APM 2016 Lifecycle Cost Estimate Update Summary Report

APM-REP-00440-0202 April 2016

Nuclear Waste Management Organization

NUCLEAR WASTE MANAGEMENT ORGANIZATION
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EXECUTIVE SUMMARY

The Nuclear Waste Management Organization (NWMO) is implementing Adaptive Phased Management (APM), Canada's plan for the long-term management of its used nuclear fuel. The APM approach includes centralized containment and isolation of used nuclear fuel in a deep geological repository (DGR) constructed within a suitable host rock formation such as crystalline or sedimentary rock. APM also includes a used fuel transportation system to safely move used fuel from reactor interim storage sites to the proposed repository site.

Two used nuclear fuel inventory scenarios are considered in this analysis: the base case, 3.6 million used CANDU fuel bundles will be directed to the DGR over a 30-year placement period, and the alternate case, which allows for potential refurbishment of existing plants and/or construction of new nuclear reactors, increases this quantity to 7.2 million used fuel bundles delivered to the DGR over a 60-year period. From these two scenarios, we can reasonably estimate the costs of any used fuel arising scenarios within these two point estimates in order to support funding formula calculations and various financial scenarios.

Since the last update, the NWMO has advanced the previous conceptual design and associated cost estimate for the APM DGR and used fuel transportation system. The most significant changes from the 2011 design and cost estimate are in the engineered-barrier design (Used Fuel Container (UFC) and In-Room Placement Methodology), and the change to planning assumptions for the duration to select a single site and obtain the construction licence.

The engineered-barrier design is comprised of a 48-bundle UFC designed by the NWMO and optimized for CANDU fuel, incorporating the latest copper-coating and welding technologies, as well as a bentonite overpack, buffer systems, and associated handling, packaging and placement processes. The placement methodology for the UFC includes in-room placement for both the crystalline and sedimentary rock geospheres. The underground layout and excavation have been developed based on preliminary thermo-mechanical studies as it relates to the engineered-barrier design, defining placement room dimensions and overall layout.

The APM site selection process commenced with the issuance of the siting process document in May 2010. Initial screening and Phase 1 desktop Preliminary Assessments were the focus of the work program from 2010 to 2014. The Phase 2 Preliminary Assessments began in January 2014. Currently, the Phase 2 work program is assumed to be completed in 2022 with a single site selection in 2023. The detailed site characterization activities within the licensing phase is expected to take eight years to complete, resulting in the start of construction in 2033. With a 10-year construction period, the DGR is expected to be operational in 2043.

By design, the NWMO has not prescribed deadlines for reaching each APM milestone. Timeline assumptions used for estimating costs were developed for planning purposes only. The NWMO will take the time needed to implement APM properly. As the steward of the site selection process, the NWMO must take the time required to carefully assess sites and confirm a strong safety case. Communities and areas will also dictate the pace at which they are prepared to proceed.

Estimated costs are stated in constant 2015 Canadian dollars.

The revised APM reference lifecycle estimate for 3.6 million used fuel bundles is $18,328 million (2015 $). The estimate for the alternate case of 7.2 million used fuel bundles is $28,429 million (2015 $).

A summary of the APM cost estimate by implementation phase and costs from the 2011 estimate are as follows:

Table E-1: APM Lifecycle Cost Estimate Variance by Implementation Phase (2015 $ Million) – Base Case Inventory

Phases and Key Milestones	2011 Schedule	2011 Estimate (2010 $ Million)	2011 Estimate (2015 $ Million)	2016 Schedule	2016 Estimate (2015 $ Million)
Siting	2010-2018	799	878	2010-2023	1,013
Detailed Site Characterization and Licensing	2019-2024	660	725	2024-2032	1,093
Construction	2025-2034	3,406	3,725	2033-2042	3,801
Operations	2035-2064	10,469	11,476	2043-2072	9,441
Extended Monitoring	2065-2134	1,548	1,712	2073-2142	1,763
Decommissioning and Closure	2135-2164	1,051	1,160	2143-2172	1,216
Total:		**17,933**	**19,675**		**18,328**

The annual cost and cumulative cost for the APM cost estimate for the Base Case inventory of 3.6 million used CANDU fuel bundles is illustrated in Figure E-1.

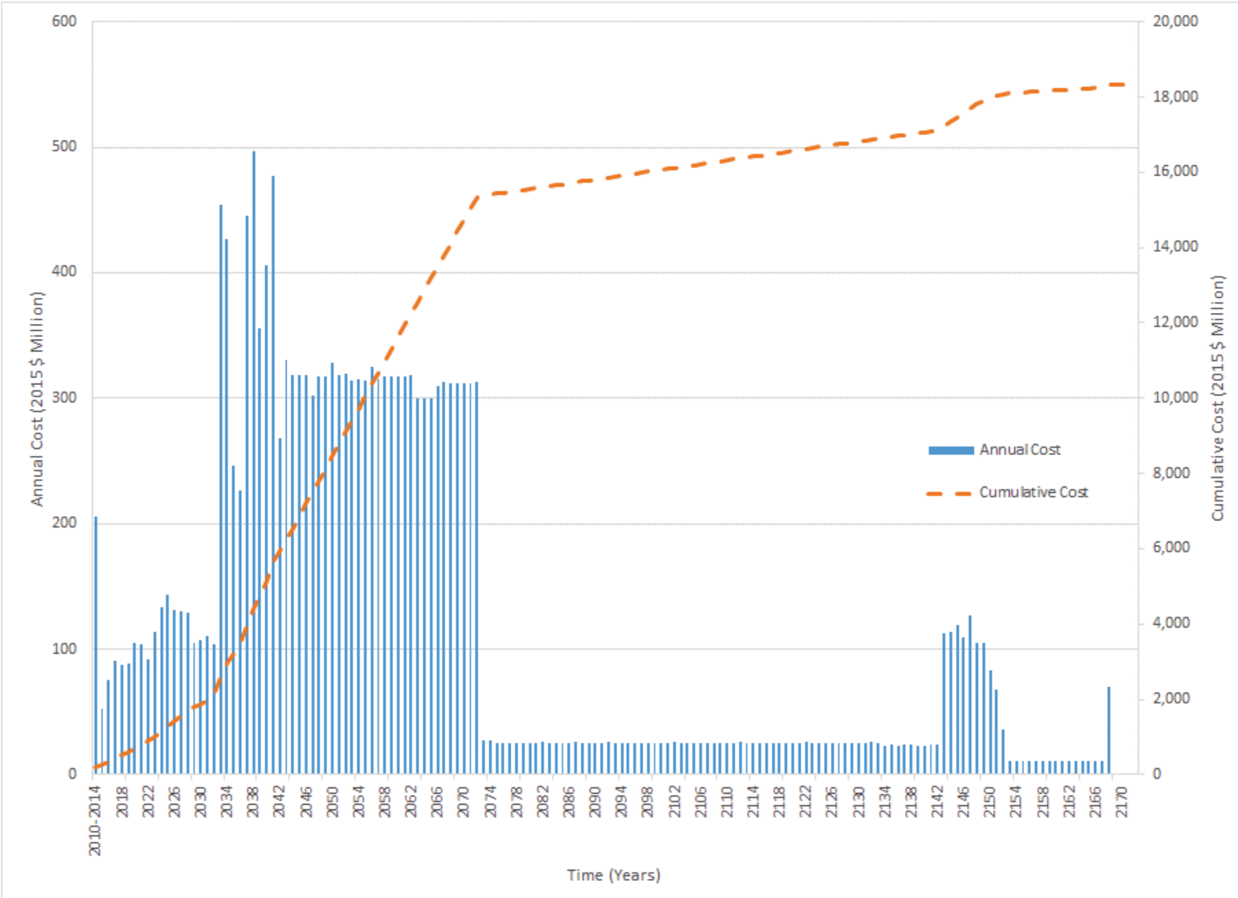

Figure E-1: APM Lifecycle Annual and Cumulative Costs – Base 3.6–Million–Bundle Scenario

The annual cost and cumulative cost for the APM cost estimate for the alternate case inventory of 7.2 million used CANDU fuel bundles is illustrated in Figure E-2.

