



Replacement Research Reactor Project

SAR CHAPTER 15 COMMISSIONING

Prepared By



For

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15 COMMISSIONING

15.1 INTRODUCTION

This chapter describes the approach adopted for the planning and execution of the Commissioning Program for the Replacement Research Reactor Facility (the Reactor Facility) in sufficient detail to show that the functional performance of structures, systems and components is being tested, verified and recorded accurately.

The Commissioning Plan ("the Plan") is the sole document by which the total scope of the commissioning activities has been planned, is scheduled (in conjunction with the Contract Master Schedule), and will be implemented and reported in order that the functional performance of structures, systems and components is tested, verified and recorded accurately.

The Plan addresses:

- Stage A Commissioning
- Stage B1 Commissioning
- Stage B2 Commissioning
- Stage C Commissioning
- Contract Performance Demonstration Tests to fulfil the Contract Performance Acceptance Criteria contained in Contract Annexure 26.

Commissioning of the Reactor Facility is being accomplished in a number of distinct stages. Only the first stage, Stage A, which is being completed prior to the loading of fuel, is being undertaken under the Construction Authorisation.

In addressing Stage A Commissioning, care has been taken to identify and manage the interface with the completion of the construction inspection & testing activities conducted under the CITP. The interface management activities include, but are not limited to:

- a) ensuring a seamless commissioning management organisation across the interface,
- b) the optimum utilisation of resources,
- c) the identification of all training/retraining needs, and
- d) the integration of scheduling of activities.

This approach to interface management has also been adopted in relation to all the other commissioning activities addressed in the Plan.

All inspection & test activities conducted during the construction phase and preceding Stage A Commissioning have been addressed in the Construction Inspection & Test Plan (CITP).

End of Section

15.2 COMMISSIONING OBJECTIVES AND GENERAL DESCRIPTION

The initial tests of the Reactor Facility consist of a series of tests categorised as post-installation, precommissioning and commissioning tests. The post-installation tests commence with the completion of system/component installation. The precommissioning test phase begins after completion of the post-installation tests of the systems and continues until the completion of systems tests. Precommissioning tests are run on individual systems, and are directed towards establishing that the system is ready for commissioning. 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 to demonstrate the performance of key safety systems and test the integration between the different systems.

Post installation tests are run under the organisational, procedural and control framework of the Construction, Inspection and Test Plan.

Precommissioning tests are run under the organisational, procedural and control framework of the Precommissioning Test Phase Plan.

Commissioning tests are run under the Plan, which presents 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
- d) Organisation and arrangements to carry out the Contract Performance Demonstration Tests

The Plan 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 ascension tests.

Although the commissioning goals are fulfilled at the end of Stage C commissioning, the Plan excludes the stage where the Contract Performance Demonstration Tests 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 is performed with the Reactor Facility in the operation phase following power ascension tests and with the operating organisation in place.

15.2.1 Approach to Commissioning

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.

Commissioning 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 with occupational health and safety requirements and regulatory requirements.
- d) The facility performs as designed.
- e) The plant interfaces appropriately with site facilities.
- f) The measurable parameters of items performing safety functions comply with the intents of design as stated in the safety case.
- g) During the Contract Performance Demonstration Tests, tests are run to demonstrate compliance with the Contract Performance Acceptance Criteria.

The commissioning phase will give opportunity to ANSTO staff to obtain practical experience in the operation of equipment and systems.

The Commissioning phase is organised into several stages, each with its own objectives and procedures.

The commissioning is managed by an organisation composed of different groups each with its defined objectives and responsibilities during the different commissioning stages.

The Commissioning arrangements are consistent with the guidelines and recommendations of:

IAEA Safety Standards Series, "Commissioning of Research Reactors", Draft Safety Guide, NS259 NS-G1 draft 5, March 2000 (ex Safety Series 35-G4, "Safety in the Commissioning of Research Reactors").

IAEA, 50-C/SG/Q12, Quality Assurance in Commissioning.

In addition, the Commissioning Program is making full use of the experience gained:

- a) by ANSTO in the operation and maintenance, including the conduct of major shutdowns, on HIFAR during the 40+ years of its successful operation, and
- b) by INVAP during their 25 years of involvement in the design, construction and commissioning of research reactors and associated nuclear facilities.

15.2.2 Preparation and Implementation of the Commissioning Plan

The Commissioning Program has been prepared and is being implemented and reported under the auspices of the Commissioning Plan which has been prepared co-jointly by ANSTO and INVAP/JHEDI. The finalisation of the Commissioning Plan by ANSTO and INVAP/JHEDI occurred in June 2004.

End of Section

15.3 COMMISSIONING ORGANISATION & RESPONSIBILITIES

The carrying out the commissioning of the Reactor Facility requires the establishment of a special organisation that is different from the one used in the earlier project phases and the one that will finally operate the Reactor Facility. The organisation is based on several groups and managers that are responsible for managing and carrying out the commissioning activities.

