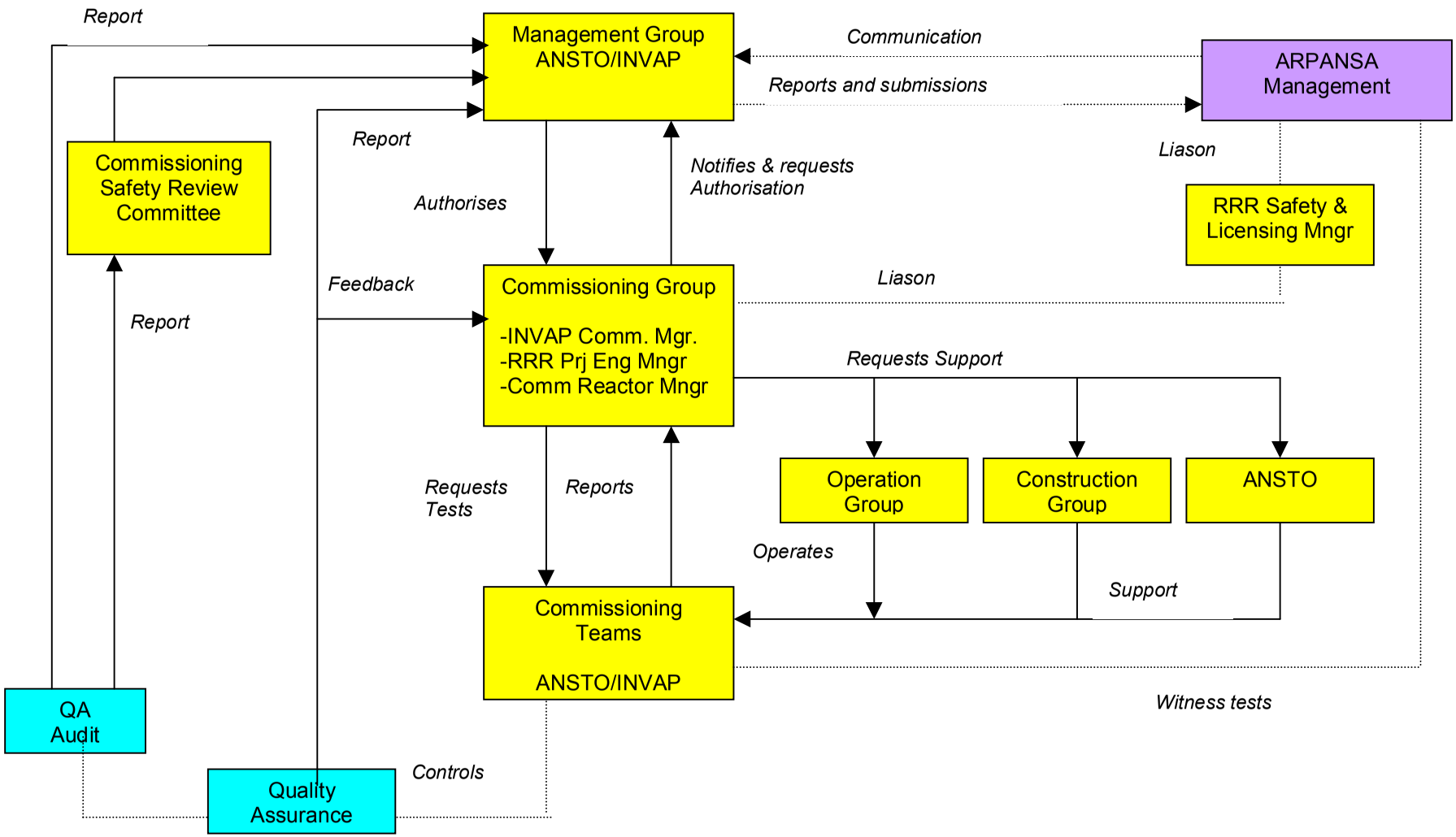


Figure 3: RRR Commissioning Organisation and composition of commissioning teams

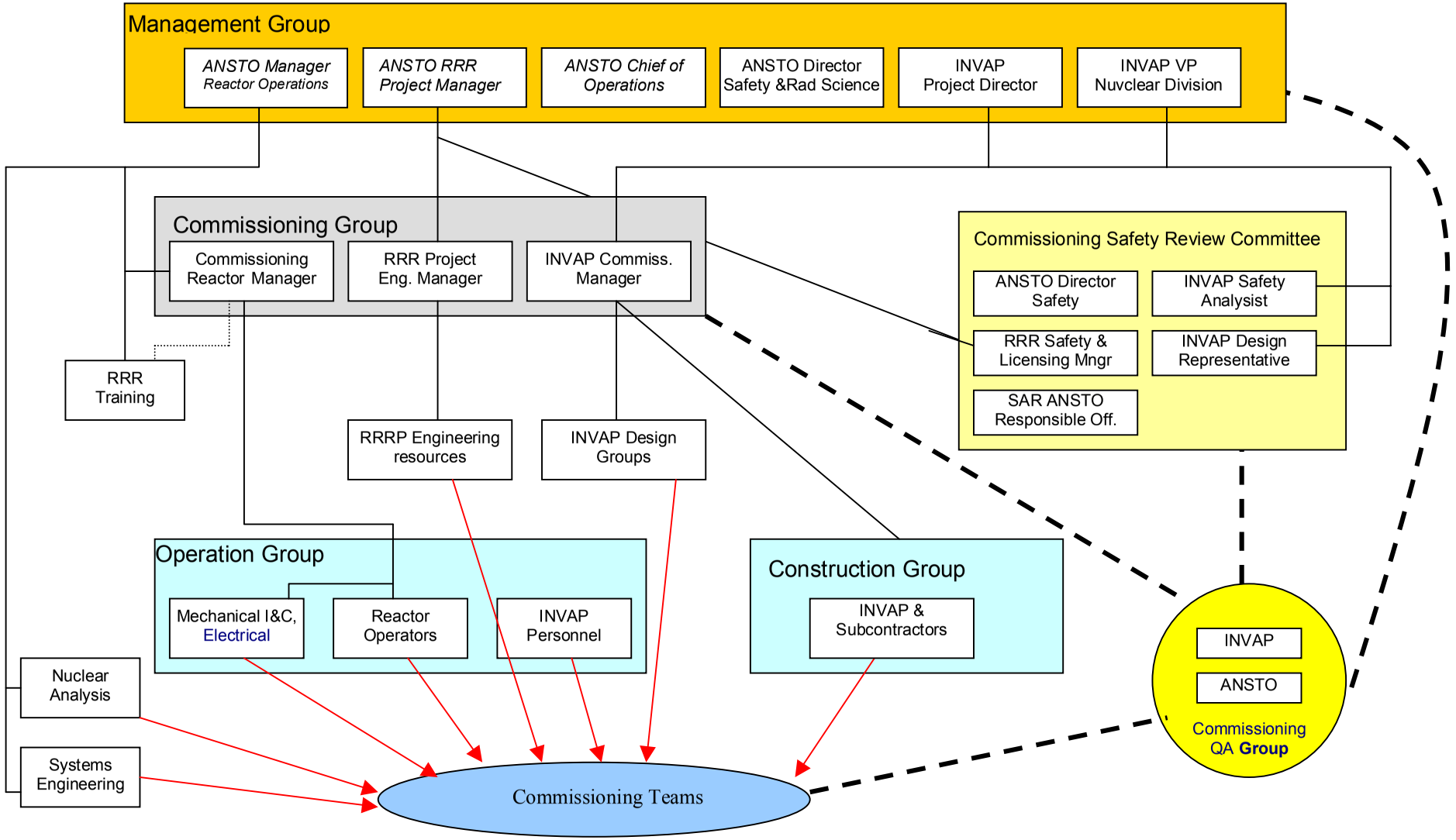
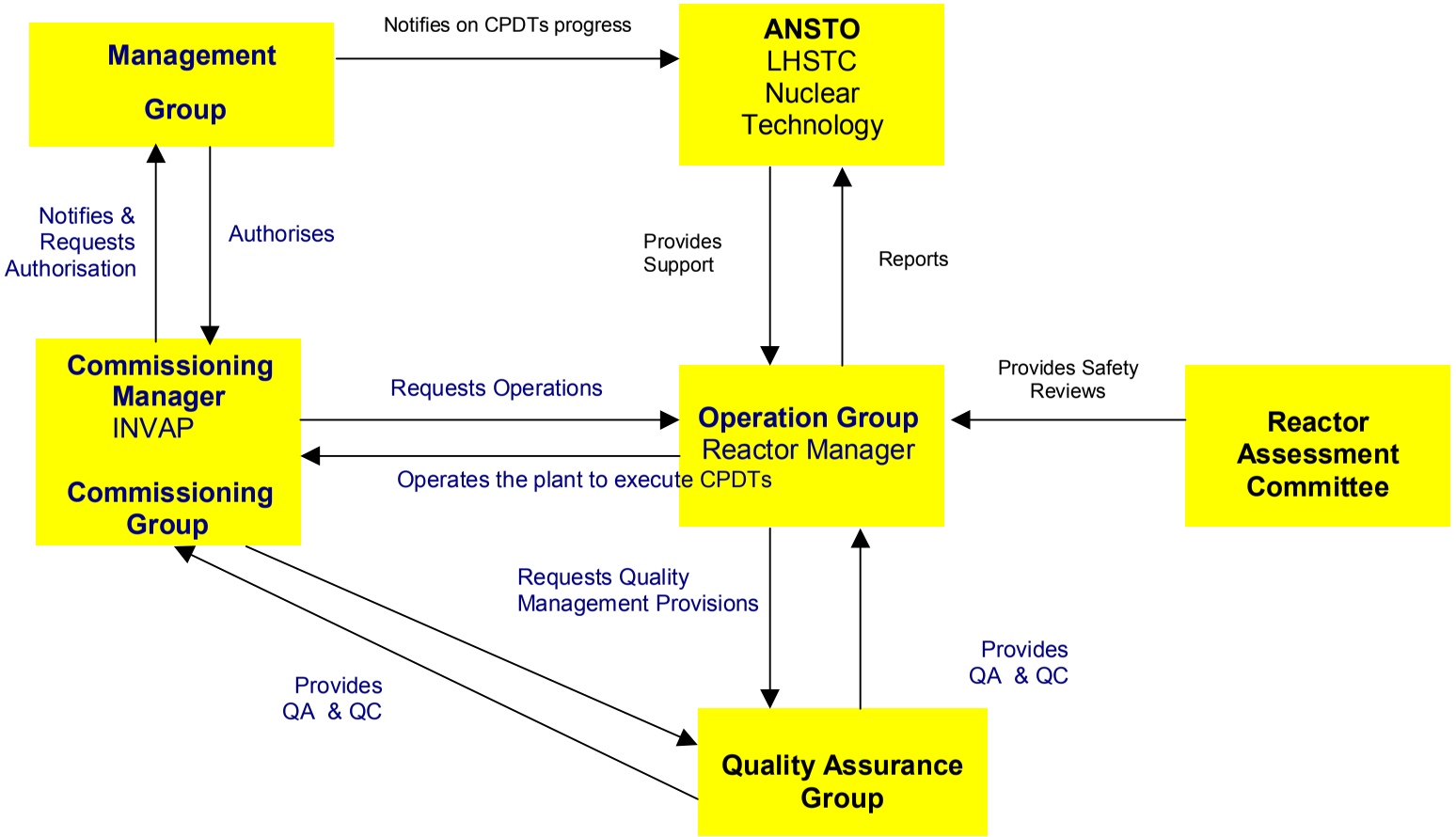


Figure 4: RRR Project Commissioning Functional Organisation Chart – Contract Performance Demonstration Tests



4 COMMISSIONING STAGES, TESTS AND PREREQUISITES

1. The commissioning phase follows the construction phase. Post-installation tests and Pre-commissioning Tests are run as a closure of the construction and installation activities to enable the release of structures and systems for the commissioning.
2. Post-installation tests are performed to demonstrate that components and equipment are correctly installed and operational. These tests include, but are not limited to, component pressure tests, cleanliness verification, electrical system tests, initial alignment and bumping of motors, checks of control and interlock functions of instruments, relays and control devices, initial calibration of instruments, valve testing, adjustment of mechanical equipment including realignment, greasing and tightening of bolts, and initial energisation and operation of equipment and systems.
3. Pre-commissioning tests are conducted to verify that plant systems are capable of operating in a safe and efficient manner compatible with the system design bases. Pre-commissioning tests are run on all the plant systems.
4. Conventional and auxiliary systems with no safety relevance or that work in an stand alone manner with very limited interaction with the rest of the facility are essentially released for operation once the Pre-commissioning tests have been successfully completed.
5. For safety systems and safety-related systems, a further set of tests, called commissioning tests, are run. The following sections provide further details on the arrangements for these tests, for further details on scope see Table 1, and Appendices 3, 4 and 5.
6. The document RRRP 7300 EDEIN 001 A *Outline of system inspection & testing during construction, precommissioning & commissioning* presents in a tabular format how the testing of the different systems within the facilitiy is carried out at the different stages.

4.1 COMMISSIONING STAGES