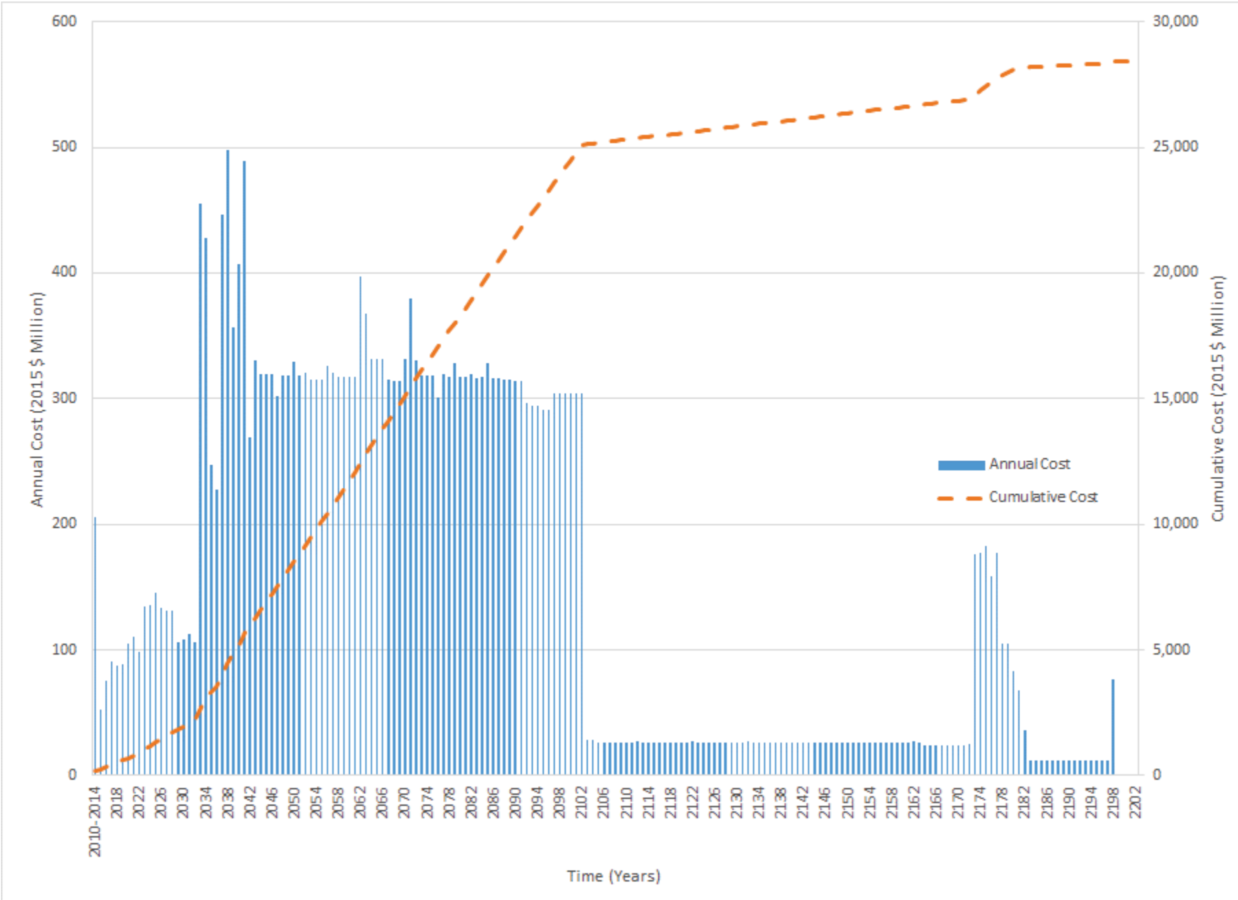

Figure E-2: APM Lifecycle Annual and Cumulative Costs – Alternate 7.2 – Million – Bundle Scenario

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1. PURPOSE

The purpose of this report is to provide an updated lifecycle cost estimate and schedule for the Adaptive Phased Management (APM) deep geological repository (DGR) for used nuclear fuel. This update replaces the previous APM reference lifecycle cost that was prepared in 2011.

To comply with the *Nuclear Fuel Waste Act* (*NFWA*) requirements and the Canadian Nuclear Safety Commission (CNSC) licensing requirement for financial guarantees on Class 3 or higher nuclear facilities, the nuclear industry updates the various lifecycle cost estimates and associated schedules and planning assumption on a five-year cycle. The Nuclear Waste Management Organization (NWMO) is accountable to manage and account for costs of transportation of the used fuel from the waste owners' facilities to the DGR and all facilities, equipment, and associated operation and maintenance activities for the ultimate long-term stewardship of all Canada's used fuel. One use of the information summarized in this report is to provide input to an updated APM cost estimate to support the requirements of the *NFWA*.

2. CONTEXT AND METHODOLOGY FOR UPDATE

The NWMO is implementing APM, Canada's plan for the long-term management of its used nuclear fuel. The APM reference approach includes centralized containment and isolation of used nuclear fuel in a DGR constructed within a suitable host rock formation – crystalline or sedimentary rock. Figure 3 provides an illustration of an APM DGR. APM also includes a used fuel transportation system (UFTS) to safely move used fuel from interim storage sites to the repository site.

The 2016 cost estimate and schedule update has been prepared by the NWMO with components contracted out to engineering, technical and manufacturing organizations with specific expertise. The cost estimate and schedule is for a DGR constructed in crystalline rock for the base case scenario of 3.6 million used CANDU fuel bundles. The alternate case scenario of 7.2 million used CANDU fuel bundles is determined based on the base case. Consistent with current and past nuclear production and associated used fuel inventories, these used fuel bundles are assumed to be produced at Canadian nuclear facilities owned by Ontario Power Generation Inc. (OPG), New Brunswick Power Nuclear (NBPN), Hydro-Québec (HQ), and Atomic Energy of Canada Limited (AECL).

Since the 2011 update, the NWMO has advanced the conceptual design and associated cost estimate for the APM DGR and UFTS. The most significant changes from the 2011 design and cost estimate are the engineered-barrier design and updated planning assumptions resulting from the site selection process.

The APM site selection process commenced with the issuance of the siting process document in May 2010. Initial screening and Phase 1 desktop Preliminary Assessments were achieved during the 2010 to 2015 time frame. Phase 2 Preliminary Assessments commenced in 2014 and is assumed to be completed in 2022 with the selection of a single site in 2023. With the selection of a single site, the detailed site characterization and licensing phase commences, with the receipt of a construction licence in 2032. The assumed durations for construction, operations, extended monitoring, and decommissioning remain the same as in 2011. The project phases and assumed planning timelines are provided in Table 1.

Table 1: Assumed Phases and Planning Timelines – 3.6-Million-Fuel-Bundle Scenario

Phases	Timeline
Siting (Site Selection and Proof Testing)	2010-2023
Detailed Site Characterization and Licensing	2024-2032
Construction	2033-2042
Operations	2043-2072
Extended Monitoring	2073-2142
Decommissioning and Closure	2143-2172

By design, the NWMO has not prescribed deadlines for reaching each APM milestone. Timeline assumptions used for estimating costs were developed for planning purposes only. The NWMO will take the time needed to implement APM properly. As the steward of the site selection process, the NWMO must take the time required to carefully assess sites and confirm a strong safety case. Communities and areas will also dictate the pace at which they are prepared to proceed.

For the alternative case, the operations phase is extended by 30 years from 2043 to 2102, resulting in the extended monitoring phase to start in 2103. All other phase durations remain the same.

The APM lifecycle estimate is composed of the three following main components:

1. Program Management;
2. Used Fuel Repository; and
3. Transportation.

The cost estimate is prepared in constant 2015 Canadian dollars.