The groups are as follows:

- Management Group.
- Commissioning Group.
- Construction Group.
- Operation Group.
- Commissioning Safety Review Committee.
- Commissioning Quality Assurance Group.

These groups include personnel from ANSTO, INVAP and its subcontractors that have been part of the project delivery from design to construction and installation and are thus knowledgeable with respect to the design of the Reactor Facility.

Commissioning of the facility is overseen by the Management Group, which is chaired by ANSTO's Project Manager.

The commissioning is organised in several stages as explained below. The commissioning functional chart for stage A is shown in Figure 15.3/1 whilst the functional chart for stages B1, B2 and C is shown in Figure 15.3/2.

For the Contract Performance Demonstration Tests the organisation is modified to be that of the operating facility.

15.3.1 Management Group

The Management Group has the authority of the ANSTO Executive Director and the INVAP CEO to conduct all activities associated with the Commissioning Program.

The Management Group is composed of:

- a) the ANSTO RRR Project Manager,
- b) the INVAP Project Director,
- c) the INVAP Vice President, Nuclear Division,
- d) the ANSTO Director, Government and Public Affairs,
- e) the ANSTO Director, Safety and Radiation Science, and
- f) the ANSTO Director, Nuclear Technology,

Their principal role is to provide all necessary resources and support to the Commissioning Group (described below) and to provide strategic oversight.

The ANSTO RRR Project Manager represents ANSTO in administration of the contract throughout the commissioning.

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.

The ANSTO Director, Government and Public Affairs, provides the interface between the Project and ANSTO stakeholders.

The ANSTO Director, Nuclear Technology ensures access to resources in reactor engineering, reactor physics and reactor operation required for commissioning and ongoing operation of the RRR.

The ANSTO Director, Safety and Radiation Science brings to the Management Group access to resources with knowledge in radiation protection, licensing and workplace safety. The Management Group has 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;
- h) Ensuring that the resources necessary to carry out commissioning activities are available.

15.3.2 Commissioning Group

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.

The Commissioning Group consists of:

- Commissioning Manager (INVAP)
- RRR Project Engineering Manager (ANSTO)
- Commissioning Reactor Manager (ANSTO)

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.

The RRR Project Engineering Manager brings his technical knowledge and experience gained throughout the design and construction stages of the project and makes available resources from within ANSTO's RRR project organisation to participate in commissioning activities.

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 will be responsible for the safety of the facility under the terms of any operating licence.

The Commissioning Group organises the commissioning of systems and components.

The Commissioning Group is responsible for:

- a) Interacting with the appropriate groups to establish, 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) Monitor the progress of the Commissioning phase
- d) Implementing procedures that ensure orderly transfer of responsibility from the Construction Group to the Operation Group for structures, systems and components, including identification of special precautions for partly installed or deficient systems;

15.3.3 Commissioning Teams

Commissioning teams are formed to undertake planning, preparatory work and commissioning tests on reactor systems.

Membership of the teams is determined by the Commissioning Group and includes personnel with knowledge and experience appropriate to the system to be commissioned and tests to be undertaken. The teams 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 are also 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 are included in Commissioning Teams as required.

INVAP personnel allocated to the Commissioning teams provide support to the Commissioning Manager in ensuring compliance with 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) Prepare 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, preparing test records, certificates and completion assurance documentation;
- i) Withdrawing or removing procedures and equipment used during commissioning but not appropriate to plant operation.

15.3.4 Construction Group

At the commencement of the construction phase, INVAP established a site Construction Group under its overall supervision. This group will continue during the commissioning providing support to the Commissioning Group as required.

The Construction Group 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 Operation Group;
- 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 Operation Group;
- d) Correcting deficiencies identified during commissioning;
- e) Correcting non-conformances from construction and installation phase and revise documentation if necessary;
- f) Assisting the Commissioning Group in formulating test objectives and acceptance criteria, in evaluating test results, in correcting non-conformance and in revising documentation as necessary;
- g) Assisting the Commissioning Group and Operation Group during the execution of commissioning activities;
- h) Maintaining the equipment necessary to carry out commissioning activities, including the calibration of such equipment.

15.3.5 Operation Group

An Operation Group is set up to operate the facility in accordance with the applicable plant documentation and commissioning procedures and requirements.

The Operation Group consists of ANSTO and INVAP personnel who have been trained in their respective roles as part of a comprehensive training program.

The ANSTO personnel are drawn in large part from Nuclear Technology and trained in accordance with the procedures and operating instructions developed under the Plan.

INVAP representatives from the Operation Group have participated in development of the Plan, and will operate the systems during Stage A Commissioning and provide guidance and oversight to ANSTO operators during Stage B and C Commissioning.

