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File: 145-00521-021

UNRESTRICTED

VIA E-MAIL/COURIER

MMIR File #6400-ACNO-07-0147-L

2007 May 22

Mr. Marc Leblanc
Commission Secretary
Canadian Nuclear Safety Commission
Secretariat
280 Slater Street
Ottawa, Ontario K1P 5S9

Re: MAPLE 1 and 2 Reactors (NPROL-62.00/2007) and the New Processing Facility (NSPFOL-03.00/2007) Licence Renewal - 2007 (Day One Public Hearing)

Dear Mr. Leblanc:

Thank you for your letter dated 2007 April 19 [1], regarding the two-day public hearing for the renewal of the Operating Licences of the MAPLE 1 and 2 Reactors and the New Processing Facility at Chalk River Laboratories.

AECL's application to renew the current licences [2,3] for the Dedicated Isotope Facilities has previously been provided to the Secretariat [4], with copy to CNSC staff.

Further to the application, please now find enclosed an information document [5] prepared specifically for consideration as a Commission Member Document (CMD) at the forthcoming Day One hearing, to be held 2007 June 22.

With specific regard to the attendance of AECL at the hearing, please note that supplementary information, including associated presentation material, will be submitted to the Secretariat on or before 2007 June 14.

Should you have any questions regarding this package, please contact Don Taylor or myself.

Yours sincerely,

22 May 2007

B.E. (Brian) McGee
Vice President

BEM/cl

c.	G. Archinoff	>CR Licensing
	D. Balla-Boudreau	>CR CNSC Site Office
	D. Garrick	B. Howden (CNSC)
	D. Hickey	E. Langlois (CNSC)
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	W.R. Shorter	M. Santini (CNSC)
	D. Taylor	L. Levert (CNSC)
	A.J. White	
	K. Wittann	
	R. Zemdegs	

References:

[1] Letter from L. Levert to B.E. McGee, "Notice of Public Hearing 2007-H-10", 1-3-1-9, 2007 April 19.

[2] AECL Document, "Non-Power Reactor Operating Licence - MAPLE 1 and 2 Nuclear Reactors. Licence Number NPROL-62.00/2007." Expiry Date: 2007 November 30.

[3] AECL Document, "Nuclear Substance Processing Facility Operating Licence – New Processing Facility. Licence Number NSPFOL-03.00/2007." Expiry Date: 2007 November 30.

[4] Letter from B.E. McGee to M. Leblanc, "MAPLE Reactors 1 and 2 (NPROL-62.00/2007) and the New Processing Facility (NSPFOL-03.00/2007) Licence Renewal Applications", 145-00521-021, 2007 March 05.

[5] AECL Document, "Renewal (2007) of the Dedicated Isotope Facilities (MAPLE 1& 2 Reactors and the New Processing Facility) Operating Licences – Information Presented for the Day One CNSC Public Hearing (2007 June 22)", 6400-00521-LP-001, Revision 0, 2007 May.

AECL EACL

Licensing Package

Renewal (2007) of the Dedicated Isotope Facilities (MAPLE 1 & 2 Reactors and the New Processing Facility) Operating Licences-Information Presented for the Day One CNSC Public Hearing (2007 June 22)

Licensing - Dedicated Isotope Facilities (DIF)

6400-00521-LP-001
Revision 0

2007 May

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Licensing Package

Renewal (2007) of the Dedicated Isotope Facilities (MAPLE 1 & 2 Reactors and the New Processing Facility) Operating Licences- Information Presented for the Day One CNSC Public Hearing (2007 June 22)

Licensing - Dedicated Isotope Facilities (DIF)

6400-00521-LP-001
Revision 0

Prepared by
Rédigé par

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Approuvé par

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Director, DIF Operations

2007 May | mai 2007

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Revision History Liste de révisions

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Document Details / Détails sur le document

Title Titre	Total no. of pages Nbre total de pages
Renewal (2007) of the Dedicated Isotope Facilities (MAPLE 1 & 2 Reactors and the New Processing Facility) Operating Licences-Information Presented for the Day One CNSC Public Hearing (2007 June 22)	112

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Revision History / Liste de révisions

Revision / Révision No./N°	Revision / Révision Date	Details of Rev. / Détails de la rév.	Prepared by Rédigé par	Reviewed by Examiné par	Approved by Approuvé par
D1	2007 April 17	Draft for Review and Comment.	DIF/MMIR Licensing Team	A. White R. Zemdegs A. Lee L. Lupton D. Garrick D. Taylor	
D2	2007 May 01	Second Draft Issued for Review.	DIF/MMIR Licensing Team	A. White A. Lee L. Lupton D. Garrick D. Taylor	
R0	2007 May 22	Issued for Use.	DIF/MMIR Licensing Team	D. Garrick	D. Taylor

TABLES

FIGURES

APPENDICES

1. INTRODUCTION

1.1 Scope

Atomic Energy of Canada Limited (AECL) is submitting this document to assist Canadian Nuclear Safety Commission (CNSC) members in their assessment of the application to renew the operating licenses for Multi-purpose Applied Physics Lattice Experimental (MAPLE) Reactors 1 and 2 and the New Processing Facility (NPF) [1-1]. The operating licences for the MAPLE 1 and 2 Reactors and NPF were granted to AECL by the CNSC on 2005 November 30 under operating licence Non- Power Reactor Operating Licence (NPROL-62.00/2007) for MAPLE [1-2] and Nuclear Substance Processing Facility (NSPFOL-03.00/2007) for NPF [1-3]. The MAPLE 1 and MAPLE 2 Reactors and the NPF are also referred to collectively as the Dedicated Isotope Facilities (DIF). The MAPLE Iodine Production Facility (MIPF), also part of DIF, is installed and will be operated as part of MAPLE 1.

This document has been compiled following the recent Mid-term Hearing (2006 December) and has taken into consideration the most relevant and recent licensing documentation since the previous renewal in 2005.

1.2 Purpose of this Submission

The principal purpose of this document is to provide information in support of AECL's application for a 47-month licence renewal period for MAPLE and NPF operating licences, under one single licence. This will align MAPLE and NPF licence renewal periods with Chalk River Laboratories (CRL) site licence period. Aligning the licence periods and combining the licences will facilitate inclusion of MAPLE and NPF facilities within CRL site licence, Nuclear Research and Test Establishment Operating Licence, NRTEOL-01.00/2011 [1-4], following CRL site licence renewal in 2011 October. The application for renewal has been made in accordance with applicable Commission Member Documents [1-5 and 1-6]. Reference [1-5] identifies guidelines for a licence period up to five years or longer, and AECL's view is that these guidelines have been met, as supported by the information contained herein.

This submission contains information on the performance of the MAPLE 1 and 2 Reactors and the NPF during the current licence period, which ends on 2007 November. It also provides a summary of the key developments and planned activities in the MAPLE 1 and 2 Reactors and the NPF and on the key compliance programs in place to ensure the health and safety of workers and members of the public and to ensure adequate security and protection of the environment.

1.3 Major Activities During the Proposed Licensing Period

The major activities during the proposed licensing period will include:

- Tests to re-measure the positive Power Coefficient of Reactivity
- Tests to determine the cause of the Positive Power Coefficient of Reactivity

- Tests to demonstrate remedies for the cause of the positive Power Coefficient of Reactivity are effective
- Irradiation of targets for the commissioning of New Processing Facility
- Completion of commissioning of the MAPLE 1 and 2 Nuclear Reactors and the Iodine Production Facility
- Completion of Inactive and Active commissioning of the New Processing Facility
- Subsequent operation of the MAPLE Reactors and the NPF for the production of medical isotopes

1.4 DIF Organization

In the beginning of 2006, after finalizing a contractual agreement with MDS Nordion, AECL took ownership of the DIF; AECL incorporated the DIF Operating Organization into the Nuclear Laboratories Business Unit (NLBU). In 2006 May, the Vice-President of Nuclear Laboratories announced an update of AECL's NLBU organization. The Director of DIF Operations now reports to the General Manager (GM), Reactor Operations who reports directly to the Vice President Nuclear Laboratories.

The Director of DIF Operations is the Facility Authority, per the MAPLE Reactors Operating Licence, and the Facility Authority for NPF, per NPF Operating Licence and their referenced documentation.

The Director of DIF Operations is responsible for the operation, maintenance, safety, licensing, technical support and support services for the MAPLE Reactors, MAPLE Iodine Production Facility (MIPF), and NPF. This includes;

- Ensuring the operational readiness of the facilities
- Management of the facility licenses and associated commitments
- Ensuring that all work carried out in the facilities, including commissioning, follows the appropriate processes (e.g. work management, work permit)

All Dedicated Isotope Facilities activities, including MMIR project work, are done under the jurisdiction of the Facility Authority, i.e. the Director of DIF Operations.

1.5 MDS Nordion Medical Isotope Reactor (MMIR) Project Organization

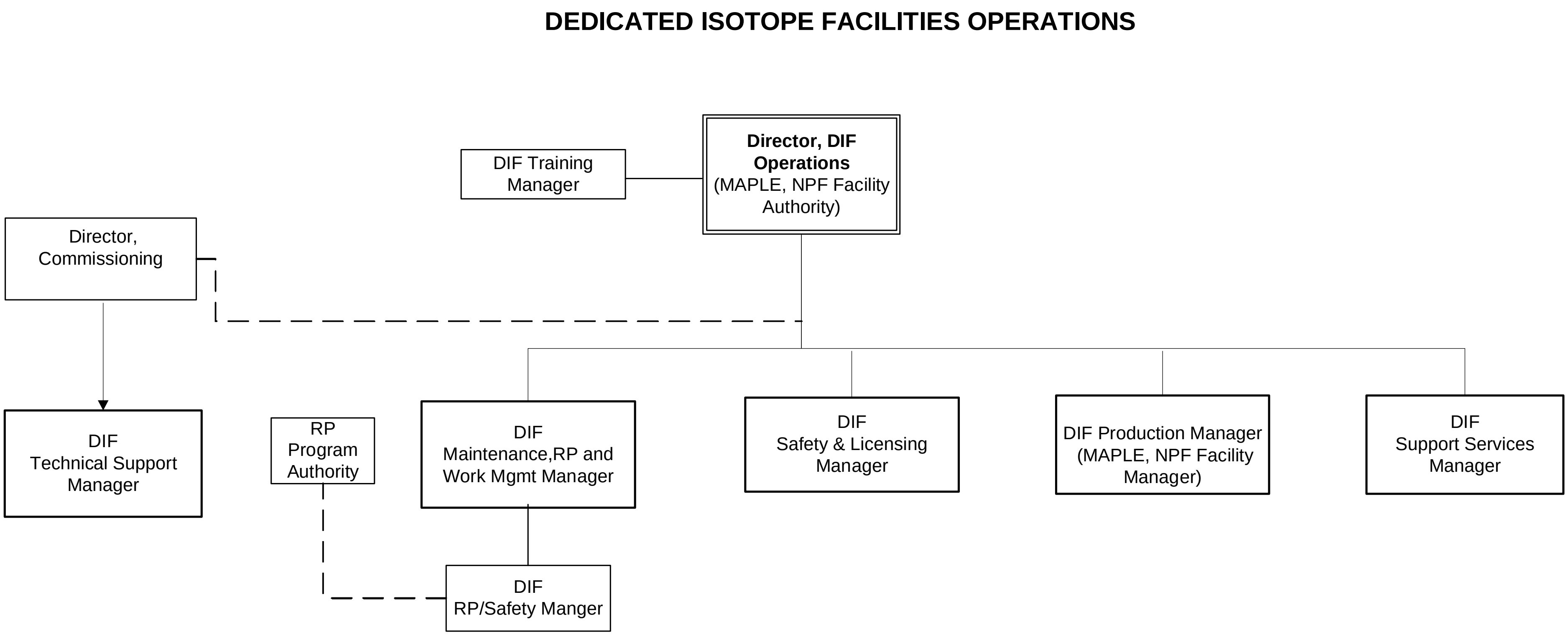
The Vice-President, Projects, has been appointed as the AECL executive responsible for the MMIR Project. The Project Director reports directly to the Vice President. The following Directors all report to the MMIR Project Director;

- Engineering and Procurement Director
- Commissioning Director
- MMIR Project Licensing Director
- MMIR Production Director

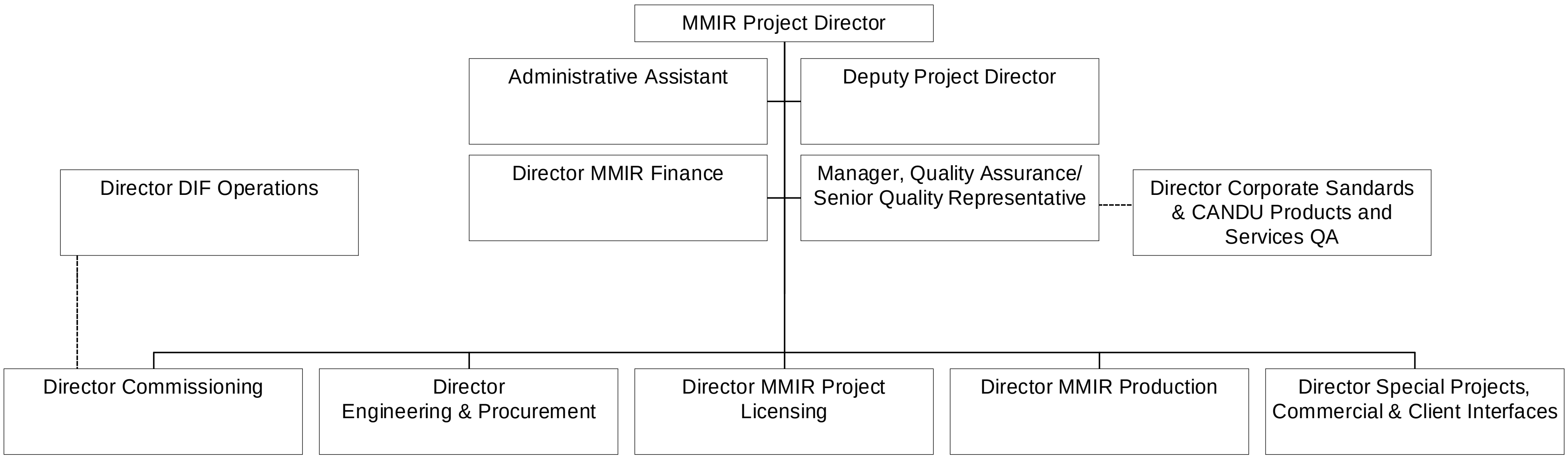
- Special Projects, Commercial & Client Interfaces Director

The Quality Assurance Manuals for both the MMIR Project and DIF Operations describe the requirements governing the performance of procurement, design, construction, and commissioning, of the Dedicated Isotope Facilities. Further to this, the DIF Operations Quality Assurance Manual covers both the Owner and Operator's responsibilities as per the applicable standards.

1.6 Organization Charts



MMIR PROJECT



1.7 References

[1-1] Letter from B.E. McGee to M. Leblanc, *MAPLE Reactors 1 and 2 (NPROL-62.00/2007) and New Processing Facility (NSPFOL-03.00/2007) Licence Renewal Applications*- 145-00521-021, 6400-ACNO-07-0016-E, 2007 March 05.

[1-2] AECL Document, *"Non-Power Reactor Operating Licence- MAPLE 1 and 2 Nuclear Reactors. Licence Number NPROL-62.00/2007."* Expiry Date: 2007 November 30.

[1-3] AECL Document, *"Nuclear Substance Processing Facility Operating Licence – New Processing Facility.* Licence Number NSPFOL-03.00/2007." Expiry Date: 2007 November 30.

[1-4] AECL Document "Nuclear Research and Test Establishment Operating Licence, Chalk River Laboratories, NRTEOL-01.00/2011." Expiry Date: 2011 October 31.

[1-5] *CNSC, New Staff Approach to Recommending Licence Periods*, CMD 02-M12, 2002 March.

[1-6] CNSC, *New Staff Approach to Recommending Licence Periods (Supplementary Information)*, CMD 02-M12.A, 2002 March.

2. FACILITY OPERATIONS DURING 2005-2007 LICENCE PERIOD

2.1 General Operations

MAPLE 1 Reactor:

- Various activities were pursued in MAPLE 1 Reactor with the primary objective of operating the reactor at high power to re-measure the Power Coefficient of Reactivity (PCR).
- Following completion of operational readiness activities, DIF Operations declared readiness to remove GSS and operate MAPLE 1 at powers up to 2 kW.
- MAPLE 1 Reactor was removed from GSS on 2006 May 01 and was then operated at 2 kW soon after.
- Following an event-free maintenance outage, AECL received approval from the CNSC staff to begin baseline testing to confirm the PCR at powers up to 5 MW. These baseline tests were completed on 2007 April 09.
- Moving forward, DIF Operations plans to complete nuclear commissioning of the MAPLE Reactor to allow the reactor to proceed to In-Service Operation.
- No commissioning has taken place in the MAPLE 1 Iodine Production Facility. The Commissioning team and DIF Operations have prioritized the outstanding work so that commissioning can resume after the New Processing Facility begins active commissioning.

MAPLE 2 Reactor:

- The MAPLE 2 Reactor remains in GSS and major work initiatives will begin only after resolving the positive PCR. Maintenance and calibration of equipment was conducted, as required, based on the configuration of the facility.

New Processing Facility:

- A variety of initiatives were pursued in the NPF with the primary focus on resolution of outstanding work that is required for safe and reliable operation of the facility.
- The most significant tasks currently ongoing are the redesigns of two major waste handling systems: Calcination and Cementation.
- Moving forward, active commissioning is planned for late 2007 leading ultimately to In-Service Operation during the next licensing period.

General to all Dedicated Isotope Facilities:

- The Dedicated Isotope Facilities (DIF) Facility Safety Representatives conducted monthly safety inspection tours. In addition, an independent safety inspection team comprised of representatives from Radiation Protection, Safety, and Emergency Preparedness, Occupational Health and Safety, the Site Safety and Health Committee and Environmental Protection inspected the facility. DIF personnel addressed findings from the inspections, accordingly.
- DIF commenced an initiative to improve the overall operating performance of the facilities. Opportunities for improvement were identified from self-assessments, event investigations, root cause analyses, DIF Operations Oversight Assessment, and CNSC inspections and audits. Additional resources have been added to ensure resolution and implementation of these opportunities for improvement. Detailed description of the improvement initiatives is provided throughout Section 3.

3. SAFETY AREAS

The following sections highlight key improvements that have taken place in the eight *Safety Areas* on which AECL is assessed by the CNSC staff.

In addition to the information provided below, Appendix A of this document provides additional information with respect to the CRL site wide programs that are in effect in DIF together with specific information on their implementation within DIF.

3.1 Operating Performance

3.1.1 Overview

DIF Operations has endeavored to improve its operating performance during the current licence period. In addition to the introduction of Operating Experience (OPEX) based process named "ImpAct", other initiatives such as System Performance Monitoring and the introduction of the use of "Event Free Tools" have all been used to facilitate the movement of DIF Operations to a first class operating organization. While reporting culture has been improved, and much lower level "issues" are being reported, recorded and trended via the ImpAct process, the DIF Organization successfully completed a 5 MW outage with zero events that would constitute an [1]Event Free Day Reset.

Details of the key improvements and initiatives that have taken place over the current licence period are provided below.

3.1.2 OPEX and the ImpAct Process

DIF Operations had identified the need for a process improvement in the areas of problem identification, cause analysis and corrective action. This need was confirmed during the CNSC audit (2005 May). A new process, named Improvement Action (ImpAct), was initiated to replace the Non-conformance and Corrective Action, and Unplanned Event Reporting, processes. In 2006 November, the DIF became the pilot for the ImpAct process.

The purpose of the ImpAct process is to gather information such that actions can be taken as appropriate to prevent occurrence/recurrence of significant problems. This process meets the pertinent requirements details in the CSA document N286.5.

The process standardizes the evaluation of identified problems by ensuring the following:

- Problems are documented;
- Causes are determined;
- Lessons learned, both within AECL and external nuclear industry, are identified and communicated;

[1] An Event Free Day Reset is declared when a human performance error results in an undesirable consequence to the workplace that exceeds established criteria and generally compromised safety.

- Approved corrective and/or remedial or compensatory actions are implemented; and
- Trends are identified and any appropriate corrective actions initiated.

3.1.2.1 Implementation of ImpAct

The ImpAct process was introduced to strengthen and streamline the use the non-conformance and unplanned event processes. Current facility problems/non-conformances are raised as ImpActs, which are subsequently generated into ImpAct Reports upon closure. A Self-Assessment of the ImpAct Pilot was completed in 2007 April by DIF Operations and OPEX Staff. It was concluded that, through the ImpAct process, DIF is documenting more issues than were identified in the prior ENF/NCR processes (191 ImpActs from 2006 December to 2007 February versus 88 ENF and NCR from 2005 December to 2006 February).

The ImpActs are appropriately reviewed (i.e. Operability, Reportability, and Significance), and they are assigned to the appropriate Responsible Manager in a timely manner. The fact that the process includes management review of ImpActs has contributed to enhanced worker buy-in to the process. Furthermore, the majority of the extra issues identified are low-level problems for trending and opportunities for improvement. The effectiveness of the ImpAct process will be continually confirmed by further effectiveness reviews and more experience with the process.

The statistics of ImpActs raised and processed is shown in the Figure 3-1. This demonstrates enhanced management oversight. The time period of this graph has been selected to best represent the ImpAct process after its initial implementation.

The introduction of the ImpAct process has resulted in a significant improvement to the reporting culture within the DIF organization, as can be seen in Table 3-1. The increased reporting will allow earlier recognition of underlying trends so that early action can be taken to prevent significant events. All events are appropriately screened and those of higher significance level are reviewed at the Management Review Meeting and appropriate action is taken.

Overall, introduction of the pilot ImpAct process has been successful. A self-assessment of the pilot has been implemented and improvement actions identified which are currently underway to further improve the process.

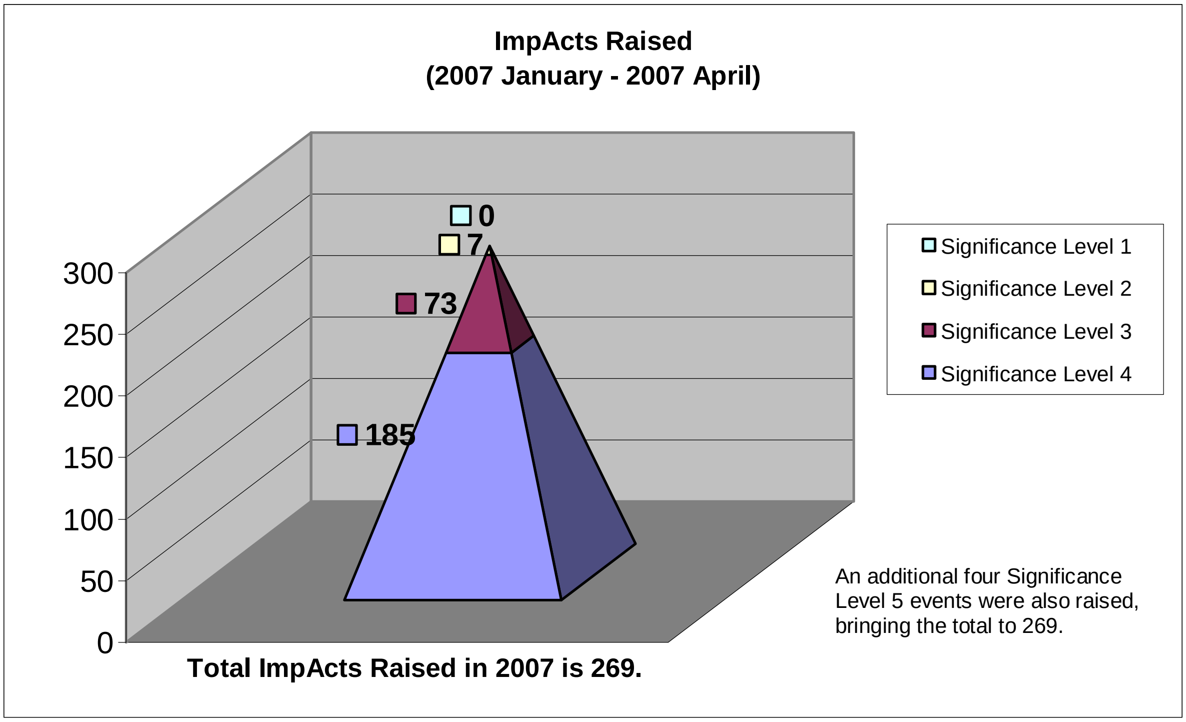


Figure 3-1 : Total ImpActs Raised in 2007

Table 3-1 : Facility Unplanned Events

Year	Reportable	Non-reportable	Total
2005*	43	37	80
2006**	97	203	300
2007***	27	242	269

* For 2005 Only ENFs were in use.
** In 2006, 190 ENFs were raised from 2006 January 1 – 2006 November 20. From 2006 November 21 – 2006 December 31, 110 ImpActs were raised.
*** In 2007, Only ImpActs were in use, Statistics for 2007 are from 2007 January 1 – 2007 April 25.

3.1.2.2 Progress in Cause Analysis

DIF Operations recognised, early in the current licence period, that the timeliness and quality of cause analyses required improvement. CNSC staff feedback at regular communication meetings reinforced this observation. As a result several improvements were undertaken.

AECL Quality Assurance has issued a Root Cause Assessment (RCA) Handbook, which now more clearly outlines the RCA methodology to be used. Subsequent training notes have also assisted in training of a large number of staff in both RCA and Apparent Cause Assessment (ACA) methodology. In addition, staff training and use of industry peers to mentor, participate in investigations, and participate in peer review meetings has proven to be effective in improving both DIF OPEX and ImpAct performance.

Eight DIF employees completed a three-day training for Event Investigation Training (Root Cause Analysis) in 2005 October and five completed a follow up Event Investigation Enhancement training in 2006 February. This enhanced DIF capability to conduct investigations, and, as a result, DIF staff were able to completely eliminate the UER backlog of UER investigations in DIF. At the beginning of 2006, all outstanding reportable and non-reportable Root Cause Analysis and Apparent Cause Assessments were completed.

Four (4) additional DIF Operations employees have completed Event Investigation Training in 2006 November. Fifteen (15) DIF staff completed Apparent Cause Assessment training in 2007 April. In addition to DIF Operations staff, 58 MMIR Project employees have completed ACA training and a further 14 have completed RCA training.

Currently, there is no backlog for reportable RCA or ACA. As for non-reportable RCA and ACA, all have been assigned and the schedule for completion for these is in place. The quality of cause analysis has improved, as reflected by comments by the CRL Site Safety Review Committee.

3.1.2.3 Use of "Lessons Learned" Process

Periodically, AECL's OPEX program provides lessons learned reports from internal and external operating experience related to performance of operations, design, procurement, construction, commissioning and maintenance practices, including human and equipment performance. These reports summarize the event and describe the findings, conclusions and the lessons learned and are intended to increase safety awareness in general, and thus reduce occurrence of unplanned events. OPEX uses several sources of industry-related unplanned events, such as the CANDU Owner's Group (COG) weekly event screening meeting, IAEA's International Reporting System, the U.S. Department of Energy website and others. These Lessons Learned Reports are generally distributed to specifically targeted facilities and programs as an attachment to an email, but they are also posted on the OPEX website and the internal AECL website.