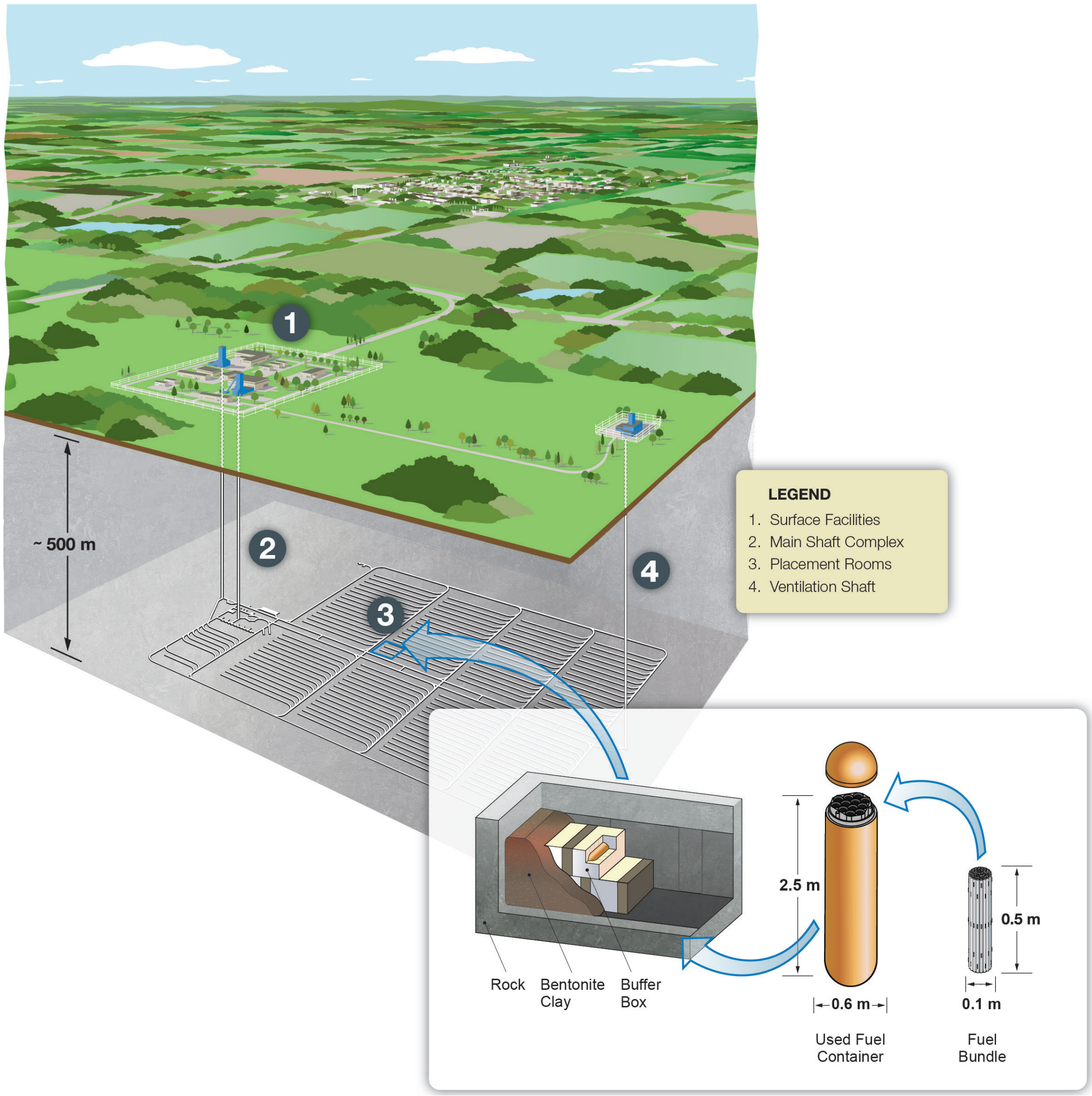

Figure 1: APM DGR and Engineered-Barrier Design

The lifecycle cost estimate is consolidated from several components of work that have been carried out since the 2011 baseline estimate was established. These include design and cost updates for all APM facility components that were impacted by a change in container type from the 2010 Reference IV-25 Used Fuel Container (UFC) (360 used fuel bundles) to the updated UFC (48 used fuel bundles). In addition, changes in site selection process and proof testing of the UFC have been incorporated into the program plan and captured in this estimate. Furthermore, a change in the battery limit between the APM DGR project and the waste owner sites has been identified for the UFTS estimate. The lifecycle cost estimate update was based on the conceptual designs for the following components:

i. Pre-construction cost estimate, which includes site selection and proof testing, as well as development of licensing submission to the start of construction;
ii. DGR in crystalline rock (construction and operations);
iii. Used Fuel Packing Plant (UFPP);

iv. UFC;
v. UFTS changes in battery limit, program schedule, and transportation logistics from interim storage locations; and
vi. Plans for extended monitoring, decommissioning and closure of the APM facility.

As part of the cost estimate and schedule update process, all aspects of the APM DGR facility were reviewed and determined to remain valid or require updating.

Updated Work Element Definition Sheets (WEDS) modified from the baseline APM estimate of 2011 were generated for all the above components and are provided in Appendix B.

Estimates are based on a baseline scenario of a repository volume of 3.6 million used fuel bundles and a throughput rate of 120,000 bundles per year, resulting in a facility operating life of 30 years.

An alternate scenario, based on the same methodology as used in 2011, is for twice the volume of used fuel as the baseline (i.e., 7.2 million used fuel bundles), resulting in an operating life of 60 years. From these two point estimates, other used fuel volume scenario estimates within this range can be reasonably generated.

3. KEY ASSUMPTIONS

The following provides the key assumptions supporting the 2016 APM DGR facility cost estimate. Cost estimates are based on these assumptions along with assumptions detailed in the WEDS found in Appendix B of this report.

2016 Estimate Assumptions
The repository will be located within a high-quality (e.g., sparsely fractured) crystalline rock geosphere.
The estimate is based on an APM facility design that receives used CANDU fuel bundles from the Canadian nuclear fuel waste owners (i.e., OPG, NBPN, HQ, and AECL).
The repository is sited in a hypothetical location in Ontario, nominally 1,000 kilometers from all Ontario-based reactor sites, as well as from the Whiteshell operations (OPG and AECL), 1,500 kilometer from the Gentilly facilities (HQ and AECL), and 2,500 kilometers from Point Lepreau (NBPN).
All fuel is assumed to be dry and in 96-bundle modules, loaded in a Used Fuel Transportation Package (UFTP) at the waste owners' facilities and prepared for transport by the waste owner; the NWMO is the carrier as defined in Canadian transportation regulations.
An all-road mode of transportation of the used fuel to the DGR facility is assumed.
The cost estimate assumes the APM program will be continuous with no hold points or abnormal periods of inactivity whilst awaiting funding approvals, management reviews or licensing decisions. However, the cost estimate has assumed reasonable time periods for the completion of these activities.
APM technical work program activities will proceed in parallel with the schedule for APM siting to support advancement of the siting process, design development and the safety case for a used fuel DGR.
Detailed site characterization will be conducted at the single site selected. Any consideration for further evaluation of more than one site would be completed as part of Phase 2 activities in advance of single site selection (i.e., additional boreholes to support site selection).
The APM facility includes construction of a campsite. Any improvement or expansion of town site services or infrastructure is a contingent item subject to discussions between the NWMO and the community.
Construction will begin in year 2033 and progress as described to deliver a functional licensed facility at end of the year 2042.
The UFC consists of a copper-coated (three-millimeter) steel shell with hemi-spherical ends and one four-layer UFC basket (48-bundle design).
A rate of placement equivalent to 120,000 used fuel bundles per year will be accommodated.
The underground portion of the APM facility is assumed to be a network of horizontal tunnels and placement rooms for the UFCs excavated at a depth of 500 metres, with vertical shafts extending to surface. During construction of the underground facilities, unsuitable rock conditions are assumed for 10 per cent of the excavations in the placement rooms.
An in-room horizontal placement method (with the UFC in a bentonite buffer box) will be utilized for the UFCs in the underground crystalline or sedimentary rock geosphere repository.
Following the start of operations, excavation of placement rooms would proceed concurrently with UFC placement activities, with sequencing of excavation and UFC placement activities, providing separation of these two activities from a manpower, ventilation and equipment perspective.
After placement is complete, there will be a 70-year period during which underground access will be maintained and the placement rooms will be monitored.
During this extended monitoring period, the capability will be maintained to recover the placed UFCs and spent fuel bundles.

