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## Summary

At the Commission Meeting of November 3, 2010, the Commission requested that Canadian Nuclear Safety Commission (CNSC) staff present a status update on Atomic Energy of Canada Limited prototype reactors currently in safe storage.

This Commission Member Document (CMD) presents an update on the status of decommissioning plans and the condition of the three prototype reactors: Douglas Point, Gentilly-1 and Nuclear Power Demonstration. The CMD also provides information on the Nuclear Research Experiment reactor that is located at Chalk River Laboratories.

The following actions are requested of the Commission:

This CMD is presented for information only.

The following items are attached:

There are no attachments.

## Résumé

Lors de la réunion de la Commission tenue le 3 novembre 2010, la Commission a demandé au personnel de la Commission canadienne de sûreté nucléaire de lui présenter un rapport d'étape sur les réacteurs prototypes d'Énergie atomique du Canada limitée actuellement en stockage sûr.

Ce document à l'intention des commissaires (CMD) présente une mise à jour sur l'état des plans de déclassement et la condition des trois réacteurs prototypes: Douglas Point, Gentilly-1 et le réacteur nucléaire de démonstration. Le CMD fournit également des informations sur le réacteur NRX qui est situé aux laboratoires de Chalk River.

On demande à la Commission de prendre les mesures suivantes :

Ce CMD est présenté à titre d'information seulement.

Les pièces suivantes sont jointes :

Il n'y a aucune pièce jointe.

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## EXECUTIVE SUMMARY

Atomic Energy of Canada Limited (AECL) owns three prototype power reactors that are located outside of Chalk River and Whiteshell Laboratories: Douglas Point, Gentilly-1 and Nuclear Power Demonstration. These facilities ceased operating in the 1980's.

After the facilities shutdown, AECL implemented a three-phase approach to decommissioning. The first phase is to place each facility into a safe state of storage. The second phase is storage with surveillance to allow for radioactive decay and the third phase allows for final dismantlement.

AECL has successfully put all facilities into a safe state of storage with surveillance. AECL is planning to keep these facilities in this state for the next 50 to 100 years.

AECL is planning to start final decommissioning between 2053 to 2106 for Gentilly-1 and Nuclear Power Demonstration while Douglas Point is planned to start final decommissioning in 2103.

Additional information is provided concerning the Nuclear Research Experiment (NRX) reactor that is located at Chalk River Laboratories.

CNSC staff reports that these facilities are currently being maintained in compliance with the requirements of the *Nuclear Safety and Control Act* and their licences. For the prototype power reactors, the licences that are in place are indefinite term licences issued by the Atomic Energy Control Board. CNSC staff has invited AECL to submit an application requesting that the licences for the prototype power reactors be amended to reflect current standards and practices.

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## ADDENDUM A. OVERVIEW

### (a) Background

At the Commission Meeting of November 3, 2010, the Commission requested that CNSC staff provide an update on the status of certain AECL reactors that are currently in a safe state of storage with surveillance including the planned timelines for decommissioning each facility.

AECL owns a number of facilities that are undergoing decommissioning, including Whiteshell Laboratories, the Nuclear Research Experiment Reactor at Chalk River Laboratories (CRL) and three prototype power reactors that are located outside of Chalk River and Whiteshell Laboratories; Douglas Point, Gentilly-1 and Nuclear Power Demonstration. Although an update is provided on the status of the Nuclear Research Experiment reactor, the focus of this CMD is on the three prototype reactors not covered by the Whiteshell and CRL site licences.

## ADDENDUM B. SPECIFIED AECL FACILITIES

### (a) AECL's Corporate Decommissioning Strategy

AECL has established a three-phase approach for reactor decommissioning. This approach is described in AECL's preliminary decommissioning plans and interim end-state reports [1]-[6] for each facility. The three phases are:

Phase 1 - bring the facility to a safe sustainable shutdown state suitable for storage with surveillance;

Phase 2 - the storage with surveillance period; and

Phase 3 - final decommissioning where the facility is completely decommissioned leading to the final end state.