1. Once pre-commissioning tests have been finished, the plant Commissioning starts.
2. For optimum organisation and planning, and due to the different nature of the activities to be carried out, the commissioning phase has been divided into stages.
3. A specific plan covers each commissioning stage. Each plan includes basic information on tests to be carried out in that stage, the general considerations and prerequisites, and the proposed schedule and other organisation and planning information for this stage. In Appendices 1 to 5, some preliminary information outlining the scope of each stage is provided.
4. The formal commissioning organisation proposed and the CP will be applied to all the commissioning stages.
5. Design of commissioning tests takes into consideration all reactor operational states, namely power, physics test, shutdown, and refuelling. Attention is also given to relevant anticipated operational occurrences such as loss of offsite power.
6. The commissioning activities regarding irradiation and neutron beam facilities are integrated in the framework of the present Commissioning Plan. However, commissioning tests of these facilities will be scheduled and organised not to interfere with the planned commissioning activities for the Reactor Facility.

7. The commissioning stages are:
   (i) Stage A for the pre-fuel loading tests.
   (ii) Stage B for the fuel loading and approach to criticality tests.
   (iii) Stage C for power ascension and power tests.
   (iv) Contract Performance Demonstration Tests.

   A summary description of each commissioning stage follows, see also Table 1.

8. Stage A

9. Stage A tests consist of those system integration tests conducted following completion of construction-related inspections and tests but before fuel loading, to demonstrate the capability of systems to meet performance requirements and to provide assurance that all systems are ready for initial loading of fuel assemblies.
10. The start of Stage A will be managed as an interface with the completion of the construction inspection and testing activities. Appropriate release certificates will provide evidence that previous steps have been executed in accordance with the project procedures.
11. Training of the reactor staff will continue during this stage.