4. BASIS OF ESTIMATE

The following documents the scope, assumptions, sources, and rates used to develop the APM DGR lifecycle cost estimate update, including the transportation of the used fuel from the waste owner's interim storage sites to the APM DGR. The estimate includes the full lifecycle costs, with adequate allowances/contingency, through the phases of siting, licensing, construction, operations, monitoring, and decommissioning and closure.

This basis of estimate is applicable to all lifecycle cost estimates for the APM Project (i.e., APM conceptual repository design and transportation) for a 3.6 million used CANDU fuel bundles scenario, and a 7.2 million used CANDU fuel bundles scenario. Key assumptions applicable to the generation of the estimate are included in Section 3 and in the WEDS included in Appendix B. Specific design input assumptions are included in the associated technical memorandums or engineering design reports.

The cost estimate information is a consolidation of various sources of estimate that have been prepared during the APM conceptual design and lifecycle cost update. The key purpose of the basis of estimate is to record the requirements of these estimates for a consistent, consolidated lifecycle estimate.

4.1 SCOPE AND BATTERY LIMIT

The scope of the APM DGR facility and transportation cost estimate incorporates all future planned expenditures, including all capital, operations, and maintenance and administration costs for the lifecycle duration of the APM program based on the key assumptions notes in Section 3. The current assumption is that the used fuel will be shipped to the DGR from the waste owner sites using an "all-road" mode of transportation. The road mode of transportation assumption requires all used fuel to arrive from waste owner sites in a certified transportation cask (UFTP). The two modules containing 96 used fuel bundles each are loaded in the UFTP and placed on a trailer ready for pickup and transport to the APM DGR. Preparation (retrieval) of the used fuel and loading the UFTP is carried out at the owner's site and does not form part of this estimate. All costs associated with the movement of the fuel from the owner's site through to final placement in the repository is part of this estimate. Once all used fuel is placed underground, extended monitoring begins until the facility is closed.

The APM DGR facility will be self-contained, and has facilities for operation, maintenance and long-term monitoring. The surface facilities include the UFPP, the Sealing Materials Compaction Plant, the Main, Service and Ventilation Shaft complexes, administration buildings, and all structures and equipment to meet nuclear security and safeguard regulations. The underground facilities are comprised of the underground services area at the base of the Main and Service Shafts, and the placement area with eight panels of placement rooms. Concepts for the safe transfer and placement of the UFCs have been developed and estimated. Details of the DGR facility design are provided in *Deep Geological Repository Design Report Crystalline / Sedimentary Rock Environment Mark II Used Fuel Container* – APM-REP-00440-0015[1]. Following the operations period, there will be a period of extended monitoring, followed by decommissioning and closure of the facility.

The underground facilities consist of two main components: the underground services area and the main repository consisting of placement rooms. The DGR is assumed to be located 500

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[1] The consolidated design report (APM-REP-00440-0015) assumes 4.6-million-fuel-bundle capacity based on current lifecycle projections contained in the 2015 fuel inventory report, which is within the range of 3.6 million and 7.2 million bundles.

meters below ground. The basic arrangement of the placement room area involves a series of parallel, dead-end placement rooms, organized into panels. The placement rooms will have a rectangular shape of nominal dimensions 3.2 meters wide by 2.2 meters high. There will be room-to-room spacing of 20 meters and an in-room container-to-container spacing of 1.5 meters. For the placement of 3.6 million fuel bundles, there are 220 placement rooms of 304 meters in length. A conceptual layout for the DGR in a crystalline rock mass that has a capacity to hold 3.6 million fuel bundles is shown in Figure 2. Once the initial panels are built during the construction phase, expansion of additional panels occurs in parallel during the operations phase until all used fuel is placed.

The in-room placement of the buffer boxes will involve a two-high stacking arrangement of the boxes. The rows of boxes will be separated by dense backfill blocks. The buffer boxes will be placed in a retreating arrangement within the placement room with any remaining voids in the room backfilled with loose bentonite pellets.

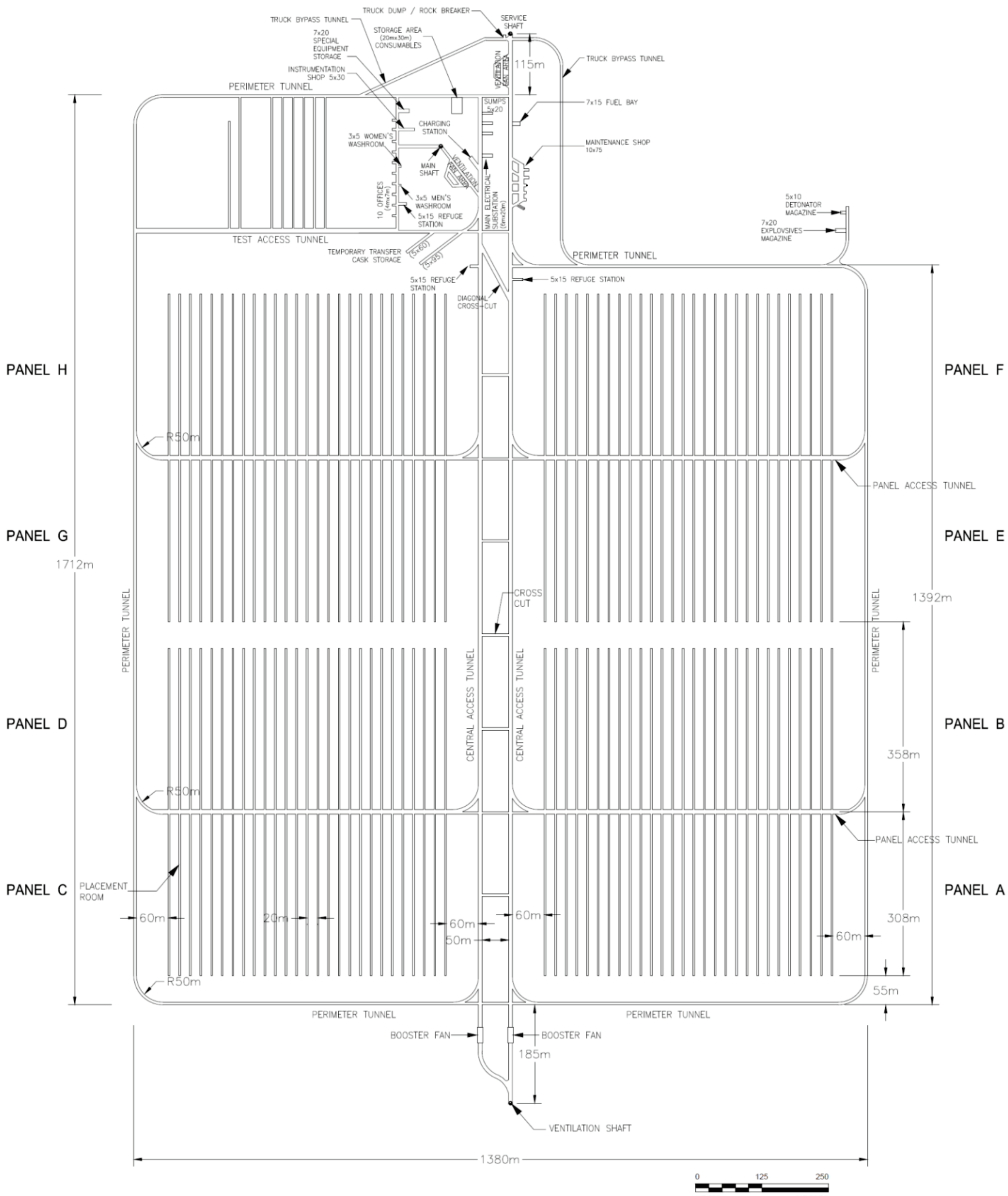

Figure 2: Conceptual Crystalline Layout for 3.6 Million Bundles

4.2 DESIGN AND COST BASIS

The lifecycle APM cost estimate is based on a set of planning and system design assumptions and dates. The cost estimate was prepared using the current state of the conceptual design of the repository and transportation system.