While the phases for AECL's decommissioning plans are the same for all facilities, the period of each phase varies and is dependent on the facility. AECL's policy regarding decommissioning has been to put the facility into a safe state of storage with surveillance for safety reasons, rather than embarking on immediate decommissioning. The duration of Phase 2 is planned to last for 50 to 100 years. By then, radiation fields will have decreased to lower levels due to radioactive decay of activated components resulting in lower radiation exposures to workers during decommissioning.

The projected start of Phase 3 decommissioning will be determined by health, safety, environmental and ALARA considerations, and the availability of appropriate waste management facilities. Any other activities that are occurring at each site may also impact the duration of Phase 2.

AECL has stated in the preliminary decommissioning plans that the final disposition of used fuel will not take place until a decision is made on the ultimate strategy for the disposal of high-level waste and irradiated fuel in Canada [4]-[6]. If no decision is made at the time when final decommissioning is anticipated, spent fuel will be placed into off or on-site storage facilities, whichever is the most suitable at the time.

## **ADDENDUM C. LICENSING APPROACH FOR REACTORS IN LONG-TERM STORAGE WITH SURVEILLANCE**

AECL's prototype power reactors were licensed to operate by the Atomic Energy Control Board (AECB). In the mid-1990's, the AECB issued Waste Facility Operating Licences to AECL for each facility for an indefinite term. In 2003, as part of assessing AECL's nuclear legacy liabilities, AECL developed and submitted preliminary decommissioning plans and interim end-state reports for each facility in line with CNSC current practices and expectations for such facilities.

In 2006, Natural Resources Canada announced the creation of the Nuclear Legacy Liabilities Program that is anticipated to exist for 70 years. The program provides AECL with financial resources to safely and cost-effectively reduce its nuclear legacy liabilities and risks based on sound waste management principles. With respect to the three prototype power reactors, they are included in the Nuclear Legacy Liabilities Program and will be decommissioned in its later phases. Currently however, there are no defined timelines under this program for when Phase 3 decommissioning may occur. Timeline estimates for the initiation of Phase 3 decommissioning that are presented here are based upon the schedules set out in each facility's respective interim end-state report.

For the prototype power reactors, the licences that are in place are indefinite term licences issued by the Atomic Energy Control Board. CNSC staff is of the opinion that the indefinite licences for the three facilities do not reflect the current practice for licensing terms. Consequently, CNSC staff advises the Commission that AECL has been requested by staff to submit an application to amend the three licences to reflect the NSCA and the CNSC's current standards and practices.

## **ADDENDUM D. STORAGE WITH SURVEILLANCE**

AECL facilities that are in an interim state of storage with surveillance are Douglas Point, Gentilly-1, Nuclear Power Demonstration and the Nuclear Research Experiment. A description of each is provided in the following sections.

### **(a) Douglas Point Prototype Power Reactor**

#### **a.i) Background**

The Douglas Point prototype power reactor is located at the Bruce Power site, between Kincardine and Port Elgin, in Tiverton, Ontario. Figure 1 in Addendum A provides a photo of the site.

Before it was permanently shutdown in May 1984, the facility was the Douglas Point Nuclear Generating Station. It consisted of a 200 MW prototype CANDU power reactor that was put into service in 1968. It was owned by AECL and operated by Ontario Hydro until 1984.

The main components of the facility are the reactor building, the service building, the turbine building and administration wing, the purification building and the plate and machine shop buildings.



### **a.ii) Progress since Shutdown**

Following the shutdown of the station in 1984, a number of activities were conducted to bring the reactor to a safe state of storage. These occurred from 1984 to 1988. After shutdown, the primary heat transport and moderator medium (heavy water) was drained and shipped to other operating sites. Certain radioactive reactor components were shipped to the Chalk River Laboratories in 1985 for long-term storage. Non-radioactive hazardous materials such as combustible and flammable materials, laboratory supplies and oils were identified and removed.

The transfer of used fuel from wet storage in the reactor pool to a dedicated exterior dry storage facility on-site was completed in 1987. Major and minor decontamination activities (disassembly, decontamination and consolidation) were completed as required. All major radioactive or radioactively contaminated components that were not shipped to other licensed facilities were consolidated on-site. Areas that possessed significant residual contamination or radioactive materials have been reduced to a few locations.