12. Stage B

13. Stage B starts with progressive loading of fuel into the reactor core, bringing the reactor to criticality for the first time, and the low power tests. The low power tests will demonstrate that the reactor and its systems can be started up and shutdown in a safe manner. Neutronic parameters of the core and performance of the shutdown systems will be measured.
14. Stage B is split into two sub-stages, namely, the stages prior (B1) and after (B2) the first criticality has been reached.
15. Stage B2 includes reactor operation at a power level such that all the nucleonic instrumentation channels are above their operational threshold.

16. Stage C

17. At Stage C, the reactor is operated at increasing power levels up to 100% of full power.
18. Stage C includes thermal balance tests and its correlation with the nucleonic instrumentation readings. It also includes, where appropriate, the verification of the effectiveness of the biological shielding.

19. Contract Performance Demonstration Tests

20. The CPDTs are undertaken to show compliance with the Contract Performance Acceptance Criteria specified in the Conditions of Contract. It is considered as part of the commissioning, although the plant is considered fully operational at the completion of Stage C.
21. Contract performance demonstration involves the measurement of a series of parameters as specified in the contract between ANSTO-INVAP for the construction of the facility. Those parameters that are safety related are addressed as part of the commissioning phase.

22. There are some measurements of performance-related parameters (i.e. neutron spectra in a given irradiation facility, neutron flux distribution within the irradiation facilities, and others) which can be conveniently undertaken while Commissioning Stages B and C are carried out. Therefore these measurements will be performed between commissioning tests, or in the periods between commissioning stages.
23. The formal CPDT stage follows the completion of Commissioning Stage C and in this sense is the beginning of the commercial operation phase.
24. The facility operation procedures, manuals and plans are replaced from the commissioning version to the definitive versions to be used during the operation phase that will address the experience gained during the commissioning.
25. While a review of operation manuals and procedures has already taken place during pre-commissioning tests, a final verification of the adequacy of the maintenance and operation procedures is undertaken at CPDT.
26. By the time the CPDTs are executed, the facility capability regarding its safe operation has already been demonstrated during commissioning stages A, B and C.

Table 1: Outline of Initial tests phases and Commissioning Stages

Phase	Stage	Stage Description	Main activities and tests
Installation	Post-installation tests	Post installation test of individual equipment and components.	For example, inspection of location and orientation of components, levelling and alignment, clearances and tolerances, tightness of connections, fluid levels, physical integrity, cleanliness, purging, seals and packings properly installed, rotation of prime movers is correct, cabling is correct.
Pre-commissioning	Pre-commissioning tests	Testing of individual components and systems. Integration of service systems, equipment and structures.	Systems are tested individually in all their modes.

Cont..

Table 1: Outline of Initial tests phases and Commissioning Stages (cont.)

Phase	Stage	Stage Description	Main activities and tests
Commissioning Phase	Stage A Pre fuel loading tests	Final integration tests of systems.	Electrical system, HVAC, PCS, RSPCS, RC&PS, I&C, (RCMS, RPS, and PAM) are integrated to demonstrate the facility operational status.
	Stage B1 Fuel loading and approach to criticality	Fuel assemblies loading until criticality is reached	Nucleonic instrumentation is tested with neutrons from fuel assemblies and start up source. Fuel assemblies are loaded in a planned strategy until fission chain reaction is self sustained.
	Stage B2 Low power tests	Low power operation (Less than 400 Kw)	Fuel loading in steps until reaching the sixteen fuel element core. Reactivity, power peaking factor and other core parameters are measured
	Stage C Power ascension and power tests	Power increase in steps up to 20 MW	Thermohydraulic parameters are measured. Radiation surveys are conducted to verify the efficiency of shields.
Transition to Operation Phase	Contract Performance Demonstration Tests	Measurements of contractual performance parameters	Plant fully operational. Compliance with contract requirements is verified.

4.2 COMMISSIONING TESTS AND PREREQUISITES

4.2.1 Conduction of Tests and General Prerequisites

1. A test is the set of measurements, examination and observations aimed to assess the suitability of a system or component, as well as operational activities and procedures. The specific plan for each commissioning stage addresses the complete list of tests to be conducted in that stage.
2. Commissioning tests and inspections include those specified by the system designers and the design authority as necessary to demonstrate and verify the objectives set for the Commissioning phase.
3. All testing is accomplished using approved procedures throughout the Commissioning.
4. When the test procedure is approved for execution, and when prerequisites to the test indicated in the test procedure are completed as required, the test can be started. Required personnel are assembled by the CG or a member of the CG in charge of the test, and the test procedure is reviewed in detail and then performed.
5. During the test, all precautions are observed, and data records are completed, reviewed, signed and dated by the member of the CG in charge of the test.
6. The plant operating staff is responsible for the safe and proper operation of equipment during the test.
7. Where systems or components are duplicated in the design to provide “Duty” and redundancies, all systems or components of both redundancies will be tested, either during the pre-commissioning tests or during the commissioning itself.
8. The specific requirements for each of the commissioning stages are given in the plan for the corresponding stage. Summary descriptions of the tests to be conducted and an outline of the specific requirements for each stage are given in Appendices 2 to 6.
9. Table 2 shows the sequence of typical steps involved in the execution of a commissioning test, provided the stage has been authorised by the MG.

Table 2: Typical Commissioning Test Sequence

Step		Details	Executed by
	Definition of the Test Procedure objective and methodology	Identifies the test objective and methodology to be used to achieve it following specifically defined instructions.	Engineering teams
	Drafting of the procedure	Define in detail the arrangements and steps to be followedand the acceptance conditions.	Engineering teams and CG
	Review, Acceptance and approval of proposed Procedure	Review and approval of the procedure. It includes acknowledging that the methodology to be employed in the test execution is adequate to verify the expected goals (identified in the scope).	INVAP/ANSTO .
	Test Authorisation	Granted at beginning of the corresponding commissioning stage.	MG
	Test Scheduling	Allocate the execution day	CM
	Resources allocated	Request the necessary human resources (from OG and COG), testing equipment and auxiliary devices.	CM
Test Execution	Procedure related tasks	Initial brief to staff involved, and Pre-test conditions verification. Perform the measurements, calculations and other actions (not related with facility system operation) indicated in the procedure. Records filling	CG
	Facility systems operation	Operate the systems specified in the test procedure following the System Operation Manual (unless a dedicated procedure is indicated in the test). After the test execution, return the system configuration to the pre-test condition.	OG and COG
	QC & QA actions	Enforcement of the QA Plan for Commissioning.	CQAG
	Test results approval	Test results are analysed and if appropriate approved, otherwise exceptions or repetition of the tests is indicated (as per 4.2.4).	CM
	Test results reporting	Reporting of results to CSRC and MG. Inclusion of relevant test results in the Commissioning Report for reporting to MG.	CM

4.2.2 Staffing Requirements for Test Execution

1. As a minimum, the following will be assigned to each commissioning test (procedure execution):
   a) A Commissioning officer from the Commissioning Group (INVAP).
   b) An ANSTO representative.
   c) Operation Group staff necessary to operate the systems or equipment.
   d) Health physics staff when required.
   e) QA and QC activities are expected to be covered by personnel who will audit or attend commissioning tests as required.
   f) Personnel assigned are to be trained so they are competent and understand the safety and quality requirements of their assigned tasks.
   g) Specific staffing requirements will be addressed in the specific test procedure.

4.2.3 Design Problems

1. In the process of post-installation, pre-commissioning and commissioning testing, design problems may be encountered. All such design problems are formally documented and reported to the design organisation for disposition. If some change is necessary to the system, and retesting is required, it will be accomplished using approved procedures and controls.