ANSTO representatives from the Operation Group have also participated in the development of the Plan and will witness the Stage A Commissioning and operate all systems in accordance with the operating procedures during Stage B and C

Commissioning, and during the conduct of the Contract Performance Demonstration Tests.

Ultimately the ANSTO personnel will operate the Reactor Facility following commissioning, performance demonstration and hand over to ANSTO as an operating facility both during and after the initial support period provided by INVAP.

During Stage A Commissioning, the group are being managed by an INVAP representative with the active participation of the Commissioning Reactor Manager. From stage B onwards, the group is headed by the Commissioning Reactor Manager, who is responsible for nuclear and conventional safety issues. INVAP is providing support during this time.

The personnel are to be accredited by the Commissioning Reactor Manager as appropriate, taking into consideration the training received during the previous project stages. Accreditation is required for stage B and beyond for staff who control the operation of the plant.

The Operation Group is responsible during the entire commissioning phase for:

- a) Operating all systems in accordance with procedures, as 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 Construction Group to the Operation Group following Stage A;
- c) Satisfying itself that the systems being received comply with the design and safety requirements, and accepting the responsibility for the transferred systems; and
- d) Assisting the Commissioning Group in any way necessary to accomplish the commissioning goals.

15.3.6 Commissioning Safety Review Committee

A Commissioning Safety Review Committee (CSRC) has been formed to consider nuclear and radiation safety implications of all Quality Audit reports during the hot commissioning phase of the project. It is also responsible for reviewing the safety implications of proposed hot commissioning tests and for making recommendations to the Management Group and the Commissioning Group on proposed tests based on safety considerations.

The CSRC has the following membership:

- ANSTO Director, Safety & Radiation Science,
- ANSTO RRRP Safety & Licensing Manager,
- ANSTO SAR Responsible Officer,
- INVAP Safety Analyst, and
- INVAP Design Representative.

15.3.7 Commissioning Quality Assurance Group

A Commissioning Quality Assurance Group has been set up, headed by the Commissioning QA Manager (INVAP) and consisting of quality assurance personnel from ANSTO and INVAP. The Commissioning QA Manager reports directly to the Management Group.

The Commissioning Quality Assurance Group assists the Commissioning Manager:

- a) In the implementation of the Commissioning Quality Plan,
- b) In the overview and provision of advice in relation to the preparation of the commissioning procedures contained in the Plan, and
- c) Monitoring commissioning activities for conformance with the Commissioning Quality Plan

The Commissioning Quality Assurance Group is responsible for the internal audit of the Plan throughout all stages of its development and implementation. The Commissioning QA Manager also ensures that, in conjunction with the Management Group, external audits are conducted during the development and implementation of the Plan.

The Commissioning Quality Assurance Group is responsible for:

- a) Preparation of the Commissioning Quality Assurance Plan,
- b) Assisting the Commissioning Manager and the Management Group in the implementation and enforcement of the Commissioning Quality Assurance Plan and other general procedures,
- c) Co-ordinating inspections of implementation of the Commissioning Plan,
- d) Maintaining and updating the Commissioning Plan documentation, including test records,
- e) Auditing commissioning activities, and
- f) Maintaining suitable test and calibration records of the equipment and tools being commissioned.