The facility was functionally divided into nuclear and non-nuclear areas, with radioactively contaminated equipment or structures being confined to the nuclear areas.

AECL has leased out part of the non-nuclear areas to Bruce Power, although AECL remains in control of these facilities as required by the licence.

### **a.iii) Future Plans**

As outlined in AECL's interim end-state report and preliminary decommissioning plan, the facility will be kept in Phase 2 storage with surveillance for approximately another 100 years [1][4]. By this time, radiation fields will have decreased due to the radioactive decay of activated components resulting in lower potential radiation exposures to decommissioning workers.

The duration of Phase 2 will be determined by health, safety and environmental, and ALARA considerations and on the availability of disposal facilities [4].

AECL expects that the Phase 3 decommissioning activities will take up to six years to complete.

AECL's reference end-state for the Douglas Point reactor is the eventual removal of the used fuel, radioactive components and wastes, and for the demolition of buildings and structures with the land suitable for reuse.

## **(b) Gentilly-1 Prototype Reactor**

### **b.i) Background**

The Gentilly-1 prototype power reactor (Gentilly-1) is located adjacent to the Gentilly-2 Nuclear Generating Station. The Gentilly station is on the south bank of the St. Lawrence River in the Municipality of Bécancour, which is approximately 15 kilometers east of Trois-Rivières in the province of Québec. Figure 2 in Addendum A provides a photo of the site.

Gentilly-1, formerly the Gentilly-1 Nuclear Generating Station, consisted of a prototype CANDU Boiling Light Water Reactor with 250 MW of power that was put into service in May 1972. The reactor had operated for a total of 183 effective full power days until 1978 when it was determined that certain modifications and considerable repairs would be required. The station was put into a lay-up state in 1980, and the decision not to rehabilitate it was made in 1982. In 1983, AECL made the decision to permanently shutdown the reactor and started the decommissioning program to bring the Gentilly-1 Nuclear Generating Station to an interim safe state of storage with surveillance.

The main components of the facility are the reactor building, the service building and the turbine building.

#### **b.ii) Progress since Shutdown**

Following the decision to decommission the reactor in 1983, a number of activities were conducted to bring the reactor to a safe state of storage. These occurred from 1984 to 1986.

The moderator was drained and shipped to other operating sites. Non-radioactive hazardous materials such as combustible and flammable materials, laboratory supplies and oils were identified and removed. The transfer of used fuel from wet storage in the reactor pool to dry storage in the Canister Storage Area, constructed for that purpose, was completed in 1986. Major and minor decontamination activities (disassembly, decontamination and consolidation) were completed as required. All major radioactive or radioactively contaminated components not shipped to other licensed facilities were consolidated on-site in either the reactor building or the turbine building. Areas that possess significant residual contamination or radioactive materials have now been reduced to a few locations.

The facility was functionally divided into nuclear and non-nuclear areas, with radioactively contaminated equipment or structures being confined to the nuclear areas.

In 1993, AECL transferred ownership of all the lands and the above grade floors of the Service Building and the Pumphouse to Hydro Québec, although AECL remains responsible for these facilities as required by the licence.

#### **b.iii) Future Plans**

It is expected that Gentilly-1 will be in Phase 2 safe state of storage with surveillance until 2053 to 2103 [2]. Decisions regarding the initiation of Phase 3 will be based on an analysis of the relevant safety issues, costs, benefits, risk and priorities at that time.

AECL expects that the Phase 3 decommissioning activities will take up to five years to complete.

AECL's reference final end-state for Gentilly-1 is the eventual removal of the used fuel, radioactive components, wastes and demolition of the buildings and structures with the land suitable for reuse.

## **(c) Nuclear Power Demonstration Prototype Reactor**

### **c.i) Background**

The Nuclear Power Demonstration prototype reactor is located in Rolphton, Ontario, adjacent to the Ottawa River, and approximately 25 kilometres upstream from the Chalk River Laboratories. Figure 3 in Addendum A provides a photo of the site.