4.2.4 Review and Approval of Test Results

1. The CM will have overall responsibility for review and approval of test results. The following paragraphs establish requirements for review and approval of individual test results.
2. Upon completion of each test, the CG responsible for the test will assemble a test package that includes the official test copy of the completed procedure, the test records and all related documentation. Commissioning result packages will be submitted to the CM for performing an in-depth review, evaluation and assessment of test results. Test discrepancies, deficiencies, failure to satisfy acceptance criteria, and omissions identified during testing or during review of test results will be documented as test exceptions.
3. Following review and resolution of review comments with ANSTO, the CM can either:
   a) Approve and accept the test results with or without exceptions, or
   b) Find the test results unacceptable until all or part of the outstanding exceptions are resolved, or
   c) Request the entire test be repeated.
4. For procedures approved with exceptions, each exception is subsequently resolved by processing retest results through the same review and approval cycle. If a certain test exception is not resolved after a reasonable effort of evaluation, it may be chosen to document the test results with a full explanation of the recommendations. Therefore, test exceptions may be acceptable provided that the CM agrees to the test exception based on engineering recommendations and consideration with respect to SAR.

5. The COG will have personnel responsible for analysing and resolving exceptions with an adequate understanding, access to pertinent background and engineering support.
6. The MG and the CSRC will be notified of test results and exceptions and the actions proposed to resolve them.

5 COMMISSIONING SCHEDULE

1. The schedule for post-installation test is according to the construction and installation program.
2. An extensive pre-commissioning test program is planned for the reactor and its auxiliary systems. During the pre-commissioning test phase, testing will be performed as system hand-over from construction allows.
3. Key systems are sequenced for completion and testing early enough to provide necessary auxiliary services for testing and operation of other systems or for construction activities. Examples of such key plant systems are the electrical system, compressed air system and water supply system. Temporary construction power is sometimes required for initial tests at the beginning of the pre-commissioning test phase.
4. The schedule relative to the pre-commissioning phase is in accordance with the allowances in the Contract Master Schedule plus the details provided in the Pre-commissioning Tests plan.
5. The commissioning stages indicated in section 4.1 are incorporated into the Contract Master Schedule that presents the planned sequence of the main activities (Work Packages) related to the commissioning.
6. The Contract Master Schedule (CMS) has the following Work Packages related to commissioning planning and execution:

   a) Planning and Document Preparation (pre-commissioning activity)
      (i) (WP 21406) DE-Commissioning Procedures

   b) Execution of Commissioning Stages:
      (i) (WP 70101) NU-Pre fuel loading (Stage A)
      (ii) (WP 70201) NU-Fuel Load & Approach to Criticality (Stage B1)
      (iii) (WP 70301) NU-Low Power tests (Stage B2)
      (iv) (WP 70401) NU-Power Ascension & Power test (Stage C)

   c) Execution of Contract Performance Demonstration Tests
      (i) (WP 70501) NU-Performance demonstration tests

7. Details on scope, assigned dates and duration of activities are provided in the Contract Master Schedule.
8. A detailed Commissioning Schedule will be prepared as a sub-schedule to the CMS. The detailed Commissioning Schedule will include details and planning of individual tests, taking into account the activities to be carried out and the different constraints and precedence requirements.
9. The sequencing of tests shall be such so that safety of the facility is never dependent on the performance of untested systems, subsystems and components.

6 COMMISSIONING PROCEDURES, RECORDS AND REPORTS

6.1 PROCEDURES

1. Tests to be executed during the commissioning phase will be planned, conducted and controlled using detailed written procedures prepared for each test. These procedures will also establish the method for assessing and recording the results of the test. The procedures for individual tests are specific in intent, objectives, methods, operating procedures, equipment requirements, detailed data sheets, and acceptance criteria.
2. INVAP will maintain overall responsibility for test procedure preparation and review.
3. Procedures will be designed to demonstrate compliance with the acceptance criteria. Commissioning procedures will be developed during the detailed engineering phase and will be reviewed and updated during the construction, inspection and test phase and the commissioning phase itself as necessary.
4. Procedures will be managed in compliance with the Commissioning QA Plan. Commissioning procedures will be managed and implemented by the CG. Commissioning procedures will be audited by the CQAG. Review of procedures will be carried out by the MG and the CSRC.
5. The commissioning procedures will include information which:
   a) Defines the objective of the procedure and, where appropriate, the reason (e.g. validation of an assumption made in the safety analysis);
   b) Identifies and defines all the activities that are required to confirm the acceptance of the item under test;
   c) Defines performance parameters that are to be measured under specified steady state and transient conditions; and
   d) Identifies the performance requirements together with clearly stated acceptance criteria.
6. Commissioning procedures for tests of equipment and systems will include the following information:
   - Title
   - Object of the procedure
   - Summary description of procedure
   - Acceptance criteria
   - Reference document list
   - Staff requirements and responsibilities
   - System involved
   - Required equipment and data
   - Operating personnel involved
   - Prerequisites for this procedure
   - Initial conditions of all involved systems
   - Step by step instructions
   - Forms and records
   - Annexes

7. Procedures during commissioning for emergency management, health physics, security will be issued under the umbrella of the Commissioning Plan.

6.2 RECORDS

1. The outputs resulting from the application of the procedures will be registered in records, the form of which will be included in the applicable procedure.
2. The records will be identified, issued, controlled and filed in accordance with the Commissioning QA Plan.

6.3 REPORTS

1. Reports will be prepared by the CG following particular stages or sub-stages to present an overview of the procedures carried out and the performance of the plant as required before commencement of subsequent stages or sub-stages (see Section 7.2). Reports provide the basis for review and approval.
2. The format of commissioning reports will include the following information:
   a) Title;
   b) Objective;
   c) Summary;
   d) References to appropriate test procedures;
   e) Summary of tests carried out (including dates), limitations, problems or deficiencies, and resolution;
   f) References to data collected, analyses and deviations;
   g) Conclusions and recommendations.
3. It is the responsibility of the MG to review the Commissioning reports to ensure that the CP objectives have been achieved. In particular, the MG will ensure that the Operational Limits and Conditions have been complied with and that the assumptions and predictions about reactor performance in the Safety Analysis Report have been confirmed.
4. A comprehensive Commissioning report will be prepared by the MG upon conclusion of the commissioning phase.
5. Commissioning reports will be used by ANSTO to provide ARPANSA with visibility on the progress of commissioning.
6. Reports will provide the basis for the summary on commissioning results to be included in the SAR (see 8.2).

7 VERIFICATION, REVIEW, CONTROL AND AUDIT

7.1 VERIFICATION

1. Verification of commissioning test results will be carried out by the CG to confirm that:
   a) The relevant parameters associated with acceptance criteria have been obtained as specified in procedures.
   b) The applicable control activities have been performed as required by this plan.
2. Verification activities will be performed in compliance with the CQAP.

7.2 REVIEW

1. Review of commissioning activities will be carried out by the MG based on commissioning reports.
2. The review process will aim to:
   a) Assess the suitability and effectiveness of the CP;
   b) Assess the adequacy of the commissioning procedures that have been carried out; and
   c) Assure that the corrective actions proposed to solve non-conformities, if any, are adequate.
3. This review will be performed in compliance with the CQAP.