A recent example of the use of external OPEX is: a problem was identified at Gentilly 2 that relates to the early ageing of Inconel springs under certain conditions. An ImpAct was raised to record the problem and via this process it was recognised that the MAPLE Reactors also used Inconel springs. An assessment of the use of the springs was undertaken with respect to their use in MAPLE and a number of actions were taken to ensure continued safe operation.

3.1.3 Progress of Maintenance

3.1.3.1 MAPLE 1 Reactor

Maintenance and calibration of equipment was conducted, as required, based on the configuration of the facility. Various testing activities were carried out and rounds and routines procedures were completed. All MAPLE 1 maintenance activities were completed as planned. This comprised of regulatory preventive maintenance tasks and mandatory preventive maintenance tasks. To put this into some context, during the current licensing period a total of 2580 PMs were completed, 485 of which were reliability PMs, and 247 of which were Mandatory PMs.

All applicable Operator Test Procedures (OTP) for both Safety System 1 (SS1) and Safety System 2 (SS2), and the Exhaust Air Filtration System (EAFS) in MAPLE 1 were executed on a schedule implemented to ensure that they are conducted as required, consistent with the reactor status. The Emergency Filtration System (EFS) was placed on-line for monthly trip and alarm testing, for filter and absorber testing, for damper maintenance, for MAPLE facility ventilation tests, and for testing of the EAFS. A total of 560 OTPs have been completed in the current licensing period on MAPLE 1 systems.

In 2006 September, the MAPLE 1 Reactor was placed in the Secure Shutdown State for an extended maintenance outage in order to prepare for operation at powers up to 5 MW. During this outage period, DIF Operations completed:

- Maintenance on the Safety System 1 Shut Off Rods (SOR) and the Resistance Temperature Detectors (RTD);
- Testing of the Primary Cooling System (PCS);
- Safety System 1 and Safety System 2 Wire Remediation;
- Commission verification testing;
- Installation and testing of the new Reactor Computer Control System Baseline Software Version 4.6.1; and
- Continued execution of OTP, as per the OTP schedule.

The DIF planned outage lasted 48 days. The outage was completed on 2006 November 29 without any significant Human Performance Errors or issues, as measured by Event Free Day Resets (EFDR).

3.1.3.2 MAPLE 2 Reactor

Various maintenance and testing activities were carried out and rounds and routines procedures were completed.

Operator Test Procedures for Safety System 1 were not conducted, as the safety system remained tripped with all channels manually rejected due to the reactor being in the Guaranteed Shutdown State. However, Safety System 2 remained available with the reflector poised and all applicable Operator Test Procedures were completed to confirm functionality of each trip test. The Emergency Filtration System was placed on-line for monthly trip and alarm testing, filter and absorber testing, damper maintenance, MAPLE facility ventilation tests and testing of the EAFS.

3.1.3.3 New Processing Facility (NPF)

Various maintenance and calibration activities were carried out in the facility. In addition, field improvements, revisions to operating manuals, enhanced equipment readiness, and dispositions of non-conformances were conducted.

The mandatory testing of the charcoal absorbers continued to be suspended due to the NPF being non-active.

The performance of the current diesel generator was tested on a monthly basis, with each test completed successfully. Semi-annual load testing was completed in 2006. A new small diesel generator was added to supply certain systems, as a back up to the current diesel generator that provides Class 3 power to DIF.

3.1.3.4 General Maintenance

Routine testing of the High Efficiency Particulate Air (HEPA) filters in the Dedicated Isotope Facilities ventilation systems was carried out as per the required schedule with no issues found.

3.1.3.5 Jumpers

The purpose of a Jumper is to ensure that any temporary changes to a component, system, structure, equipment, computer hardware or software, Operations Document / Operating Procedure, or urgent documentation corrections contained in or used by MAPLE 1, MAPLE 2 or NPF are documented and authorized.

The procedure *Jumper System* was revised to address Findings from the 2005 CNSC Audit of DIF Operations. DIF Operations Management undertook an initiative to reduce the number of jumpers in the Facility, with a specific focus on ones that were older than 6 months. To date, the number of jumpers has been significantly reduced and target removal dates/milestones for the remainder have been reviewed and approved by the Facility Authority.

Since DIF Operations management undertook a jumper removal initiative, 50% of the jumpers that have been in place for over 6 months have been removed.

3.1.4 System Performance Monitoring

During the current licensing period, a System Performance Monitoring Program was initiated. This consists of a standard process, which encompasses the activities used to establish system, structures, and components monitoring requirements, to evaluate system, structures, and components performance, and to report on results, including the provision of input to changes or improvements to the facility.

Since the inception of the System Performance Monitoring Program, several field walkdowns have been performed and many system binders have been prepared by the respective System Responsible Engineers for MAPLE 1. The program is waiting a full year of production before full implementation can be achieved, as it relies on accumulation of meaningful data.

3.1.5 Fire Protection

There were no fires in the Dedicated Isotope Facilities during the current licensing period. Fire drills were conducted during 2006 April, with no issues found. Two separate third party independent reviews of the DIF fire protection system were also conducted, one in December of 2005 and the other in December of 2006. DIF personnel are continuing to address findings from the 2005 report, most of which are recommendations for improvement. The 2006 report is currently in-progress by the third party reviewer and has not yet been received by DIF. In addition to these independent reviews, DIF undergoes a monthly Fire Prevention Inspection performed by Fire Prevention Officers.

During the internal audit performed by the AECL Performance Improvement and Nuclear Oversight (PINO) group in 2006 November, the DIF was singled out by the audit team, which included several industry peers, as a model for the rest of the site in terms of good building design and management taking responsibility for understanding and developing a fire-prevention culture.

3.1.6 Public Information Program

AECL Public Information Program continues to evolve and make steady progress. Proactive and transparent actions taken during the current licensing period are enhancing the program and further activities are planned for operations moving forward. A major improvement to the program resulted from comments made by the Commission and interveners at the Day Two Public Hearing in 2003 April with respect to AECL being more open in its communications (reference was to redacted reports and timely delivery of information). As a result, AECL implemented a Disclosure Policy which is posted on the external website. The introduction of the Disclosure Policy was shared with the communities and public interest groups prior to being launched and since its launch in 2005 September, AECL has responded to about 1,100 requests for information. Furthermore, AECL is posting copies of annual environmental monitoring reports, the Ecological Effect Review of Chalk River Laboratories, the Comprehensive Preliminary Decommissioning Plan for Chalk River Laboratories, the associated Framework for a Communications and Public Consultation Plan, and other key reports of interest on the external website as they become available. While all of these reports can be accessed on the website, copies are also provided to all stakeholders (this includes local and regional public interest groups) to ensure they are kept apprised in a timely manner.

As public tours of the site are no longer possible due to enhanced security post 9/11, it is important to find other ways to keep the public informed. During this period, regular briefings and discussions with regard to all aspects of our business continued with federal, provincial, county, and municipal elected officials and councils on both sides of the Ottawa

River. Members of the Dedicated Isotope Facilities are actively participating in these meetings are providing regular updates on the project. These meetings provide the opportunity for AECL to share information on the current status of our operations and projects and to listen to the concerns that councils or their constituents may have. Participants complete a survey at the end of each meeting to measure effectiveness and value. Collaborative efforts are made to promptly resolve issues. While no major issues have been raised, AECL continues to support the Municipalité régionale de comté de Pontiac in their efforts to develop an emergency response plan. AECL was invited to make a presentation on its emergency preparedness program to the Fort Williams' Cottagers' Association in 2003 July and AECL's Emergency Preparedness management met with representatives from Québec ministries 2005 October 11 to 2005 October 12 to tour the NRU Reactor and discuss the NRU planning basis. AECL also sits on the Chalk River Regional Nuclear Emergency Preparedness Committee and is currently working with the group to revise their plans to coincide with a new exclusion zone of 9 km. Information on emergency exercises, testing of the new site siren system as well as reportable events classified as Significance Level 1 or 2 is provided to community stakeholders and the Emergency Management Ontario Duty Officer.

During the last licensing period AECL released *Contact*, its quarterly bilingual community newsletter in the fall of 2006. Mailed to more than 33,000 residents, businesses, and interested members of the public, it features a note from the Vice-President of AECL Nuclear Laboratories, profiles of the people and the work done on site, environmental monitoring results, and an opportunity for community input with a question and answer section. *Contact* is also posted on the external website.

AECL's external website continues to improve. Recent changes include the addition of sections on the MAPLE Reactors, the New Processing Facility, and the importance of medical isotopes and the posting of documents of public interest. Information on decommissioning and waste remediation projects is available and includes details on projects, dates and locations of public information sessions, letters to officials and public interest groups, and contact information. Information is updated as warranted. A section on Community Relations was added in 2006.

In 2006, AECL launched Environmental Stewardship Council to enhance communications with key area stakeholders and the communities surrounding its operations near Chalk River, Ontario. Meetings provide regular opportunities for face-to-face discussion that promotes two-way dialogue on environment-related matters and other topics including MAPLE and NPF.

In February and March of 2007 a number of breakfast meetings were held with local residents (Deep River and Renfrew) to provide information pertaining to the MAPLE and NPF licence renewal in addition to general information with respect to operations on the CRL site.

Finally, the highlight for AECL's public information program is undoubtedly the successful transfer of Canada's first nuclear reactor, ZEEP (Zero Energy Experimental Pile), to the Canada Museum of Science and Technology in Ottawa during 2005 October. This was a collaborative effort between AECL and the Museum with tremendous care and attention being paid at all times to ensuring public safety. CNSC staff were kept informed throughout the transfer process and provided the necessary approvals.

3.1.7 Foreign Materials Exclusion Program

DIF Operations operates a Foreign Materials Exclusion program to minimize the risk of any foreign material entering the reactor building, specifically the reactor and service pool. During the last licensing period a self-assessment of the Foreign Materials Exclusion program was undertaken. While a number of improvement actions were identified which would further enhance the program, it was determined that the FME program had been fully implemented.

3.2 Performance Assurance

3.2.1 Quality Assurance

A number of initiatives have been undertaken by DIF Operations with respect to improvement of the quality assurance programs in use. Of key importance is the implementation of the Continuous Improvement Plan (CIP) which has been used a vehicle for identifying improvement actions resulting from audits (internal & external) in addition to self-assessments and defining appropriate actions to rectify these finding. In addition, during the recent licensing period, DIF Operations has introduced the use of “Event Free Tools” throughout its operations to make further improvements with respect to the quality of its operations. Details of the specific processes that DIF operations has introduced, e.g. CIP, event free tools, and details of audits and self-assessments carried out within DIF are provided below.

3.2.1.1 Continuous Improvement Plan

3.2.1.1.1 Overview

Based on the review of an internal assessment in 2005 April, a CNSC audit in 2005 June, observations from industry mentors, and findings and trends from Unplanned Event Reports, DIF developed a “Continuous Improvement Plan” (CIP). The actions in the plan are monitored on a regular basis. An example of one action that was put in place as a result of internal assessment and CNSC observation is the implementation of the ImpAct process, details of which can be found in 3.1.2.1.

As implementation progresses, the plan is updated and modified as required to reflect operating experience and feedback from industrial peers and other independent assessments. The initial CIP was implemented in DIF in 2005 September. Revision 1 of the plan, with 59 additional actions, was subsequently released in 2006 January.

The CIP has been developed to achieve the following:

- Clearly communicate accountabilities for program requirements and for execution of work,
- Implement an Operation Score Card to continuously evaluate performance,
- Implement a Human Performance Improvement program for Operations and Maintenance,
- Incorporate lessons learned from major improvements in NRU processes,
- Establish performance benchmarks against utilities and other research reactors,
- Improve the planning process by incorporating lessons learned from utilities and other AECL projects, and
- Implement a plan for a transition from the MMIR Project to routine operations, maintenance, and technical support.

DIF management identified a set of actions and an implementation strategy to achieve improvement. These actions were grouped into four main areas of improvement:

- Leadership,
- Human Performance,
- Processes, and
- Equipment Performance Programs.

Based on a review of best industry practices, DIF Operations have developed and implemented conduct of operations expectations. With assistance from recognized experts, DIF Operations has developed and implemented an observation and coaching program for operations and maintenance staff.

3.2.1.1.2 Progress Highlights and CIP Performance

The following provides a summary of progress highlights and overall CIP implementation within the four continuous improvement areas:

Leadership

- DIF Operations was reorganized along functional lines similar to Canadian nuclear utilities.
- Staffing was doubled.
- Detailed Accountability Statements for all Managers were prepared and issued.
- Several DIF Management Team workshops were held to increase DIF organization commitment to improvement.
- Improved plans/schedules for DIF Operations activities were developed.
- Several managers visited Darlington and Point Lepreau to familiarize themselves with industry practice and standards.

Human Performance

- Industry peers helped to adopt current best practices from industry.
- Expectations for operations conduct were issued and initial training completed.
- Field observation/coaching was rolled out and initial training completed.
- Self-assessment plan was issued; overview training is complete.
- The Facility Authority Approval Record (FAAR) process was implemented.

DIF Processes

- Work planning process was improved.
- Control of licensing correspondence was improved.
- Operations documentation was implemented in TRAK.
- Storage of records was consolidated.

Equipment Programs

- Document describing all elements of the DIF Maintenance Program was issued.
- Maintenance deferral process was implemented.
- Baseline operations documentation list for the Control Room was implemented.
- A System Performance Monitoring program and supporting procedures were issued.

3.2.1.1.3 Monitoring of CIP Implementation and Effectiveness

For progress, a detailed activity plan developed from the CIP action plan is used as the basis for monitoring progress of implementation of the improvements. A work-down curve, as shown in Figure 3-2, is derived from this.

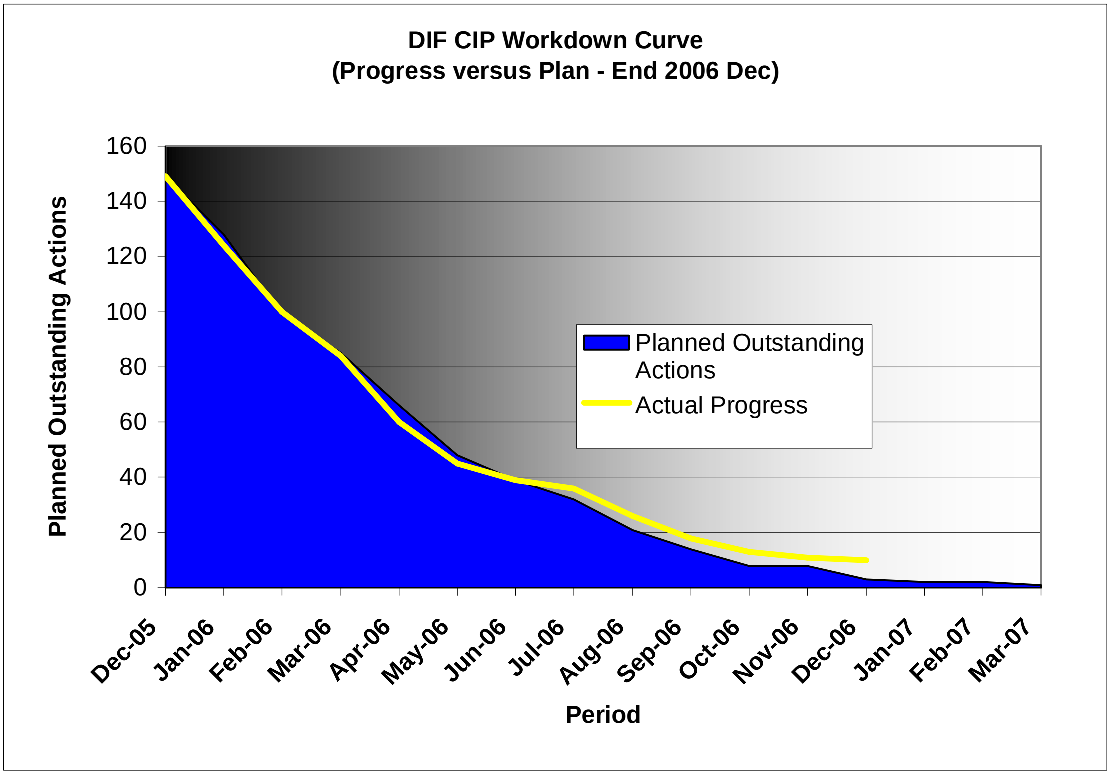


Figure 3-2 : CIP Workdown Curve

3.2.1.1.4 Current Status Summary of the Continuous Improvement Plan

The overall progress of activities for the CIP as of 2007 April is 93% completed (252 of the 272 actions completed).

Revision 2 of the CIP and the Quarterly Status Report for the period ending 2006 December 31, was transmitted to the CNSC in 2007 February. The CIP document was revised to incorporate new actions, remove completed actions and explain the transition to the new Improvement Action (ImpAct) Process, a process for problem identification and subsequent corrective actions. Completion of the remaining actions will be monitored through ImpAct.

DIF Operations CIP team continues to meet on a bi-weekly basis to review action progress and discuss additional attention that may need to be given to ongoing actions. NLBU senior management provides oversight to the CIP.

DIF Operations has also been working with the MMIR Project to assist where possible with the Performance Improvement Plan.

The CIP has been successful in initiating operating performance improvements. Of note are achievements such as: exiting GSS, operation at powers up to 2 kW and 5 MW, an event-free maintenance outage, and the integration of Observation and Coaching into DIF Operations culture. It should also be noted that the MMIR project has initiated a Project Improvement Plan, details of which are provided in Appendix A.

3.2.1.2 Event Free Tools

The purpose of the Event Free Tools (EFT) are to minimize human performance errors, ensure and safe execution of activities, and to support a strong safety culture based on a formal and disciplined approach to all activities. EFT have been embraced industry wide as key to improving performance.

During the current licensing period, EFT was rolled-out through training to all DIF Operations Staff. Event Free Tools, such as a questioning attitude and conservative decision making, have been embraced by operations staff as can be seen in the event free maintenance outage and the constant use of EFT during PCR testing.

Furthermore, the use of EFT is continually verified and reinforced through regular Observation and Coaching performed by all DIF Operations leaders.

3.2.1.3 Self-Assessments

DIF Operations developed and implemented a self-assessment process in 2005 October based on the AECL Company Wide Self Assessment Procedure. All the DIF managers were trained in the new process of self-assessment.

In accordance with DIF Self-assessment plans, 10 planned, focused self-assessments have been completed by the end the fiscal year 2006-2007. In addition, 8 additional focused self-assessments, not in the original plan, were also conducted. Activities are underway to continually execute DIF self-assessment plans and to address any issues arising from self-assessments. Through completing these actions, DIF Operations is continually improving and refining their practices, processes, and overall safety culture.

3.2.1.4 Audits

A number of audits, both internal and external, have been undertaken in the recent licensing period. In addition, outstanding issues from previous audits have been addressed in the current licensing period. As detailed above, the CIP has been instrumental in taking the results of audit finding and producing specific actions which, when completed, address the audit finding and refine the manner in which operations are conducted within DIF.

3.2.1.4.1 2003 Commissioning Quality Assurance Program Audit

The CNSC audit 03-C-05 resulted in 7 Directives and 2 Action Notices. AECL has submitted responses and supporting information to address this audit. The CNSC has confirmed that AECL responses to 3 of 7 Directives and 2 Action Notices are acceptable. As requested, AECL has submitted additional supporting information for the remaining 4 Directives and awaits CNSC staff confirmation that the responses to those Directives are acceptable and that audit 03-C-05 is now closed.

3.2.1.4.2 2005 DIF Operations Quality Assurance Program Audit.

The CNSC audit OMSD-AECL-2005-T4009-QA-12 resulted in 1 Directive, 9 Action Notices and 3 Recommendations. The CNSC has confirmed that AECL responses to the 3 Recommendations were acceptable. The Directive and 9 Action Notices have been reviewed by CNSC staff and responses prepared to their comments. An AECL-CNSC meeting to discuss the details of the Directive and each Action Notice is scheduled for 2007 May. AECL's formal responses and supporting information to address this audit is scheduled to be issued to the CNSC by the end of 2007 May.

3.2.1.4.3 2007 Quality Assurance Program Audit

The Dedicated Isotope Facilities Commissioning Quality Assurance Program Inspection (Type 1) took place in 2007 April. While the final report has not yet been produced, DIF operations has identified where further work is required to address some weaknesses in its procedures. One specific example being the ImpAct process, which is discussed in section 3.1.

3.2.1.4.4 Internal Audits and Assessments

From 2006 April to present there have been three internal evaluations of DIF Operations, performed by Corporate Quality Audits in line with the DIF Operations Audit Program Plan. Two of these evaluations were conducted as audits and one as an assessment.

As a result, a total of three non-conformities were identified. To aid resolution of these non-conformities DIF initiated sixteen actions, seven of these actions have been completed with nine continuing to be in progress.

The evaluations also identified thirty opportunities for improvement / recommendations, DIF Operations initiated twenty-four actions in response to these. Eight of these actions have been completed with sixteen on going. These actions were added to the CIP which is the vehicle for tracking and ensuring their completion. A significant number relate to refining the processes in use in the DIF Maintenance section. With the exception of two long-term actions being handled by the MMIR project, all other actions are scheduled for completion prior to the end of 2007 June.

3.2.2 Training Program

DIF specific training programs are in effect for both MAPLE and NPF, details of which are provided below. In addition, DIF is fully implemented with respect to the CRL site training programs, details of which are provided in Appendix A.

It is worth noting that training continued through those periods when operations within DIF were limited, e.g. times when MAPLE 1 commissioning operations were on hold pending a path forward to resolve PCR issues. Refresher and update training in these periods, together with the execution of regular testing procedures (e.g. OTPs) helped ensure that the Reactor Operators remained in a high level of readiness for when reactor operations resumed.

3.2.2.1 MAPLE

CNSC Initial Certification exams were written in 2005 June and November and 2006 October resulting in 7 additional Reactor Operators, bringing the total number to 13, and 3 Manager, Operations, bringing the total number to 8, receiving CNSC certification. There are sufficient certified MO and RO to cover the shift requirements for MAPLE Operations as per the Operating Limits and Conditions (OLC). The description of the curriculum has been updated and the Training Plan has been revised. The MAPLE Reactors remained on a two, 12-hour shifts per day operating schedule.

3.2.2.2 NPF

Hot Cell Technicians (HCT) are continuing their initial On-the-Job/ Field Check Out training. Furthermore, authorized HCTs are continuing their training with update and refresher training. One new HCT completed the classroom portion of the initial training program and is continuing with On-the-Job training. Two HCTs who have taken new positions as NPF Supervisors and started on supervisory training are also continuing with their initial On-the-Job/ Field Check Out training.

There is sufficient staff, 6 HCT supervisors and 14 HCTs, to cover the shift requirements for the NPF as per the Operating Limits and Conditions (OLC). The NPF continued to be staffed 24-hours a day, seven days a week with shift schedules in-line with those in place in the MAPLE facilities

3.3 Emergency Preparedness

The DIF organization is fully integrated with the CRL site Emergency Preparedness program. Specific details of the program and its implementation within DIF can be found in Appendix A.

During the current licence period, Emergency Preparedness and Fire Services conducted 3 successful drills. There was a Fire Drill in 2006 April, a Bomb Threat Drill in MAPLE 1 in 2006 December, and a High Radiation Drill in the NPF in 2006 November.

Three improvement actions were identified and have been completed as a result of these drills, one specific action being a repair to a faulty hazard light.

3.4 Environmental Protection

The DIF organization is fully integrated with the CRL site Environmental Protection program. Specific details of the program and its implementation within DIF can be found in Appendix A.

The Dedicated Isotope Facilities remain consistently below regulatory Action Levels and the Derived Release Limit (DRL).

Within the current licence period a set of “Significant Environmental Aspects” (SEA) have been identified and documented. SEA are reviewed annually and updated as required. SEA Training for all DIF staff is now fully complete.

An internal audit of the implementation of the AECL Environmental Protection Program at the facilities at Chalk River Laboratories was conducted in 2007 January. The Dedicated Isotope Facilities was included as one of those facilities. There were no deficiencies identified against the DIF during the audit.

Installation of an on-line chlorine analyzer for the MAPLE Reactors Process Water System discharge from the Primary Cooling System Heat Exchanger, with remote monitoring at the powerhouse, is planned for Fiscal Year 2007-2008. The purpose of this unit is to help optimize the amount of chlorine that is used to treat the process water.

As DIF is not yet fully operational, data pertaining to solid, liquid, and gaseous emissions is not reflective of the performance expected when full operations come into effect. However, DIF Operations has fully implemented an Environmental Protection program such that effective environmental monitoring and protection is in place.

3.5 Radiation Protection & Industrial Safety

The DIF organization is fully integrated with the CRL site Radiation Protection program. Specific details of the program and its implementation within DIF can be found in Appendix A.

Due to the limited level of operation within MAPLE, and more so within NPF, the doses recorded currently are not reflective of the performance expected when full operations come into effect. Currently, no individual has received a committed effective dose above 1 mSv in 2006 while working at the DIF.

In addition, there is a sufficient number of qualified Radiation Protection staff in the DIF, that is, one Manger of Radiation and Industrial Safety supported by 7 Radiation Surveyors.

The Radiation Monitoring Systems in the Dedicated Isotope Facilities operated as expected throughout the current licensing period. There were no changes to this equipment and no new procedures were implemented.

Industrial Safety for the DIF organization is covered by the CRL site Occupational Safety and Health program which is fully integrated within DIF. Specific details of the program and its implementation within DIF can be found in Appendix A.

During the current licence period there were no recordable lost-time accidents in the MAPLE Reactors during the current licensing period, however, there was one recordable lost-time accident in the New Processing Facility. In December of 2006, an employee was at a co-worker’s desk and when the employee turned to leave, his/her right foot got caught in the strap of a soft-sided briefcase under the desk. The employee did not fall, but twisted and felt sharp pains in his/her right hip. The CRL accident reporting process was followed and an accident report was prepared.

3.6 Nuclear Security

The DIF organization is fully integrated with the CRL site Nuclear Security program. Specific details of the program and its implementation within DIF can be found in Appendix A.

3.7 Safeguards and Non-Proliferation

The DIF organization is fully integrated with the CRL site Nuclear Materials and Safeguards Management (NM&SM) Program. Specific details of the program and its implementation within DIF can be found in Appendix A.

During the current licensing period, the DIF has successfully met all NM&SM program requirements.

3.8 Commissioning

3.8.1 MAPLE 1

Various activities were pursued in the MAPLE 1 Reactor with the primary objective of operating the reactor at high power to re-measure the Power Coefficient of Reactivity. The facility incurred several major changes including: installation of an additional interlock trip for Safety System 2 (the "Reflector Vent Line High Level" trip) and installation of the Reactor Computer Control System Baseline Release (RCCS) Software Version 4.6.1.

A Safety Case for operation up to 2 kW was prepared and submitted to CNSC for approval in late 2005. The MAPLE Operating Limits and Conditions document was revised to reflect reactor operation at a power up to 2 kW, and was approved by the Safety Review Committee (SRC) and the CNSC staff.

Following submission of the Safety Case, AECL applied to CNSC staff for approval to exit the MAPLE 1 Reactor from GSS in 2006 January. Subsequently, following completion of operations readiness activities, DIF Operations declared readiness to remove the reactor from GSS and operate MAPLE 1 at powers up to 2 kW. The declarations were accepted by the Facility Authority 2006 April and the records documenting operations readiness were submitted to CNSC staff.