The former Nuclear Power Demonstration Nuclear Generating Station, consisting of a 20 MW CANDU reactor, was put into service in 1962 and was operated by Ontario Hydro (now Ontario Power Generation) until 1987. In 1988, operating and compliance responsibilities were transferred from Ontario Hydro to AECL, and the facility became the Nuclear Power Demonstration Waste Management Facility.

The facility was used for training purposes for nuclear power plant operations while also providing electricity for the Ontario Hydro grid.

The main components of the Nuclear Power Demonstration Nuclear Generating Station were the reactor building, the training centre and various miscellaneous support buildings.

### **c.ii) Progress since Shutdown**

Following shutdown, the reactor was de-fuelled and drained and the fuel bundles were transferred to a special constructed Dry Storage Facility at Chalk River Laboratories. Water treatment components were removed from the various process systems and transferred to storage at Chalk River Laboratories. Major and minor decontamination activities were completed as required. The facility was functionally divided into nuclear and non-nuclear areas, with radioactively contaminated equipment or structures being confined to the nuclear area. All cross connections between the two areas were blocked off, sealed or permanently locked.

All accessory buildings were demolished, with only the main reactor building and the guardhouse remaining.

### **c.iii) Future Plans**

AECL has indicated in the interim end-state report for the Nuclear Power Demonstration facility that the duration of Phase 2 will be until at least 2053 [3]. The duration of this phase will be determined by health, safety, environmental and ALARA considerations, and the availability of appropriate waste management facilities.

AECL is expecting that the Phase 3 decommissioning activities will take from four to six years to complete.

The reference final end-state for the Nuclear Power Demonstration facility is the eventual removal of the radioactive components and wastes, and the demolition of buildings and structures with the land suitable for reuse.

## (d) Nuclear Research Experiment

### d.i) Background

The Nuclear Research Experiment (NRX) research reactor is located at the Chalk River Laboratories in Chalk River, Ontario. Figure 4 in Addendum A provides a photo of the site.

The NRX, Canada's first large-scale research reactor, commenced operation in 1947 and played a major role in developing the CANDU reactor. The reactor was used extensively for the testing of fuels and materials, and for nuclear physics research in support of the Canadian Nuclear Power program [7]. Ten NRX Ancillary Buildings were constructed in mid-1940's to service and support the reactor operations.

The NRX reactor is a vertical assembly of permanent tubes kept in a calandria, which contain the reactor fuel assemblies. The reactor is heavy-water-moderated and light-water-cooled, and has a power rating of 42 MW. After approximately 250,000 hours of operating time, the NRX reactor was shutdown in January 1992 [7]. AECL decided to prepare the NRX reactor for decommissioning in April 1993.

### d.ii) Progress since Shutdown

The NRX decommissioning process began with the permanent shutdown of the NRX reactor facility. Shutdown operations for the NRX reactor and ancillary buildings have been completed.

The CNSC issued a Nuclear Research and Test Establishment Operating Licence, NRTEOL-01.06/2011 for CRL in August 2006. The NRTEOL licence expires in October 2011 and AECL has applied to the CNSC for renewal.

The licence authorizes AECL to operate the CRL. This includes the operation of the nuclear facilities at CRL, the maintenance in storage with surveillance of facilities listed in Part I of Appendix C to the licence, and the decommissioning of those facilities listed in Part II of Appendix C to the licence. The NRX is one of the facilities listed in Appendix C.

### d.iii) Current Status

The reactor and its associated ancillary buildings are currently in a storage with surveillance state. The NRX reactor is in Appendix C of the CRL licence as a permanently shutdown nuclear facility at the CRL site.

An environmental assessment (EA) under the *Canadian Environmental Assessment Act* (CEAA) is currently being completed for the decommissioning of the NRX Ancillary Buildings. Both the CNSC and Natural Resources Canada are Responsible Authorities for this EA.

AECL has identified activities to establish the storage with surveillance state for the NRX Fuel Storage Bays. AECL is updating the storage with surveillance plan for the Fuel Storage Bays.