7.3 CONTROL

1. The activities carried out during the commissioning phase are controlled by the CG. The following paragraphs provide information on how the controls are to be carried out.
2. Each commissioning test will require the participation of an ANSTO representative whose responsibility will be to establish that the test is carried out in accordance to the test procedure. At the end of the test, he will sign the test record together with the INVAP officer responsible for the test.
3. During each commissioning test, it will be mandatory that an INVAP representative who is a part of the CG participate and direct the execution of the test in accordance with the applicable procedure. The INVAP representative will ensure that the steps and indications of the test procedure are followed, will take note of any anomaly or relevant fact that occurs during the test, and will fill in and sign the test record.
4. In addition to the control activities, there will be also hold points, where in order to proceed it will be required to gain the approval of an identified authority (for example the CM or the MG).
5. The following hold points are envisaged:
   a) in order to start each Commissioning stage, authorisation by the MG will be required.
   b) in order to start each test, authorisation by the CM will be required.
   c) in addition, the MG may require that in order to start some particular tests a previous formal authorisation is provided by the MG.

6. The specific commissioning plan for each commissioning stage provides the hold points foreseen for the referred stage.
7. The Commissioning Group will implement appropriate controls to identify systems ready for commissioning and to ensure that there is no unauthorised tampering with those systems prior to and following the commissioning tests.

7.4 AUDITS

1. An Audit Programme for the commissioning phase will be established to verify compliance with relevant aspects of the CP. The audit schedule includes the arrangements for production and control of the required documentation.
2. As a rule, an appropriate team of experienced personnel not having direct responsibilities in the areas being audited, co-ordinated by the QA officer, will perform the audits.
3. The CM will ensure that the actions necessary to correct any deficiencies revealed by the audit are taken in a timely manner.
4. Independent external audits will be carried out as necessary (see 9.1).

8 DOCUMENTATION REQUIREMENTS

8.1 GENERAL

1. Procedures will be established under the CQAP to identify, collect, issue, review, approve, keep, revise and file documents.
2. Documentation related to commissioning will be made available to the whole organisation and retained.
3. A list of the commissioning documentation is included in Appendix 7.
4. Commissioning records and reports will be managed according to the CQAP.

8.2 MODIFICATIONS TO SAR

1. A summary of the commissioning program and its results will be incorporated in the SAR. The information is included for historical purposes.
2. The following results will be reported in the SAR following commissioning of the facility:
   a) Critical mass and final criticality conditions for the initial core and operational core;
   b) Control and regulating control rod reactivity calibration, including measurements of differential and integral rod worth for the initial and operational core;
   c) Excess (operational) reactivity;
   d) Measured shutdown margin;
   e) Reactor power calibration and thermal neutron flux distributions, nuclear instrumentation set-points, detector positions and detector output;
   f) Radiation measurements of reactor coolant inventory or release during the commissioning phase;
   g) Results of radiation measurements of shielding;
   h) Measurements of airborne effluents released from the facility;
   i) Reactivity worth of irradiation facilities;
   j) Measurements of reactivity feedback coefficients for the reactor core;
   k) Thermal-hydraulic characteristics of the core and reactor coolant system flow rates and pressure drops; and
   l) Measurements of performance of engineered safety features and other tested systems.

9 COMMISSIONING QUALITY ASSURANCE PLAN

9.1 GENERAL

1. A Commissioning QA Plan (CQAP) for the whole commissioning phase will be issued and put into effect during the commissioning planing and execution.
2. The CQAP will comply with the requirements of IAEA, 50-C/SG/Q12, Quality Assurance in Commissioning, 1995.
3. The CQAP shall be prepared by INVAP in consultation with ANSTO. The Commissioning Quality Assurance Manager will be responsible for administering the plan. Details on how the Quality Manager and Group interface with the Commissioning organisation are provided in section 3. The CQAP shall be endorsed by the Commissioning Management Group and the Commissioning Group.
4. The CQAP will describe the system which controls the development and implementation of the commissioning process. The provisions of the plan will be based on the following three functional categories: management, performance and assessment.
   a) Management provides the means and support to achieve objectives;
   b) People performing the work achieve quality; and
   c) The effectiveness of management processes and work performance is assessed.
5. The QA plan ensures that verification of compliance with the quality requirements during commissioning is carried out by qualified personnel who are not directly responsible for performing commissioning activities.
6. The CQAP will be documented in procedures. The procedures will address all applicable quality assurance requirements specified in the CQAP.
7. Measures will be established under the CQAP to identify, report, review, deal with, control and document items, activities and services that do not conform with requirements.
8. A history of all non-conformances and the resulting corrective actions will be maintained by the Commissioning QA Officer.
9. The CQAP requirements will be communicated to the staff of the commissioning organisation.
10. Controls will be established to ensure that commissioning activities meet established requirements and perform as specified.
11. Internal and external audits will be conducted during the development and implementation of the Plan. See section 3.2.6 for further details.
12. During the CPDTs, the QA plan for operation will be put in place. The commissioning QA procedures and instructions will be replaced by those corresponding to the operation phase. The QA plan will take account of the management of procedures and instructions that will be used for the execution of the performance demonstration tests.

9.2 CQAP PURPOSE

1. The CQAP provides the overall framework for the arrangements for the management, performance and assessment of the commissioning.
2. The CQAP also provides the means to ensure that work is suitably planned, correctly performed and properly assessed.

9.3 CQAP TABLE OF CONTENTS

1. A preliminary Table of Contents for the CQAP follows

10 COMMISSIONING EMERGENCY MANAGEMENT

1. The Commissioning Emergency Plan (CEP) will involve emergency response procedures to be enforced during the commissioning stages.
2. The Commissioning Emergency Plan (CEP) is a special version of the Facility Emergency Plan (EP). The CEP will also integrate into current site emergency management.
3. The CEP and the corresponding emergency response procedures will be in place before the commencement of any commissioning activity and before the introduction of any fissile material into the facility. During stage A commissioning, emergency training will be completed, and a demonstration emergency drill will be carried out to the satisfaction of ANSTO and the regulator.
4. The efficiency of the Commissioning Emergency Procedures will be tested by means of drills co-ordinated with ANSTO, LHSTC Divisions and ARPANSA. Procedures and acceptance criteria will be an integral part of the plan.
5. During the CPDTs, the CEP will be replaced by the Operational Emergency Plan.

11 HEALTH PHYSICS DURING COMMISSIONING

1. Before the introduction of any fissile material into the facility, health physics procedures will be in place and appropriate training will be completed.
2. ANSTO will provide the health physics staff and portable equipment as stated in the contract.
3. It is planned to use to the maximum extent possible the health physics procedures designed for the routine facility operation, nevertheless there may be some specific clauses or procedures that will be issued as necessary to address specific situations or conditions of the commissioning phases. Their content will differ only as may be necessary to cover situations specific to this stage and thus allow the personnel to gradually become familiar with their use.
4. There are special health physics procedures that correspond to non-routine activities within the installation, e.g. verification of the integrity of the main shielding structures, determination of dose maps during power rise, etc. These will be included in the respective commissioning procedures.

12 SECURITY MANAGEMENT DURING COMMISSIONING

1. Before the introduction of any fissile material into the facility, security procedures will be in place and appropriate training will be completed to the satisfaction of ANSTO, ARPANSA and ASNO.
2. For the commissioning stage, specific versions of the security procedures may be issued. These procedures will apply during Commissioning, to be later replaced with those corresponding to routine operation. Their content will differ only as may be necessary to cover situations specific to this stage and thus allow the personnel to gradually become familiar with their use.
3. The procedures related to security during commissioning may also cover the modification of access restrictions to various areas of the plant so as not to affect the performance of the commissioning.
4. Nuclear material accounting and Security procedures will be handled appropriately in compliance with the requirements of the permits issued to ANSTO by ASNO.