Estimated costs were prepared for labour, permanent material, equipment, other costs, and an allowance. The estimate was constructed by packaging the overall scope into a Work Breakdown Structure (WBS), which defines the APM program work elements for cost estimating and scheduling purposes.

4.3 WORK BREAKDOWN STRUCTURE (WBS)

More detailed cost estimating assumptions are captured in the WEDS for each work element of the WBS. The complete WBS is included in Appendix A.

4.4 WORK ELEMENT DEFINITION SHEETS (WEDS)

Detailed cost estimate assumptions pertaining to work at the lower levels of the WBS are documented in the WEDS for each work element. The following information was provided by the engineering lead for each WEDS at the lowest level of the WBS. Changes will be in reference to the baseline cost estimate WEDS.

- Primary estimator (“prepared by”);
- WBS code and description;
- Deliverables;
- Assumptions;
- Task start and end year;
- Type of cost (fixed, step-fixed or variable);
- Labour (labour ID, start year, finish year, and hours per year);
- Material and equipment (by item);
- Other costs (by item);
- Allowance (as a per cent of the value of labour, material and equipment, and other);
- Changes from the baseline estimate;
- Rationale for the change; and
- Concerns and risks related to the WBS element.

4.5 CURRENCY AND ESCALATION

The estimate is expressed in constant 2015 Canadian dollars. Estimates generated in prior years were escalated based on rates provided in Table 2. The cost estimate is primarily comprised of costs from the 2011 estimate update (prepared in constant 2010 dollars) or estimate updates produced in 2014.

Table 2: Escalation Factors per January 2014 University of Toronto Economic Forecasts

APM	Labour	Material	Other	Contingency
from 2010 C$ to 2015 C$	1.1236	1.0837	1.0910	1.0971
from 2014 C$ to 2015 C$	1.0340	1.0160	1.0200	1.0224

4.6 COST CATEGORIES

Labour

Internal and external labour costs where rates are inclusive of payroll burdens, including contractor profit. The cost of labour for non-NWMO work was based on Ontario commercial or industrial rates. Labour rates are consistent for similar worker activity and type.

Labour rates were derived as follows:

- NWMO Program Management rates are derived from the NWMO 2015-2019 Business Plan and are a weighted average based on 2014 NWMO Staff Profile distribution. Rates include a calculated burden;
- DGR rates are derived from existing OPG, Association of Management, Administrative and Professional Crown Employees of Ontario, and industrial skilled labour rates, and include conventional labour burden (payroll tax, benefits, etc.). This burden is comprised of involuntary labour surcharges such as payroll taxes, unemployment insurance and employee benefits, including that for sickness, accidents, vacation, and holiday, as well as training;
- Architect/engineer costs are based on burdened labour with subcontractor overhead and profit, i.e., they represent “charge-out rates”; and
- Design build costs represent inclusive labour costs and incorporate a range of typical project indirects, including training, tools, supervision, job-site housekeeping, etc.

Material

Permanent material costs (e.g., concrete, cable, pipes, valves, etc.), inclusive of contractor mark ups, required to construct, operate or maintain the transportation system or DGR facility.

Equipment

Permanent or temporary equipment costs (e.g., hoists, cranes, stand-by generators, etc.), that are rented, leased or purchased, required to construct, operate or maintain the transportation system or DGR facility.

Other

Items such as consumables (fuel, utilities and non-permanent materials), permits and fees, taxes, communication costs, furniture, spare parts for permanent material and equipment, temporary monitoring equipment, and travel and accommodation expenses, required to construct, operate or maintain the transportation system or DGR facility. For supply and install type contracts, where labour and material costs cannot be easily separated, the estimate is categorized as other.

Allowance/Contingency

Generally, in a project estimate, allowances and contingencies are included to reflect the “known unknowns” and “unknown unknowns”. They are an estimated value to cover costs that are expected to arise, but we do not know when or precisely what the impact will be at this juncture of the design evolution. They are usually calculated as a percentage-based sum to cover the cost of known, but presently undefined, requirements for each work element. The allowances and contingencies are nominally 25 per cent for most work elements to reflect the level of design and uncertainties. In some cases, additional contingencies have been applied.

4.7 KEY COST DRIVERS

To gain an understanding of what various influences would impact the estimate, the key cost drivers were requested and identified. These cost drivers could include, but are not limited to, design parameters (life of equipment), external factors (number of fuel bundles/UFCs handled), repository location, or operating factors (years the facility operates).

4.8 COST TYPES

Each WBS element was identified with a cost type of fixed, step-fixed, or variable as defined below.

Fixed cost – is a cost that is not sensitive to total quantity of used fuel arising, or to facility or system capacity, given a constant used fuel facility throughput rate. For example, most development costs, all siting costs, safety assessment, licensing and approval costs, environmental monitoring costs, many infrastructure costs (roads, surface facilities, utilities), and program costs (program management, public affairs, administration) are not sensitive to total quantity of used fuel arising or the facility or system throughput capacity. Fixed costs are generally unavoidable costs and must be paid irrespective of total used fuel quantity or facility throughput capacity.

Step-fixed cost – is a type of fixed cost that is sensitive to changes in total quantity of used fuel shipped or stored, or to the used fuel throughput capacity of the facility or system. If the total quantity of used fuel changes or the used fuel facility throughput capacity changes, then the size or number and the associated cost of some infrastructure or capital cost items will change. Examples of step-fixed costs are the following:

- Equipment reaches its end of design life (e.g., 10 or 15 years is the norm for most equipment), and new equipment needs to be acquired and installed.
- Productivity rates are achieved, and additional resources are required. For example, one staff can process “x widgets”; once “x” is reached, another staff is required until “2x” is achieved, and so forth.

Variable cost – is a cost that is directly proportional to quantity of used fuel arising. When the quantity of used fuel arising changes, the estimates will change in direct proportion to the change in quantity of used fuel arising. Examples of variable costs are the following:

- Labour directly involved in handling the used fuel (e.g., packing used fuel, emplacing used fuel in emplacement rooms);
- The number of transportation trips is dependent on the assumed used fuel bundles arising; and
- The number of UFCs required is dependent on the assumed used fuel bundles arising.

5. COST ESTIMATE SUMMARY

The following table illustrates source estimates for program management, repository design, and transportation by phase for the base case scenario. The source estimates are described in Sections 5.1, 5.2 and 5.3, respectively.

Table 3: APM Lifecycle Cost Estimate by Implementation Phase and WBS Level 1 (Base Case) (2015 $ Million)

			Cost Element			
			Program Management	Repository	Transportation	Total
Phase	Siting	2010-2023	976	-	37	**1,013**
	Detailed Site Characterization and Licensing	2024-2032	1,038	-	55	**1,093**
	Construction	2033-2042	849	2,822	131	**3,801**
	Operations	2043-2072	830	8,067	544	**9,441**
	Extended Monitoring	2073-2142	552	1,208	4	**1,763**
	Decommissioning and Closure	2143-2172	260	956	-	**1,216**
	Total		**4,505**	**13,051**	**771**	**18,328**

The alternate fuel bundle volume scenario of 7.2 million used fuel bundles was estimated following the methodology outlined in the Section 2.