### d.iv) Future Plans

It is anticipated AECL will submit the storage with surveillance plan for the Fuel Storage Bays to the CNSC in mid-2011.

The EA for the decommissioning of the NRX Ancillary Buildings is expected to be completed by the end of 2011.

It is unknown when AECL plans to enter Phase 3 decommissioning for the NRX.

## **ADDENDUM E. REGULATORY OVERSIGHT**

With respect to regulatory oversight, the three prototype power reactors are licensed as Class I waste management facilities which are in a safe state of storage with surveillance. AECL maintains a number of ongoing programs for each of these facilities, and each facility has dedicated staff which oversees the programs and maintenance activities at each facility.

In order to assure compliance with the NSCA, its Regulations and each specific licence, CNSC staff oversees a compliance program for each facility. The compliance program consists of compliance inspections, reviews of reports and submissions, reviews of reportable events and events that are reported to CNSC staff outside of a formal reporting requirement. Based on a facility's relative risks, CNSC staff establishes a baseline inspection plan for each facility. In accordance with this plan and based upon the risk that these facilities pose in their current state, CNSC staff conducts annual inspections. Safeguards and security inspections may also be conducted at each facility to verify that the licensee is operating in compliance with CNSC regulatory requirements.

Although shutdown and in storage with surveillance, each facility has various systems that must be maintained and kept operational for surveillance, inspection, servicing and maintenance. These include; electrical power systems, emergency lighting systems, drainage systems, heating and ventilation systems, security systems, fire alarm and remote monitoring systems. Additionally, AECL maintains a number of programs for these facilities, such that their operations will be compliant with AECL's policies and programs. These include; radiation protection, environmental protection, occupational health and safety, quality assurance and training. CNSC staff also assesses the licensee's performance by reviewing AECL's performance under these programs during inspections.

In accordance with conditions in the licences, AECL is required to provide the CNSC with an annual operations report for each facility. The purpose of the report is to demonstrate compliance with the terms and conditions of the licence and all applicable regulations. The annual compliance report provides information on the following:

- A summary of the operating experience of the facility;
- The waste inventory and any changes to it;
- Any effluent treatment and waste processing that occurred;
- Any modifications to the facility;
- Results of the radiation protection program and the health and safety program;
- Results of facility and environmental monitoring;
- Any new discoveries;
- Compliance with other Federal or Provincial Legislation;

- Any training conducted;
- Any public information program changes; and
- Any reports submitted to the CNSC during the year.

CNSC staff assess these reports in relation to environmental performance and human health and safety issues. Based on site inspections and desktop reviews, CNSC staff are satisfied that AECL is taking adequate measures to assure that these sites remain in a safe state, as required by the licence.

## **ADDENDUM F. CONCLUSION**

CNSC staff conclude that:

1. AECLs shutdown prototype reactors are being managed safely; and
2. These facilities can be managed safely with a robust care and maintenance program.

**Summary Table for Specified AECL Prototype Reactors in Decommissioning**

Reactor	Reactor Size (MW)	Type of Reactor	Start of Operation	Years of Operation	Phase 1 Decommissioning	Current Status	Estimated Start of Phase 3 Decommissioning (Duration)	Estimated Waste Volume (m <sup>3</sup> ) Radiological / Clean	Estimated Cost (\$M)
Douglas Point	200 MW	Power	1968	16	1984-1988	Phase 2 Storage with Surveillance	2103 (6 Years)	7,400 / 34,000	\$293 (2003)
Gentilly-1	250 MW	Power	1972	8 (sporadic) ~ 0.5 full-power	Laid up 1980-1984, 1984-1986	Phase 2 Storage with Surveillance	2053 - 21	11,300 / 7,600	\$225 (2003)

							03 (5 Ye ars )		
Nuclear Power Demonstration Reactor	20 MW	Power	1 9 6 2	25	1987-1988	Phase 2 Storage with Surveillance	20 56 - 21 06 (4- 6 Ye ars )	2,200 / 9,900	\$60 (2003)
NRX	42 MW	Research	1 9 4 7	45	1992	Phase 2 Storage with Surveillance	U nk no w n	3,000 / 4,500	\$77 (2002)



## REFERENCES

The following documents were used in the preparation of CMD 11-M11:

ADDENDUM G. AECL Interim End-state Report for Douglas Point Waste Management Facility, 22-00960-IES-001, Revision 0, NSN-394 (R2), 2003 March; E-DOCS #: 1135533.