End of Section

Figure 15.3/1 Reactor Facility Commissioning Organisation Chart - Stage A

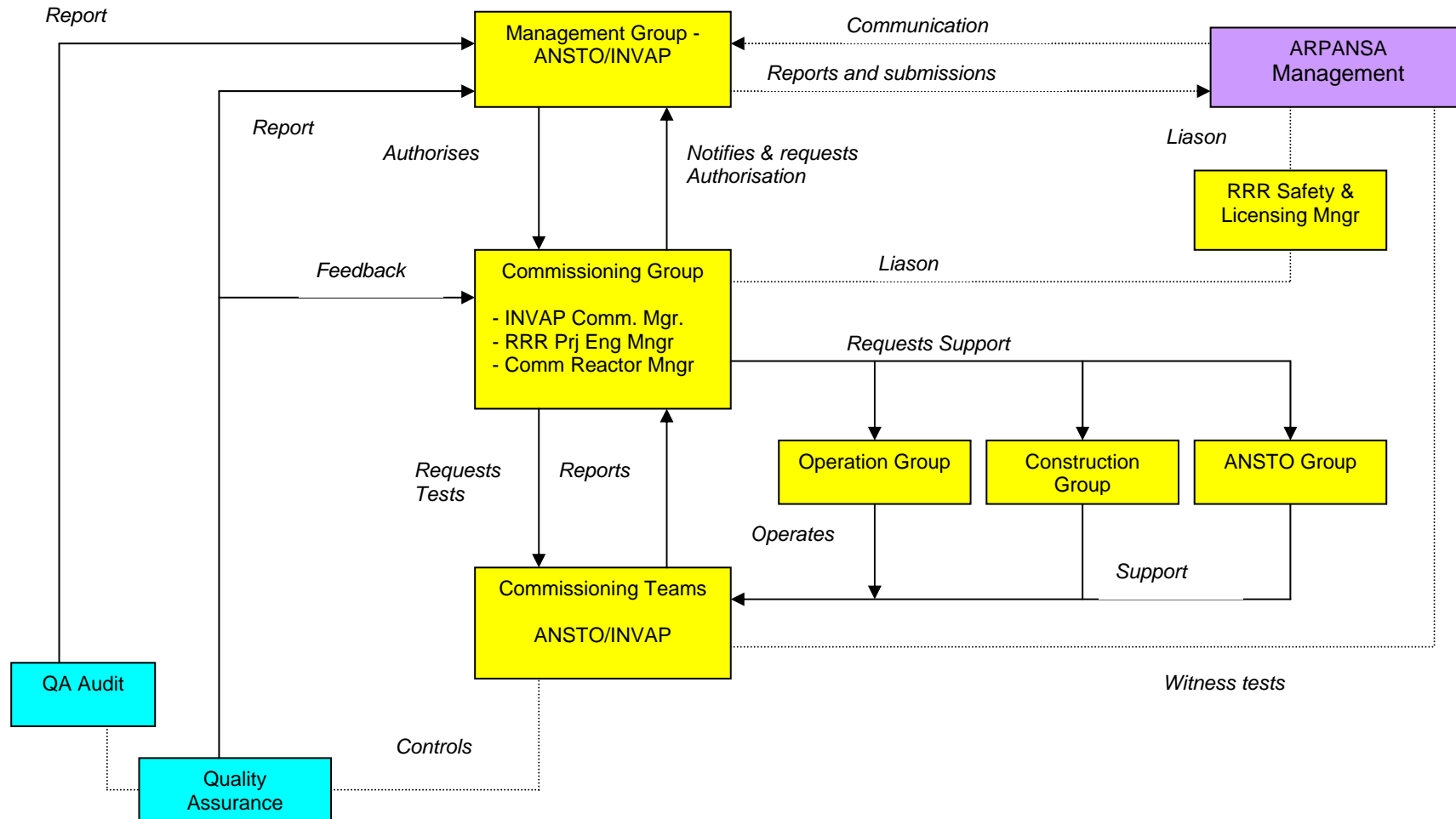
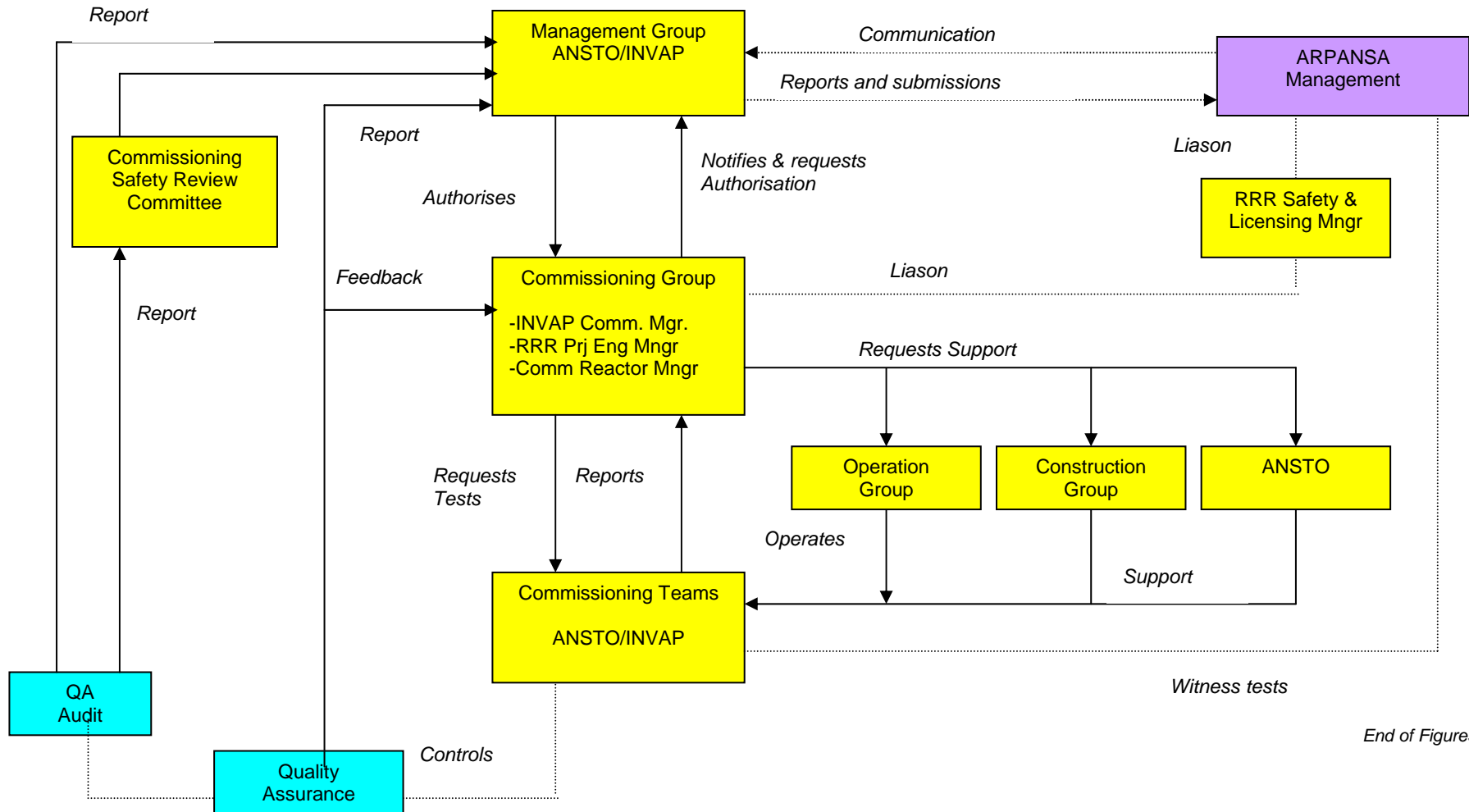