13 LIMITS AND CONDITIONS FOR COMMISSIONING

1. Specific Commissioning Limits and Conditions shall be provided for Commissioning stages B and C.
2. No Limits and Conditions are required for stage A Commissioning.
3. The stage specific CLCs will be provided in each stage commissioning plan.
4. The CLCs will be set to provide an adequate margin between the limits of operation and the Safety Limit in accordance with the Defence in Depth Principle.
5. The results of commissioning tests will be used to validate Chapter 17 of the SAR and determine the appropriateness of proposed Operating Limits and Conditions.
6. Operational Limits and Conditions and Chapter 17 of the SAR will become effective upon completion of Stage C commissioning.

14 TRAINING FOR COMMISSIONING

1. A Training Program will be established prior to the commencement of commissioning. The Program will address the necessary qualifications and training for personnel performing commissioning activities.
2. Training will provide the necessary knowledge on the plant systems and its safety features, commissioning tests and procedures, the intended operational procedures, and other relevant competencies.
3. Training for RRR operation will be provided to applicable ANSTO staff in preparation for commissioning activities. Completion of this training will result in provisional accreditation.
4. At least one month prior to the commencement of the commissioning phase, personnel participating in the commissioning will receive training in the procedures that will be used. This training will include the following:
   a) Overall commissioning planning and management.
   b) Quality assurance procedures.
   c) Emergency procedures.
   d) Health physics procedures.
   e) Security procedures.
5. Training of ANSTO personnel who will participate in the operation of the Reactor Facility will continue during the commissioning phase.
6. The training of ANSTO facility operation staff will take advantage of the different commissioning activities to provide additional training and first hand experience for the personnel. The training during the commissioning phase will:
   a) Ensure the familiarity of the operating personnel with the plant systems, organisational structure and plant procedures.
   b) Emphasise the paramount importance of safety in all aspects of plant operation.

APPENDIX 1:GENERAL PREREQUISITES FOR COMMISSIONING STAGES

General Prerequisites

The general prerequisites for each commissioning stage are:

a) Approval of the stage planning and procedures.

b) Verification that all essential activities of the previous stage have been completed.

c) All non-conformances and unexpected results identified during the previous stage have been addressed.

d) Approval from the owners of control points to proceed into the stage.

e) Authorisation from the MG to proceed into the stage.

General Prerequisites for Each Commissioning Test

The general prerequisites for each test are:

a) Existence of an approved procedure for the test.

b) The Commissioning Manager will issue the order to proceed with the test.

c) Personnel required by procedure to perform the test will be present and ready to proceed.

d) All personnel will have read the procedure and will be knowledgeable about all aspects of the task to be performed.

e) Equipment, instruments and tools required by procedure will be available and operational.

f) Advance notification of the commencement of the test will be given to the CM and Commissioning QA Officer.

g) Technical prerequisites: As indicated in the corresponding procedure.

APPENDIX 2: PRECOMMISSIONING TESTS

Systems and Components to be Tested and/or inspected During Pre-commissioning Phase

1. Fuel clamps
2. First shutdown system
3. Control rod drives
4. Second shutdown system
5. Reflector Vessel
6. Spent and fresh fuel storage and handling systems
7. Reactor pool internals
8. Reactor pool core structures and chimney
9. Reactor pool I& C
10. Service pool internals and isolation gate
11. Primary cooling system
12. Reflector cooling and purification system
13. Deuterium recombination system
14. Emergency make-up water system
15. Reactor and service pool cooling system
16. Reactor coolant purification system
17. Secondary cooling system
18. Reactor pool hot water layer system
19. De-mineralised water supply system
20. All buildings including: architecture and finishings as well as services (elevators, sewage, lighting, potable water)
21. Nucleonics instrumentation
22. First Reactor Protection System
23. Second Reactor Protection System
24. Post accident monitoring system
25. Reactor control and monitoring system
26. Main control room
27. Emergency control centre
28. Radiation monitoring systems
29. Electrical system
30. Reactor ventilation systems and containment systems
31. Radioactive waste management systems

32. Services – Fire protection, compressed and breathable air, communication systems, gases, BMCS, vacuum)
33. Conventional area HVAC systems
34. Cranes & hoists
35. Physical security system
36. Neutron beam facilities
37. Cold neutron source
38. Radioisotope handling systems
39. Pneumatic conveyor systems

Examples of Pre-commissioning Tests

1. Building structures and services
   a) Check operation of all access doors and access control equipment.
   b) Check performance and load capacity of all lifts.
   c) Check performance of HVAC systems
   d) Check availability of power, water and gas services
   e) Verify correct operation of the Building Management System
   f) Verify operation of the Security system
2. Auxiliary Systems
   a) Demonstrate operability.
3. Electrical Systems
   a) Ensure that they are checked out and energised; adjust their voltage and frequency; test starting load; verify electrical independence; full load will be tested at the end of stage A when the other systems are commissioned.
   b) Check operation under simulated accident conditions and full loss of off-site power.
   c) Check operation of emergency power initiating devices and performance of emergency power systems.
   d) Verify UPS discharge tests, capability of battery chargers, transfer devices and inverters.
4. Reactor Control and Monitoring System
   a) Test operation of functions for normal operation: regulation, control, monitoring, log in and operation of computer systems (hardware and software).
5. Reactivity Control, Reactor First and Second Shutdown and Protection Systems
   a) Trip tests
   b) Instrumentation and signals verification from MCR.
   c) Movement of control rods from MCR, verification of maximum speed.

6. Reactor Pool and Internals
   a) Check re-circulation, filtration, evaporation rate of the purification and make-up systems, and the level and leak indication of their relevant components.
7. Cooling and purification Systems
   a) Operate at design flow and pressure when possible and test for vibration.
8. Reflector Systems
   a) Check systems and component tests.
9. Emergency Make up water System
   a) Test performance in all expected operating modes, and proper operation of initiating devices, logic and set points.
10. Reactor Containment System Functions
    a) Check normal operation, heating/ventilation requirements.
    b) Check isolation (operation, initiation, logic), and containment permeability (full system and components), and verify redundancy, electrical independence, qualification requirements, and integrity requirements under accident conditions.
    c) Verify operation and capability of the Containment isolation heat removal system under normal and standby power supply systems
11. Fuel Storage and Handling
    a) Check functional tests of all equipment.
12. Radiation Monitoring System and Waste Management
    a) Make functional tests of all equipment, response tests and calibrations.
    b) Check leak tests of liquid waste disposal systems.
    c) Verify availability of related facilities.
13. Experiments and Experimental Devices
    a) Verify installation and removal operations, fit tests, and verify proper operation of equipment, where possible at this stage.
14. Radiation Measurements and Tests
    a) Verify area radiation monitor responses and calibration.

For further information please refer to the document *Outline of system inspection & testing during construction, precommissioning & commissioning* RRRP 7300 EDEIN 001 A.

APPENDIX 3: STAGE A COMMISSIONING

1. The information presented in this appendix is preliminary and will be further developed in the specific plan for this stage. It should be noted that there will be no nuclear fuel in the core during Stage A and hence reference to particular reactor states during Stage A is descriptive only.