ADDENDUM H. AECL Interim End-state Report for Gentilly-1 Waste Management Facility, NSN-406R3, 61-01600-IES-001, Revision R1, 2006 March; E-DOCS #:1129680.

ADDENDUM I. AECL Interim End-state Report for Nuclear Power Demonstration Waste Management Facility, 64-01600-IES-001, Revision 2, 2003 September, E-DOCS #: 1177727.

ADDENDUM J. AECL Preliminary Decommissioning Plan for Douglas Point Waste Management Facility, 22-00960-PDPWMF-001, Revision 0, 2003 October, E-DOCS #: 1135533.

ADDENDUM K. AECL Preliminary Decommissioning Plan for Gentilly-1 Waste Management Facility, 61-01600-PDPWMF-001, Revision 0, 2003 October, E-DOCS #: 1260531.

ADDENDUM L. AECL Preliminary Decommissioning Plan for Nuclear Power Demonstration Waste Management Facility, 64-01600-PDP-001, Revision 0, 2003 October; E-DOCS #: 1263275.

ADDENDUM M. AECL Preliminary Decommissioning Plan for NRX Reactor and Building 100, 3611-01610-PDP-004, Revision 0, 2002 October, E-DOCS #: 1114584.

ADDENDUM N. CNSC Regulatory Guide G-219: Decommissioning Planning for Licensed Activities, June 2000. [http://www.nuclearsafety.gc.ca/pubs\\_catalogue/uploads/G219\\_e.pdf](http://www.nuclearsafety.gc.ca/pubs_catalogue/uploads/G219_e.pdf)

ADDENDUM O. CSA N294-09: Decommissioning of facilities containing nuclear substances.

## GLOSSARY

### **ALARA**

The principle of keeping radiation doses As Low As Reasonably Achievable, social and economic factors taken into account [8].

### **Decommissioning**

Those actions taken in the interest of health, safety, security, and protection of the environment, to retire a licensed activity/facility, or site permanently from service and render it to a predetermined end-state condition [9].

### **Decontamination**

The complete or partial removal of contamination by a deliberate physical, chemical, or biological process [9].

### **Detailed Decommissioning Plan**

A plan setting out the detailed work program, safety and environmental protection procedures, and management systems to be followed in the decommissioning of a licensed activity/facility. Detailed decommissioning plans should evolve from the preliminary decommissioning plan [8].

### **End-state (final or interim)**

The proposed physical, chemical and radiological condition of the facility at the end of decommissioning program [8].

### **Preliminary Decommissioning Plan**

A plan that defines the areas to be decommissioned and the general structure and sequence of the principal decommissioning work [9].

**Note:** *The preliminary decommissioning plan:*

- (a) forms the strategic basis for establishing financial guarantees;*
- (b) provides the structural outline of the subsequent detailed decommissioning plan(s); and*
- (c) is sufficiently detailed to ensure that the proposed approach is, in the light of existing knowledge, technically and financially feasible and appropriate in the interests of health, safety, security, and protection of the environment.*

### **Storage with Surveillance**

A planned stage during a decommissioning program during which the remaining nuclear substances, equipment and site(s) are placed under controlled surveillance for a specified period of time [8].

## ADDENDUM A. PHOTOS OF AECL FACILITIES IN DECOMMISSIONING

Figure 1: Douglas Point Prototype Reactor in Tiverton, Ontario



Figure 2: Gentilly-1 Prototype Reactor in Bécancour, Québec



Figure 3: Nuclear Power Demonstration Prototype Reactor in Rolphton, Ontario



Figure 4: Nuclear Research Experiment Building in Chalk River, Ontario