Table 4: APM Lifecycle Cost Estimate by Implementation Phase and WBS Level 1 (Alternate Case) (2015 $ Million)

			Cost Element			
			Program Management	Repository	Transportation	Total
Phase	Siting	2010-2023	1,009	-	38	**1,047**
	Detailed Site Characterization and Licensing	2024-2032	1,055	-	55	**1,109**
	Construction	2033-2042	859	2,822	144	**3,824**
	Operations	2043-2102	1,553	16,390	1,175	**19,119**
	Extended Monitoring	2103-2172	594	1,208	5	**1,806**
	Decommissioning and Closure	2173-2202	285	1,239	-	**1,524**
	Total		**5,354**	**21,658**	**1,417**	**28,429**

5.1 PROGRAM MANAGEMENT

The cost estimate for the program management portion of the APM lifecycle estimate was prepared by NWMO subject matter experts, consistent with the 2016-2020 NWMO business plan assumptions, including near-term costs. The Phase 2 siting and engineered-barrier proof testing projects are reflected in the estimate through to 2023. The subject matter experts reviewed, updated and prepared WEDS, which are provided in Appendix B and the results incorporated into the cost estimate update.

The 2016 APM lifecycle cost estimate update incorporates the design changes to the engineered-barrier design, specifically comprising the UFC, bentonite overpack and buffer, and placement methodology, resulting in significant reduction in the lifecycle cost estimate. For program management costs, the activities associated with the container design and development have been updated to reflect the option of using the UFC, which includes the proof testing project focused on further development and demonstration of the engineered-barrier design concept. The proof testing activities were advanced from the previous schedule assumption to be able to demonstrate the engineered-barrier design to support the site selection and licensing phases of the APM program. In parallel, the Phase 2 siting project is a multi-year preliminary assessment of a number of different siting study areas, with final analyses and decision of one preferred site for detailed site characterization in 2023.

APM planning objectives include the advance planning and capabilities for the construction and operation of the DGR and the associated Centre of Expertise at the site selected to host the project. The centre will be the home for an active technical and social research and technology demonstration program, and will be developed with the interested community, First Nation and Métis communities in the area, and surrounding communities. The scope of the Centre of Expertise, initially included in the 2011 cost estimate, was broadly defined. The updated estimate is based on clarification of the scope and purpose of the facility. This advancement of planning and capabilities also includes the proof testing project, which has brought forward activities that were planned for phases later in the program, in order to build and demonstrate confidence in the engineered-barrier design.

Experience gained from the low- and intermediate-level waste hearing and licensing process has provided an updated estimate for the CNSC fees to be expected during the lifecycle of the APM program. This most recent experience has been incorporated to the estimate, in addition to the additional years of the licensing phase.

Expectations to meet International Atomic Energy Agency (IAEA) safeguard requirements have been better understood and incorporated into the 2016 cost estimate update. Safeguards are measures through which the IAEA seeks to verify that nuclear material is not diverted from peaceful uses and to deter the proliferation of nuclear weapons. In accordance with the Safeguards Agreement between the Government of Canada and the IAEA, the APM DGR will need to be under IAEA safeguards from the time the used fuel is received at the owner's interim storage facility and transferred into the transportation package. The activities required to meet the agreement assume that the APM program will be granted integrated exemptions as a result of well-defined operating and security procedures similar to current interim storage activities.

The cost estimate has been revised to incorporate the following changes:

a) Updated escalation to constant 2015 dollars and specific labour rate differences from general national escalation, and to reflect the estimate start date of 2015 onward;
b) Other planning assumptions and cost updates consistent with the 2015-2019 NWMO Business Plan; and

c) Siting and licensing duration changes as a result of operating experience.

5.1.1 Cost and Schedule Estimate

As part of the cost estimate and schedule update process, all aspects of the program management costs from the 2011 estimate were reviewed to identify whether changes were required or if the existing continued to be valid. The WBS was reviewed and simplified, resulting in redistribution of costs and some minor estimate changes as a result of removal of duplicated, redundant cost items from the 2011 baseline cost estimate.

The 2011 NWMO program management cost estimate has been updated with changes to areas, including the Centre of Expertise, CNSC fees, safeguards, and schedule.

- The national Centre of Expertise will be an important component of the DGR facility and will be established within the area that is selected for the DGR. The Centre of Expertise will be home to an active technical and social research and technology demonstration program. The Centre of Expertise includes all staffing, equipment, and construction estimates based on conceptual requirements, and it is assumed to be constructed following the selection of a single site and continue through the end of the operations phase.
- CNSC fees, including the cost recovery of their staff assigned to oversee the APM program, incur throughout the lifecycle of the DGR, through to closure and abandonment. CNSC fees include all costs associated with their activities required to meet their regulatory oversight of the APM program.
- The purpose of safeguards measures is to provide credible assurance of non-diversion and the absence of undeclared safeguards-relevant activities. In the DGR facility, this would be accomplished through nuclear material accounting techniques (to maintain knowledge of the contents of each package), and a containment and surveillance system. The updated cost estimate includes safeguards costs for the APM facility, including the design and installation of safeguards equipment, such as satellite imagery, aerial photography, and geophysical monitoring, and all IAEA and CNSC oversight costs.
- There is an eight-year difference to the point of receipt of a construction licence from the 2011 baseline cost estimate to the 2016 updated estimate. This eight-year increase is due to a five-year increase in the siting phase of the program based on program experience to date from Phase 1 of the site selection process, including the greater than expected communities stepping forward to participate in the siting process, as well as three additional years to the licensing phase based on experience gained from the recent low- and intermediate-level waste DGR Project licensing hearings. This cost increase includes the incremental NWMO labour costs over the additional eight-year period, as well as the additional common services costs, Centre of Expertise, CNSC fees, safeguards, and governance and financial surety costs.

The 2016 APM cost estimate includes the proof test project, with planned duration of 2015 to 2022. The decision was made to have the proof testing project complete in advance of licensing submissions, and to include the design and testing activities associated with the engineered-barrier design. This results in costs previously estimated during the construction phase moving forward into the siting phase.

5.1.2 Program Management Summary by WBS Level 2

The following table provides a summary of the 2016 cost estimate at the WBS Level 2.

Table 5: Program Management Cost Summary by WBS Level 2 (2015 $ Million)

WBS Level 2	2016 Estimate
Building Relationships	614
Siting	621
Geoscience/Detailed Site Characterization	507
Environmental	56
Licensing	684
Safety Assessment	240
Technical Research and Collaboration	212
Engineering and Design	609
Financial Surety	20
Governance	61
Common services	884
Total	**4,505**

Details of the WBS Level 2 are provided below.

Building Relationships

Critical to the success of APM is the involvement of the Canadian public, including First Nation and Métis peoples, at all stages of implementation and in key decisions through open, transparent and inclusive engagement processes. In building relationships, the NWMO will seek and be responsive to a diversity of views and perspectives. The NWMO will communicate and consult actively, promoting thoughtful reflection and facilitating a constructive dialogue in different aspects of APM implementation.

Siting

The process to select an APM site in an area with an informed and willing host was initiated in May 2010. The siting process begins with a period of learning and capacity building for communities. The APM program assumes communities elect to progress through subsequent steps of screening, feasibility study and field investigations. The assumptions for this cost estimate are that a single site is selected by 2023 to enter into more detailed site characterization and licensing. All costs associated with siting activities (i.e., municipal and aboriginal engagement, geoscience, environmental, design, safety assessment, etc.) are included in this WBS through to the point of single site selection.

Geoscience/Detailed Site Characterization

Technical activities related to site selection, including initial geoscience investigations, are included in siting until a single site is selected. Following site selection, geoscience and detailed site characterization activities are captured as part of the WBS. This includes surface-based borehole drilling, borehole investigations, installation of monitoring equipment and down-the-hole instrumentation, and ongoing monitoring of these activities during all phases.

Environmental

Technical activities related to site selection, including initial environmental investigations, are included in siting until a single site is selected. Following site selection, environmental activities, including field investigations, environmental assessment preparation, and ongoing environmental oversight, are included in this WBS.

Licensing

Staffing, resources, CNSC fees, and costs associated with regulatory reviews, for all phases of facility licensing, are included in this WBS. The ongoing costs for maintenance of the licences are also captured. This includes estimates of annual CNSC oversight fees. IAEA staff and equipment costs to meet the international safeguard requirements are recovered through CNSC fees.

Safety Assessment

Following site selection, all costs associated with the development of the safety case in support of licensing submissions, as well as the maintenance of the safety case through implementation phases, are included in this WBS.