Upon successful completion of all licensing prerequisites, approval to remove the MAPLE 1 Reactor from GSS was granted by CNSC staff in 2006 April. As a result, the MAPLE 1 core was removed from GSS on 2006 May 01, and the Facility Authority released the transfer key (as per the Operating Limits and Conditions) to the duty Manager of Operations. After installing three modified target clusters in the reactor core, core refuelling was completed in 2006 June.

On 2006 June 30, an approach to Critical was completed and the reactor reached criticality. MAPLE 1 continued to operate at up to 2 kW until 2006 September 11, when it was placed in the Secure Shutdown State (SSS) for an extended maintenance outage to prepare for operation at powers up to 5 MW.

3.8.1.1 Power Coefficient of Reactivity

On 2007 January 30, AECL received approval from the CNSC staff to begin baseline testing to confirm the PCR. These baseline tests were completed on 2007 April 09, and included raising reactor power on six separate occasions for a period of a few hours. The maximum power achieved was 48% full power, or 4.8 MW.

The results of these tests confirmed the values recorded in 2003, and all acceptance criteria were met. CNSC staff observed all tests and were in attendance at the interim results review meetings.

The next phase of the PCR tests is to modify the fuel and the reactor core. Tests are underway to commission the new core and to re-measure the PCR. Upon receipt of approval from CNSC staff, modifications will begin.

3.8.2 MAPLE 2

As stated previously, the MAPLE 2 Reactor remained in GSS during the previous licensing period. No commissioning of the MAPLE 2 Reactor took place.

3.8.3 New Processing Facility

The following commissioning activities have taken place during the current licensing period:

- The redesigning of the two major waste handling systems: Calcination and Cementation. Replacements for the calcination unit and the cement mixer unit are being tested and will be implemented to resolve reliability and maintainability issues.
- A new Small Diesel Generator has been added to the NPF and is currently being maintained. Commissioning of the Small Diesel Generator is well advanced and is planned for completion during 2007.
- Improvements continue to be implemented on the Closed Loop Cooling System to add overpressure protection and to provide back-up cooling by firewater in the event of loss of two independent sources of Class 3 power.

In addition to the above major areas, other changes continue to be implemented to other systems to improve operability and reliability.

Furthermore, in 2005-2006, AECL completed a HAZards and OPerability (HAZOP) group of studies for NPF. HAZOP is a structured technique used to identify and evaluate the potential hazardous events and operability issues for a process. A process was implemented for reviewing and assigning priority to the HAZOP findings as well as all the outstanding remedial work. Three categories were used for assigning priority: 1) Work to be completed prior to active commissioning; 2) Work to be completed prior to in-service; and 3) Work for completion after in-service. All HAZOP recommendations were dispositioned and prioritized for implementation.

Throughout 2006, Commissioning Specification and Objectives and their associated System Status Table documents were produced as part of the NPF Commissioning process.

4. PLAN AND SCHEDULE FOR LICENSED ACTIVITIES

This section presents the plan and schedule for the licensed activities for the MAPLE Reactors, MIPF, and NPF.

The current plan for the licensed activities is based on a revised strategy to enable the MAPLE 1 Reactor and NPF to begin routine production of radioisotopes prior to completion of nuclear commissioning of the MAPLE 1 Reactor up to 10 MW. This strategy, which includes placing the MAPLE 1 Reactor “in-service” at 8 MW, allows for the possibility that a resolution to the positive PCR issue may not be fully implemented and demonstrated by 2008 October 31. It is noted that AECL intends to complete the work to commission MAPLE 1 and MAPLE 2 Reactors up to 10 MW after MAPLE 1 has been placed “in-service” at 8 MW. The plan for completing the commissioning activities up to 10 MW will be developed based upon the measurements of the PCR value up to 8 MW.

After the MAPLE Reactors, MIPF and NPF are placed “in-service”, planned outages for maintenance will be performed in accordance with the *Dedicated Isotope Facilities (DIF) Periodic and Inaugural Inspection Program* [4-1] and *DIF In-Service Inspection Program* [4-2]. DIF Operations will prepare a Maintenance and Production schedule prior to the declaration of In-Service Operation of the DIF. The maintenance schedule will involve two major maintenance outages, most likely occurring during the spring and fall, and the production schedule will ensure that AECL meets all of its customer isotope requirements. In addition, once the MAPLE 2 Reactor has been declared In-Service, it is planned to alternate operation with the MAPLE 1 Reactor to ensure a constant production of isotopes.

The schedules up to declaring all facilities in-service are shown in Figure 4-1, Figure 4-2, and Figure 4-3. It is noted that these are “work schedules” and they contain uncertainties associated with the positive PCR and the work to be performed beyond 5 MW for the MAPLE 1 Reactor. The path forward may change either somewhat or significantly as more data and analysis related to PCR become available from tests at 5 MW. After additional data has been analyzed and progress has been made in the determination of the cause of the PCR, the schedules will be revised to improve the degree of certainty and commitment beyond 5 MW.

The schedules, based on AECL key milestones, have been developed to establish targets by which the MMIR/DIF management runs the project, in accordance with the current plan for licensed activities. The AECL key milestones address the regulatory hold points included in the current operating licences for the MAPLE Reactors, MIPF, and NPF, and the acceptance criteria identified for each regulatory hold point in the CNSC Commission Member Documents CMD 05-H20 [4-3], CMD 05-H21 [4-4], and CMD 05-H21.A [4-5]. It is noted that not all the AECL key milestones are specifically identified in the aforementioned CNSC CMDs. For example, the CMD 05-H20 [4-3] does <u>not</u> specify separate acceptance criteria and actions for obtaining approval to operate MAPLE 1 Reactor up to 5 MW, up to 8 MW or to declare “in-service” at 8 MW, as these intermediate milestones are part of AECL’s revised strategy to resume nuclear commissioning of the MAPLE 1 Reactor and to enable the MAPLE 1 Reactor and NPF to begin routine production of radioisotopes. To demonstrate assurance for operating the MAPLE 1 Reactor at the different power levels mentioned above, AECL has derived acceptance criteria from those required for obtaining agreement to resume nuclear commissioning and approval to operate above 8 MW (which are part of [4-3]), where applicable. They have been included separately to clearly identify the AECL deliverables for these specific AECL key milestones.

The AECL key milestones for the remaining period of the current licence and for the next licence period are presented in Table 4-1. Details on the activities planned by AECL to address each key milestone are presented in the following subsections. Details on the progress and current status, as well as deliverables that AECL plans to produce to address the outstanding licensing prerequisites identified in the CNSC CMDs [4-3], [4-4], [4-5] are presented in Appendix B.

Table 4-1 : Key Milestones

Facility	Milestone			Planned AECL Activities to Address the Milestone
		To complete during current licence period (until 2007 December)	**To complete during next licence period (2007 December 1 to 2011 October 31)**	
MAPLE 1	5 MW	CNSC staff approvals to operate MAPLE 1 to complete PCR re-measurements		See Section 4.1.1
	5 MW	MAPLE 1 available to irradiate targets for NPF Active Commissioning and irradiate xenon gas for MIPF Nuclear Commissioning		See Section 4.1.1
	8 MW		CNSC staff approval to operate up to 8 MW	See Section 4.2.1
	8 MW		MAPLE 1 available to irradiate targets for NPF Active Commissioning and irradiate xenon gas for MIPF Nuclear Commissioning and In-Service Operation	See Section 4.2.1
	In-Service at 8 MW		MAPLE 1 available for In-Service at 8 MW	See Section 4.2.1
	Above 8 MW		CNSC staff approval to operate above 8 MW	See Section 4.2.1
	In-Service above 8 MW		MAPLE 1 available for In-Service above 8 MW	See Section 4.2.1
MIPF	Nuclear Commissioning	MIPF available for Nuclear Commissioning		See Section 4.1.2
	In-Service		MIPF available for In-Service	See Section 4.2.2
	In-Service Operation		Planned outages at MIPF	See Section 4.2.2
MAPLE 2	2 kW		CNSC staff approval to restart and resume commissioning up to 2 kW	See Section 4.2.3
	500 kW		CNSC staff approval to operate up to 500 kW	See Section 4.2.3
	8 MW		CNSC staff approval to operate up to 8 MW	See Section 4.2.3
	8 MW		MAPLE 2 available to irradiate targets	See Section 4.2.3
	In-Service at 8 MW		MAPLE 2 available for In-Service at 8 MW	See Section 4.2.3
	Above 8 MW		CNSC staff approval to operate above 8 MW	See Section 4.2.3
	In-Service above 8 MW		MAPLE 2 available for In-Service above 8 MW	See Section 4.2.3
NPF	Active Commissioning	CNSC staff confirmation that prerequisites for NPF Active Commissioning are completed		See Section 4.1.3
	In-Service		NPF available for In-Service	See Section 4.2.4

4.1 Planned Activities until 2007 December

4.1.1 MAPLE 1 Reactor

Between 2007 April and December, AECL plans to complete the following activities for MAPLE 1:

1. Complete all licensing prerequisites to allow the reactor to operate up to 5 MW (5 MW Milestone) to perform tests to re-measure the PCR, to aid in determining the cause of the positive PCR, and to assess proposed changes for mitigating the positive PCR.
2. Identify and complete the remaining licensing prerequisites to allow the reactor to operate at 5 MW to irradiate targets for active commissioning of the NPF and irradiate xenon gas for nuclear commissioning of the MIPF (based on a successful outcome of the PCR tests and implementation of the associated design changes). In particular, to support the request to obtain CNSC staff approval for interim operation at 5 MW, AECL plans to submit:
    - A safety case to demonstrate that there is no impact on health, safety, security, the environment, and Canada's international obligations;
    - Request for approval of changes in the MAPLE OLCs required to support operation at 5 MW;
    - Documents to address the licensing issues associated with obtaining CNSC staff approval to operate MAPLE 1 at 5 MW, as described in Sections B.1.1.3 and B.1.1.4; and
    - A plan to operate the MAPLE 1 Reactor to irradiate xenon gas for the MIPF Nuclear Commissioning and to irradiate MAPLE targets for the NPF Active Commissioning.

4.1.2 MIPF

It is assumed that Nuclear Commissioning of the MIPF will begin once the MAPLE 1 Reactor has operated up to 5 MW. Between 2007 April and December, AECL plans to complete the following activities for MIPF:

1. Complete Non-Nuclear Commissioning;
2. Submit documents to address the licensing issues associated with obtaining CNSC staff approval for irradiating xenon gas for the first time in the MAPLE 1 Reactor, as described in Section B.3.1 (Nuclear Commissioning Milestone); and
3. Commence Nuclear Commissioning.

4.1.3 NPF

Pursuant to Licence Condition C2 (a) of NSPFOL-3.02/2003 [4-6], approval was granted in 2003 May to commence Active Commissioning of the NPF. Between 2007 May and December, AECL plans to complete the following activities for NPF:

1. Complete the licensing prerequisites to obtain CNSC staff confirmation of readiness for performing the Active Commissioning (Active Commissioning Milestone). To demonstrate completion of all prerequisites for Active Commissioning readiness, AECL plans to submit:
    - A safety case to demonstrate that there is no impact on health, safety, security, the environment, and Canada's international obligations.
    - Documentation to address the licensing issues associated with obtaining CNSC staff confirmation of readiness for Active Commissioning, as described in Section B.4.1.
2. Commence Active Commissioning.

4.2 Planned Activities During the Next Licence Period

4.2.1 MAPLE 1 Reactor

During the next licence period, AECL's plans for the MAPLE 1 Reactor are as follows:

1. Identify and complete the licensing prerequisites to allow the reactor to operate up to 8 MW (8 MW Milestone). Operation of the MAPLE 1 Reactor up to 8 MW will allow to:
    - Perform tests to re-measure the PCR.
    - If required, and depending on the results of the tests at 5 MW, perform tests to aid in determining the cause of the positive PCR and to assess and/or confirm proposed changes for mitigating the positive PCR.
    - Confirm the effects of fuel burn up and the transition to an equilibrium core by re-measurements of the PCR.
    - Implement measures for mitigating the positive PCR.
    - Operate to irradiate targets for NPF Active Commissioning.
    - Irradiate xenon gas for the MIPF Nuclear Commissioning and In-Service operation.
    - Operate to increase experience in the operating performance of the reactor.

    To support the request to obtain CNSC staff approval to operate up to 8 MW, AECL plans to submit:

    - A safety case to demonstrate that there is no impact on health, safety, security, the environment, and Canada's international obligations;
    - Request for approval of changes in the MAPLE OLCs required to support operation up to 8 MW;

- Documents to address the licensing issues associated with obtaining CNSC staff approval to operate MAPLE 1 up to 8 MW, as described in Section B.1.1.4;
- A plan for the anticipated tests to re-measure the PCR, to aid in determining the cause of the positive PCR and to assess proposed changes for mitigating the positive PCR; and
- A plan to operate the MAPLE 1 Reactor to irradiate xenon gas for the MIPF Nuclear Commissioning and to irradiate MAPLE targets for the NPF Active Commissioning.

2. Identify and complete the licensing prerequisites to allow In-Service Operation at 8 MW (In-Service at 8 MW Milestone). A revised strategy is currently considered to enable the MAPLE 1 Reactor and NPF to begin routine production of radioisotopes prior to completion of nuclear commissioning of the MAPLE 1 Reactor up to 10 MW. This strategy, which includes placing the MAPLE 1 Reactor “in-service” at 8 MW, allows for the possibility that a resolution to the positive PCR issue may not be fully implemented and demonstrated by 2008 October 31. The effectiveness of the engineered solutions that will be tested to reduce the PCR will determine the path forward and timeline for achieving In-Service Operation of the MAPLE 1 Reactor, the MIPF and the NPF at a reactor power of 8 MW or greater.

   To support the request to obtain CNSC staff approval to allow In-Service Operation at 8 MW, AECL plans to submit:

   - A safety case to demonstrate that there is no impact on health, safety, security, the environment, and Canada’s international obligations;
   - Request for approval of changes in the MAPLE OLCs required to support in-service operation at 8 MW;
   - Documents to address the licensing issues associated with obtaining CNSC staff acceptance for In-Service for MAPLE 1, as described in Section B.1.2; and
   - Revised MAPLE 1 Reactor commissioning plan.

3. Identify and complete the licensing prerequisites to allow the reactor to operate above 8 MW (Above 8 MW Milestone). Operation of the MAPLE 1 Reactor above 8 MW will allow to complete the Phase C commissioning program and to perform tests to demonstrate that the measure to mitigate the positive PCR are effective. In particular, to support the request to obtain CNSC staff approval to operate above 8 MW, AECL plans to submit:

   - A safety case to demonstrate that there is no impact on health, safety, security, the environment, and Canada’s international obligations;
   - Request for approval of changes in the MAPLE OLCs required to support operation above 8 MW;
   - Documents to address the licensing issues associated with obtaining CNSC staff approval to operate MAPLE 1 above 8 MW, as described in Section B.1.3; and
   - Revised MAPLE 1 Reactor commissioning plan.

4. Identify and complete the licensing prerequisites to allow In-Service Operation (In-Service above 8 MW Milestone). In particular, to support the request to obtain CNSC staff approval to allow In-Service Operation above 8 MW, AECL plans to submit:
   - A safety case to demonstrate that there is no impact on health, safety, security, the environment, and Canada's international obligations;
   - Documents to address the licensing issues associated with obtaining CNSC staff acceptance for In-Service for MAPLE 1, as described in Section B.1.4.
5. After declaring In-Service, perform planned outages and inspections in accordance with [4-1] and [4-2].

4.2.2 MIPF

During the next licence period, AECL's plans for the MIPF are as follows:

1. Complete Nuclear Commissioning.
2. Submit documents to address the licensing prerequisites associated with obtaining CNSC staff acceptance of In-Service for the MIPF (In-Service Milestone), as described in Section B.3.2.
3. After declaring In-Service, perform planned outages and inspections in accordance with [4-1] and [4-2].

4.2.3 MAPLE 2 Reactor

The MAPLE 2 Reactor is currently in Guaranteed Shutdown State (GSS). Resumption of MAPLE 2 Phase B Commissioning will depend upon an agreement between AECL and CNSC staff on a resolution of the positive PCR. During the next licence period, AECL's plans for the MAPLE 2 Reactor are as follows:

1. Complete the licensing prerequisites to exit GSS and complete the Phase B commissioning tests up to 2 kW (2 kW Milestone), as described in Section B.2.1.
2. Complete the licensing prerequisites to operate above 2 kW and complete the Phase B commissioning tests up to 500 kW (500 kW Milestone), as described in Section B.2.2.
3. Complete the licensing prerequisites to operate above 500 kW, complete the Phase C commissioning tests up to 8 MW, and operate to irradiate targets (8 MW Milestone), as described in Sections B.2.3 and B.2.4.
4. Pending the outcome of the PCR testing, identify and complete the licensing prerequisites to allow In-Service Operation at 8 MW (In-Service at 8 MW Milestone). To support the request to obtain CNSC staff approval to allow In-Service Operation at 8 MW, AECL plans to submit:
   - A safety case to demonstrate that there is no impact on health, safety, security, the environment, and Canada's international obligations;
   - Documents to address the licensing issues associated with obtaining CNSC staff acceptance for In-Service for the MAPLE 2 Reactor, as described in Section B.2.5.

5. Complete the licensing prerequisites to operate above 8 MW and complete the commissioning tests above 8 MW (Above 8 MW Milestone), as described in Section B.2.6.
6. Complete the licensing prerequisites to allow In-Service Operation (In-Service above 8 MW Milestone). In particular, to support the request to obtain CNSC staff approval to allow In-Service Operation, AECL plans to submit:
    - A safety case to demonstrate that there is no impact on health, safety, security, the environment, and Canada's international obligations;
    - Documents to address the licensing issues associated with obtaining CNSC staff acceptance for In-Service for the MAPLE 2 Reactor, as described in Section B.2.7.
6. After declaring In-Service, perform planned outages and inspections in accordance with [4-1] and [4-2].

4.2.4 NPF

During the next licence period, AECL's plans for the NPF are as follows:

1. Complete Active Commissioning.
2. Complete the licensing prerequisites to allow In-Service Operation (In-Service Milestone):
    - Issue a revised FSAR to demonstrate that there is no impact on health, safety, security, the environment, and Canada's international obligations;
    - Issue a revised NPF OLC document to reflect lessons learned and knowledge gained from commissioning;
    - Documents to address the licensing issues associated with obtaining CNSC staff acceptance for In-Service for NPF, as described in Section B.4.2.
3. After declaring In-Service, perform planned outages and inspections in accordance with [4-1] and [4-2].

4.2.5 Reports to Be Revised During the Next Licence Period

4.2.5.1 MAPLE 1 and 2 Reactors Operating Licence

The following documents, referred to in the current MAPLE 1 and 2 Reactors licence, NPROL-62.00/2007 [4-7], are planned to be revised during the next licence period:

- *Final Safety Analysis Report for MAPLE Reactors* [4-8];
- *MAPLE Reactors Operational Limits and Conditions* [4-9];
- *MAPLE Reactor Commissioning Plan* [4-10].

The safety analysis sections of the FSAR will be updated once the source of the positive PCR is identified, and the mitigation measures are known. In the meantime, the following safety cases will provide the safety analysis support for reactor commissioning and operation:

- Safety Case to Support Operation of MAPLE 2 Reactor to 2 kW;

- Safety Case to Support Operation of MAPLE 2 Reactor to 500 kW;
- Safety Cases to Support Operation of MAPLE Reactor to 5 MW;
- Safety Case to Support Operation of MAPLE Reactor to 8 MW;
- Safety Case to Support Operation of MAPLE Reactor above 8 MW.

Additional revisions to the OLC document will be produced to be consistent with the safety cases listed above. As required, revisions to the *MAPLE Reactor Commissioning Plan* and additional operating and test plans will be produced based on the safety cases listed above. The operating and test plans will include procedures for investigating the positive PCR and potential remedies.

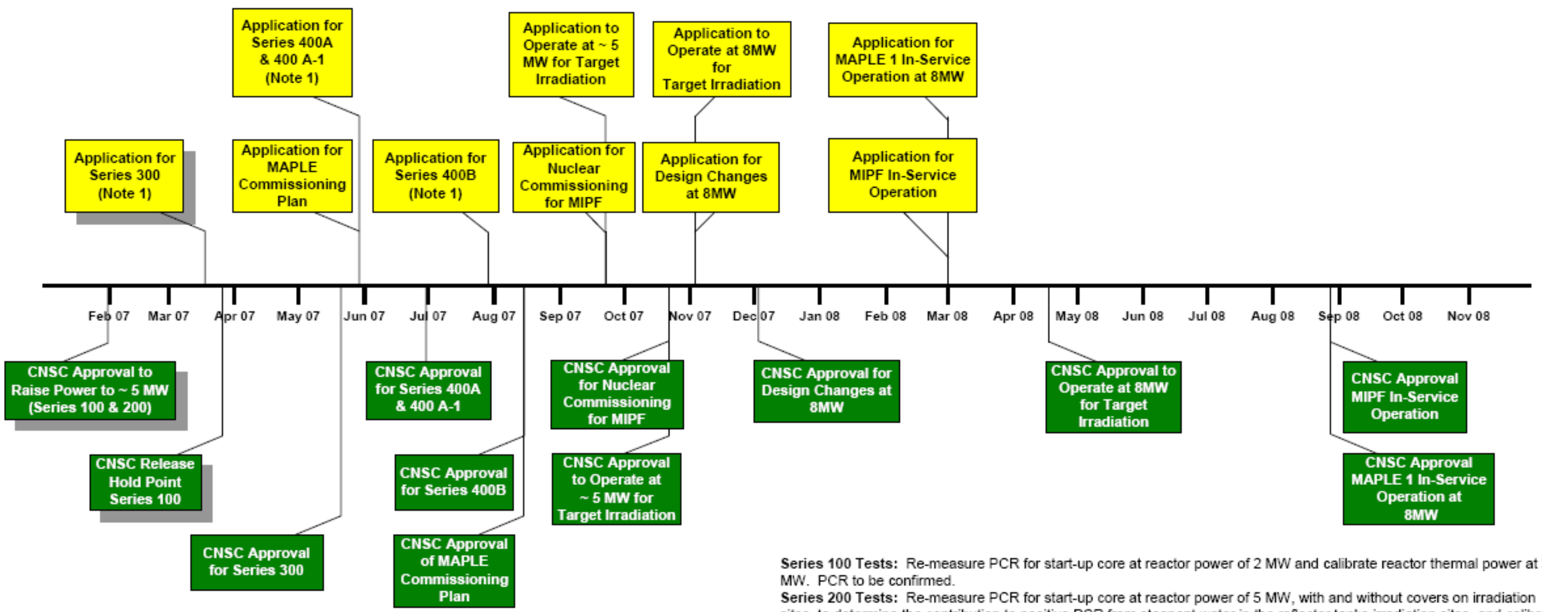
4.2.5.2 NPF Operating Licence

The following documents, referred to in the current NPF licence, NSPFOL-03.00/2007 [4-11], are planned to be revised during the next licence period:

- *Final Safety Analysis Report for the New Processing Facility* [4-12].
- *NPF Operational Limits and Conditions* [4-13].
- *New Processing Facility Commissioning Plan* [4-14].

Timeline and Milestone Schedule for MAPLE Licensing Submissions

As of May 14, 2007



Series 100 Tests: Re-measure PCR for start-up core at reactor power of 2 MW and calibrate reactor thermal power at 3 MW. PCR to be confirmed.
Series 200 Tests: Re-measure PCR for start-up core at reactor power of 5 MW, with and without covers on irradiation sites, to determine the contribution to positive PCR from stagnant water in the reflector tanks irradiation sites, and calibrate reactor thermal power at 5 MW. PCR to be confirmed.
Series 300 Tests: Measure PCR for LEU core, without HEU targets, at reactor power of 5 MW to determine the contribution to positive PCR from HEU targets. PCR to be determined.
Series 400A Tests: Measure PCR for LEU core, without HEU targets, and with modified flow tubes for an upward moderator water flow, at reactor power of 5 MW to determine contribution to positive PCR from moderator water heating. PCR to be determined.
Series 400A-1 Tests: Measure the PCR value after replacing the LEU driver fuel bundles with modified LEU driver fuel bundles to prevent binding of the LEU fuel pins in the top plate, for an LEU core, without HEU targets, and with modified flow tubes for an upward moderator flow, at a reactor power of 5 MW, to determine the contribution to positive PCR from binding the LEU driver fuel pins in the driver fuel bundle top plate. PCR to be determined by the tests.
Series 400B Tests: Measure PCR for start-up core with HEU targets restrained in a modified target cluster holder and with modified flow tubes for an upward moderator water flow, at a reactor power of 5 MW to confirm the PCR value for isotope production configuration. PCR to be determined.