Figure 15.3/2 Reactor Facility Commissioning Organisation Chart - Stages B1, B2, and C



End of Figures

15.4 COMMISSIONING STAGES, TESTS & PREREQUISITES

15.4.1 Commissioning Stages

In order to ensure optimum use of resources and efficient planning, the commissioning phase has been divided into stages:

Stage A for the pre-fuel loading tests.

Stage B for the fuel loading and approach to criticality tests.

Stage C for power ascension and power tests.

A specific plan covering each commissioning stage has been developed. 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 required for the stage.

The planning and design of all the commissioning tests have taken into consideration the reactor operational states. In addition, attention has also been given to relevant anticipated operational occurrences such as loss of offsite power.

The commissioning activities regarding irradiation and neutron beam facilities have been integrated into the framework of the Plan. However, commissioning tests of these facilities are being scheduled and organised so as not to interfere with the planned commissioning activities for the Reactor Facility.

15.4.1.1 Stage A

Stage A tests consist of those system integration tests conducted following completion of construction related inspections and tests, but before fuel loading. The tests are designed 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.

The start of Stage A is being managed as an interface with the completion of the construction inspection and testing activities. Appropriate release certificates are providing evidence that previous steps have been executed in accordance with the project procedures.

15.4.1.2 Stage B

Stage B starts with progressive loading of fuel into the reactor core, bringing the reactor critical 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.

Stage B is split into two sub-stages, namely, the stages prior to (B1) and after (B2) the first criticality has been reached.

Stage B2 includes reactor operation at a power level such that all the nucleonic instrumentation channels are above their operational threshold.

15.4.1.3 Stage C

At Stage C, the reactor is operated at increasing power levels up to 100% of full power.

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.

15.4.1.4 Contract Performance Demonstration Tests

The Contract Performance Demonstration Tests are undertaken to show compliance with the Contract Performance Acceptance Criteria specified in the Conditions of Contract. The tests are considered as part of the commissioning although the plant is considered fully operational at the completion of Stage C. They are included in this chapter for completeness even though they form no part of the safety case for the Reactor Facility.

Contract performance demonstration involves the measurement of a series of parameters as required in the contract between ANSTO and INVAP for the construction of the facility. Those parameters that are safety related are addressed as part of the commissioning phase.

There are some 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 Stage B and C Commissioning are being carried out. Therefore these measurements will be performed between commissioning tests, or in the periods between commissioning stages.

The formal Contract Performance Demonstration Test stage follows the completion of Stage C Commissioning and in this sense is the beginning of the commercial operation phase.

The Reactor Facility operating procedures, manuals and plans are replaced from the commissioning version to the versions to be used during the operation phase and incorporate the experience gained during the commissioning.

While a review of operation manuals and procedures will have already taken place during precommissioning tests, a final verification of the adequacy of the maintenance and operation procedures is undertaken during Stage C and adopted for the Contract Performance Demonstration Tests.

By the time the Contract Performance Demonstration Tests are executed, the facility capability regarding its safe operation will have already been demonstrated during commissioning stages A, B and C.

15.4.2 Commissioning Tests and Prerequisites

“Test” is defined as the set of measurements, examinations 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.

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 that Commissioning stage.

All testing is accomplished using approved procedures throughout Commissioning.

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 Commissioning Group or the member of the

Commissioning Team in charge of the test, and the test procedure is reviewed in detail and then performed.

During the test, all precautions are observed, and data records are completed, reviewed, signed and dated by the member of the Commissioning Team in charge of the test.