Technical Research and Collaboration

A number of technical and scientific activities are being conducted to further increase confidence in the safety case for the APM facility and to improve the NWMO's understanding of key scientific processes that may influence repository safety. These confidence building and process understanding activities include models of the engineered-barrier system, groundwater flow system evolution, integrated safety assessment models, and full-scale demonstration of repository technology both in Canada and with international partners in joint research facilities.

Engineering and Design

Engineering and design includes all activities related to the development of conceptual, feasibility and preliminary designs for the APM facility. The work activities include the optimization and proof testing activities related to the engineered-barrier design in advance of single site selection. Following site selection, site-specific designs will be further developed in support of the licence application.

Areas where technology requires additional development for deployment in the APM program are generally focused around the used fuel processes. Canada has demonstrated leadership in CANDU fuel transfer operations, and this domestic expertise will be investigated for fuel transfer operations. Similar advancement programs are required for monitoring, container placement and retrieval, and sealing system demonstration.

Financial Surety

As APM is implemented, the NWMO will continue to ensure that the cost estimates remain updated and that the funding formula supports the financing of all aspects of APM. Contributions will be adjusted periodically to reflect updated projections of overall costs of APM and the number of fuel bundles expected to be produced by each used fuel owner. Financial surety includes the resources required to maintain the APM cost estimates and funding requirements per the *NFWA*.

Governance

This WBS captures the costs associated with the ongoing maintenance of the NWMO's various governance processes and oversight. These include the Board of Directors, Advisory Council, and other forums from which the NWMO receives guidance and/or oversight.

Common Services

Overall business, administrative and management function that will provide the necessary back-office support to the program, including the provision and/or management of finances, systems, people, infrastructure, and supplies. Costs associated with the NWMO's common services include, but not limited to, the corporate executive office, finance, procurement, IT, performance assurance, and human resources.

5.2 USED FUEL REPOSITORY

The concepts for a DGR facility receiving the UFC is described in APM-REP-00440-0015. The design report describes the required facilities and infrastructure needed to safely receive and package the used nuclear fuel, and place a UFC in the DGR. Details are found in the WEDS in Appendix B.

The APM DGR facility cost estimate has been updated by NWMO subject matter experts and external engineering firms with technical expertise in design, construction and underground mining.

The engineered-barrier design is comprised of a 48-bundle UFC designed by the NWMO and optimized for CANDU fuel, incorporating the latest copper-coating and welding technologies, as well as a bentonite overpack, buffer systems, and associated handling, packaging and placement processes. The placement methodology for the UFC includes in-room placement for both the crystalline and sedimentary rock geospheres. The underground layout and excavation has been developed based on the thermo-mechanical studies as it relates to the engineered-barrier design, defining placement room dimensions and overall layout. The design includes UFC loading, welding and overpacking a bentonite buffer box in the UFPP at the DGR.

5.2.1 Cost and Schedule Estimates

The 2016 Used Fuel Repository cost estimate update is shown in Table 6 by program phase.

Table 6: APM Used Fuel Repository Cost Estimate (2015 $ Million)

Program Phase	2016 Estimate
Siting	-
Detailed Site Characterization and Licensing	-
Construction	2,822
Operations	8,067
Extended Monitoring	1,208
Decommissioning and Closure	956
Total	**13,050**

5.2.2 Used Fuel Repository Summary by Cost Element

Details within the WBS elements that were assessed to be not affected by the design changes from the 2011 reference estimate were escalated to constant 2015 dollars. Details are found in WEDS in Appendix B.

In summary, the 2016 lifecycle cost estimate for the repository cost work packages is as follows:

Table 7: Repository Facility Cost Estimate by Work Package (2015 $ Million)

Work Package	2016 Estimate
UFC	**2,097**
Surface Facilities	**4,377**
UFPP	2,144
Sealing Materials Equipment and Production	1,119
Shafts, Headframes and Hoisting Systems	464
Additional Surface Facilities	651
Underground Facilities	**1,818**
Underground Excavation	638
Underground Ventilation, and Mining Heat and Power	756
UFC Placement	424
Operations Management	**2,594**
Extended Operations and Decommissioning	**2,163**
Total	**13,050**

The cost estimate update includes the costs for lifecycle of the used fuel repository facility, including the UFC, surface facilities, underground facilities, operations management, and extended operations and decommissioning. The scope of the lifecycle estimate is summarized below with additional design information provided in APM-REP-00440-0015 and cost estimate details found in the WEDS in Appendix B.

5.2.2.1 Used Fuel Container (UFC)

A cost estimate to manufacture and deliver an empty UFC to the APM DGR has been assembled based on inputs from various external experts in the manufacturing sector. The UFC cost estimate considers five stages of the UFC production sequence. The five stages (in production sequence) are:

- Fabrication of the steel core and internal fuel basket;
- Copper coating of the steel core, using electro-deposition;
- Closure welding of the UFC (cost of consumable material estimated only);
- Copper coating over the closure weld zone, using copper cold spray (cost of consumable material estimated only); and
- Transportation of the empty UFCs (without used fuel) to the UFPP.

The steel vessel component costs consist of an estimate for the core and internal basket, and an estimate for the materials consumed in the closure weld process.

Estimates for the manufacture of the steel core and internal basket were solicited to provide a range of conceptual manufacturing approaches, experiences and associated costs. The estimates for the steel core and internal basket were based on a realistic manufacturing sequence developed from analysis of technical specifications and UFC conceptual designs with a sound understanding of the requirements and experience to meet nuclear procurement standards.

An estimate for the costs of the consumables for Hybrid Laser Arc Welding (HLAW) closure weld was developed considering the costs of welding wire, shielding gas, and electricity. The copper coating component cost consists of an estimate for the electro-deposited coating and an estimate for the materials consumed in the cold-spray process.

The cost estimate of electro-deposition coating is based on the latest developed Cuproclad process (Integran Technologies, Inc.) for a coating of the UFCs to a target copper thickness of three millimeters. The cost of consumed material and power was the most significant component of the estimate. The unit cost of $4 per kilogram of copper was used in developing the estimate for the UFC. An estimate was prepared for the costs of cold-spray consumables over the final closure weld area in 2013 by the NWMO, which recommended that the four-millimeter coating thickness value should be utilized for all costing to account conservatively for post-deposition machining requirements.

Transportation costs are all-inclusive for the transportation of the empty UFCs from the site of manufacture to the UFPP located at the APM DGR site using 2014 shipping rates. The UFC manufacturing facilities are assumed to be located near the UFPP (within 100 kilometers). The UFC will be built largely from components with standard dimensions and is intended to be fabricated with conventional methods in order to reduce the quantity of specialized equipment/technologies required. The net cost impact of locating the manufacturing facilities near the DGR instead of in southern Ontario has yet to be fully assessed.

Transportation does not include any movement of used fuel; costs for transporting fuel from reactor sites are addressed in the APM DGR transportation cost estimate. Costs of transportation between the steel fabrication and electro-deposition facilities are deemed immaterial as it has been assumed that both facilities will be located beside each other.

Table 8: UFC Cost Summary (2015 $)

UFC Cost	2016 Estimate
Cost per UFC	27,961
Annual Cost ($ Million)	69.9
Total Cost ($ Million) – 3.6 Million Base Case	2,097

5.2.2.2 Surface Facilities

The DGR facility will be self-contained, and has facilities for operation, maintenance and long-term monitoring. The surface facilities will have an area with restricted access, including the UFPP, and shaft complexes, as well as facilities outside the restricted area such as the Sealing Materials Compaction Plant, Concrete Batch Plant, and all other surface facilities, including administration buildings, water and waste buildings, and accommodation for construction personnel. The surface facilities that are unique to the used fuel repository and are designed based on the engineered-barrier design (UFC and emplacement methodology) are the UFPP, the Sealing Materials Compaction Plant, and the Main, Service and Ventilation Shaft complexes. These are summarized below. All other surface facilities are detailed in the WEDS in Appendix B.