Note: (1) Submission of Safety Case, Change Requests, Commissioning Procedures, Operational Readiness Review, Operating Limit of Conditions (OLC) where applicable

(x)

Figure 4-1 : Schedule for MAPLE 1 Reactor and MAPLE 1 IPF

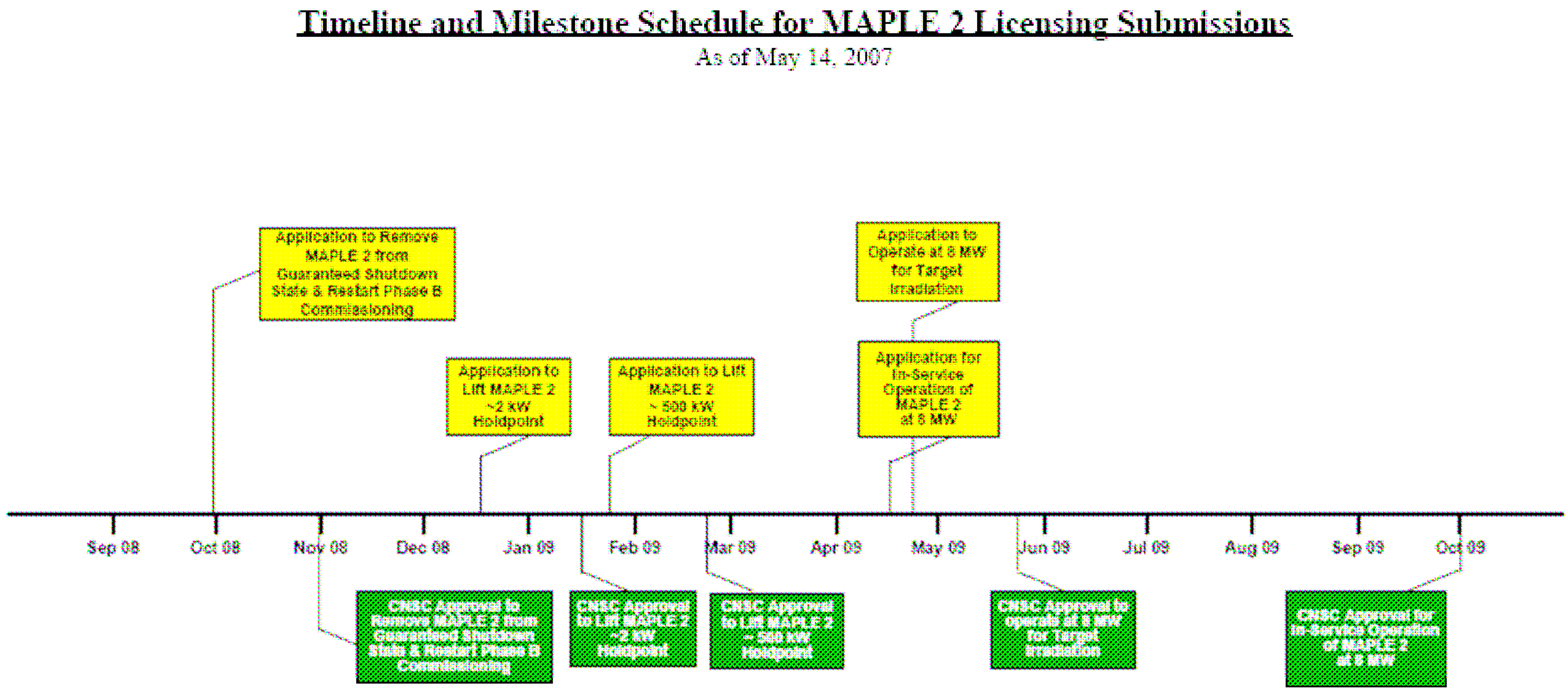


Figure 4-2 : Schedule for MAPLE 2 Reactor

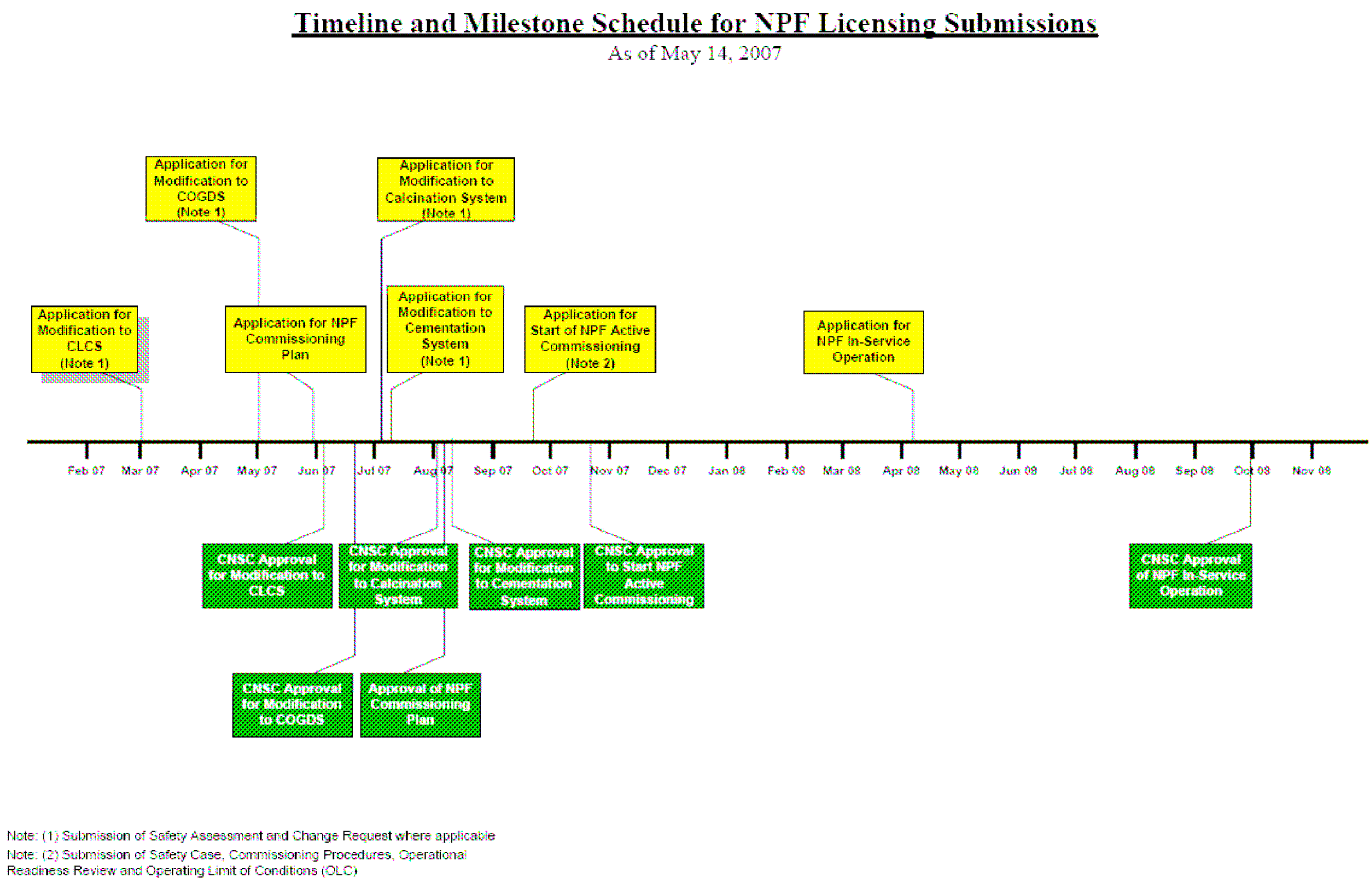


Figure 4-3 : Schedule for NPF

4.3 References

[4-1] *Dedicated Isotope Facilities (DIF) Periodic and Inaugural Inspection Program*, 6423-01510-TD-001, Revision 2, 2006 February.

[4-2] *DIF In-Service Inspection Program*, 6423-01510-TD-002, Revision 0, 2006 May.

[4-3] CMD 05-H20, *Information and Recommendations from Canadian Nuclear Safety Commission Staff Regarding Atomic Energy of Canada Limited Renewal of the Operating Licence of the MAPLE Reactors at the Chalk River Laboratories – Public Hearing Day One*, 2005 August 18.

[4-4] CMD 05-H21, *Information and Recommendations from Canadian Nuclear Safety Commission Staff Regarding Atomic Energy of Canada Limited Renewal of the Nuclear Substance Processing Facility Operating Licence for the New Processing Facility (NPF) at the Chalk River Laboratories – Public Hearing Day One*, 2005 August 18.

[4-5] CMD 05-H21.A, *Supplementary Information, Information and Recommendations from Canadian Nuclear Safety Commission Staff Regarding Atomic Energy of Canada Limited Renewal of the Nuclear Substance Processing Facility Operating Licence for the New Processing Facility (NPF) at the Chalk River Laboratories – Public Hearing Day 2*, 2005 October 18.

[4-6] *Nuclear Substance Processing Facility Operating Licence – New Processing Facility*, NSPFOL-3.02/2003, CNSC # 24-1-3-0, 2002 July 11.

[4-7] *Non-Power Reactor Operating Licence- MAPLE 1 and 2 Nuclear Reactors*, NPROL-62.00/2007, AECL # 6400-00500-130-001, CNSC # 26-1-62-0-0, 2005 November 30.

[4-8] *Final Safety Analysis Report for MAPLE Reactors*, Revision 1 of Volume 1, 2006 April and Revision 0 of Volume 2, 1998 August.

[4-9] *MAPLE Reactors Operational Limits and Conditions*, 6425-05410-OLC-001, Revision 20, 2007 April.

[4-10] *MAPLE Reactor Commissioning Plan*, 6401-92000-CM-001, Revision 5, 2002 March.

[4-11] *Nuclear Substance Processing Facility Operating Licence – New Processing Facility*, NSPFOL-03.00/2007, AECL # 6403-00500-130-001, CNSC # 24-1-3-0, 2005 November 30.

[4-12] *Final Safety Analysis Report for the New Processing Facility*, Chapters 10 and 11 as Revision 0, 1999 January and all other chapters as Revision 1, 2006 April.

[4-13] *NPF Operational Limits and Conditions*, 6424-05410-OLC-001, Revision 4, 2002 May.

[4-14] *New Processing Facility Commissioning Plan*, 6403-92000-CM-002, Revision 1, 2002 September.

5. CONCLUSION

AECL is making steady progress on all commitments and requirements to continue to safely operate the Dedicated Isotope Facilities as a capable, competent organization, with a sufficient number of qualified and CNSC-certified staff. Information given in this document supports the conclusion that the DIF has adequate programs in existence to protect the safety of the public, the environment and the staff at these facilities. DIF has resolved several technical issues and is committed to resolving the remaining technical issues, completing active commissioning, and processing isotope targets during the next licensing period.

Through the implementation of Operating Performance Improvement initiatives the Dedicated Isotope Facilities has improved its Operating Performance as demonstrated by our event-free maintenance outage and the enhanced use of event free tools by our operations staff.

The completion of commissioning of the DIF and the production of medical isotopes in these facilities are vital to Canadians and to thousands of people around the world. AECL is focused on meeting all regulatory criteria related to health, safety, security, the environment, and Canada's international obligations.

AECL is committed to safe operation of the Dedicated Isotope Facilities, therefore believes that the performance of the DIF and the activities planned for the proposed licensing period supports our application for a 47-month Licence Renewal.

6. ACRONYMS

ACA	Apparent Cause Analysis
AECB	Atomic Energy Control Board
AECL	Atomic Energy Canada Limited
ALARA	As Low As Reasonably Achievable
ALW	Active Liquid Waste
AMMS	Advanced Maintenance Management System
AOR	Analysis of Record
AVS	Active Ventilation System
CANDU	Canadian Deuterium Uranium
CDDI	Commission Demonstration of Design Intent
CIP	Continuous Improvement Plan
CLCS	Closed Loop Cooling System
CNSC	Canadian Nuclear Safety Commission
COG	CANDU Owner’s Group
COGDS	Cetral Off-Gas Delay System
CRL	Chalk River Laboratories
CSA	Canadian Standards Association
CSD	Criticality Safety Document
DIF	Dedicated Isotope Facilities
DRL	Derived Release Limit
EAFS	Exhaust Air Filtration System
EFDR	Event Free Day Reset
EFS	Emergency Filtration System
EFT	Event Free Tools
EmP	Emergency Preparedness
EOP	Emergency Operating Procedure
FA	Facility Authority
FME	Foreign Material Exclusion
FSAR	Final Safety Analysis Reports
GSS	Guaranteed Shutdown State
HAZOP	Hazard and Operability Study
HCT	Hot Cell Technician
HEPA	High Efficiency Particulate Air
HLLW	High Level Liquid Waste
HSE	Health and Safety of persons and the protection of the Environment
IAEA	International Atomic Energy Agency
ImpAct	Improvement Action (Process)
ISO	International Standards Organization
ITS	Instruction to Staff
LEU	Low Enriched Uranium
LLW	Low Level Waste
MAGS	Modular Above Ground Storage
MAPLE	Multipurpose Applied Physics Lattice Experimental (Reactor)
MBA	Material Balance Area

MMIR	MDS Nordion Medical Isotope Reactor (Project)
MIPF	MAPLE Iodine-125 Production Facility
MO	Manager Operations
MRM	Management Review Meeting
NCSP	Nuclear Criticality Safety Panel
NFPA	National Fire Protection Association
NIIT	NPF Integrated Inactive Testing
NLBU	Nuclear Laboratories Business Unit
NMMT	Nuclear Materials Management and Radioactive Materials Transportation
NM&SM	Nuclear Material and Safeguard Management
NPF	New Processing Facility
NPROL	Non-Power Reactor Operating Licence
NRTEOL	Nuclear Research and Test Establishment Operating Licence
NRU	National Research Universal
NSPFOL	Nuclear Substance Processing Facility Operating Licence
OHS	Occupational Health and Safety
OLC	Operating Limits and Conditions
OM	Operating Manual
OPEX	Operating Experience
OR	Operator Routines
OSA	Operational Safety Assessment
OTP	Operator Test Procedures
PCR	Power Coefficient of Reactivity
PCS	Primary Cooling System
PINO	Performance Improvement and Nuclear Oversight
PIP	Project Improvement Plan
QA	Quality Assurance
RAM	Radioactive Material
RCA	Root Cause Analysis
RCCS	Reactor Computer Control System
RO	Reactor Operator
RTD	Resistance Temperature Detector
SAT	Systematic Approach to Training
SEA	Significant Environmental Aspects
SERP	Safety, Environmental, and Radiological Protection
SOR	Shut-Off Rod
SPMP	System Performance Monitoring Program
SRC	Safety Review Committee
SS1	Safety System 1
SS2	Safety System 2
SSHC	Site Safety and Health Committe
SSS	Secure Shutdown State
UER	Unplanned Event Report
UPS	Uninterruptible Power Supply
WHMIS	Workplace Hazardous Materials Information System

ZEEP	Zero Energy Experimental Pile

Appendix A

CRL and DIF Specific Programs

A.1 Quality Assurance Program

The DIF Operations [A-1] and MMIR Project [A-2] Quality Assurance Manuals describe the QA Programs for the DIF and the MMIR Project. These documents are supplementary to and meet the requirements of the AECL Management Manual [A-3] and the AECL Overall QA Manual [A-4].

A.1.1 DIF Operations QA Program

The DIF Quality Assurance Manual is the top tier Quality Assurance Manual for the operation of the MAPLE 1 and 2 Reactors and NPF, including all support activities in the areas of design, procurement, construction, and commissioning. Presently, the MAPLE Reactors and NPF are in the commissioning phase with the majority of systems turned over to Operations control following inactive commissioning.

The DIF Operations Quality Assurance Program covers the Owner and Operator's responsibilities as per the requirements of the CSA N286.0 and N286.5-standards and the AECL Management System described in the AECL Management Manual and the Overall Quality Assurance Manual.

DIF Operations has established and implemented an Operations QA Program to ensure that qualified individuals operate and maintain DIF safely and within the requirements defined in the Operating Licence for MAPLE Reactors and for NPF.

The DIF QA Manual is supported by the following set of document types:

- Company wide procedures (00 and CW)
- Chalk River procedures (CRL)
- DIF specific procedures (6423)
- MMIR Project procedures (6400)
- Conduct of Operations Procedures (CO)
- Instructions to Staff (ITS) Documents
- Nuclear program manuals (e.g. radiation protection, emergency preparedness) and their referenced procedures that are described in further detail in following sections

The DIF QA program includes verification activities, self-assessments, audits, and other actions to verify that activities are performed to obtain the assurance of quality and that non-compliance with specified requirements are identified, recorded, and corrected. Records are produced and retained as objective evidence of compliance with the specified requirements.

A.1.2 MMIR Project QA Program

MMIR Project Quality Assurance Manual, which complies with the requirements, specified in the Canadian Standards Association CSA-N286.1, CSA-N286.2, CSA-N286.3, CSA-N286.4, and CSA-N286.7 and the AECL Management System described in the AECL Management Manual and the Overall Quality Assurance Manual describes the Quality Assurance Program for the MMIR project.

The MMIR Quality Assurance Program includes verification activities, self-assessments, audits, and other actions to verify that activities are performed to obtain the assurance of quality and that non-compliance with specified requirements are identified, recorded, and corrected. Records are produced and retained as objective evidence of compliance with the specified requirements.

The documents supporting the program objectives are:

- MMIR Project procedures to provide specific guidance on the QA program implementation.

The QA programs applicable to the MMIR Project activities are described as follows:

- Procurement is performed in accordance with the requirements described in the Company-Wide Procurement QA Manual and the MMIR Project QA Manual.
- Design activities are performed in accordance with the requirements described in the Company-Wide Design QA Manual [A-5] and the MMIR Project QA Manual.
- Construction and fieldwork activities performed under direct MMIR Project control are conducted in accordance with the MMIR Project QA Manual and the Company-Wide Construction QA Manual [A-6] as applicable. Construction activities performed by Participants and /or Contractors are conducted in accordance with their quality program manual, which is accepted by the MMIR Project prior to the start of the activity. QA programs specified by MMIR Project and acceptable to jurisdictional authorities govern these activities, depending on the system classification.
- Commissioning activities are performed in compliance with the requirements of the MMIR Project QA Manual.
- The development and use of analytical, scientific, and design software complies with the Company-Wide QA Manual for Analytical, Scientific, and Design Computer Programs, [A-7].

A.1.2.1 Project Improvement Plan

Management reviews of the MMIR Project performance conducted in 2005, as part of AECL's effort to continuously improve its operations, identified the need for a systematic improvement plan. The Project Improvement Plan (PIP) [A-8], led by the MMIR Project, was therefore developed to address issues and pursue opportunities for improvement by strengthening human performance, safety culture, improving the execution of engineering work processes, and implementing feedback derived from operating experience on the MMIR Project.

The PIP is organized into three broad areas of improvement, People, Process, and Plant. Each area is addressed through specific elements with detailed actions as described in the PIP. The main objectives for each area are:

- ***People*** **–** improve the human performance aspect of the Project, which includes focusing on methods and tools (e.g., procedural use and adherence, questioning attitude, event free tools), lessons learned, and feedback from operating experience;
- ***Process*** **–** review the processes (procedures) currently used in conducting engineering, safety analysis, and licensing work, and revise them if needed by improving the procedural understanding, incorporating efficiencies where required based on feedback and lessons learned, and developing new ones to improve the overall design process; and
- ***Plant*** **–** ensure that documentation (design, procurement, construction and commissioning) reflects the as built and commissioned plant configuration.

The plan is being implemented in phases. Phase 1, from 2006 May to 2006 November, was in support of safe operation of the MAPLE 1 Reactor up to 5 MW nominal power to perform PCR tests. Phase 2 activities, started in 2007 February, will support the proposed higher power operation of the MAPLE 1 Reactor and the active commissioning of the NPF.

A.1.2.1.1 PIP Progress Highlights

The MMIR PIP received management approval in 2006 May. Phase 1 of the PIP was completed in 2006 November. Phase 2 is in progress. Over 100 main and sub-activities have been completed since 2006 May. Key completed activities are summarized below.

Conduct of Engineering:
A *Conduct of Engineering guideline* document was issued. This document identifies the management high-level expectations with respect to the overall functions performed by the MMIR Project organization to support DIF Operations based on twelve key design and engineering guiding principles (i.e., respect for the hazard, product safety, meeting regulations, codes and standards, proven technology base, respect for quality, positive control, effective processes and tools, human capability, team performance, leadership, learning and improvement, and early identification).

Safety Culture Workshops:
The MMIR Project completed a series of Safety Culture workshops for Project personnel. The focus of the workshops was industry standard Nuclear Safety Culture and its application in Design and Engineering. The topics covered were AECL's Mission and Values, Safety Culture Framework for Design and Engineering, Cultural Cycle, Questioning Attitude, Rigorous and Prudent Approach, and Communication (QARPAC) Worker Characteristics, *Defence in Depth, and Safety Management System.*

Safety Analysis Process:
The MMIR safety analysis process was updated. This includes guidelines for performing safety analysis, preparing and maintaining an Analysis of Records and FSAR Issues List, configuration management and change control for computer model datasets, and preparation of the Safety Analysis Data List (SADL). The updated safety analysis process has been used for developing the safety analysis supporting operation of the MAPLE 1 Reactor up to 5 MW nominal power, where an enhanced data control and verification process has been applied for verifying all the design parameters in the SADL.

System Status Reports:
System status reports were prepared for fourteen (14) MAPLE 1 safety and key safety-related systems as part of the 5 MW Operational Readiness Review. These reports summarize the design history, design changes, non-conformances, corrective actions, and change request closeout status for each system. The reports provide the status of the design and safety documentation, design verification activities, and specific design approvals such as pressure boundary registration. The reports also provide the status of manufacturing, procurement, installation, and commissioning.

Cause Assessments of Non-Conformances:
Cause assessments of historical significance level 1 and level 2 NCR were completed. Based on the findings, corrective action plans to prevent the recurrence of the NCR are being implemented.

HAZOP Assessment:
The NPF HAZOP (Hazards and Operability) recommendation dispositioning process was defined. This provides the requirements, responsibilities and the process for reviewing and recording the disposition of HAZOP recommendations. Description of the NPF HAZOP study is provided in Section 3.

Configuration Management Plan:
A Configuration Management plan was issued to ensure that that proper controls exist between the design, analysis and physical configuration for plant systems, structures or components. The plan is being implemented on a system-by-system basis, starting with MAPLE 1.

A.1.2.1.2 Current Status Summary of the Project Improvement Plan

AECL has implemented PIP in a phased manner. Phase 1 activities, completed in 2006 November, were in support of 5 MW operation of the MAPLE 1 Reactor. The Phase 2 activities will support the proposed higher power operation of the MAPLE 1 Reactor, and the active commissioning of the NPF.

Revision 1 of the PIP was transmitted to the CNSC on 2007 February 21.

Phase 2 of the MMIR Project Improvement Plan (PIP) commenced at the end of 2007 February. The Phase 2 plan is in support of MAPLE 1 operation at 8 MW and active commissioning of the

NPF (New Processing Facility). The Phase 2 work follows the approach used in Phase 1, which was completed in 2006 November to support PCR tests in MAPLE 1 at 5 MW. The work is grouped into three main areas – People, Process and Plant.

- People category, which relates to human performance,
- Process category, which includes engineering procedural aspects, and
- Plant category, which deals with configuration aspects, i.e, consistency between as-designed documentation and as-built plant configuration

Figure A-1 shows the 2007 March end status of the workdown curve of Phase 2 actions.

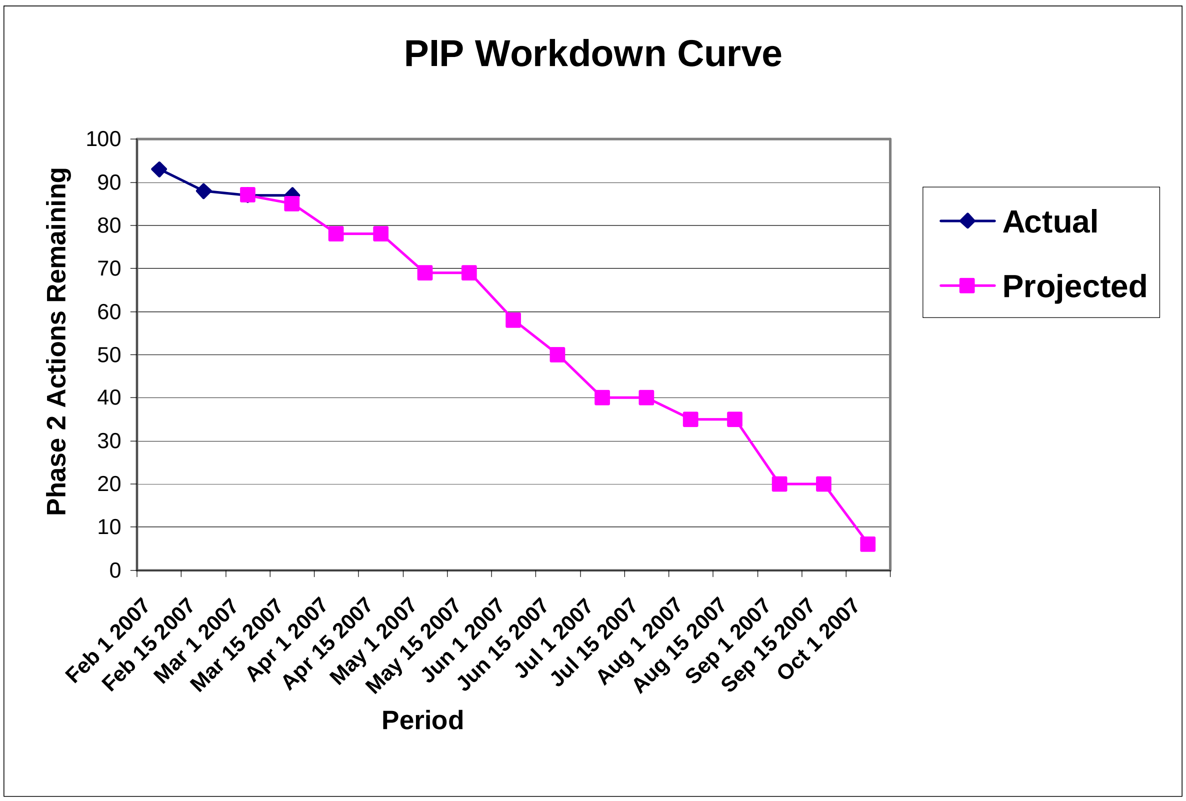


Figure A-1 PIP Workdown Curve

A.2 Emergency Preparedness Program

AECL Emergency Preparedness (EmP) Program defines and describes the organizational structure, responsibilities, and processes, and reports on the implementation of the AECL Health and Safety and Environment policies with respect to emergency preparedness within AECL sites. The EmP Program ensures that all of the components of emergency preparedness and response are effectively maintained.

The EmP Program comprises planning, exercises and training to ensure that the processes are in place to control and to mitigate the consequences of an emergency at CRL, as well as the emergencies related to the transportation of nuclear materials.

The program structure and requirements are documented in the Emergency Preparedness Program Requirements Manual. The NLBU is specified in AECL's Management Manual as being responsible for the compliance management of the emergency preparedness requirements for operation at AECL sites in Canada and the business processes related to Emergency Preparedness. As such, the Vice President, NLBU is the designated Executive Authority for the Emergency Preparedness Program. In addition, the Senior Director, Nuclear Programs is the designated authority for the company-wide EmP program.

The EmP Program Authority is appointed by the Senior Director, Nuclear Programs and has the authority and responsibility for defining and implementing the EmP Program.
As required by the CRL site licence, the EmP Program carries out an annual program review that covers the organization, drills, exercises, training, documentation, interactions with outside agencies and status of emergency preparedness.
The EmP Program uses the following performance measures to assess site-wide compliance with program requirements:

- Emergency procedures are reviewed annually and revised as required.
- Designated personnel are trained in their emergency response duties.
- Facility building personnel conduct and/or participate in drills and exercises as identified in the annual exercise schedule.
- Emergency equipment is maintained in a state of readiness and quarterly confirmation is reported to the EmP office.

AECL has in place, and is continuously improving, general and specific plans to enable appropriate responses to be made on short notice to various emergency situations that might arise. These plans define the on and off-site response procedures and the communications and organizational arrangements that would be brought into effect to deal with an emergency situation.

Lower-level procedures are prepared by building/facility/branch staff to ensure a planned, orderly, and timely response to a building or site-wide emergency condition, and to support off-site arrangements. The building procedures identify specific hazards and provide actions to be taken by the staff and by designated building emergency teams. The Building Emergency Procedures are reviewed annually and are revised as changes occur. The communication protocols and emergency response activities identified in these procedures are integrated with the CRL Site Emergency Plan and the EmP Program Requirements Manual.

The CRL Exercise and Drill Plan outlines the exercise program over five years. It is used to develop an annual schedule. Approximately 50 drills are conducted annually. The drills and exercises are used to train staff, test and validate plans and procedures for on-site and off-site response. Briefing sessions are held after every drill and exercise to discuss objectives, actions taken during the response, and lessons learned. The actions and recommendations are documented in final reports and lessons learned are used to improve future response and the EmP program.

Training of the emergency response personnel is in place to ensure that personnel have the required skills and knowledge to perform their assigned functions. The training program was developed in accordance with AECL Systematic Approach to Training and supporting documents.

A.2.1 Emergency Preparedness Program Documentation

- Emergency Preparedness Program Requirements Manual [A-9]
- Chalk River Laboratories Site Emergency Plan [A-10]
- Chalk River Laboratories Site Emergency Plan, Addendum 1 [A-11]

A.2.2 Specific Implementation of Emergency Preparedness Program

The DIF emergency procedure documents, MAPLE Reactor Buildings and the New Processing Facility, are prepared based on the CRL Site emergency response strategy.
The Emergency Operating Procedure (EOP), *Fuel Failure Event*, covers actions and checks to be executed following a fuel or target failure event, in the MAPLE 1 or MAPLE 2 Reactor Core during Reactor operation. This procedure covers the Entry Conditions for this event and ends with a stabilized situation and radioactive releases minimized.