The plant operating staff is responsible for the safe and proper operation of equipment during the test.

Where systems or components are duplicated in the design to provide "Duty" and redundancies, all systems or components of all redundancies will be tested, either during the precommissioning tests or during the commissioning itself.

The specific requirements on 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 1 to 3.

15.4.2.1 Staffing Requirements for Test Execution

As a minimum the following are to be assigned to each commissioning test (procedure execution):

- a) A Commissioning officer from the Commissioning Team (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 to 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.

15.4.2.2 Unexpected Results and Resolution of Non-Conformances

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

Structures, systems and components will be either accepted, rejected, repaired or reprocessed according to the acceptance criteria of the relevant commissioning procedure.

The Commissioning Manager has the following responsibilities concerning the resolution of non-conformities and unexpected results:

- a) Ensuring the provision of adequate resources for identifying non-conformity conditions.
- b) Resolving differing opinions on the extent or causes of non-conformities and proposed corrective actions.
- c) Establishing the safety and security implications of non-conformities.
- d) Informing the commissioning Safety Review Committee on the status and implications of the non-conformances or unexpected results.

The Construction Group has personnel responsible for classifying, analysing and resolving non-conformities, who have an adequate understanding of the area in which they are working, and access to pertinent background information concerning the non-conformity.

Consequences of non-conformities arising from tests are considered in retrospect so as to assess the need to repeat previous tests where necessary.

Non-conformances will be addressed before the end of the Commissioning Stage.

The Commissioning Quality Assurance Officer will maintain an updated record of all non-conformities and resulting corrective actions.

The Commissioning Manager and the Commissioning Safety Review Committee will be notified of non-conformances and the actions proposed to resolve them.

The Commissioning Safety Review Committee will analyse the safety implications of relevant non-conformities and adequacy of the proposed solutions and advise the Commissioning Manager accordingly.

15.4.2.3 Review and Approval of Test Results

The Commissioning Manager has overall responsibility for review and approval of test results.

Upon completion of each test, the Commissioning Team 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 Commissioning Manager for 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.

Following review and resolution of review comments with ANSTO, the Commissioning Manager either:

- a) Approves and accept the test results with or without exceptions, or
- b) Finds the test results unacceptable until all or part of the outstanding exceptions are resolved, or
- c) Requests the entire test be repeated.

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 evaluations, 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 Commissioning Manager agrees to the test exception based on engineering recommendations and consideration with respect to the safety case.

The Construction Group has personnel responsible for analysing and resolving exceptions with an adequate understanding, access to pertinent background and engineering support.

The Management Group and the Commissioning Safety Review Committee are notified of test results and any exceptions together with any actions proposed to resolve them.

End of Section

15.5 SCHEDULING

Commissioning tests are sequenced so that the safety of the Reactor Facility is never dependent upon untested structures, systems and components.

The sequence followed is that prescribed in IAEA Safety Guide NS259 NS-G1:

Pre-Operational (Construction) Stage:

Pre-Commissioning Tests

Commissioning & Performance Demonstration Stages:

Stage A: Pre-Fuel Loading Tests

Stage B1: Fuel Loading & Approach to Criticality

Stage B2: Low Power Tests

Stage C: Power Ascension & Power Tests

Contract Performance Demonstration Tests

A detailed Commissioning Schedule has been prepared. Hold Points have been identified in the Commissioning Schedule to make provision for reviews of reports on prerequisite activities and to provide formal approvals to proceed with specific commissioning activities. Commissioning Hold Points include:

- a) completion of Pre-Commissioning Tests
- b) completion of Stage A Commissioning
- c) completion of Stage B1 Commissioning
- d) completion of Stage B2 Commissioning
- e) completion of Stage C Commissioning

Hold points also apply prior to the commencement of any commissioning activity for which the successful completion of activities is a prerequisite under the Plan.

End of Section

15.6 COMMISSIONING PROCEDURES, RECORDS, & REPORTS

15.6.1 Procedures

Tests to be executed during the commissioning phase are planned, conducted and controlled using detailed written procedures prepared for each test. These procedures 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.

Procedures are designed to demonstrate compliance with the acceptance criteria. Commissioning procedures have been developed during the detailed engineering phase and have been reviewed and updated during the construction, inspection and test phase and the commissioning phase itself as necessary.

Procedures are being managed in compliance with the Commissioning QA Plan. Commissioning procedures are managed and implemented by the Commissioning Group. Commissioning procedures are audited by the Commissioning Quality Assurance Group. Review of procedures is carried out by the Management Group and the Commissioning Safety Review Committee.

The commissioning procedures include information that:

- a) Defines the objective of the procedure and, where appropriate, the reason for a test (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;
- d) Identifies the performance requirements together with clearly stated acceptance criteria.

Procedures used during commissioning for emergency management, health physics, and security are issued under the umbrella of the Plan.