Prerequisites for Stage A

1. The construction and installation of structures, systems and components will have been completed in accordance with the Construction Inspection & Test Plan to the extent that other activities will not affect the validity of test results.
2. All systems have passed the pre-commissioning tests and are operative.
3. An approval has been provided in compliance with the requirement stated in Construction Licence Condition 4.7.
4. A CITP Summary Report, including the status of all plant systems, shall be prepared by INVAP and discussed with the CM before the commencement of Stage A commissioning. This shall take into account the information from release certificates issued during the construction, installation and precommissioning tests.
5. The Commissioning QA Plan is in place.
6. Non-conformances generated during the CITP have been resolved.
7. Verification that the LHSTC services shall be available with capacity to cope with the demand.

Preliminary List of tests to be carried out during Stage A

Instrumentation and Control Systems Initial Tests

First Reactor Protection System Functionality Verification

Second Reactor Protection System Functionality Verification

Post Accident Monitoring System Functionality Verification

Reactor Control and Monitoring System Functionality Verification

Nucleonics Instrumentation Functionality Verification

Radiation Monitoring Instrumentation Functionality Verification

Emergency Preparedness Tests

Emergency Drill

Reactor Power State Tests

Transition from Shutdown to Power State Procedure Trial Test

Primary Cooling System Forced Circulation Mode Test

Reactor and Service Pool Cooling System Rigs Cooling Mode Test

Reflector Cooling & Purification System Reflector Cooling Mode Test

Secondary Cooling System Power State Heat Removal Mode Test

Core Coolant Flow Distribution Measurements

Irradiation Rigs Coolant Flow Distribution Measurements

Reactor Pool Hot Water Layer System Test

Normal Power System Test

Control Rod Drives Reactivity Regulation Function Test

First Shutdown System Test

Second Shutdown System Test (Power State)

Transition from Power to Shutdown State Procedure Trial Test

PCS and R&SPCS Coast Down and Flap Valves Actuation Test

Reactor Shutdown State Tests

Shutdown State Inhibitions Verification

Long Term Pool Cooling Mode Test

Second Shutdown System Test (Shutdown State)

Reactor Physics Test State Tests

Transition from Shutdown to Physical Tests State Procedure Trial Test

Reactor Physics Tests State Inhibitions Verification

First Shutdown System Functionality Verification (Physics Tests State)

Second Shutdown System Functionality Verification (Physics Tests State)

Transition from Physics Tests to Shutdown State Procedure Trial Test

Refuelling State Tests

Transition from Shutdown to Refuelling State Procedure Trial Test

Refuelling State Inhibitions Verification

Second Shutdown System Functionality Verification (Refuelling State)

Transition from Refuelling to Shutdown State Procedure Trial Test

Containment and Containment Ventilation Systems Tests

Containment and Containment Ventilation Systems Normal Mode Test

Containment and Containment Ventilation Systems Isolation Mode Test

Control Rooms Tests

Main Control Room Evacuation to Emergency Control Centre Procedure Trial Test

Emergency Control Centre Ventilation and Pressurisation System Test

Entire Facility Cold Run Tests

Entire Facility Cold Run Test

Health Physics Walk Through

Simulation Tests for Verification of Facility Behaviour Upon Loss of Normal Power Supply

Facility Behaviour Verification Upon Loss of Normal Power Supply

Standby Power System Test

CNS Related Activities and Tests

Cold Neutron Source I&C Systems Functionality Verification

CNS Connected Systems Tests

Integrated CNS Test

Neutron Guide Systems Tests

CNS Tests with Deuterium

CNS Refrigeration Cryo System Manoeuvring Tests

Details on each of the tests listed above, including test objectives and methodologies, are provided in RRRP 7320 EDEIN 001 Stage A Commissioning specific plan.

Stage A Commissioning Report

1. A review of the results from Stage A Commissioning shall be included in the Stage A Summary Report approved by the Commissioning Manager. Non-conformances shall be resolved, and results which fail to satisfy the established acceptance criteria shall be addressed to the satisfaction of the Management Group prior to proceeding to the Stage B1 Commissioning.

APPENDIX 4: STAGE B COMMISSIONING

1. The information presented in this appendix is preliminary and will be further developed in the specific plan for this stage.

Prerequisites for Sub–Stage B1 (Fuel Loading and Approach to Criticality)

1. Prerequisites for Sub–Stage B1
   a) Stage A report prepared by the CG approved by the MG.
   b) All non-conformances and unexpected results shall be addressed prior to proceeding to Sub-Stage B1 Commissioning.
   c) An Authorisation to Operate has been issued by ARPANSA that permits fuel loading to occur and for first criticality to occur.
   d) Core load sequence and intermediate cores defined.

Preliminary list of the proposed tests/procedures for Sub-Stage B1

1. Setup of Safety System Settings.
2. First reactor core fuel loading procedure.
3. Confirmation of nucleonic instrumentation
4. Approach to criticality procedure.
5. First shutdown system shutdown margin measurement procedure.

Details on each of the tests listed above, including test objectives and methodologies, are provided in RRRP 7330 EDEIN 001 Sub-Stage B1 Commissioning specific plan.

Stage B1 Commissioning Report

A review of the results from Stage B1 Commissioning shall be included in the Stage B1 Summary Report approved by the Commissioning Manager. Non-conformances shall be resolved and results which fail to satisfy the established acceptance criteria shall be addressed to the satisfaction of the Management Group prior to proceeding to the Stage B2 Commissioning.

Prerequisite for Sub-Stage B2 (Low Power Tests)

1. General pre-requisites apply. Pre-requisites will be reviewed in the specific plan for this stage.

Preliminary List of Proposed Tests for Sub-Stage B2

Setup of Safety System Settings

First Full Reactor Core Configuration Setup Procedure

Approximation to Criticality Procedure

Control Rod calibration and Reactivity Excess measurement

First Shutdown System Shutdown Margin Measurement Procedure

Second Shutdown System Reactivity Measurement Procedure

Power Calibration of the Nuclear Instrumentation

First Shutdown System Actuation Test Procedure

Second Shutdown System Actuation Test Procedure

Neutron Flux Distribution and Power Peaking Factor Measurement Procedure

Core Temperature Reactivity Coefficients Measurement Procedure

Void Feedback Coefficient Evaluation Procedure

Kinetic parameters Evaluation Procedure

Power Reactivity Coefficient Measurement in Natural Convection Procedure

Power Calibration of the Wide Range Neutron Detectors Procedure

Power Calibration of the Compensated Ionisation Chambers Procedure

Power Calibration of the N16 Detector Procedure

Loss of Normal Power Supply Test Procedure

Measurement of the Reactivity Worth of Irradiation Facilities

Reactor Shielding Measurements

Neutron Guide Bunker Shielding Measurement

Liquid and Gaseous Streams Measurement

Radiation Area Monitoring

Details on each of the tests listed above, including test objectives and methodologies, are provided in RRRP 7340 EDEIN 001 Sub-Stage B2 Commissioning specific plan.

Stage B2 Commissioning Report

A review of the results from Stage B2 Commissioning shall be included in the Stage B2 Summary Report approved by the Commissioning Manager. Non-conformances shall be resolved and results which fail to satisfy the established acceptance criteria shall be addressed to the satisfaction of the Management Group prior to proceeding to the Stage C Commissioning.

APPENDIX 5: STAGE C COMMISSIONING

The information presented in this appendix is preliminary and will be further developed in the specific plan for this stage.