A.3 Environmental Protection

The objectives of the AECL Environmental Protection Program are to establish and maintain the overall processes and procedures that implement AECL's environmental policy within AECL owned or operated sites in Canada, and to ensure compliance with legal and policy requirements with respect to protection of the environment.

The AECL Environmental Protection Program applies to operations and activities within sites in Canada owned or operated by AECL insofar as they may affect the environment in and around those sites.

The primary legal requirements related to protection of the environment applicable to operations and activities at AECL sites in Canada, including the CRL site, are:

- Nuclear Safety and Control Act,
- Canadian Environmental Protection Act,
- Canadian Environmental Assessment Act,
- Fisheries Act,
- Transportation of Dangerous Goods Act, and
- Species at Risk Act.

The Environmental Protection Program is defined and described in tiered series of documents:

- A first tier document, Environmental Management System for AECL Sites in Canada, provides an overview of the program, the key processes, organizational structure and responsibilities for the management and implementation of the program.

- A second tier consists of two series of documents. The Level 2A series (RC-2000-021-1.x) addresses requirements related to ISO-14001 for environmental management. The Level 2B series (RC-2000-021-2.x) defines the key requirements, processes and responsibilities related to environmental performance and compliance to applicable regulations.
- A third tier of company-wide or site-wide documents provides guidelines, procedures, standards and specifications at the working level. At this level are specific procedures related to the control and management of the facility or operations as they relate to environmental protection. Monitoring and measurement processes used to characterize any release of radioactive and non-radioactive substances to the environment exist at the third tier.

The program and documentation meet the ISO-14001 International standard for Environmental Management Systems. CRL was first registered to IS0 14001: 1996 in 2004, and as a result of a CRL surveillance audit in 2005 June, CRL was re-registered to ISO-14001: 2004.

A.3.1 Environmental Protection Program Management

AECL 's Management Manual describes distribution of responsibility and authority in the implementation of the environmental policy. The Executive Authority for the Environmental Protection Program is Vice-President, Nuclear Laboratories. The Program Authority is the Director, Environmental Division.

The Program Manager and staff are responsible for identifying legal and other requirements, developing and maintaining program documents, advising and assisting managers and facility staff to implement environmental protection requirements, preparation and reporting progress of AECL's environmental plan, coordinating environmental compliance monitoring programs and reporting on environmental performance.

A.3.2 Specific Implementation of Environmental Protection Program

Facility specific environmental objectives and targets will be established as required to support applicable site-wide environmental objectives, targets and performances measures in accordance with Environmental Aspects, Objectives, Targets and Plans prior to In-Service Operation of the DIF. Releases of radioactive liquids and gases to the environment are being controlled, monitored and recorded, and the DIF has not exceeded any of AECL’s Derived Release Limits for Airborne and Liquid Effluents from Chalk River Laboratories During Normal Operations [2-42].

A.3.3 Environmental Protection Program Documentation

Environmental Management System for AECL Sites in Canada, including:

- Level 1 Overview Document: Environmental Management System for AECL Sites in Canada [A-12]
- Level 2A Requirements Documents: Requirements for the Environmental Management System, RC-2000-021-1.X (series)
- Level 2B Requirements Documents: Requirements of the EMS for Environmental Performance and Compliance, RC-2000-02 1 -2.X (series)
- Chalk River Laboratories -Action Levels for CRL Air and Liquid Radioactive Effluents [A-13]
- Derived Release Limits for Airborne and Liquid Effluents from Chalk River Laboratories During Normal Operations [A-14]

A.4 Radiation Protection

AECL Radiation Protection Program covers all Chalk River Laboratories (CRL) activities involving ionizing radiation. The program is designed to ensure that AECL complies with, or exceeds, the level of radiation safety that is required by the relevant regulations pursuant to the Nuclear Safety and Control Act.

The objectives of AECL Radiation Protection Program are to:

- Limit doses to less than the regulatory limits;
- Limit the risk of detrimental stochastic health effects in employees and members of the public to levels as low as reasonably achievable, social and economic factors being taken into account (ALARA principle); and
- Prevent detrimental non-stochastic (deterministic) health effects caused in employees and members of the public by the AECL use of radiation.

At all CRL facilities, these objectives are achieved through facility design, internal and external dosimetry program, staff training, administrative exposure control procedures, contamination control requirements, and work planning and supervision. An independent Radiation Protection Organization supports the radiation safety responsibilities of line management and employees. The structure of the Radiation Protection organization is provided in AECL 's Radiation Protection Requirements. At the lowest level are facility, branch-specific, or other working level documents. These include radiation work plans, procedure documents and Radioisotope Laboratory Protocols. All CRL employees and contractors receive formal initial and ongoing radiation protection training corresponding to their work and responsibilities in the use and handling of radioactive materials. Program reviews are conducted annually and improvement initiatives arising from the review are tracked through the Actions/Issues Management System Program.

As part of the ALARA philosophy, dose Action Levels, radiological hold points, and individual

Dose Control Points are established to trigger investigations and corrective actions when these levels are exceeded. These internal AECL levels are significantly below the dose limits defined in the CNSC Radiation Protection Regulations.

A.4.1 Specific Implementation of Radiation Protection Program

All applicable elements of the AECL Radiation Protection Requirements are implemented in DIF to the extent required for current commissioning and operational status. Examples include: the provision of dedicated Radiation Protection Group l qualified staff (Radiation Surveyors and Manager, Radiation & Industrial Safety), implementation of an internal dosimetry sampling program and supplementary external dosimetry program (personal electronic dosimeters), and the implementation of radiological zoning of the DIF.

The documents supporting the program objectives are:

- AECL's Radiation Protection Requirements, [A-15]
- Radiation Protection Manual, RC-2000-633-1
- Radiation Protection training documents
- Facility specific documents

DIF Management ensures that radiation doses received by individuals are As Low As Reasonably Achievable (ALARA) through the implementation of AECL's Radiation Protection Program.

Access Control to areas of the DIF considered to be High radiation areas will be established and maintained in accordance with procedure *Access Control*.

A.5 Nuclear Security

Emergency and Protective Services at CRL organizes and manages the Physical Security program in accordance with the needs of the organization, regulators and key stakeholders. The Emergency and Protective Services group is accountable for Physical Security and the program reports to the Director, Emergency and Protective Services, who reports to the Senior Director, Nuclear Programs.

Corporate Security reports to the Chief Security Officer under Compliance and Corporate Oversight, and supports the Emergency and Protective Services program.

A.5.1 Physical Security

CRL Protective Services, within Emergency and Protective Services, is structured to provide continuous security coverage of the site. A dedicated crew of personnel is assigned to augment a five-shift rotation during normal company workdays. This ensures adequate staffing levels meet customer requirements. The Emergency and Protective Services Branch is comprised of security systems support/personnel, security supervisors, administrative staff, Nuclear Security Officers and Nuclear Response Force Officers.

CRL Protective Services provides physical protection against unauthorized access and malicious damage to nuclear and non-nuclear facilities, and to specified nuclear materials that are used, processed, stored or possessed by the Company. AECL maintains processes to prevent unauthorized disclosure, destruction, removal, modification or loss of classified, sensitive, designated or valuable assets, whether in physical or electronic form.

AECL remains bound to the provision of security services as described in the Nuclear Safety and Control Act, Nuclear Security Regulations, Government of Canada Governmental Security Policy. AECL updates security-related documents accordingly, when there are policy changes and government directives.

Regulatory performance is measured by our adherence to applicable policies and procedures in a timely manner. The CNSC conducts visits and audits of the Physical Security Program to ensure compliance with the Nuclear Security Regulations and the CNSC Nuclear Response Force Standard (S-298).

The Director, Emergency and Protective Services within Nuclear Laboratories also ensures the provision of physical security at Whiteshell, Douglas Point, Gentilly 1, and Laprade.

A.5.2 Corporate Security

The AECL Corporate Security Program ensures all AECL security requirements are met. The Chief Security Officer position is accountable for setting the framework and overall direction, organization and coordination of all aspects of AECL corporate security. The Chief Security Officer also provides oversight of the Physical Security program to ensure that the requirements are properly identified and implemented.

The Chief Security Officer’s mandate is structured to administer programs under Personnel Security Screening, Access Control, Security Awareness, Investigative Services, Threat and Risk Assessments, Identification of Assets and Regulatory Compliance.

AECL is mandated to comply with Treasury Board and Privy Council guidelines and policies for security at federal facilities and as such is required to ensure appropriate safeguarding of all sensitive information and assets of the Government of Canada.

The Chief Security Officer and Corporate Security liaise with local, provincial, and national police forces as required.

A.5.3 Security Documentation

- *Security of Nuclear Materials Program Manual* [A-16]
- Chalk River Laboratories Site Security Report [A-17]
- Canadian Nuclear Safety Commission, Nuclear Response Force Standard, Regulatory Document S-298.

A.6 Nuclear Materials and Safeguards Management Program

The overall objective of the Nuclear Materials and Safeguards Management Program is to ensure

that processes and interfaces involved in the management and safeguards of nuclear materials adhere to the terms of the Treaty on the Nuclear Non-Proliferation of Nuclear Weapons, the Canadian Nuclear Safety and Control Act, as well as applicable international, federal and AECL company-wide requirements. The program oversees the procurement, transfer, accounting, safeguards and storage of nuclear materials to ensure that all requirements are met.
The controls of nuclear materials are discussed in the following sections.

A.6.1 Procurement

Procurement of fissionable materials, heavy water, radioisotopes, and radiation sources is the responsibility of Nuclear Programs - Nuclear Materials Management and Radioactive Materials Transportation (NMMT). When procuring nuclear materials, a written request is submitted from the requisitioner to the Procurement and Safeguards Policy Program Officer (at Chalk River Laboratories, NMMT). The Procurement and Safeguards Policy Program Officer determines the contractual parameters and any licensing aspects to import/export the nuclear materials, and to ensure that all necessary approvals are obtained from the Canadian Nuclear Safety Commission (CNSC), as required.

A.6.2 Nuclear Material Control

Movement of nuclear materials is controlled by ensuring the material is radiologically safe to move, that is, free of contamination and radiation hazards as per AECL's Radiation Protection Requirements. Furthermore, the movement is made in accordance with the rules laid out for criticality control. An accountability control system is maintained for each of the Material Balance Areas (MBA) to record the transaction and maintain the balance of nuclear materials within the MBA. Emergency and Protective Services is involved, as required in the movement of materials.

A.6.3 Inventory Management Control

Heavy water, tritium, fissionable materials, and radioisotopes at Chalk River Laboratories are nuclear substances that are controlled in accordance with relevant sections of the Nuclear Safety and Control Act.

Separate accounting systems have been developed to satisfy the requirements of AECL management and the Nuclear Safety and Control Act relating to nuclear substances.
Nuclear Programs-NMMT is responsible for the accounting and control of the various inventories at Chalk River. These accounting systems and inventories are open to inspection and audit by the CNSC and the International Atomic Energy Agency (IAEA).

A.6.4 Safeguards

To meet Canada's obligations under the Treaty on the Non-Proliferation of Nuclear Weapons, a mandatory Safeguards Program has been implemented at AECL. One component of the Safeguards Program is outlined in AECB-1049, Reporting Requirements for Fissionable and Fertile Substances. This document defines the national system of accounting for the control of nuclear materials within Canada. Nuclear Programs-NMMT ensures that the requirements of the

CNSC are put in place and maintained. The program involves regular and unannounced inspection visits by IAEA Inspectors to carry out spot-checking of physical inventories of unirradiated and irradiated fissionable material, audit monthly inventory accounting records and compare records with actual quantities. Annually, AECL is also required to provide information about all areas, buildings and activities at each AECL site in Canada. The IAEA confirms the submitted information by performing random, unannounced inspections.

A.6.5 Nuclear Materials and Safeguards Management Compliance Program Documentation

- Nuclear Materials and Safeguards Management (NM&SM) Compliance Program [A-18]
- Radioactive Material (RAM) Transportation Compliance Manual [A-19]
- AECL's Radiation Protection Requirements [A-15]

A.6.6 Specific Implementation of Nuclear Materials and Safeguards Management Program

The Dedicated Isotope Facilities carry out all activities involving nuclear materials (heavy water, fissionable material (targets, driver fuel, fission chambers, calcine waste), radioisotopes and radiation sources) in accordance with approved procedures that conform to *Nuclear Materials And Safeguards Management (NM&SM)* Compliance Program. This includes procurement, receipt, disposition, transfer, accounting, safeguards management, storage, and inventory management.

A.7 Commissioning

A.7.1 MAPLE

The commissioning of the MAPLE Reactors is done in accordance with the MAPLE Reactor Commissioning Plan [A-20]. Details of commissioning activities carried out in the current licence period are provided in section 2.

A.7.2 MAPLE 1 Iodine Production Facility

There was no commissioning performed with respect to the MAPLE 1 Iodine Production Facility. However, when commissioning commences it will be done in accordance with the Commissioning Manual I-125 Production Facility [A-21].

A.7.3 New Processing Facility (NPF)

The commissioning of the NPF is done in accordance with the New Processing Facility Commissioning Plan [A-22]. Details of commissioning activities carried out in the current licence period are provided in section 2.

A.8 Maintenance

A comprehensive Maintenance Program at Chalk River Laboratories supports the DIF Maintenance Program. Maintenance support to DIF is provided in the following areas:

- Providing maintenance services for all nuclear facilities;
- Landlord maintenance and maintenance services within research and development facilities at CRL;
- Training and qualification of maintenance personnel;
- Calibration and initial servicing of new safety relief valves, and the servicing of safety relief valves at CRL;
- Providing calibration services for instrumentation and measurement of test equipment at CRL;
- Welded structures at CRL; and
- Providing support to pressure boundary programs.

A.8.1 Specific Implementation of Maintenance Program

The objectives of the Maintenance Program are to detect and minimize deterioration in equipment and systems. The DIF Maintenance Manager ensures that the structures, systems and equipment in the DIF are maintained in good condition and good working order such that they can perform their design function and meet design requirements.

Maintenance work is done in accordance with approved work orders and written maintenance procedures where the complexity or safety significance of the work warrants the latter. Maintenance procedures are prepared, reviewed and approved in accordance with a defined process as detailed in the DIF *Maintenance Procedure*. Initiation, planning, scheduling, execution and closure of work are conducted as per the Work Management procedure.

DIF Preventive Maintenance requirement, which is to ensure that safety-related systems, structures, components and equipment in the DIF function reliably, is defined in the DIF Maintenance Program. This document defines the type and frequency of the preventive maintenance activities to be performed.

The Advanced Maintenance Management System (AMMS), managed and operated by the Maintenance, Radiation Protection, and Work Management group within DIF Operations, forms the basis of scheduling and other management aspects of facility maintenance at DIF.

DIF Operations Maintenance, Radiation Protection, and Work Management is responsible for leading and managing the maintenance, radiation protection and work management groups with overall responsibility for ensuring that DIF is maintained in a safe condition in accordance with the Operating Licenses and the OLC documents.

Specific responsibilities include:

- Managing the DIF Maintenance program, including oversight, initiation, planning, assessment, scheduling, execution and closeout of all DIF maintenance activities;
- Establishing priorities for maintenance activities;
- Directing management of DIF Maintenance personnel, as well as additional

maintenance resources, ensuring all personnel are trained and qualified to conduct maintenance duties;
- Developing, executing and making ongoing changes to work management and work control;
- Establishing and executing DIF Maintenance Plan;
- Interfacing with MMIR Project planning for DIF Operations;
- Provision of industrial radiological safety support to DIF; and
- Providing leadership and coaching to ensure process and procedural compliance while encouraging continuous improvement.

There are two types of maintenance:

Preventive Maintenance, which includes pre-planned routine testing, inspection, servicing, and overhaul of systems, equipment, and components. The Preventive Maintenance program is made up of periodic inspection, periodic testing, in-service inspection, and predictive maintenance.

Corrective Maintenance, which includes all actions taken to repair and/or restore equipment and components that have failed or are not performing their intended function.

The governing documents of the maintenance program are:
- Work Management [A-23]
- DIF Maintenance Program [A-24]
- DIF Periodic and Inaugural Inspection Program [A-25];
- Facility-specific maintenance procedures;
- CRL maintenance procedures, as applicable.

A.8.2 DIF Safety-Related Systems Testing Program

The MAPLE Reliability Plan and the NPF Reliability Plan have been produced to guide DIF Operations in the development of a maintenance program for testing and inspection to demonstrate that the availability, reliability, and effectiveness of any structure, system, or component remain consistent with the applicable Final Safety Analysis Reports (FSAR). An Operating and Routine Maintenance Schedule was formulated based on the results of an activity base analysis conducted in the DIF in accordance with operational and regulatory requirements.

A.8.3 DIF Periodic Inspection Program

The DIF Periodic Inspection Program specifies the criteria used to develop the program and then addresses the implementation of these criteria on a system-by-system basis to produce the resulting Periodic Inspection Program for DIF.

The Inaugural and Periodic Inspection Program, based on criteria to be embedded in the overall program document, was completed in 2000 October. The scope of the periodic inspection is to provide assurance of structural integrity of pressure retaining boundaries in compliance with the mandatory requirements identified by the Regulatory Authority. It includes, but is not limited to, the following:

- The mandatory inspections of key equipment and piping to confirm that there is no significant deterioration of the pressure boundary, which may result in failure of the pressure boundary.
- Inspection of code-classified systems and components per the approved Form 73 (Classification Approval Form), with additional requirements.

An Overall In-Service Inspection Program was issued in 2006 May. This program defines the requirements for mandatory and non-mandatory inspections of systems essential to safe shutdown, cooling, and confinement of the MAPLE 1, MAPLE 2 and NPF. The overall program elements and guidance described in this program include:

- Definition of the Mandatory and Non-Mandatory categories of the In-Service Inspection Program;
- Criteria established to differentiate the subprograms;
- The CSA Standard requirements appropriate to the NPF.

The documents supporting the program objectives are:

- Dedicated Isotope Facilities (DIF) Periodic and Inaugural Inspection Program [A-25], and
- DIF In-Service Inspection Program [A-26].

A.9 Operating Limits and Conditions

The MAPLE Reactors are operated in accordance with Non-Power Reactor Operating Licence NPROL-62.00/2007 [A-27] and Nuclear Research and Test Establishment Operating Licence NRTEOL-01.00/2011 [A-28] for CRL for site wide programs. The OLC document for the MAPLE Reactors [A-29] sets out the key requirements, limits, and conditions for the safe operation of MAPLE 1 and 2 Reactors and MAPLE 1 Iodine-125 Production Facility (MIPF) up to 5 MW. Revision 20 is the version currently approved by the CNSC Staff. The MAPLE OLC has been revised several times in the past licensing period to be kept current with commissioning activities and the corresponding Safety Cases.

The Technical Basis Document for the MAPLE Reactors OLC has also submitted to CNSC staff for information.

The NPF is operated in accordance with NSPFOL-03.00/2007 [A-30] for the facility and NRTEOL-01.00/2011 for CRL site-wide programs. The OLC document for the NPF [A-31] sets out the key requirements, limits, and conditions for the safe operation of the NPF. Revision 4 is the version currently approved by the CNSC staff. Revision 5 of the NPF OLC has been completed and sent to CNSC staff for approval. Revision 5 was created to align reporting practices to those of the MAPLE OLC and to update the document to the current NPF configuration.

A.10 Operating Experience

The Operating Experience (OPEX) Program uses information from within AECL and from external sources to improve the safety of operations, improve operational performance, and reduce the significance and the occurrence of unplanned events at sites in Canada. The OPEX group provides the processes for the identification and investigation of unplanned events, determination of corrective actions, internal notification to stakeholders, and trending and information sharing, both internally and with the nuclear industry in general. The overall objective of the OPEX Program is to achieve higher levels of safety by providing the following processes:

- Internal events are identified, categorized according to their significance, and reported internally, and to regulatory agencies if required, pursuant to the Nuclear Safety and Control Act. Events are screened for applicability and shared with industry peers.
- External events are screened for applicability and significance, and communicated internally.
- A corrective action process is applied to significant events and follow-up is performed to ensure that the corrective actions taken have been effective.
- The causes of internal events are analysed for apparent cause or root cause, the choice of which is dependent on the significance of the event.
- Results of investigations are compiled and analysed for trends. Adverse trends are documented and communicated to the responsible line management for investigation as to the cause(s).
- Information gained from operating the facilities is used to improve facility and equipment performance, and operating requirements and practices.
- Information is made available for use in improving design, procurement, construction and commissioning requirements and practices.
- The OPEX Program promotes safety culture, safety awareness and lessons learned.

The OPEX group also performs an annual Program Management Review, in accordance with the AECL Management Manual, where the effectiveness of the program is assessed, and new objectives and actions are identified.

The program is supported by the following documents:

- NLBU Operating Experience Program Manual [A-32]
- Root Cause Analysis Handbook [A-33]

A.11 Training

The Organizational Development & Training group supports managers and their work teams in their efforts to accomplish performance objectives, enhance their effectiveness, meet job competency/qualification requirements, and achieve the goals of AECL. Specifically, the group provides service in the following areas: facilitation and consulting, training design and development, coordination and conduct of training, and implementation of the systematic approach to training (as identified in AECL Systematic Approach to Training (SAT). Numerous instructor-led and computer based courses are offered internally, targeted at knowledge and skills training generic to AECL in the following program areas:

- General and Safety Orientation/Contractor Safety and Orientation;

- Basic Skills Training (i.e., Writing, Effective Presentation, etc.);
- Computer Skills Training;
- Technical (i.e., Nuclear Theory, Equipment Principles, Waste Management, etc.);
- Compliance Programs (i.e., Emergency Preparedness, Environmental Protection, etc.);
- Safety (i.e., Fire, First Aid, WHMIS, Event Free Tools, Safety Culture etc.);
- Leadership Management; and
- AECL Systems/Programs/Processes.

A.11.1 Training Program

AECL's Training Program provides training for site-wide programs, organizational development, and radiation protection. Line Managers define training requirements for staff. The objectives for AECL's Training Program are:

- Identify and design training targeting any specific need to increase knowledge, skills, and competencies;
- Develop customized training programs for all job levels, with particular expertise in the technical areas;
- Conduct training process and program evaluations and validations as required;
- Assess, value and cost effectiveness of courses required to be offered internally; and
- Ensure that the programs developed comply with regulations and meet with the requirements of internal as well as external regulatory bodies.

A.11.2 Specific Implementation of Training Program

The DIF Training Program is designed to provide and maintain the training, qualification, authorization, and certification (where applicable) of personnel in direct operating positions, namely, the MAPLE Manager Operations, the MAPLE Reactor Operator, NPF Supervisors and NPF Hot Cell Technicians. Certification applies only to the MAPLE operating positions.

The DIF Training Program also provides training for employees involved in supporting the operation of MAPLE and the NPF.

The documents supporting the program objectives are:

- AECL Systematic Approach to Training [A-34] and supporting procedures;
- DIF Training Plan [A-35];
- System Task Analysis;
- System Training Manuals;
- Master Lesson Directives, On-Job-Training/Field Checkouts Guides; and
- Assessments (exams and answer guides).

Records of training, CNSC Certification exam development, conduct, and marking follow CNSC-ST1, Revision 2.2 (2002 July), Written and Oral Examination for Certified Operating Personnel at Nuclear Reactor Facilities [A-36].

A.12 System Performance Monitoring Program

The System Performance Monitoring Program is a standardized process which encompasses the activities used to establish system, structures, and components monitoring requirements, to evaluate system, structures, and components performance, and to report on results, including the provision of input to changes or improvements to the facility.

The System Performance Monitoring Program is not intended to duplicate or replace the Surveillance program carried out by the Operations staff, rather it is intended to review the performance of structures, and components vis-à-vis design requirements, normal operating performance, and long term operating performance.

Documentation supporting this program is as follows:

- *System Performance Monitoring Program* [A-37];
- *Preparation of System Performance Monitoring* [A-38];
- *Preparation of System Performance Monitoring Reports* [A-39]; and
- *Guidelines for System Performance Monitoring Field Walkdowns* [A-40].

A.13 Occupational Health and Safety

AECL places the health and safety of its employees and the public as its highest priority. The AECL Occupational Health and Safety (OHS) Program provides a management framework and processes that, together with active employee involvement, can help to ensure the health and safety of people involved in all aspects of AECL's activities. The AECL OHS Program is applicable to all AECL organizational units, facilities and projects.

The primary responsibility for occupational safety and health lies with management. All managers and supervisors are held accountable for the health and safety of persons who report to them. The effectiveness of this program depends on commitment of management to provide a safe and healthy work environment, and on active employee involvement.

The OHS Program addresses the legal requirements of:

- The Nuclear Safety and Control Act and Regulations.
- The terms of the CNSC licences issued to AECL.
- Human Resources and Skills Development Canada, as specified in the Canada Labour Code Part II, and the Regulations Respecting Occupational Health and Safety made under Part II of the Canada Labour Code, and the Safety and Health Committees and Representatives Regulations.

The current AECL OHS Program Manual [A-41] establishes the framework for the OHS Program. Further documentation includes processes, procedures, supporting documents, records, forms and training packages to be used in achieving the objectives of the OHS Program. These allow for site-specific and project-specific needs, while still ensuring consistent application of the OHS Program requirements.

In summary, DIF Operations has successfully implemented the Chalk River Laboratories Occupational Safety & Health Program.

A.13.1 Specific Implementation of Occupational Health and Safety Program

The MAPLE Reactors and NPF are operated in accordance with AECL Occupational Health and Safety program. All applicable elements of the program are implemented in the DIF, such as control of hazardous material in the MAPLE Reactors and NPF, confined space protocol, and personal respirators.

The identification of and the requirements (e.g. approved storage locations and allowable quantities) for controlling hazardous and combustible materials in the DIF are performed in accordance with *Control of Hazardous Materials*. Housekeeping monitoring, including confirmation that hazardous and combustible materials are controlled are performed in accordance with the *Routine Operations* procedure.

Procedure to minimize and control personnel radiation exposure and personnel protection have been established, per nuclear programs documentation, AECL's Radiation Protection Requirements and AECL Occupational Safety and Health Program Manual.

A.14 Fire Protection

CRL Fire and Emergency Services are organized into two sections: Fire Prevention and Operations. This structure enables a higher level of fire prevention services and a more comprehensive maintenance and training program. The Fire Chief manages both sections, supported by Deputy Chiefs, Assistant Chief, Fire Prevention Officers, a Fire Systems/Protection Engineers and Fire Administration Officers. Four rotating shifts provide continuous on-site fire protection, each shift being comprised of a Fire Lieutenant and Fire Fighters.

Fire and Emergency Services provides services in fire prevention, investigation, fire safety inspection, fire advisory, fire suppression, emergency rescue, hazardous materials response, and medical first aid. Various educational and training programs are continually being developed, improved and delivered to satisfy the needs of AECL.

Applicable requirements for CRL Fire and Emergency Services are National Building Code of Canada, the National Fire Code of Canada, and *Fire Protection for Facilities Handling Radioactive Material* (NFPA 801), and Canadian Standard Association CSA N293: Fire Protection for CANDU Nuclear Power Plants, where applicable at CRL.