15.6.2 Records

The outputs resulting from the application of the procedures are registered in records whose forms are enclosed in the applicable procedure. The records are identified, issued, controlled, and filed in accordance with the Commissioning QA Plan.

15.6.3 Reports

Reports are prepared by the Commissioning Group 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. These reports provide the basis for review and approval.

The Management Group will review the commissioning reports to ensure that the Plan's objectives have been achieved. In particular, the Management Group ensures that limits and conditions have been complied with and that the assumptions and predictions about reactor performance made as part of the safety case have been confirmed.

A comprehensive Commissioning report will be prepared for the Management Group upon conclusion of the commissioning phase.

End of Section

15.7 VERIFICATION & REVIEW, AUDITS & DEVIATIONS

15.7.1 Verification

Verification of commissioning test results is carried out by the Commissioning Group to confirm that the relevant parameters associated to acceptance criteria have been obtained as specified in procedures and that the applicable control activities have been performed as required by this plan.

15.7.2 Review

Review of commissioning activities is carried out by the Management Group based on commissioning reports. The review process assesses the suitability and effectiveness of the Plan, assesses the adequacy of the commissioning procedures that have been carried out and provides assurance that the corrective actions proposed to solve non-conformities are adequate.

15.7.3 Control

The activities carried out during the commissioning phase are controlled by the Commissioning Group. Each commissioning test requires the participation of an ANSTO representative whose responsibility is to establish that the test has been carried out in accordance with the test procedure.

Each commissioning test is directed by an INVAP representative of the Commissioning Team using the appropriate test procedure. The INVAP representative ensures the steps and indications of the test procedure are followed, takes note of any anomaly or relevant fact that occurs during the test, and completes and signs the test record.

In addition to the control activities, there are also hold points where, in order to proceed, approval of an identified authority (for example the Commissioning Manager or the Management Group) is required.

The following hold points are identified:

- a) In order to start each Commissioning stage, authorisation by the Management Group is required.
- b) In order to start each test, authorisation by the Commissioning Manager is required.
- c) In addition, the Management Group may require that, in order to start a particular test, a formal authorisation is provided by the Management Group

The specific commissioning plan for each commissioning stage details the hold points foreseen for that stage.

The Commissioning Group is implementing appropriate controls to identify those systems ready for commissioning and to ensure that there is no unauthorised tampering with those systems prior to, and following, the commissioning tests.

15.7.4 Audits

An Audit Programme for the commissioning phase will be established to verify compliance with relevant aspects of the Plan. The audit schedule includes arrangements for production and control of the required documentation.

The Commissioning Manager ensures that the actions necessary to correct any deficiencies revealed by an audit are undertaken in a timely manner. Independent external audits are also carried out.

End of Section

15.8 DOCUMENTATION

Procedures have been established in accordance with the Commissioning Quality Assurance Program to identify, collect, maintain, review, modify, approve, issue and file documents.

Commissioning documentation includes the following:

- a) Commissioning Plan.
- b) Specific Commissioning Plans for each Stage
- c) All commissioning procedures and instructions for each structure, system and component tested and commissioned.
- d) A Summary Report after each stage is completed.
- e) Work reports, including:
 - (i) checklists and logs
 - (ii) certificates and approvals
 - (iii) significant event reports
 - (iv) reporting of deviations and resolution
 - (v) reporting of changes
- f) QA Manual for commissioning.
- g) Quality assurance records.

Permanent records will be maintained for the lifetime of the facility and meet one or more of the following criteria:

- a) demonstrate a capability of safe operation
- b) determine the cause of an accident or the malfunction of an item
- c) provide baseline data for periodic inspection
- d) are required for maintenance, modification or replacement of an item
- e) facilitate decommissioning
- f) are required by ARPANSA or other relevant organisations
- g) specifications, procedures and test results which constitute historical data.

The following information will be included in the revision to the SAR once the commissioning of the Reactor Facility is complete:

- 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. Results of radiation measurements of shielding; measurements of airborne effluents released from the facility.

- g) Reactivity worth of irradiation facilities.
- h) Measurements of reactivity feedback coefficients for the reactor core.
- i) Thermal-hydraulic characteristics of the core and reactor coolant system flow rates and pressure drops.
- j) Measurements of performance of engineered safety features and other tested systems.

End of Section

15.9 COMMISSIONING QUALITY ASSURANCE PROGRAM

A Commissioning QA Plan for the whole commissioning phase is being issued and put into effect during the commissioning planning and execution. The Commissioning QA Plan complies with the requirements of IAEA, 50-C/SG/Q12, Quality Assurance in Commissioning, 1995.

The Commissioning QA Plan describes the system that controls the development and implementation of the commissioning process. The provisions of the plan are based on the following three functional categories: management, performance and assessment where:

- 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.