General Considerations

1. Tests conducted during Stage C are intended to confirm where practicable that the reactor can be operated in accordance with the proposed Operational Limits and Conditions.
2. During Stage C, baseline data will be established for all safety related parameters that are routinely measured and monitored, including initial system operating parameters and diagnostic data on components having significance for safety. These data will then form a basis for future determination of performance degradation or trends.
3. During Stage C, the reactor power will be raised in steps until full power is reached. Tests and adjustments are performed at each step, as necessary. Of particular interest will be the performance of protection and regulating systems, radiation survey results, and the response of the reactor to anticipated operational occurrences, including transients.
4. Testing will be sufficiently comprehensive to establish that the facility and the proposed operating procedures result in performance in accordance with the design intent and the Safety Analysis Report upon which the Operating Licence is issued.

Prerequisites for Stage C

1. General pre-requisites apply. Pre-requisites will be reviewed in the specific plan for this stage.

Preliminary List of proposed Tests for Stage C

Reactor measurements and tests

Intermediate Power – Performance tests

High Power - Performance tests

Reactivity power coefficient measurement

Automatic reactor power control system performance test

Xenon effect assessment

Loss of normal power supply test

LTPC performance test

Deuterium recombination system performance test

Containment ventilation systems performance test

Calibration of N16 Power Detector

Final layout adjustment of nucleonic instrumentation position

Evaluation of the Secondary Cooling System Performance

Health-Physics measurements and shielding tests

Assessment of main reactor shieldings

Assessment of the neutron guides shielding structures

Activity measurements in liquid and gaseous streams

Radiation survey in facility rooms and areas

Cold neutron source tests

CNS tests at reactor power below 20 MW

CNS tests at reactor power of 20 MW

Irradiation facilities tests

Test of the production cycle of the bulk irradiation facilities

Pneumatic transport systems and associated hot cells tests

Details on each of the tests listed above, including test objectives and methodologies, are provided in RRRP 7350 EDEIN 001 Stage C Commissioning specific plan.

Stage C Commissioning Report

A review of the results from Stage C Commissioning shall be included in the Stage C Summary Report approved by the Commissioning Manager. Non-conformances and results which fail to satisfy the established acceptance criteria shall be addressed to the satisfaction of the Management Group prior to proceeding with Contract Performance Demonstration Tests.

APPENDIX 6: CONTRACT PERFORMANCE DEMONSTRATION TESTS

The information presented in this appendix is preliminary and will be further developed in the specific plan for this stage. The Contract Performance Demonstration Tests will be performed after commencement of normal operation of the RRR. The CPDT will be undertaken in accordance with the SAR Chapters 13 “Conduct of Operations” and 17 “Operational Limits and Conditions”.

Prerequisites for the Stage

1. General prerequisites apply. Prerequisites will be reviewed in the specific plan for this stage.

Tests

1. Tests will be carried out to demonstrate the achievement of Contract Performance Acceptance Criteria detailed in Annexure 26, Conditions of Contract. These tests include performance measurements in relation to:

   a) integrated flux and energy spectrum

   b) neutron flux in irradiation facilities

   c) operational availability

   d) maximum continuous operating power

CPDTs Closure Report

A review of the results from the CPDT Stage C will be included in a Closure report to be approved by the Commissioning Manager. The output of the CPDTs will be compared with the applicable CPACs.

APPENDIX 7: KEY TO COMMISSIONING DOCUMENTATION

1. The documents included in the following list will be issued along the planing and execution of the commissioning. Except for the Commissioning Plan, the rest of the documents are yet to be drafted.
2. The documents identified with an asterisk (*) are required to be submitted to the MG for approval prior to the commencement of the commissioning phase.

3. Commissioning QA Programme (RRRP-7312-EDEIN-001) (*): covers the QA activities to be developed during the commissioning.
4. Commissioning Plan (*): this document.
5. Commissioning Emergency Plan (RRRP-7314-EDEIN-001) (*).
6. Commissioning Manual (RRRP-7310-EDEIN-001) (*): comprises the collection of general procedures, instructions and forms to be used along the whole commissioning phase. Procedures for specific stages will be issued separately.
7. Stage A commissioning specific plan (RRRP-7320-EDEIN-001) (*):details the commissioning plan for stage A commissioning.
8. Stage A commissioning procedures (RRRP-7322-EDEIN-XXX): all the procedures to be implemented during stage A commissioning. They include the forms to be filled out during the procedure execution, which will be issued as records.
9. Stage A records (RRRP-7324-EDEIN-XXX): these documents are the output of the procedures executed during this commissioning stage (i.e. they are the procedure attached forms appropriately filled out). They will be issued after the procedure execution, and processed as a record.
10. Sub-stage B1 commissioning specific plan (RRRP-7330-EDEIN-001) (*):details the commissioning plan for stage B1 commissioning.
11. Sub-stage B1 commissioning procedures (RRRP-7332-EDEIN-XXX): all the procedures to be implemented during stage B1 commissioning. They include the forms to be filled out during the procedure execution, which will be issued as records.
12. Sub-stage B1 records (RRRP-7334-EDEIN-XXX): these documents are the output of the procedures executed during this commissioning stage (i.e. they are the procedure attached forms appropriately filled out). They will be issued after the procedure execution and processed as a record.
13. Sub-stage B2 commissioning specific plan (RRRP-7340-EDEIN-001) (*):details the commissioning plan for stage B2 commissioning.
14. Sub-stage B2 commissioning procedures (RRRP-7342-EDEIN-XXX): all the procedures to be implemented during stage A commissioning. They include the forms to be filled out during the procedure execution, which will be issued as records.
15. Sub-stage B2 records (RRRP-7344-EDEIN-XXX): these documents are the output of the procedures executed during this commissioning stage (i.e. they are the procedure attached forms appropriately filled out). They will be issued after the procedure execution and processed as a record.
16. Stage C commissioning specific plan (RRRP-7350-EDEIN-001) (*):details the commissioning plan for stage C commissioning.

17. Stage C commissioning procedures (RRRP-7352-EDEIN-XXX): all the procedures to be implemented during stage C commissioning. They include the forms to be filled out during the procedure execution, which will be issued as records.
18. Stage C records (RRRP-7354-EDEIN-XXX): these documents are the output of the procedures executed during this commissioning stage (i.e. they are the procedure attached forms appropriately filled out). They will be issued after the procedure execution and processed as a record.
19. Contract performance demonstration tests specific plan (RRRP-7360-EDEIN-001): details the plan for the CPDT stage.
20. Contract performance demonstration tests procedures (RRRP-7362-EDEIN-XXX): all the procedures to be implemented during CPDT stage. They include the forms to be filled out during the procedure execution, which will be issued as records.
21. Contract performance demonstration tests records (RRRP-7364-EDEIN-XXX): these documents are the output of the procedures executed during this stage (i.e. they are the procedure attached forms appropriately filled out). They will be issued after the procedure execution and processed as a record.
22. The stage A, B, C and D schedule programs: they are a detailed schedule for each commissioning stage, allocating resources to every activity.
23. Design Manuals (*): Comprises the collection of design inputs, technical specifications and design procedures.
24. Plant Operation Manual (*): Comprises the procedures and instructions for operation.
25. Plant Maintenance Manual: Comprises the procedures and instructions for maintenance of plant systems.
26. Operational Limits and Conditions Document.
27. Safety Analysis Report.
28. Reports related to the testing of structures, systems or components, construction tests and reports, construction deficiency lists, and accepted construction non-conformances (*).
29. Commissioning reports at the end of each commissioning stage, including a comprehensive report to be produced at the end of the commissioning phase;
30. Work reporting documentation, including:
    a) Checklists and logs;
    b) Certificates and approvals;
    c) Significant event reports;
    d) Reporting of deviations and resolution;
    e) Reporting of changes implemented; and
    f) Quality assurance and other records.