The Fire Department is committed to developing Firefighter safety, education and training, and priority objectives. A training officer has been hired to lead the emergency response training. Essential training will continue to be delivered and monitored, integrating the International Fire Service Training Association, Ministry of Natural Resources, and Ontario Fire College programs. Courses taken by Firefighters include confined space rescue, high angle rescue, auto extraction, hazardous materials, fire cause and determination and officer training courses. On-shift training is also conducted at regular intervals.

A.15 DIF Safety Analysis Program

The objective of the Safety Analysis program is to demonstrate that the requirements for health and safety of persons and for protection of the environment are met for all accident scenarios in the Final Safety Analysis Reports (FSAR).

The safety analysis program includes the revision and update of the FSAR for both the MAPLE Reactors and for the NPF. This will include updating on a regular basis all FSAR sections, with the exception of those sections containing safety analysis results.

The program also includes the production of safety cases to support PCR tests in the MAPLE 1 Reactor, design changes to systems, structures and components in the DIF, and NPF Active Commissioning.

As per the FSAR Issues List and Analysis of Record (AOR), the MMIR Analysis of Record database defines the current licensing basis for MMIR by compiling all submissions to CNSC that modify, supersede or supplement safety analysis information in the latest version of the FSAR.

A Safety Case to support operation of MAPLE 1 Reactor at up to 5 MW was submitted to the CNSC Staff and approval was granted 2007 January. This safety case covers the current MAPLE 1 core configuration. Additional safety cases will be prepared and submitted to the CNSC in support of several tests designed to establish the cause of the positive PCR and operation at high power.

Once the source of the positive PCR is identified, and the mitigation measures are known, a schedule for update of these safety analysis sections will be developed.

A Safety Case to support the active commissioning of the NPF is being prepared and will be submitted to CNSC staff upon completion. Additional safety cases will be prepared for other projects within the NPF, e.g. improvements to the Closed Loop Cooling System, as needed.

A.16 DIF Foreign Material Exclusion (FME) Program

This program defines how the foreign material exclusion methods are established and implemented for the commissioning, operation and maintenance of the DIF.

It is applicable to facility systems or components that are normally open or opened for maintenance or operational activities where the potential introduction of foreign material could result in degraded performance. This program applies to all DIF personnel, non-DIF AECL personnel, contractors, and visitors who perform activities that may introduce foreign material into a system or component within DIF.

The purpose of this program is to:

- Prevent or minimize the potential of foreign material intrusion into an open system.
- Define the foreign material exclusion requirements for Operations, Maintenance, and all other staff when planning and implementing both routine and non-routine work activities in and around open systems in the Dedicated Isotope Facilities.
- Provide guidance and documentation requirements on recovery from intrusion of foreign material in a facility system.

- Evaluate and document the effects of un-recovered foreign material from facility systems and components.

The document supporting this program objective is:

- Foreign Material Exclusion Program in the Dedicated Isotope Facilities [A-42]

A.17 DIF Chemistry Control Program

The Chemistry Control Program in the DIF has been put in place to prevent or minimize corrosion or other deterioration of components and to demonstrate compliance with any limits or conditions required as listed in both MAPLE and NPF OLC documents.

The MAPLE Chemistry Control Program consists of the routine sampling and monitoring of the following systems:

- Reactor Pool and Primary Cooling System;
- Reflector Cooling System;
- Reflector Dump Tank – Cover Gases and Instrument Lines;
- De-Ionized Water Supply;
- Groundwater Drainage System; and
- Plumbing and Drainage System.

The MAPLE Chemistry Control Operating Manual and the Rationale For Chemistry and Corrosion Control support the program. In summary, the Chemistry Control Program has been successfully implemented in DIF and has supported operation of the MAPLE Reactor over the current licensing period.

The Chemistry Control Program in the NPF consists of the routine sampling and monitoring of the following systems:

- Closed Loop Cooling System (CLCS);
- Active Liquid Waste System;
- Plumbing and Drainage System;
- Low Level Liquid Waste System; and
- High Level Liquid Waste System.

The program is supported by the *New Processing Facility Chemistry Control* Operating Manual and the *Preliminary Chemistry Rationale for the Closed Loop Cooling System (CLCS) of the New Processing Facility (NPF)*. Due to the non-operational state of the NPF, the Chemistry Control program has not been challenged.

Both Operating Manuals have been revised in early 2007 and are supported by various Operator Routines (OR) and Instruction to Staff (ITS) documents.

The Chemistry Control Program for the NPF is in place and ready to be fully implemented as NPF operations come on line.

A.18 Decommissioning

AECL Chalk River Laboratories (CRL) site is large and diverse and contains many structures and features, some dating back to the beginning of the site's first establishment in 1944. The site is expected to continue in operation as a licensed facility for a wide range of nuclear research and development/industrial and production activities for many years to come. Several of the original structures have been decommissioned over the life of the site and the decommissioning of specific facilities is expected to continue in the future, as structures age or as business needs change. In addition to this, the site has seen new structures and facilities installed and this too is expected to continue for many years to come. Accordingly, the decommissioning model for the CRL site, including the Waste Management Areas, is one of individual decommissioning projects for its various components over time. At the end of the site's operational life, a single project for the site decommissioning as a whole will occur. The Minister of Natural Resources Canada provided a proposal for a financial guarantee for the decommissioning of the CRL site to the Canadian Nuclear Safety Commission (CNSC) in 2003 December.

As per clauses 11.1 in the MAPLE Operating licence [A-29] and 10.1 of the NPF Operating licence [A-31], a Comprehensive Preliminary Decommissioning Plan for the CRL site was provided to the Commission.

A.18.1 DIF Decommissioning

The Preliminary Decommissioning Plan for the Dedicated Isotope Facilities [A-43] presents an outline of the decommissioning activities, as currently planned, for the DIF. The decommissioning would be carried out in several phases at the end of the Facilities' useful life. The decommissioning would be accomplished with activities designed to minimize the hazards to the workers, the public and the environment.

This Conceptual Decommissioning Plan has been updated to reflect current designs of the DIF. It has also been updated to reflect CNSC Regulating Guide G-219 due to the fact that AECB Regulating Guide R-90 was withdrawn.

A.19 Nuclear Criticality Safety Program

The Nuclear Criticality Safety Program documents how AECL prevents criticality accidents through appropriate design, analysis, operations, and decommissioning of facilities involving fissionable materials. This Nuclear Program specifies the requirements to fulfill company business, regulatory, environment, health, safety and quality assurance responsibilities. Nuclear Programs-Nuclear Materials Management and Radioactive Materials Transportation (NMMT) administer this Program.

This Nuclear Program addresses Condition 14.2 of the Nuclear Research and Test Establishment Operating Licence for Chalk River Laboratories, CNSC licence NRTEOL-01.00/2011. This Program defines a new AECL Nuclear Program that demonstrates clear alignment with the ANSI/ANS-8 standards, and will be implemented beginning in 2007 January.
In 2007, AECL will begin to develop program procedures. Using initial versions of these procedures, AECL will update the Nuclear Criticality Safety Analyses and Criticality Safety

Documents (CSD) on a risk-graded basis. The procedures will be refined based on experience with updating the Nuclear Criticality Safety Analyses and CSD for the five most significant facilities, and will result in a baseline set of program procedures.

In parallel with updating the Nuclear Criticality Safety Analyses and CSD on a risk-graded basis beginning with the most significant facilities, CRL will continue to review, revise and approve CSD at Chalk River Laboratories in accordance with past AECL nuclear criticality safety practices. CSD require approval to authorize changes (e.g., design or use) that could affect criticality safety, as well as periodic review and re-approval. To the extent possible, these CSD will be updated to meet or move closer to meeting the requirements in this Program. This approach updates the CSD on a risk-graded basis and takes advantage of necessary CSD re-approvals to complete the implementation of the Program as soon as possible.

A.19.1 Specific Implementation of Nuclear Criticality Safety

All activities involving fissionable materials within the Dedicated Isotope Facilities (DIF) are carried out in accordance with Section 3.7, Nuclear Materials And Safeguards Management (NM&SM) Compliance Program [2-46], until the Nuclear Criticality Safety program is fully established. Per this program, the DIF maintains the following criticality safety documents:

- CSD-55 Criticality Safety Document for the MAPLE Reactor Buildings 110 and 111 [A-44]
- CSD-56 Criticality Safety Document for the Irradiated Fuel Transfer Flask [A-45]
- CSD-57 Criticality Safety Document for the New Processing Facility [A-46]
- CSD-58 Criticality Safety Document for the Calicine Waste Transfer Flask [A-47]

A.19.2 Independent Review

The AECL Nuclear Criticality Safety Panel (NCSP) is a permanent subcommittee of the AECL Safety Review Committee (SRC), which performs oversight and independent review, reporting to the President through the Vice President for Compliance and Corporate Oversight. The SRC operates independently of the line organization, and acts for the Board of Directors, President and Chief Executive Officer in matters of health, safety and the environment. Members of the NCSP are experts in the fields that are relevant to nuclear criticality safety.

The NCSP is responsible for:

- Reviewing, and if found satisfactory, approving all CSD;
- Reviewing and if found satisfactory, approving reports and other documents;
- Unplanned Event Reports, relating to criticality safety;
- Reviewing and approving the removal of Balance After Processing burdens;
- Reviewing and accepting criticality safety training material;
- Reviewing and accepting Nuclear Criticality Control Officer appointments; and
- Participating in independent audits of the Nuclear Criticality Safety Program, nuclear criticality training programs, safety practices and compliance with procedures relevant to criticality safety.

In summary, DIF Operations has successfully implemented the Chalk River Laboratories Nuclear Criticality Safety Program.

A.20 Radioactive Material (RAM) Transportation Program

The program document, Radioactive Materials (RAM) Transportation Compliance Program, establishes and describes in detail the process to be used for the safe transport (both shipments sent off-site and receipt of shipments on-site) of radioactive materials.

This program is administered by Nuclear Materials Management and Radioactive Materials Transportation (NMMT), within Nuclear Programs. The Branch Manager of Nuclear Programs NMMT is the RAM Program Authority.

This program applies to all AECL personnel at all AECL sites in Canada.

A.20.1 Emergency Response

The Nuclear Programs-NMMT, through the AECL Radioactive Material (RAM) Transportation Compliance Program Authority, ensures that an Emergency Response Plan for potentially dangerous occurrences involving radioactive material shipped from all AECL sites, as required by Response Plan for Off-Site Transportation Accidents Involving Radioactive Material, is in place. The RAM Program Authority also ensures that all personnel involved in the transportation process are aware of the emergency response requirements.

The Emergency Response Plan is registered with Transport Canada. The RAM Program Authority ensures that all unplanned events pertaining to the transport of radioactive materials are investigated, documented, and reported to the regulatory authorities in accordance with regulatory requirements.

A.20.2 Specific Implementation of RAM Transportation Program

The Dedicated Isotope Facilities carry out all shipments and receipts of radioactive materials in accordance with approved procedures that conform to Radioactive Material (RAM) Transportation Compliance Program. This includes security, emergency response, regulatory permits/licences/certifications, packaging, markings, and documentation.

A.20.3 RAM Transport Documentation

- Radioactive Materials (RAM) Transportation Compliance Program [A-19]
- Response Plan for Off-Site Transportation Accidents Involving Radioactive Material [A-48]

A.21 Radioactive Waste Management Program

The mandate of Waste Management Operations at Chalk River Laboratories is the safe and reliable management of solid and liquid radioactive wastes. This organization is responsible for waste processing and storage operations and for operating a waste management service for CRL and external customers.

Waste Management Operations, operates the Waste Treatment Centre (per Facility Authorization document AECL-FA-16) and the Waste Management Areas (per AECL-FA-18).

A.21.1 Solid Waste Management

All solid radioactive waste generated by AECL facilities is stored in designated areas at the CRL site. Pending the availability of disposal facilities, wastes are managed using a variety of facilities, including sand trenches, concrete canisters, tile holes, and bunkers. It is anticipated that during the next licensing period the option of sending radioactive waste to the Shielded Modular Above Ground Storage Facility (SMAGS) will be available.

Radioactive solid wastes generated in CRL consist of contaminated equipment, irradiated materials (including fuels), and a wide variety of wastes resulting from maintaining and operating the nuclear facilities at the sites.

A.21.2 Liquid Waste Management

Liquids containing a high-level of radioactivity are stored in stainless steel tanks pending the availability of future permanent disposal facilities. The storage tanks are monitored on a routine basis to ensure that leakage has not occurred.

Liquids containing low-levels of radioactivity are stored in tanks, and are monitored and processed as required.

Depending on the activity level of the liquid, processing may include:

- Delay and decay,
- Micro filtration and reverse osmosis, and
- Evaporation.

One of the primary objectives in the processing of liquid radioactive wastes is to concentrate the radioactive contaminants and to subsequently immobilize those contaminants. The immobilized wastes are stored in the CRL Waste Management Areas.

The primary operation for the Waste Treatment Centre is the liquid waste evaporator, allowing liquid waste from the Decontamination Centre, the Chemical Active Drain System, and the National Research Universal (NRU) Reactor drains system to be routinely treated. The distillate produced from the liquid waste evaporator is monitored against acceptance criteria and, if acceptable, is discharged to the Ottawa River through the Process Sewer.

A.21.3 Gaseous, Emissions, Environmental Control

The active ventilation systems of AECL facilities are used for cooling thermal columns in the reactors and removing radioactive species and other hazardous contaminants in the air from other areas, such as radioactive laboratories. In all areas where airborne contamination is reasonably expected, the radioactive species are removed by a filtration system. All active ventilation systems contain High-Efficiency Particulate Air (HEPA) filters and, in areas where there is likelihood that radioiodines may be present, are combined with High-Efficiency Charcoal Absorbers.

It is recognized that radioiodines could be released during some operations, and would be present in the event of a severe reactor accident. In order to reduce the radioiodine releases on these occasions, a separate Emergency Filtration System, incorporating both charcoal adsorbers and HEPA filters, is placed on-line and bypasses the normal filters. The Emergency Filtration System serves the DIF and NRU Reactor and comes on-line automatically in the event of high radiation levels in the exhaust stream (accident conditions) or may be put on-line manually.

The effectiveness of the gaseous effluent management systems is continuously monitored and routinely tested to ensure that releases to the environment remain at small fractions of the site Derived Release Limits.

A.21.4 Radioactive Waste Management Program Documentation

- Management of Radioactive Waste [A-49]
- Management of Non-Radioactive Waste [A-50]
- Management of Radioactive Emissions [A-51]
- Management of Non-Radioactive Emissions [A-52]
- Radiological Effluent and Environmental Monitoring [A-53]

A.21.5 Specific Implementation of Radioactive Waste Management Program

The specific implementation of the program in DIF is done through procedures and Operating Manuals (OM). DIF handling and storage of solid radioactive waste are performed in accordance with approved procedures, which include:

- Operating Manual Calcination;
- Operating Manual Cementation ; and
- Management of Radioactive Waste .

DIF handling, storage and transfer of radiological liquid waste are performed in accordance with approved procedures, which include:

- Plumbing & Drainage System;
- Plumbing & Drainage System;
- Liquid Waste Storage (Fissile HLLW);
- Liquid Waste Storage (ALW); and
- Liquid Waste Storage (LLW).

Due to the operational status of the DIF, very little waste is generated. The waste generated from the facilities mostly consists of low-level waste, e.g. used mop-heads.

A.22 References

[A-1] DIF Quality Assurance Manual, 6400-01913-QAM-004, Revision 10, 2006 October.

[A-2] MMIR Project Quality Assurance Manual, 6400-01913-QAM-003, Revision 9, 2006 October.

[A-3] AECL Management Manual, CW-514000-MAN-002, Revision 1, 2005 April.

[A-4] Overall Quality Assurance Manual, 00-01913-QAM-010, Revision 3, 2003 July.

[A-5] Company-Wide Design Quality Assurance Manual, 00-01913-QAM-005, Revision 2, 2003 August.

[A-6] Company-Wide Construction Quality Assurance Manual, CW-505000-QAM-105, Revision 0, 2007 March.

[A-7] Quality Assurance Manual for Analytical, Scientific, and Design Computer Programs, CW-507230-QAM-102, Revision 0, 2005 April.

[A-8] MMIR Project Improvement Plan, 6400-07110-PGP-001, Revision 0, 2006 May.

[A-9] Emergency Preparedness Program Requirements Manual, EMP-508000-MAN-001, Revision 1, 2005 February.

[A-10] Chalk River Laboratories Site Emergency Plan, CRL-508000-PLA-001, Revision 0, 2003 October.

[A-11] Chalk River Laboratories Site Emergency Plan, CRL-508000-PLA-001, Addendum 1 to Revision 0, 2004 March.

[A-12] Environmental Management System for AECL Sites in Canada, CW-509200-OV-113, Revision 0, 2006 November.

[A-13] Chalk River Laboratories -Action Levels for CRL Air and Liquid Radioactive Effluents, RC-2000-021 -ENV-2.3-SC-02, Revision 0, 2004 April.

[A-14] Derived Release Limits for Airborne and Liquid Effluents from Chalk River Laboratories During Normal Operations, RC-1731, Addendum 1, Revision 0, 1998 November.

[A-15] AECL's Radiation Protection Requirements, RC-2000-633-0, Revision 2, 2000 October.

[A-16] Security of Nuclear Materials Program Manual, 119-508720-MAN-001, Revision 0, 2006 October.

[A-17] Chalk River Laboratories Site Security Report, EPS-14000-RPT-17, Revision 10, 2005 April.

[A-18] Nuclear Materials and Safeguards Management (NM&SM) Compliance Program, 9100-01900-MAN-001, Revision 0, 2005 April.

[A-19] Radioactive Material (RAM) Transportation Compliance Manual, 9200-01900-MAN-001, Revision 0, 2004 July.

[A-20] MAPLE Reactor Commissioning Plan, 6401-92000-CM-001, Revision 5, 2002 March.

[A-21] I-125 Production Facility, 6401-43000-CM-001, Revision 3, 2004 September.

[A-22] New Processing Facility Commissioning Plan, 6403-92000-CM-002, Revision 1, 2002 September.

[A-23] Work Management, 6423-650.1, Revision 15, 2006 July.

[A-24] DIF Maintenance Program, 6400-01500-MN-001, Revision 2, 2005 December.

[A-25] Dedicated Isotope Facilities (DIF) Periodic and Inaugural Inspection Program, 6423-01510-TD-001, Revision 2, 2006 February.

[A-26] DIF In-Service Inspection Program, 6423-01510-TD-002, Revision 0, 2006 May.

[A-27] AECL Document, "Non-Power Reactor Operating Licence- MAPLE 1 and 2 Nuclear Reactors. Licence Number NPROL-62.00/2007.", AECL # 6400-00500-130-001, CNSC # 26-1-62-0-0.

[A-28] AECL Document, "Nuclear Research and Test Establishment Operating Licence – Chalk River Laboratories. Licence Number NRTEOL-01.00/2011", CNSC # 24-1-0-1.

[A-29] MAPLE Reactors Operational Limits and Conditions, 6425-05410-OLC-001, Revision 20, 2007 April.

[A-30] AECL Document, "Nuclear Substance Processing Facility Operating Licence. Licence Number NSPFOL-03.00/2007", AECL # 6403-00500-130-001, CNSC # 24-1-3-0.

[A-31] NPF Operational Limits and Conditions, 6424-05410-OLC-001, Revision 4, 2002 May.

[A-32] NLBU Operating Experience Program Manual, OPEX-514000-MAN-001, Revision 1, 2005 August.

[A-33] Root Cause Analysis Handbook, CW-514300-GL-112, Revision 0, 2005 December.

[A-34] AECL Systematic Approach to Training (SAT), CW-510000-MAN-001, Revision 1, 2005 June.

[A-35] DIF Training Plan, 6423-91000-TPL-001, Revision 1, 2006 May.

[A-36] CNSC, Written and Oral Examination for Certified Operating Personnel at Nuclear Reactor Facilities, Operational Procedure CNSC-ST1, Revision 2.2, 2002 July.

[A-37] System Performance Monitoring Program, 6423-01300-IMP-001, Revision 0, 2005 October.

[A-38] Preparation of System Performance Monitoring Plans, 6423-480.1, Revision 1, 2007 April.

[A-39] Preparation of System Performance Monitoring Reports, 6423-480.2, Revision 0, 2006 May.

[A-40] Guidelines for System Performance Monitoring Field Walkdowns, 6423-480.3, Revision 0, 2006 February.

[A-41] AECL Occupational Safety and Health Program Manual, 00-07010-MAN-001, Revision 1, 1999 November.

[A-42] Foreign Material Exclusion Program in the Dedicated Isotope Facilities, 6423-05500-MAN-001, Revision 2, 2006 March.

[A-43] Preliminary Decommissioning Plan for the Dedicated Isotope Facilities, 6400-01702-DWP-001, Revision 3, 2006 March.

[A-44] Criticality Safety Document for the MAPLE Reactor Building 110 and 111, 6400-03200-AR-005, Revision 5, 2006 November.

[A-45] Criticality Safety Document for the Irradiated Fuel Transfer Flask, 6400-03200-AR-006, Revision 1, 2000 April.

[A-46] Criticality Safety Document for the New Processing Facility, 6403-03200-AR-002, Revision 4, 2001 October.

[A-47] Criticality Safety Document for the Calcine Waste Transfer Flask, 6403-03200-AR-005, Revision 1, 2000 June.

[A-48] Response Plan for Off-Site Transportation Accidents Involving Radioactive Material, EMP-508000-PLA-001, ERP2-1456, Revision 0, 2004 March.

[A-49] Management of Radioactive Waste, RC-2000-021-2.5, Revision 1, 2001 October.

[A-50] Management of Non-Radioactive Waste, RC-2000-021-2.6, Revision 1, 2001 October.

[A-51] Management of Radioactive Emissions, RC-2000-021-2.3, Revision 3, 2005 June.

[A-52] Management of Non-Radioactive Emissions, RC-2000-021-2.4, Revision 2, 2005 June.

[A-53] Radiological Effluent and Environmental Monitoring, RC-2000-021-2.7, Revision 3, 2005 July.

Appendix B

Outline of Licensing Plan

Details on the progress and current status, as well as deliverables that AECL plans to produce to address the outstanding licensing prerequisites identified in the CNSC CMDs [B-1], [B-2], [B-3] are presented in the following sections.

B.1 MAPLE 1 Reactor

B.1.1 Agreement to Resume Nuclear Commissioning

B.1.1.1 Background

The MAPLE Reactors were designed to have a negative Power Coefficient of Reactivity (PCR) to minimize the consequences of abnormal or accident conditions. The PCR represents an integrated effect of a change in power, on the temperature and density induced changes in reactivity associated with the fuel, coolant, moderator, reflector, and structural components. The expected PCR value, based on the MAPLE Final Safety Analysis Report (FSAR), was -0.12 mk/MW ± 0.02 mk/MW. In 2003 June, during Phase C commissioning of the MAPLE 1 Reactor, the PCR value was measured to be about 0.28 ± 0.12 mk/MW. This finding represents a non-conformance with design.

On 2003 July 16, AECL presented, to the Commission, the plan to address the positive PCR issue. A revised plan was developed and submitted to the CNSC staff for information in 2004 October. This plan was developed in conjunction with a revised strategy for resuming the nuclear commissioning of the MAPLE 1 Reactor and it is based on a comprehensive approach to:

- Understand the discrepancy between the PCR value inferred from the measurements and that predicted,
- Re-measure the PCR and confirm the original PCR measurements,
- Identify possible cause(s) of the positive PCR,
- Find the ways to remedy and/or mitigate the positive PCR, and
- Commit to the implementation of a long-term mitigation strategy or specific change if required.

The revised strategy was communicated to the Commission during the public hearings for MAPLE Reactors licence renewal in 2005 and it is based on operation of the MAPLE 1 Reactor at different power levels to resume nuclear commissioning, as follows:

- Complete all prerequisites to exit the Guaranteed Shutdown State (GSS) and operate up to 2 kW (2 kW Milestone).
- Identify and complete all prerequisites to allow the reactor to operate up to 5 MW (5 MW Milestone).
- Identify and complete all prerequisites to allow the reactor to operate up to 8 MW (8 MW Milestone).

Details on the progress and the status of AECL activities undertaken to address the CNSC licensing prerequisites are presented below.

B.1.1.2 Approval to Operate up to 2 kW

All licensing prerequisites for obtaining CNSC approval to operate the MAPLE 1 Reactor up to 2 kW have successfully been completed, and approval to remove the MAPLE 1 Reactor from the reference GSS was granted on 2006 April 28 [B-4].

B.1.1.3 Approval to Operate up to 5 MW

In 2006 June, AECL submitted to the CNSC the formal application to change the operating status of the MAPLE 1 Reactor from operation at 2 kW to operation up to an indicated power level of 5 MW to conduct the first two series of tests to investigate and/or confirm the leading causes of the positive PCR [B-5]. Testing of the PCR started in 2007 March based on the CNSC approval granted on 2007 January 30 [B-6], conditional on acceptable results being obtained during the conduct of one of the test procedures; the regulatory hold was removed and final approval was granted on 2007 March 22 [B-7]. Separate regulatory approvals are required to perform the remaining series of PCR tests. AECL submitted a separate application for approval to perform the third series of tests, which is currently under review by the CNSC staff. Preparatory work to perform the remaining series of PCR tests is underway.

CMD 05-H20 [B-1] does <u>not</u> specify separate acceptance criteria and actions for obtaining approval to operate MAPLE 1 Reactor up to 5 MW. The acceptance criteria included in this section have been derived from those required for obtaining agreement to resume nuclear commissioning and approval to operate above 8 MW, where applicable. They have been included separately to clearly identify the AECL deliverables for this specific AECL milestone.

B.1.1.3.1 Positive Power Coefficient of Reactivity

A) Practical Design and Operations Options

CNSC Acceptance Criterion:
- AECL must demonstrate that all practical options of design and operation have been considered to remedy the positive PCR.

During 2004-2005, the following activities were performed to demonstrate that all practical options of design and operation have been considered to remedy the positive PCR prior to operating the MAPLE 1 Reactor up to 5 MW:

- Assess the positive PCR causes and perform a design options study:

  The Commission was informed of the completion of the assessment of possible causes of positive PCR and the design options study during Day 2 Public Hearing for the MAPLE Reactors licence renewal in 2005.

- Independent calculations to determine PCR (performed by external organization):

  The Idaho National Laboratory (INL) in the U.S. was contracted to perform independent physics and thermalhydraulics simulations to predict the PCR for the MAPLE 1 Reactor initial core. The predicted PCR results were almost identical to those of AECL (-0.06 to -0.12 mk/MW $\pm$ 0.0283 mk/MW) over the 0-10 MW power range under forced convection conditions. The INL independent PCR simulations have fully confirmed AECL predictions thus providing the necessary confidence in the AECL analysis tools, methods and approaches. A summary of the INL work was presented to the Commission during the Day 2 Public Hearing for the MAPLE Reactors licence renewal in 2005. The INL independent calculation task is complete. To address a Commission request for information during Day 2 Public Hearing in 2005, the abstract of the INL report is included in Appendix C.

- Review of AECL work on PCR (performed by external organization):

  The Brookhaven National Laboratory (BNL) in the U.S. was also contracted to perform an independent review of AECL's tests measurements of the PCR during the commissioning tests in 2003. The independent BNL review confirmed the adequacy and rigour in the AECL measurements and analyses. A summary of the BNL work was presented to the Commission during the Day 2 Public Hearing for the MAPLE Reactors licence renewal in 2005. The BNL independent review task is complete. To address a Commission request for information during Day 2 Public Hearing in 2005, a relevant excerpt from the executive summary of the BNL report is included in Appendix D.