The Commissioning QA Plan ensures that verification during commissioning of compliance with the quality requirements is carried out by qualified personnel who are not directly responsible for performing commissioning activities.

The Commissioning QA Plan is documented in procedures. The procedures address all applicable quality assurance requirements specified in the Commissioning QA Plan.

Measures have been established under the Commissioning QA Plan to identify, report, review, deal with, control and document items, activities and services that do not conform to requirements. A history of all non-conformances and the resulting corrective actions are maintained by the Commissioning QA Officer.

The Commissioning QA Plan requirements are communicated to the staff of the commissioning organisation and controls are being established to ensure that commissioning activities meet established requirements and perform as specified.

Internal and external audits are being conducted during the development and implementation of the Plan.

During the Contract Performance Demonstration Tests, the operational QA arrangements will be put in place. The commissioning QA procedures and instructions will be replaced by those corresponding to those of the operation phase.

End of Section

15.10 EMERGENCY PROCEDURES

The Commissioning Emergency Plan identifies emergency response procedures to be put in place during the commissioning stages.

The Commissioning Emergency Plan is a special version of the emergency planning arrangements addressed in Chapter 20. As such, it integrates into the current site emergency management.

The Commissioning Emergency Plan 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.

The efficiency of the Commissioning Emergency Procedures will be tested by means of drills whose procedures and acceptance criteria will be an integral part of the plan.

During the CPDTs, the arrangements detailed in the Commissioning Emergency Plan will be replaced by those set out in Chapter 20.

End of Section

15.11 RADIATION PROTECTION PROCEDURES

Before the introduction of any fissile material into the facility, health physics procedures will be in place and appropriate training will be completed. ANSTO is providing the health physics staff and portable equipment as required.

Use is being made, to the greatest extent possible, of the health physics procedures designed for the routine facility operation. Nevertheless there may be some specific 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.

There are special health physics procedures that correspond to non-routine activities within the facility, 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.

End of Section

15.12 SECURITY PROCEDURES

Before the introduction of any fissile material into the facility, security procedures will be in place and appropriate training will be completed.

End of Section

15.13 LIMITS & CONDITIONS

Specific Commissioning Limits and Conditions are being produced for Commissioning stages B and C. No Limits and Conditions are required for stage A Commissioning. Stage specific Commissioning Limits and Conditions are being provided for each stage commissioning plan.

The Commissioning Limits and Conditions are set so as to provide an adequate margin between the limits of operation and the Safety Limit in accordance with the Defence in Depth Principle.

The results of commissioning tests will be used to validate Chapter 17 and determine the appropriateness of proposed Operating Limits and Conditions. Operating Limits and Conditions and Chapter 17 of this document will become effective upon completion of Stage C commissioning.

End of Section

15.14 TRAINING FOR COMMISSIONING

A Training Program has been established that addresses the necessary qualifications and training for personnel performing commissioning activities. The training provides the necessary knowledge on the plant systems and its safety features, commissioning tests and procedures, the intended operational procedures, and other relevant competencies.

Training for RRR operation is being provided to ANSTO staff in preparation for commissioning activities. Completion of this training will result in provisional accreditation.

At least one month prior to the commencement of the commissioning phase, personnel participating in the commissioning are to 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.

Training of ANSTO personnel who will participate in the operation of the Reactor Facility will continue during the commissioning phase.

The training of ANSTO facility operation staff will take advantage from the different commissioning activities to provide additional training and first hand experience for the personnel. The training during the commissioning phase will ensure the familiarity of the operating personnel with the plant systems, organisational structure and plant procedures and emphasize the paramount importance of safety in all aspects of plant operation.

End of Section

APPENDIX 1 PREREQUISITES & TESTS FOR STAGE A COMMISSIONING**Prerequisites for Stage A**

1. The construction and installation of structures, systems and components will be completed in accordance with the Construction Inspection & Test Plan to the extent that other activities will not affect the validity of tests 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 the 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 Commissioning Reactor Manager 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 site 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

Stage A Commissioning Report

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.

End of Appendix 1

APPENDIX 2 PREREQUISITES & TESTS FOR STAGE B COMMISSIONING**Prerequisites for Sub-Stage B1 (Fuel Loading and Approach to Criticality)**

Prerequisites for Sub-Stage B1:

- a) Stage A report prepared by the Commissioning Group approved by the Management Group.
- 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

Setup of Safety System Settings.

First reactor core fuel loading procedure.

Confirmation of nucleonic instrumentation

Approach to criticality procedure.

First shutdown system shutdown margin measurement procedure.

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)

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 Linear 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

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.

End of Appendix 2

APPENDIX 3 PREREQUISITES & TESTS FOR STAGE C COMMISSIONING**General Considerations**

1. Tests conducted during Stage C are intended to confirm where practicable that the reactor can be operated in a safe manner.
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.

Prerequisites for Stage C

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 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 shielding
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

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.

End of Appendix 3