During 2006, additional independent calculations and reviews were performed to demonstrate that all practical options of design and operation have been considered to remedy the positive PCR. As these activities were *not* deemed necessary to complete prior to operate the MAPLE 1 Reactor up to 5 MW, the summary of their status is included in Section B.1.2.1.

From the AECL analyses and tests, the leading candidates for the cause of the positive PCR are bowing of the targets and fuel elements (to a much smaller extent), and unexpectedly higher temperatures in the water between the flow tubes and the reflector tank wall. These results were presented to the CNSC staff on 2006 October 6. The independent assessments of the commissioning data and AECL's work on the positive PCR have not identified any other potential causes for the positive PCR than those already identified by AECL. These independent assessments have suggested some PCR tests to investigate the potential causes.

The path forward to resolving these issues involves executing the tests described below.

B) PCR Tests

CNSC Acceptance Criterion:

In order to resume nuclear commissioning for the purpose of re-measuring the PCR, CNSC staff has developed the following criterion:

- AECL must show that any newly proposed commissioning tests are appropriately planned and that such tests can be performed safely and are capable of meeting their intended objectives.

To address the above CNSC acceptance criterion, AECL performed and planned to perform the following PCR-related tests, as summarized below:

- In-Reactor tests (to re-measure the PCR);
- Out-of-Reactor tests (to support the in-reactor tests).

B.1) In-Reactor Tests

As part of the PCR activities, as well as to address the above CNSC acceptance criterion, a 5 MW PCR Test Plan [B-8] was developed and submitted to CNSC outlining the steps to be taken to obtain additional data to assist in resolving the non-conformance caused by the positive PCR. Regulatory approval for use of the plan was obtained on 2007 January 30, in accordance with Licence Condition 9.1 of the MAPLE Operating Licence.

The change in the operating status of the MAPLE 1 Reactor from 2 kW up to 5 MW, as well as the expected duration for operation up to an indicated power level of 5 MW, were described in the 5 MW Operating Plan [B-9], which was submitted to the CNSC as accompanying document of the 5 MW PCR Test Plan.

The current logic of the planned tests leads to the following test subdivisions:

- <u>Series 100 Tests</u>: Re-measure the PCR for start-up core at reactor power of 2 MW and calibrate reactor thermal power at 3 MW.

  The tests, supported by the 5 MW safety case [B-10] and detailed test procedures, were performed during 2007 March and the acceptance criteria and expected results were met. The PCR value measured at 1.03 MW was 0.282 ± 0.038 mk/MW, which is in good agreement with the measurements performed in 2003.

- <u>Series 200 Tests</u>: Re-measure the PCR for start-up core at reactor power of 5 MW, with and without covers on the irradiation sites to determine the contribution to positive PCR from stagnant water in the reflector tank irradiation sites, and calibrate reactor thermal power at 5 MW.

  The tests, supported by the 5 MW safety case [B-10] and detailed test procedures, were performed during 2007 March-April and the acceptance criteria and expected results were met. The PCR value measured at 2.48 MW was 0.271 ± 0.030 mk/MW, which is in good agreement with the measurements performed in 2003. The PCR values measured for a power range between 0.82 MW and 4.15 MW to determine the effect of the irradiation sites indicated that there is no apparent impact on the PCR.

- Series 300 Tests: Measure the PCR for a Low Enriched Uranium (LEU) core, without Highly Enriched Uranium (HEU) targets, at reactor power of 5 MW to determine the contribution to positive PCR from HEU targets. The safety case and the detailed test procedures supporting the 300 series testing have been submitted to the CNSC, and are currently under CNSC staff review.
- Series 400Tests:
  - 400A: Measure the PCR for LEU core, without HEU targets, and with modified flow tubes for an upward moderator water flow, at reactor power of 5 MW to determine the contribution to positive PCR from moderator water heating. The PCR is to be determined by the tests.
  - 400A-1: Measure the PCR value after replacing the LEU driver fuel bundles with modified LEU driver fuel bundles to prevent binding of the LEU fuel pins in the top plate, for an LEU core, without HEU targets, and with modified flow tubes for an upward moderator flow, at a reactor power of 5 MW, to determine the contribution to positive PCR from binding the LEU driver fuel pins in the driver fuel bundle top plate. The PCR is to be determined by the tests.
  - 400B: Measure the PCR for start-up core with HEU targets restrained in a modified target cluster holder and with modified flow tubes for an upward moderator water flow, at reactor power of 5 MW to confirm the PCR value for isotope production configuration. The PCR is to be determined by the tests.

  The safety cases supporting the 400 series and associated detailed test procedures are under development.

B.2) Out-of-Reactor Tests

AECL has made a considerable effort to assess all aspects required to determine the effects of target bowing on the MAPLE initial core flux gradients. Restraints (e.g. modified cluster holder) are being manufactured. The Critical Heat Flux (CHF) tests required for the 5 MW PCR testing, and stress-deflection tests were completed.

Consideration has also been given to the possibility of target rotation. Such a test was performed in the original Full-Scale Hydraulic Test Rig (FSHTR) in 2006 April at the AECL Sheridan Park Laboratory (CPFS). The results of the tests showed minor rotations. A modified FSHTR with a fluted reflector wall is being manufactured for further testing.

By the time that the Series 400 tests will be ready to start, gap flow measurements in the FSHTR and the results of 3D Computational Fluid Dynamic calculations with FLUENT will be available. These measurements and calculations will be made with the reference core configuration and with a set of modified flow tubes to determine the changes to the gap flow when more water is introduced to the gaps.

Tests using the TCTR at AECL are in progress. The TCTR allows for flow visualization, Laser Doppler Anemometry (LDA) gap flow measurements and FLUENT validation.

In addition, Post Irradiation Examination (PIE) of the irradiated targets (2003-Phase C commissioning) to learn about the flux gradients is in progress.

C) Safety Case

> ***CNSC Acceptance Criteria:***
>
> In order to resume nuclear commissioning for the purpose of re-measuring the PCR, CNSC staff has developed the following criteria:
>
> - AECL must demonstrate adequate trip coverage for the commissioning program for the MAPLE reactors in light of the positive PCR (relying on the rules in the FSAR);
> - AECL must demonstrate that the safety case continues to meet the acceptance criteria of no sheath failure and avoidance of superprompt criticality for all design basis events for all operating core states.

As part of the PCR-related activities, as well as to address the above CNSC acceptance criteria and CNSC's separate request for a consolidated safety case to support the MAPLE 1 Reactor change in the operating state, AECL submitted a safety case to support operation and testing at reactor power up to 5 MW [B-10]. The 5 MW safety case is an impact assessment on the FSAR, taking into account phenomena postulated to be responsible for causing the positive PCR. The safety case provides assurance that consequences remain acceptable should an accident occur during operation of the MAPLE Reactor at power levels up to 5 MW indicated reactor power. As previously mentioned, the 5 MW safety case also supports the Series 100 and 200 PCR tests.

Separate impact assessments on the 5 MW safety case were submitted to support the Series 300 PCR tests [B-11], [B-12].

Separate impact assessments on the 5 MW safety case will be produced to support the Series 400 PCR tests to identify and mitigate or remedy the causes for the positive PCR.

In addition to the 5 MW safety case, several supporting analyses (physics, thermalhydraulics, mechanics, chemistry) were performed to support and assess mitigating or remedial potential options to resolve the positive PCR.

B.1.1.3.2 Operational Readiness

> ***CNSC Acceptance Criterion:***
>
> In order to resume nuclear commissioning for the purpose of re-measuring the PCR, CNSC staff has developed the following criterion:
>
> - AECL must demonstrate that an adequate number of trained staff, and that systems and equipment, are available for the resumption of commissioning.

To demonstrate that adequate staff, systems and equipment are available to change the operating status of the MAPLE 1 Reactor from operation at 2 kW to operation up to an indicated power level of 5 MW, AECL performed a number of activities and submitted a series of deliverables as summarized below.

AECL has submitted Revision 18 of the *MAPLE Reactors Operational Limits and Conditions* [B-13]. The OLC document provides evidence of evaluation of the licensed activity specific to MAPLE 1 operation up to an indicated (nominal) power of 5 MW. Regulatory approval was granted on 2007 January 30, in accordance with Licence Condition 1.2 of the MAPLE Operating Licence. It is noted that this deliverable supports the PCR testing under Series 100 and 200 only, and further revisions are required to be submitted to support Series 300 and 400 respectively. Revision 20 of the *MAPLE Reactors Operational Limits and Conditions,* supporting the Series 300 PCR tests, has been recently approved by the CNSC.

A comprehensive system status review (SSR) was completed and documented for 14 safety and safety-related systems. This review provided evidence that the MAPLE 1 Reactor is safe to operate up to 5 MW to perform PCR tests. AECL provided a walkthrough of the three reports (Control Absorber Rods, Fire Protection System, and Reflector Dump System) to the CNSC staff on 2006 November 9. For the remaining systems, a separate review was performed and documented, along with the dispositions to the remaining Non-Conformance Reports (NCR), Field Change Notices (FCN), Change Requests (CR), and Cause Assessments (CA). Based on these reports, an operating and maintenance system readiness review was completed prior to issue of the Operational Readiness Declaration by the Facility Authority.

A Licensing Application was submitted to request CNSC approval to install the revised Reactor Computer Control System (RCCS) baseline software required for operating the MAPLE 1 Reactor up to 5 MW nominal power. Regulatory approval was granted on 2007 January 30, in accordance with Licence Condition 1.2 of the MAPLE Operating Licence.

Following the CNSC site inspections in 2004 November and December, a number of issues were raised by the CNSC staff regarding the seismic qualification of the design changes introduced in *Modification of SS1, SS2 and RCCS to Address the Power Coefficient Issue* [B-14]. All AECL commitments to address the seismic qualification issues have been completed.

An Operational Readiness Declaration (ORD) was issued to support AECL's position to 5 MW Operational Readiness. As previously mentioned, CNSC approvals were granted on 2007 January 30, and 2007 March 22, to operate the MAPLE 1 Reactor up to 5 MW to perform Series 100 and 200 PCR tests.

To obtain further CNSC approvals to perform the remaining PCR tests and to close the CNSC acceptance criterion for this specific AECL milestone, AECL plans to submit to the CNSC the following remaining outstanding deliverables:

- Documentation showing the objective evidence on adequate number of trained staff, and available systems and equipment to perform the Series 400 PCR tests through the implementation of the Readiness for Service process.
- Licensing Applications to request CNSC approval to perform the Series 400 PCR tests.

- Revised *MAPLE Reactors Operational Limits and Conditions*, supporting Series 400 PCR tests (to be determined).

B.1.1.3.3 Commissioning Demonstration of Design Intent

CNSC Acceptance Criterion:

The criterion for acceptable resolution of this issue is as follows:

- AECL must demonstrate that systems and equipment perform according to their safety, functional, performance or control specifications using objective evidence obtained from routine operational tests and inspections (i.e., not from commissioning tests).

To demonstrate that systems and equipment perform according to their safety, functional, performance or control specifications using objective evidence obtained from routine operational tests and inspections (i.e., not from commissioning tests), AECL developed a process for assessment of whether the Phase A Commissioning performed on MAPLE units has met the design intent. This process, described in [B-15], was to perform an independent evaluation of the completeness of the MAPLE Reactors commissioning program for each safety system or safety-related system. Twenty-nine safety and safety related systems in MAPLE 1 were assessed and Commissioning Specifications and Objectives (CSOs) and Commissioning Demonstration of Design Intent (CDDI) documentation was produced for the assessed systems by 2006 May, following the process described in [B-15] and confirmed by the CNSC [B-16]. The assessment resulted in NCRs being raised to address commissioning deficiencies in 16 of the assessed systems.

All commissioning work required to address the program findings based on the outcome of the CDDI assessment prior to raising the power of the MAPLE 1 Reactor above 2 kW is complete.

All commissioning work which requires the MAPLE 1 Reactor to operate at power levels above 2 kW and within the parameters of the PCR test plan is underway, as required to address the program findings based on the outcome of the CDDI assessment, and will be completed by the end of the PCR testing.

To demonstrate that systems and equipment perform according to their safety, functional, performance or control specifications using objective evidence obtained from routine operational tests and inspections (i.e., not from commissioning tests), AECL has submitted:

- CSO and CDDI documents submitted to the CNSC to address the acceptance criterion.
- Detailed procedures to perform the CDDI work as identified in the CDDI documents.

B.1.1.3.4 Computer Code Validation

CNSC Acceptance Criterion:

The criterion for acceptable resolution of this issue is as follows:

- AECL must demonstrate that the validation work has not shown any deviations that would have a negative impact on the FSAR (based on commissioning results up to 8 MW). As explained in Section 4.1.1.1, the PCR is currently an exception.
- The validation results quantify the simulation error (systematic departure from reality) in key output parameters over the range of phenomena and parameters for reactor operating conditions and geometries prototypical of the intended application.

The safety analysis in the MAPLE safety report has been performed using a set of computer codes and methodologies that are in general use in the Canadian nuclear industry. Over the last five years, these codes have been validated more rigorously as part of an AECL program in response to CNSC Generic Action Items. Beyond this generic validation, there is a need to validate these tools for conditions that more closely reflect the parameter ranges seen in the MAPLE accident analysis.

For operating up to 5 MW, no specific computer code validation exercises were required to be performed, and this issue is considered as covered by the 5 MW safety case.

B.1.1.4 Approval for Interim Operation at 5 MW and up to 8 MW

AECL intends to seek CNSC approval to allow operation of the MAPLE 1 Reactor at 5 MW and up to 8 MW to irradiate targets for NPF Active Commissioning and irradiate xenon gas for MIPF Nuclear Commissioning, pending the outcome of the PCR re-measurement tests up to 5 MW.

The CNSC CMD 05-H20 [B-1] does not specify separate acceptance criteria and actions for obtaining approval to operate MAPLE 1 Reactor at 5 MW and up to 8 MW for the abovementioned purposes. The acceptance criteria and actions included in this section have been derived from those required for obtaining approval to operate above 8 MW, where applicable. They have been included separately to clearly identify the AECL deliverables for this specific AECL milestone.

B.1.1.4.1 Positive Power Coefficient of Reactivity

CNSC Acceptance Criteria:

In order to resume nuclear commissioning for the purpose of re-measuring the PCR, CNSC staff has developed the following criteria:

- AECL must demonstrate adequate trip coverage for the commissioning program for the MAPLE Reactors in light of the positive PCR (relying on the rules in the FSAR).
- AECL must demonstrate that the safety case continues to meet the acceptance criteria of no sheath failure and avoidance of superprompt criticality for all design basis events for all operating core state.
- AECL must show that any newly proposed commissioning tests are appropriately planned and that such tests can be performed safely and are capable of meeting their intended objectives.

To demonstrate adequate trip coverage and that the safety case continues to meet the acceptance criteria of no sheath failure and avoidance of superprompt criticality for all design basis events for all operating core state, AECL plans to submit the following:

- Safety assessment to support operation at 5 MW to irradiate targets for NPF Active Commissioning and irradiate xenon gas for MIPF Nuclear Commissioning.
- Safety assessment to support operation up to 8 MW to irradiate targets for NPF Active Commissioning and irradiate xenon gas for MIPF Nuclear Commissioning and In-Service operation.

To show that any newly proposed commissioning tests are appropriately planned and that such tests can be performed safely and are capable of meeting their intended objectives, AECL plans to submit the following:

- Revised *MAPLE Reactor Commissioning Plan*.
- Operating plan to support operation of the MAPLE 1 Reactor at 5 MW to irradiate targets for NPF Active Commissioning and irradiate xenon gas for MIPF Nuclear Commissioning.
- Operating plan to support operation of the MAPLE 1 Reactor up to 8 MW to irradiate targets for NPF Active Commissioning and irradiate xenon gas for MIPF Nuclear Commissioning and In-Service operation.
- Test plan to support testing at reactor power up to 8 MW.
- Detailed test procedures to support testing at reactor power up to 8 MW.

B.1.1.4.2 Operational Readiness

> ***CNSC Acceptance Criterion:***
>
> In order to resume nuclear commissioning for the purpose of re-measuring the PCR, CNSC staff has developed the following criterion:
>
> - AECL must demonstrate that an adequate number of trained staff, and that systems and equipment, are available for the resumption of commissioning.

To demonstrate that adequate staff, and systems and equipment are available to operate the MAPLE 1 Reactor at 5 MW and up to 8 MW to irradiate targets, AECL plans to submit the following:

- Revised *MAPLE Reactors Operational Limits and Conditions*.
- Documentation showing the objective evidence on adequate number of trained staff, and available systems and equipment through the implementation of the Readiness for Service process.
- Documentation showing the objective evidence of completion of the Project Improvement Plan Phase 2 activities, in accordance with the latest revision of the plan.

B.1.2 In-Service Operation at 8 MW

A revised strategy is currently considered to enable the MAPLE 1 Reactor and NPF to begin routine production of radioisotopes prior to completion of nuclear commissioning of the MAPLE 1 Reactor up to 10 MW. This strategy, which includes placing the MAPLE 1 Reactor "in-service" at 8 MW, allows for the possibility that a resolution to the positive PCR issue may not be fully implemented and demonstrated by 2008 October 31.

To obtain regulatory acceptance of MAPLE 1 for "in-service" operation at 8 MW and ensure compliance with CNSC requirements for "In-Service Operation", AECL will address the acceptance criteria currently identified in Sections 4.1.2 and 4.1.3 of CMD 05-H20 [B-1], as detailed below.

B.1.2.1 Positive Power Coefficient of Reactivity

A) Practical Design and Operations Options

> ***CNSC Acceptance Criteria:***
>
> The criterion for CNSC staff's acceptance of resolution of the positive power coefficient issue is as follows:
>
> - AECL must demonstrate that all practical options of design and operation have been considered to remedy the positive PCR.

Further to the summary presented in Section B.1.1.3.1, the activities that were performed during 2006 or are currently in progress to demonstrate that all practical options of design and operation have been considered to remedy the positive PCR, are presented below.

A.1) Independent Calculations to Determine PCR (Additional Work)

As part of the continuing efforts related to the MAPLE 1 PCR, AECL requested additional independent calculations to be performed by INL. The following tasks were assigned to INL for the year of 2006:

- The physics sensitivity studies for the MAPLE Reactor nominal core and that with dimensional changes due to mechanical tolerances;
- The assessment of uncertainty in the predicted PCR value;
- The prediction of the impact on the PCR of the fuel burnup during the core transition from the initial core to the equilibrium core;
- The PCR prediction for a modified MAPLE 1 Reactor core in which 36-element LEU driver fuel bundles have been replaced with the HEU targets;
- The PCR prediction for the MAPLE 1 initial reactor core due to targets and driver fuel bowing, applying the integrated analysis that includes neutronics, fluid dynamics, heat transfer, heat conduction and mechanical behaviour to assess the impact of target and driver fuel bowing on the PCR (to address a recommendation by BNL from their report in 2005); and
- The prediction of gap water flow using 3-D simulations for the revised PCR predictions as well as for the possibility of voiding in the moderator and the reflector.

The reactor physics sensitivity studies, documented in [B-17], were completed in 2006 April and submitted to the CNSC staff for information on 2006 July 12. These studies consisted primarily of computer model simulations of the MAPLE Reactor core:

- One sensitivity study was performed to better understand the MAPLE 1 Reactor core reactivity response relative to material temperature and fluid density changes that would encompass MAPLE Reactor temperature conditions for forced convection power conditions up to 10 MW. The results indicated that there was no impact on the PCR compared with the model developed by INL for performing the independent PCR simulations in 2005.
- Another sensitivity study was performed to identify the individual regions in the initial MAPLE core that could induce positive reactivity with an increase in the temperature in that region. For this study, the MAPLE 1 core was divided into 34 separate regions. Of these 34 regions, seven were identified as to induce positive reactivity. These seven regions included the isothermal core, Highly Enriched Uranium fuel, target coolant, gap water, depleted uranium bundle coolant, and light water in all test facilities. Of these seven regions, the gap water was calculated to have the largest positive PCR component (+0.028 mk/MW maximum) and also determined to have the greatest potential to be significantly larger in positive magnitude due to the uncertainty in the flow. Detailed 3-D gap water flow modelling is further needed to assess the impact.

- As part of the sensitivity studies, an assessment of PCR sensitivity to manufacturing and assembly tolerances was also performed. The results showed that the predicted PCR value is insensitive to variations in dimensions.

The PCR prediction for a modified MAPLE 1 Reactor core in which the HEU targets have been replaced with 36-element LEU driver fuel bundles was another task completed by INL in 2006. The INL study [B-18] concluded that in case of forced circulation (within 2.5-10 MW) and natural circulations at 0.2 MW, the PCR results are statistically the same as for the reference case (i.e., for the core with targets) while for natural circulation at 0.5 MW the PCR results are more negative than for the reference case, thus not causing any concern.

The remaining analyses are planned to complete during 2007.

A.2) Review of AECL Work on PCR (Additional Work)

As part of the continuing efforts related to the MAPLE 1 PCR, AECL also requested an additional review of the available commissioning data. BNL and INVAP (Argentina) were contracted to perform independent reviews of the Phase B (isothermal) and the Phase C commissioning (natural and forced circulation) test data, and of the corresponding predictions (AECL and INL data) to define and quantitatively support the identification of the positive PCR causes. The review of the commissioning tests was focused on three types of experiments performed at the MAPLE 1 Reactor:

- Isothermal tests;
- Tests at power levels up to 580 kW with natural circulation; and,
- Tests at various power levels up to 8 MW with forced flow.

The BNL review [B-19] was completed in 2006 October and submitted to the CNSC staff for information on 2006 October 24. The conclusions of the BNL review are as follows:

- All conclusions from the 2005 BNL review remain valid. In particular, target bowing is the most likely contributor to the positive PCR and a steep power gradient in the initial core – the cause of the target bowing. It explains the core behavior during the commissioning tests.
- Follow the suggested sequence of tests given in the 2005 review report to improve understanding and potentially remedy the situation.
- The more homogenous core the less impact on target bowing and positive PCR.

No new phenomena have been identified to contribute to the positive PCR.

The INVAP review has concluded that the MAPLE 1 Reactor core presents a strong heterogeneity in power distribution (core enrichment varies from depleted uranium to high enrichment) and in geometry (many different assemblies). Therefore, its analysis is very complex and difficult, and then predicted PCR values are very small and sensitive to chosen assumptions, methodologies and calculation codes and nuclear libraries. The obtained PCR results are statistically similar to those of AECL and INL.

A.3) Summary

Based on the results from the re-measurement of the PCR at 5 MW, AECL will define and commit to implement a PCR mitigation strategy or specific change, if a practical one (technically and economically feasible) exists. The measures defined to resolve the positive PCR will be then implemented in the MAPLE Reactors.

B) Safety Case

CNSC Acceptance Criteria:

The criterion for CNSC staff's acceptance of resolution of the positive power coefficient issue is as follows:

- AECL must demonstrate that the safety case continues to meet the acceptance criteria of no sheath failure and avoidance of superprompt criticality for all design basis events for all operating core states.

To demonstrate that the safety case continues to meet the acceptance criteria of no sheath failure and avoidance of superprompt criticality for all design basis events for all operating core states, AECL plans to submit:

- Safety case to support the licensing application to request CNSC approval to install the design changes to address the positive PCR issue.

B.1.2.2 Commissioning Demonstration of Design Intent

***CNSC Acceptance Criterion*:**

The criterion for acceptable resolution of this issue is as follows:

- AECL must demonstrate that systems and equipment perform according to their safety, functional, performance or control specifications using objective evidence obtained from routine operational tests and inspections (i.e., not from commissioning tests).

To close the CNSC acceptance criterion, AECL plans to submit to the CNSC the following deliverables, in addition to those submitted in support of this acceptance criterion as detailed in Section B.1.1.3.3:

- Commissioning Reports for all commissioning tests performed as part of the CDDI work.
- Licensing submission to request closure of the CDDI acceptance criterion.

B.1.2.3 Computer Code Validation

CNSC Acceptance Criteria:

The criteria for CNSC staff's acceptance of code validation for the MAPLE 1, 8 MW hold point condition, are as follows:

- AECL must demonstrate that the validation work has not shown any deviations that would have a negative impact on the FSAR (based on commissioning results up to 8 MW). The PCR is currently an exception.
- The validation results quantify the simulation error (systematic departure from reality) in key output parameters over the range of phenomena and parameters for reactor operating conditions and geometries prototypical of the intended application.

To address the computer code validation acceptance criteria, AECL will submit the following:

- Assessment of Code Validation Results from MAPLE 1 Commissioning up to 8 MW and Impact on FSAR.
- Validation Manual, after the code validation exercises for the MAPLE 1 Phase C commissioning tests above 8 MW are completed.

B.1.2.4 Safety System 1 Low Power Commissioning Completion Assurance

***CNSC Acceptance Criterion*:**

AECL must demonstrate that the deployment of three SORs results in normal subcritical margin, defined as $k_{eff}<0.965$, and that deployment of any two out of three SORs results in a stable subcritical margin, defined as $k_{eff}<0.99$.

To demonstrate that the deployment of three SORs results in normal subcritical margin, defined as $k_{eff}<0.965$, and that deployment of any two out of three SORs results in a stable subcritical margin, defined as $k_{eff}<0.99$:

AECL has submitted the following:

- *Measurement and Calculation of Subcritical k-Values in MAPLE* [B-20].
- *Comparison of MAPLE 1 SOR and CAR Reactivity Worth Measurements to MCNP Calculations* [B-21].

There are no further outstanding deliverables to address the CNSC acceptance criterion.

B.1.2.5 High Power Commissioning Completion Assurance

***CNSC Acceptance Criterion*:**

The criterion for acceptance of AECL's high power commissioning completion assurance is as follows:

- AECL must demonstrate, through the availability of objective evidence, that MAPLE 1 high power nuclear commissioning up to 8 MW has been successfully completed.

To demonstrate, through the availability of objective evidence, that MAPLE 1 high power nuclear commissioning up to 8 MW has been successfully completed, AECL will submit:

- Report to describe the results from the PCR testing performed up to 8 MW to close the NCRs related to PCR and radiation fields.
- Commissioning Report(s) for commissioning tests up to 8 MW.
- Signed MAPLE 1 Phase C Commissioning Completion Assurance Certificate (up to 8 MW).
- Licensing Application to request CNSC agreement to declare the MAPLE 1 Reactor available for in-service operation at 8 MW.

B.1.2.6 Baseline and Residual Regulatory Activities

***CNSC Acceptance Criteria*:**

The criteria for CNSC staff's acceptance of AECL's declaration that the MAPLE 1 Reactor is available to be placed in-service are as follows:

- AECL must modify its Periodic Inspection Program documentation to be fully compliant with documentation requirements.
- AECL must update the Operational Limits and Conditions document to reflect CNSC staff comments and incorporate lessons learned and knowledge gained from commissioning.
- AECL must establish, document, and implement a document baseline.
- AECL must update the Final Safety Analysis Report once commissioning has been completed to incorporate feedback from the commissioning process.

To address the baseline and residual regulatory acceptance criteria, AECL submitted the following deliverables:

- Revised version of *Dedicated Isotope Facilities (DIF) Periodic and Inaugural Inspection Program* [B-22] to address CNSC staff comments.
- The *DIF Operations Baseline* was issued and submitted to the CNSC for information in 2005 October.
- Revised Volume 1 of the *MAPLE Final Safety Analysis Report (FSAR) for the MAPLE Reactors* [B-23], which includes revisions to Chapters 1 to 15 and 18 to 20 (except Sections 5.10 and 5.11), was issued and submitted to the CNSC at the end of

2006 April. Sections 5.10 and 5.11 will be affected by the PCR work done at INL and BNL, and the results of the PCR tests at 5 MW. Once the tests are complete and have been analyzed, the extent of the revisions will be reconsidered, and a schedule showing the target dates for these sections will be issued and submitted to the CNSC.

To close the CNSC acceptance criteria, AECL plans to submit the following:

- Revised version of *MAPLE Reactors Operational Limits and Conditions* to reflect CNSC staff comments and incorporate lessons learned and knowledge gained from commissioning.
- Updated document baseline to support ongoing operation of MAPLE 1. This will ensure proper document configuration control.
- Revised version of *Final Safety Analysis Report for MAPLE Reactors* and Protected Appendix to Final Safety Analysis Report for MAPLE Reactors. A revised schedule for production of the revisions to the chapters of the FSAR will be provided.

B.1.3 Approval to Operate Above 8 MW

Operation of the MAPLE 1 Reactor for the first time above 8 MW will require approval of the Commission or a person authorized by the Commission, as per Licence Condition 9.2 (a) of the MAPLE 1 and 2 Reactors Operating Licence NPROL-62.00/2007. This approval will be granted on the basis that all prerequisites described in Section 4.1.2 of [B-1] have been completed.

B.1.4 Acceptance of MAPLE 1 for In-Service Operation above 8 MW

Declaration of the MAPLE 1 Reactor for In-Service Operation above 8 MW will require approval of the Commission or a person authorized by the Commission, as per Licence Condition 9.2 (a) of the MAPLE 1 and 2 Reactors Operating Licence NPROL-62.00/2007. This approval will be granted on the basis that all prerequisites described in Section 4.1.3 of [B-1] have been completed.

B.2 MAPLE 2 Reactor

B.2.1 Approval to Restart

***CNSC Acceptance Criterion*:**

The acceptance criterion for CNSC approval to restart the MAPLE 2 Reactor is as follows:

- AECL must install redesigned target cluster holders to resolve the issue of sticking target cluster holders.

AECL formally requested in 2006 January approval by the Commission or a person authorized by the Commission to install the redesigned cluster holders. Approval was granted in 2006 May [B-24] for installation of the redesigned cluster holders in MAPLE 1 Reactor.

To address the CNSC acceptance criterion, AECL will submit the following deliverables:

- Licensing Application to request installation of the redesigned cluster holders in the MAPLE 2 Reactor.
- Completion Assurance Report, demonstrating that all prerequisites specified in Sections 4.1.1 and 4.2.1 of CMD 05-H20 [B-1] have been met, as per Licence Condition 10.2 of the Operating Licence NPROL-62.00/2007.
- Licensing Application to request CNSC agreement to remove the MAPLE 2 Reactor from the approved reference Guaranteed Shutdown State, as per Licence Condition 10.2 of the Operating Licence NPROL-62.00/2007.

B.2.2 Approval to Operate Above 2 kW

***CNSC Acceptance Criterion*:**

The acceptance criterion for CNSC approval to operate the MAPLE 2 Reactor above 2 kW for the first time is as follows:

- AECL must demonstrate, through the availability of objective evidence, that low power nuclear commissioning up to 2 kW has been successfully completed. This includes confirmation that the design change to address the stuck target holder has been successfully implemented.

To address the CNSC acceptance criterion, AECL will submit the following:

- Commissioning Reports for commissioning tests up to 2 kW.
- Signed Interim MAPLE 2 Phase B Commissioning Completion Assurance Certificate.
- Licensing Application to request CNSC approval to operate the MAPLE 2 Reactor above 2 kW for the first time, as per Licence Condition 9.2(b) of the Operating Licence NPROL-62.00/2007.

B.2.3 Approval to Operate Above 500 kW

***CNSC Acceptance Criterion*:**

The acceptance criterion for CNSC approval to operate the MAPLE 2 Reactor above 500 kW for the first time is as follows:

- AECL must demonstrate, through the availability of objective evidence, that MAPLE 2 low power nuclear commissioning up to 500 kW has been successfully completed.

To address the CNSC acceptance criterion, AECL will submit the following:

- Commissioning Reports for commissioning tests up to 500 kW.
- Signed MAPLE 2 Phase B Commissioning Completion Assurance Certificate.

- Licensing Application to request CNSC approval to operate the MAPLE 2 Reactor above 500 kW for the first time, as per Licence Condition 9.2 (c) of the Operating Licence NPROL-62.00/2007.

B.2.4 Approval for Interim Operation at 8 MW

Interim operation of the MAPLE 2 Reactor at 8 MW to irradiate targets will require CNSC approval. To obtain regulatory approval, all prerequisites described in Section B.1.1.4 (for MAPLE 1 Reactor) will be completed for MAPLE 2 Reactor.

B.2.5 Acceptance of MAPLE 2 for In-Service Operation at 8 MW

***CNSC Acceptance Criterion*:**

- AECL must demonstrate, through the availability of objective evidence, that MAPLE 2 high power nuclear commissioning up to 8 MW has been successfully completed.

To address the CNSC acceptance criterion, AECL will submit the following:

- Commissioning Reports for commissioning tests up to 8 MW.
- Signed MAPLE 2 Phase C Commissioning Completion Assurance Certificate.
- Document baseline to support the ongoing operation of MAPLE 2.
- Licensing Application to request CNSC agreement to place the MAPLE 2 Reactor in-service at 8 MW.

B.2.6 Approval to Operate Above 8 MW

Operation of the MAPLE 2 Reactor for the first time above 8 MW will require approval of the Commission or a person authorized by the Commission, as per Licence Condition 9.2 (d) of the MAPLE 1 and 2 Reactors Operating Licence NPROL-62.00/2007. This approval will be granted on the basis that all prerequisites described in Section 4.2.4 of [B-1] have been completed.

B.2.7 Acceptance of MAPLE 2 for In-Service Operation above 8 MW

Declaration of the MAPLE 2 Reactor for In-Service Operation above 8 MW will require approval of the Commission or a person authorized by the Commission, as per Licence Condition 9.2 (d) of the MAPLE 1 and 2 Reactors Operating Licence NPROL-62.00/2007. This approval will be granted on the basis that all prerequisites described in Section 4.2.5 of [B-1] have been completed.

B.3 MAPLE 1 Iodine Production Facility

B.3.1 Approval of Nuclear Commissioning

B.3.1.1 Commissioning

***CNSC Acceptance Criteria*:**

The acceptance criteria for CNSC approval of nuclear commissioning of the MIPF are as follows:

- AECL must demonstrate that the commissioning tests proposed are appropriately planned and that tests can be performed safely and are capable of meeting their intended objectives.
- AECL must demonstrate, through the availability of objective evidence, that non-nuclear commissioning has been successfully completed.

To demonstrate that the commissioning tests proposed are appropriately planned and that tests can be performed safely and are capable of meeting their intended objectives:

AECL has submitted the following:

- Revised *MAPLE Reactor Commissioning Plan* [B-25]. The MAPLE commissioning plan was revised to reference and include the MIPF Commissioning Plan [B-26].

To close the CNSC acceptance criterion, AECL plans to submit the following:

- Revised *I-125 Production Facility Commissioning Manual*. The plan will be revised to make it consistent with the MAPLE commissioning plan, if required.

To demonstrate through the availability of objective evidence that non-nuclear commissioning has been successfully completed, AECL plans to submit the following:

- Commissioning Reports for non-nuclear commissioning tests.
- Signed MAPLE 1 Iodine Production Facility Commissioning Completion Assurance Certificate for non-nuclear commissioning.
- Licensing Application to request CNSC approval to introduce xenon gas into the MIPF for nuclear commissioning of the facility, as per Licence Condition 10.1 of the Operating Licence NPROL-62.00/2007.

B.3.1.2 Training

***CNSC Acceptance Criteria*:**
The acceptance criteria for CNSC approval of nuclear commissioning in the MIPF are as follows:
- AECL must establish, document and implement a program for refresher and continuing training that meets the requirements of AECL's Systematic Approach to Training.
- AECL must demonstrate that it has qualified staff (through classroom training and OJT) to operate the MIPF.

The classroom training program for the MIPF has been established, documented, and is in routine use. The on-the-job (OJT) elements have been defined. Pilot testing and ensuing operator training to be conducted as required to meet the requirements of Phase B MIPF commissioning prior to commencement of such.

To address the CNSC acceptance criteria, AECL plans to submit the following:

- A letter to confirm that initial and refresher training (as required) for the MIPF has been completed for specified staff.

B.3.2 Acceptance of the MIPF for In-Service Operation

***CNSC Acceptance Criterion*:**
The acceptance criterion for CNSC acceptance of AECL's declaration that the MAPLE 1 Iodine Production Facility is available to be placed in-service is as follows:
- AECL must demonstrate, through the availability of objective evidence, that nuclear commissioning has been successfully completed.

To demonstrate (through the availability of objective evidence) that nuclear commissioning has been successfully completed, AECL plans to submit the following:

- Commissioning Reports for commissioning tests.
- Signed MAPLE 1 Iodine Production Facility Commissioning Completion Assurance Certificate for nuclear commissioning.
- Licensing Application to request CNSC agreement to place the MIPF in-service.

B.4 New Processing Facility

B.4.1 Confirmation of Readiness for Active Commissioning

> ***CNSC Acceptance Criteria*:**
>
> The acceptance criteria for CNSC staff to confirm that the New Processing Facility is ready for active commissioning are as follows:
>
> - AECL must demonstrate that it has successfully completed its Operational Readiness Review Workplan.
> - AECL must modify the NPF building Emergency Procedures to reflect the evacuation requirements under certain loss of ventilation accidents.
> - AECL must demonstrate that it has implemented the seismic walkdown findings for the dissolver/decladder and the Central Off Gas Delay System.
> - AECL must complete a backup firewater cooling test of the Closed Loop Cooling System.
> - AECL must demonstrate that all outstanding work designated as ‘required for active commissioning’, that was noted in the completion assurances and nonconformance reports (including any NCRs raised after 2003 May 30) is completed.
> - AECL must demonstrate that items from the NIIT report, which AECL designated as essential for the start of Phase B Commissioning, have been successfully completed.
> - AECL must have completed the procurement, installation and commissioning of a small diesel generator to power the Closed Loop Cooling System and the charger for the Uninterruptible Power Supply when normal Class III power supplies are lost.

To address the CNSC acceptance criterion on the Closed Loop Cooling System (CLCS), AECL has submitted a licensing application [B-27] to install the addition of firewater for emergency backup cooling in a once-through mode, connected between the Firewater System and CLCS to facilitate the supply of backup cooling water. The application is currently under CNSC staff review.

To address the CNSC acceptance criterion regarding the outstanding work designated as ‘required for active commissioning’, systematic reviews have been carried out for various NPF systems, and specific recommendations for each system have been documented in HAZOP (**HAZ**ard and **OP**erability) and “What If” reports[2]. AECL submitted the HAZOP and “What If” reports to the CNSC. Dispositioning of the recommendations resulted from the HAZOP and What If reports is currently in progress.

To address the CNSC acceptance criterion on the small diesel generator, AECL submitted the results of the Third Party Review (i.e., design review and field inspection) and the Fire Hazard Assessment to the CNSC and requested CNSC approval to load diesel fuel into the small diesel

[2] HAZOP is a structured systematic brainstorming technique used to identify and evaluate the potential hazardous events and operability issues for a process. The specific HAZOP approach used for the NPF work is based on the use of "guide words" to generate possible deviations from the design intent of an operating step or the operating conditions in a process. The "What If” approach is similar to the HAZOP approach.

generator. CNSC reviewed the Third Party Report concerning the fire protection aspects of the New Processing Facility small diesel generator and has found it to be acceptable. Approval to load diesel fuel into the small diesel generator was granted on 2006 February 20. Commissioning of the small diesel generator is underway.

To close all the CNSC acceptance criteria, AECL plans to submit the following outstanding deliverables:

- Documentation showing the objective evidence on adequate number of trained staff, and available systems and equipment through the implementation of the Readiness for Service process.
- Modified NPF building Emergency Procedures to reflect the evacuation requirements under certain loss of ventilation accidents.
- Document to confirm implementation of the seismic walkdown findings for the dissolver/decladder and the central off gas delay system.
- Documentation of a backup firewater cooling test of the Closed Loop Cooling System.
- Documentation to confirm that all outstanding work designated as ‘required for active commissioning’ has been completed.
- Documentation to confirm that the items from the *NPF Inactive Integrated Testing Report*, which AECL designated and confirmed as essential for the start of Phase B Commissioning, have been addressed.
- Documentation showing the objective evidence of completion of the Project Improvement Plan Phase 2 activities, in accordance with the latest revision of the plan.
- Safety case to support active commissioning of NPF.
- Revised *NPF Commissioning Plan*.
- Documentation to account for the nuclear material and nuclear loss in DIF and to address the specific requirements on safeguards measures to meet Canada’s international obligations, as identified in letter from R. Keeffe to K. Strapac, “Declaration of Nuclear Loss in HEU Targets and LEU Fuel in the DIF (CNBM)”, 2002 January 16.
- Licensing Application to request CNSC confirmation that prerequisites for NPF active commissioning are completed.

B.4.2 Approval for In-Service Operation

***CNSC Acceptance Criteria*:**

The acceptance criteria for CNSC approval for in-service operation of the New Processing Facility are as follows:

- AECL must demonstrate, through the availability of objective evidence, that active commissioning has been successfully completed.
- AECL must implement the corrective actions from the Human Factors program.
- The calibration and commissioning of IAEA instrumentation must be completed.
- AECL must modify its Periodic Inspection Program documentation to be fully compliant with documentation requirements.
- AECL must update the Operational Limits and Conditions document to reflect lessons learned and knowledge gained from commissioning.
- AECL must establish, document and implement a document baseline.
- AECL must update the Final Safety Analysis Report.

To address the CNSC acceptance criteria, AECL submitted the following deliverables:

- Revised version of *Dedicated Isotope Facilities (DIF) Periodic and Inaugural Inspection Program* [B-22] to address CNSC staff comments.
- The *DIF Operations Baseline* was issued and submitted to the CNSC for information in 2005 October.
- The revised NPF FSAR (except Sections 10 and 11) [B-28], was issued and submitted to the CNSC at the end of 2006 April. Chapters 10 and 11 of the FSAR will be revised prior to requesting CNSC approval to place the NPF In-Service.

To close the CNSC acceptance criteria, AECL plans to submit the following:

- Commissioning Reports for commissioning tests.
- Signed NPF Commissioning Completion Assurance Certificates for active commissioning.
- Documentation showing that implementation of the corrective actions from the Human Factors program has been addressed.
- IAEA confirmation that calibration and commissioning of IAEA instrumentation has been completed.
- Revised version of the *New Processing Facility Operational Limits and Conditions* to reflect CNSC staff comments and incorporate lessons learned and knowledge gained from commissioning.
- Updated document baseline to support ongoing operation of NPF. This will ensure proper document configuration control.

- Revised version of the *Final Safety Analysis Report for the New Processing Facility* to incorporate feedback from the commissioning process; plan and schedule for revising the *Final Safety Analysis Report for the New Processing Facility*.
- Licensing Application to request CNSC approval to place NPF in-service, as per Licence Condition 9.2 (b) of the Operating Licence NSPFOL-03.00/2007.

B.5 References

[B-1] CMD 05-H20, *Information and Recommendations from Canadian Nuclear Safety Commission Staff Regarding Atomic Energy of Canada Limited Renewal of the Operating Licence of the MAPLE Reactors at the Chalk River Laboratories – Public Hearing Day One*, August 18, 2005.

[B-2] CMD 05-H21, *Information and Recommendations from Canadian Nuclear Safety Commission Staff Regarding Atomic Energy of Canada Limited Renewal of the Nuclear Substance Processing Facility Operating Licence for the New Processing Facility (NPF) at the Chalk River Laboratories – Public Hearing Day One,* August 18, 2005.

[B-3] CMD 05-H21.A, *Supplementary Information, Information and Recommendations from Canadian Nuclear Safety Commission Staff Regarding Atomic Energy of Canada Limited Renewal of the Nuclear Substance Processing Facility Operating Licence for the New Processing Facility (NPF) at the Chalk River Laboratories – Public Hearing Day 2*, October 18, 2005.

[B-4] Letter from B.D. Howden to K.R. Hedges, *Approval to Remove MAPLE 1 Reactor from the Reference Guaranteed Shutdown State*, CNSC # 26-1-62-0-0, AECL # 6400-NOAC-06-0096-L, 2006 April 28.

[B-5] Letter from D.B. Taylor to B.D. Howden, *Application to Operate the MAPLE 1 Reactor up to 5 MW*, AECL # 6400-ACNO-06-0147-L, 2006 June 8.

[B-6] Letter from B.D. Howden to D.B. Taylor, *Application to Operate the MAPLE 1 Reactor up to 5 MW*, CNSC # 26-1-62-0-0, AECL # 6400-NOAC-07-0006-L, 2007 January 30.

[B-7] Letter from B.D. Howden to D.B. Taylor, *Application to Operate the MAPLE 1 Reactor up to 5 MW*, CNSC # 26-1-62-0-0, AECL # 6400-NOAC-07-0012-L, 2007 March 22.

[B-8] *MAPLE 1 5 MW Test Plan*, 6401-92000-CM-003, Revision 2, 2006 June.

[B-9] *Overview of Objectives and Proposed Modes of Operation of the MAPLE 1 Reactor at Powers up to 5 MW*, 6401-90000-PLA-001, Revision 1, 2006 November.

[B-10] *Safety Case to Support Operation of the MAPLE Reactor to 5 MW*, 6400-05600-AR-063, Revision 0, 2006 May.

[B-11] *Analysis to Support PCR Tests in the MAPLE Reactor to 5 MW with the LEU/Mo-99 Target Replacement Core*, 6400-05600-AR-065, Revision 0, 2006 September.

[B-12] *Safety Case to Support Operation of the MAPLE Reactor up to 2 kW with LEU/Mo-99 Target Replacement Core and PCS Pump Not Running*, 6400-05600-ASD-020, Revision 0, 2006 October.

[B-13] *MAPLE Reactors Operational Limits and Conditions*, 6425-05410-OLC-001, Revision 18, 2007 February.

[B-14] *Modification of SS1, SS2 and RCCS to Address the Power Coefficient Issue*, 6400-68000-CR-007, Revision 2, 2005 April.

[B-15] *Commissioning Demonstration of Design Intent - MAPLE Phase A Commissioning Program*, 6400-92000-AB-001, Revision 1, 2005 June.

[B-16] Letter from B.M. Pearson to V.G. Snell, *Commissioning Demonstration of Design Intent*, CNSC # 26-1-62-0-0, AECL # 6400-NOAC-05-0084-L, 2005 November 2.

[B-17] *INL MAPLE 1 Initial Core Reactor Physics Sensitivity Analyses*, 6400-03000-AR-003, Revision 0, 2006 April.

[B-18] *INL MAPLE 1 Power Coefficient of Reactivity Analyes – Target Replacement Core*, 6400-03000-AR-9001, 2006 September.

[B-19] *BNL Review of MAPLE 1 Tests Relevant to the Power Coefficient of Reactivity (PCR) - Contract Extension*, 6400-03000-ASD-002, Revision 0, 2006 October.

[B-20] *Measurement and Calculation of Subcritical k-Values in MAPLE*, 6400-03100-AR-018, Revision 0, 2004 December.

[B-21] *Comparison of MAPLE 1 SOR and CAR Reactivity Worth Measurements to MCNP Calculations*, 6400-03100-AR-015, Revision 1, 2005 April.

[B-22] *Dedicated Isotope Facilities (DIF) Periodic and Inaugural Inspection Program*, 6423-01510-TD-001, Revision 2, 2006 February.

[B-23] *Final Safety Analysis Report for MAPLE Reactors*, Revision 1 of Volume 1, 2006 April and Revision 0 of Volume 2, 1998 August.

[B-24] Letter from B.D. Howden to D.B. Taylor and V.G. Snell, *Approval of MMIR Cluster Holder Modifications*, CNSC # 26-1-62-0-0, AECL # 6400-NOAC-06-0098-L, 2006 May 8.

[B-25] *MAPLE Reactor Commissioning Plan*, 6401-92000-CM-001, Revision 6, 2005 June.

[B-26] *I-125 Production Facility*, 6401-43000-CM-001, Revision 3, 2004 September.

[B-27] Letter from D.B. Taylor to E. Langlois, *Change Request 6403-44262-CR-003, "Provide Firewater as Emergency Back Up Cooling to the CLCS*, AECL # 6400-ACNO-07-0041-L, 2007 March 1.

[B-28] *Final Safety Analysis Report for the New Processing Facility*, Chapters 10 and 11 as Revision 0, 1999 January and all other chapters as Revision 1, 2006 April.

Appendix C
"INL MAPLE 1 Initial Core Power Coefficient of Reactivity Analyses", 2005 November

Abstract (extracted from the report)

"Coupled physics and thermal-hydraulic calculations were performed to estimate the power coefficient of reactivity for the MAPLE 1 Reactor initial core. The MCNP5 and RELAP5-3D computer codes were used in an iterative process to calculate the multiplication factor during steady state operation at several power levels. Under forced convection cooling, with total reactor powers of 2.5, 5, 7.5, and 10 MW, the power coefficient of reactivity was calculated to be in the range of -0.06 to -0.12 mk/MW, with a 1-sigma standard deviation of ±0.0283 mk/MW. Under natural convection cooling, with total reactor power of 200 and 500 kW, the power coefficient of reactivity was calculated to be much more negative, in the range of -1.59 to -6.65 mk/MW, with a 1-sigma standard deviation of approximately ±0.35 mk/MW. The standard deviations reported herein include only the inherent Monte Carlo statistical convergence error and are therefore not complete. Thermal-hydraulic sensitivity studies were also performed to investigate the effects of code, input model, and phenomenological uncertainties on the calculated core conditions."

Appendix D
BNL – "Final Report on Review of AECL Work to Measure, Analyze and Predict Power Coefficient of Reactivity for the MAPLE 1 Initial Core", 2005 December

Extracted from Executive Summary

"AECL contracted Brookhaven National Laboratory (BNL) to perform an independent review of the AECL work to provide:

- An assessment of the analysis of the measurements of the PCR;
- An assessment of the modeling methods to improve AECL's understanding of the discrepancy between the measured and predicted values of the PCR;
- An assessment of the PIRT study to provide an independent perspective on the phenomena causing the positive PCR;
- An assessment of the procedures to re-measure the PCR;
- An assessment of the possible options to remedy the positive PCR;
- Recommendations for tests to understand and mitigate the positive PCR; and
- Recommendations for improvements to the methods for the prediction of the PCR.

BNL has performed the work in the areas noted above, including an assessment of the initial and some of the ongoing AECL activities to resolve the discrepancies in the calculated versus measured PCR. The approach followed by BNL in reviewing and assessing the prior and ongoing AECL work followed a formal work activity plan and quality assurance procedures, both of which were accepted by AECL.

The BNL review was based primarily on documents supplied by AECL. However, it was recognized that there had been significant follow-on work by AECL to address this issue, and that these activities were ongoing. The assessment and observations provided in the review by BNL reflect these activities, to the extent that BNL was informed about them.

In addition, the BNL team has performed some limited sensitivity analyses and "independent checks" primarily in the areas of neutronics, error estimation and propagation, and estimates of bowing of target elements.

The following observations are made on the AECL work to resolve the discrepancy in the

PCR thus far:

1. The AECL analysis was in general thorough and of high quality.
2. The neutronic models are complete and rigorous, accurately reflecting the as-built reactor both geometrically, and in materials compositions.
3. The thermal-hydraulic model, CATHENA, of the MAPLE reactor and the application of temperatures calculated by the code are consistent with the methodology used by AECL to predict the PCR. However, an integrated analysis scheme that incorporates neutronic,

mechanical and thermal hydraulic elements, along with appropriate feedback is required to analyze this reactor. Rough estimates by BNL based on available data from AECL indicate that bowing of the targets in high flux gradients can provide a mechanism for the positive PCR of an appropriate magnitude. An integrated, consistent analysis could serve to confirm these preliminary estimates.

4. The PIRT followed a methodology successfully used in the past; it was thorough and detailed and provided justification for the results.
5. The PIRT has been very useful in providing direction for the remedial options that are currently being considered.
6. While the proposed re-measurement of the PCR should yield a more precise and accurate value for the PCR, it is unlikely to change the sign of the PCR. Careful analysis of all of the experimental data strongly points to the high flux gradients present in the core, along with the bowing of target elements, as being the most probable cause of the positive PCR.
7. All documentation should be reviewed to ensure consistent, statistically valid error treatment. The acceptance criteria for the uncertainty of future measurements of a negative PCR need to be established.
8. The options report developed by AECL for future tests is logical and well thought out. The rationale given for choosing some tests and options and rejecting others is clear.
9. The analysis of the random error in the calculated PCR could be improved by including the effect of uncertainties in cross section libraries and geometrical modeling.
10. The magnitude of the random error is currently estimated to be small enough so that the calculation provides a negative PCR with high certainty.

Based on BNL's review of the material provided by AECL, the following conclusions are drawn:

1. The measured positive PCR is real.
2. The most probable proximate cause is bowing of the targets.
3. The most probable root cause is the very large flux gradients in the startup core.
4. It is possible that the gradients, and concomitant target bowing, would be sufficiently reduced to yield a negative PCR for the equilibrium core with its more even distribution of fissile material.
5. Examination of AECL experiments and analyses does not suggest any realistic mechanism for significant void formation in the coolant during the PCR tests. It is unlikely for void formation being a major cause of the measured positive PCR.

The following recommendations are made for AECL's consideration:

In order to improve the prediction of the PCR, an integrated analysis technique that recognizes all important phenomena is needed. This is especially true for the initial core of MAPLE-1, which is a small heterogeneous reactor with significant power gradients.

While AECL analyses to date have certainly taken into consideration the key neutronic, thermal and mechanical aspects, it appears that this has not been done in a consistent, integrated fashion.

This should be done in a tightly coupled procedure amongst the models chosen for this analysis. Further, the level of detail in each of the three major areas (neutronics, fluid dynamics and heat transfer, and heat conduction and mechanical behavior) should be consistent, and the analyses should be performed until a converged solution is attained.

Consideration should be given to obtaining the error in the calculated isothermal temperature coefficient using corresponding measurements.

The PCR should be determined as a function of burnup from the initial core until the equilibrium core. A code, such as MONTEBURNS, can be used for this purpose to preserve the high fidelity of the MCNP Monte Carlo geometrical modeling, and representation of nuclear data. This analysis should confirm the expected variation in the sign and the magnitude of the PCR for the transition and equilibrium cores.

Finally, BNL has developed a possible course of action for AECL to consider, in terms of a flow chart for proposed tests to re-measure and investigate the PCR in MAPLE-1. The flow chart outlines a set of tests that could be accomplished quickly, for which all fuel is already fabricated and qualified, and for which the analysis would not be as extensive as some other options. Decision points are clear and unequivocal, and the end result is at least an improved understanding, and potentially remediation of the present situation."

bc:

>CR Licensing – SPOC
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