Used Fuel Packing Plant (UFPP)

The used nuclear fuel will be received at the UFPP from the originating interim storage sites. The used fuel will be transported in certified road transportation packages (UFTPs) as outlined in the Used Fuel Transportation System (UFTS) section, Section 5.3. The UFTPs will be received at the UFPP, and the used fuel bundles will be transferred to the UFCs. The filled UFCs will be sealed, inspected and inserted into buffer boxes, consisting of a two-piece metallic outer shell that is filled with highly compacted bentonite formed into blocks with a machined cavity to house the UFC. The buffer box and UFC will be dispatched for placement in the underground repository.

The UFPP facility layout and conceptual design has been updated to reflect the engineered-barrier design including:

- Three autonomous fuel transfer lines;
- Three HLAW cells;
- Six copper cold-spray coating cells;
- Non-destructive examination equipment for three welding and six copper spray cells; and
- 30 shielded flasks and six automatic guided vehicles.

The buffer box assembly area was not a component of the UFPP in the 2011 baseline UFPP estimate. The UFC and placement methodology includes an in-room methodology in which the UFC is encapsulated in a bentonite buffer box above ground. This methodology may increase the cost of the UFPP above ground; however, it replaces work that was to be performed underground in confined spaces and difficult to maneuver.

UFPP operations costs are proportional to the volume of UFCs to be processed and handled annually to achieve the target rate of 120,000 fuel bundles per year, which is 2,500 UFCs per year versus 333 IV-25 UFCs for the 2011 estimate. The UFPP equipment and layout allows for multiple simultaneous activities to occur. To handle the greater UFC throughput, increased staffing and equipment maintenance are required.

A summary of the UFPP cost elements for the engineered-barrier design is as follows (2015 $):

Table 9: UFPP Cost Estimate Summary by Cost Component (2015 $ Million)

UFPP Cost Component	2016 Estimate
UFPP Design, Construction, Commissioning	209
UFPP Equipment and Services Design, Supply and Install	767
Buffer Box Assembly Area	44
UFPP Operations	1,124
UFPP Decommissioning	22
Total	**2,165**

Sealing Materials Production Plants

Concrete Batch Plant and Sealing Materials Compaction Plant operations are required to produce repository sealing materials for the encapsulation of the placed UFCs. The UFC will be pre-packaged, above ground in the UFPP, into a rectangular-shaped buffer box consisting of a two-piece metallic outer shell that is filled with highly compacted bentonite with a machined cavity to house the UFC. The UFCs are encapsulated in bentonite, and the placement rooms are backfilled with dense backfill blocks and gap fill, comprised of aggregate, clay and bentonite. Spacing between the encapsulated UFCs in the placement room is 1.5 meters. The spacing between UFCs is filled with dense backfill blocks which are manufactured at the Sealing Materials Compaction Plant, as well as the 100 per cent bentonite gap fill that will be placed around the stack of buffer boxes inside each placement room. The plant will employ custom-designed presses and moulds for manufacturing the blocks with specialized lifting devices in place to handle the formed materials.

The estimate for the production of the sealing materials includes the equipment and facilities of the concrete and sealing materials plants, as well as the material, labour and power required to operate the plants for the life of the facility.

The volume of backfill required for the design has reduced from the 2011 reference design, due to the size and shape of the placement rooms, and the methodology of in-room placement versus vertical in-floor borehole placement. The total volume of bentonite has increased slightly while the volume requirements for the other backfill materials have decreased. In addition, the very large and specialized presses needed to create the dense backfill blocks and bentonite buffer discs for the in-floor borehole scenario can be smaller for the blocks required for the UFC, and fewer presses are needed to produce the volume of blocks required for backfill.

Shafts, Headframes and Hoisting Complexes

The APM DGR facility includes three shaft complexes – the Main Shaft, Service Shaft, and Ventilation Shaft, as detailed in *Deep Geological Repository Design Report Crystalline / Sedimentary Rock Environment Mark II Used Fuel Container* – APM-REP-00440-0015. The shaft complexes will support the underground development works, and the Main Shaft complex serves as the exclusive conveyance structure for the surface-to-underground transfer of the buffer boxes (with UFCs). The Service Shaft complex hoisting facility incorporates equipment for delivering excavated rock to ground surface, and personnel and materials to the underground repository. The Ventilation Shaft complex handles the majority of the repository exhaust and serves as a secondary means of egress from the underground repository.

The shaft diameters and excavation methods have been reviewed and updated with mining industry best practices and safety case requirements. The changes to the shaft costs for the Main and Service Shafts are related to the updated requirement for redundant services.

Previously, services such as electrical, water, power, etc., were provided through one shaft only. Having services provided through only one shaft left the facility vulnerable to any interruptions from issues in the shaft. Redundant services in the Main and Service Shafts includes a complete set of all supply and return lines; in the event that there is an issue with one, there is a backup. The Ventilation Shaft has been modified based on updated air flow calculations, and has been resized to prevent water droplets from forming and remaining suspended within the Ventilation Shaft.

The cost estimate for the shaft complexes includes the excavation associated with the sinking of the three shafts, the maintenance and replacement of the hoist rope and associated equipment, as well as the sealing and decommissioning of the shafts at the end of the monitoring period.

Table 10: Shaft, Headframes and Hoist Complexes Cost Summary (2015 $ Million)

Shaft, Headframe and Hoist Complexes Cost Component	2016 Estimate
Service Shaft and Headframe	188
Main Shaft and Headframe	164
Ventilation Shaft and Headframe	94
Service Shaft Decom	58
Main Shaft Decom	48
Ventilation Shaft Decom	40
Hoist Rope Replacement	18
Total	**610**

Additional Surface Facilities

Activities and costs included in additional surfaces includes the preparation of the site for surface facilities, including access road, transmission towers, off-site waste rock disposal areas, construction indirects otherwise not included in engineering, procurement and construction price items, process facilities, and other surface auxiliary facilities, including the engineering, design, construction, and commissioning of facilities to service the daily operations of the DGR. Details are found in the WEDS specific to each facility building included in Appendix B.

5.2.2.3 Underground Facilities

The scope of the underground facilities estimate includes the excavation of the underground repository, including the services area, perimeter and access tunnels, and placement rooms, and includes the underground ventilation system and underground operations (i.e., UFC placement).

Underground Facility Excavation

The underground facilities are comprised of two main areas: a) underground services area located at the base of the Main Shaft and Service Shaft; and b) the placement area comprised of eight panels of rooms as shown in Figure 2 of Section 4.1. The underground services area would provide a range of facilities to support DGR operations, including the Underground Demonstration Facility (UDF), refuge station, office, washrooms, maintenance shops and warehouses, explosives and detonator magazines, etc. Details can be found in the design report and the WEDS found in Appendix B.

The basic arrangement of the underground repository involves a series of parallel, dead-end placement rooms organized into panels. All underground openings will be excavated by controlled drill and blast methods. The placement rooms will have a rectangular shape of nominal dimensions 3.2 meters wide by 2.2 meters high.

Initial construction of the underground repository would span a period of approximately 10 years. During this time, the underground services area, including the UDF, the perimeter tunnels, the central access tunnels, and two panels of placement rooms would be developed. Following the start of operations, excavation of placement rooms would proceed concurrently with UFC placement activities. Sequencing of excavation and UFC placement activities would provide separation of these two activities from a manpower, ventilation and equipment perspective.

The engineered-barrier design results in a reduction in excavation costs resulting from in-room placement and a reduced cross-section of room dimensions from the 2011 reference placement method.

Underground Ventilation, and Mining Heat and Power

A series of surface fans and underground booster fans will be required to achieve the design flow distribution in the underground repository. A surface-based fresh air heating plant will used to heat air in winter months. Auxiliary fans and ducting that are located in the underground tunnels and rooms will direct airflow into active placement rooms.

The cost estimate for the underground ventilation, and mining heat and power includes emergency power generation, the design, procurement, installation, and commissioning of the ventilation system, including spares and eventual decommissioning, as well as costs incurred for mine heating and electricity required for the fans, hoisting, pumps, etc., during operations.

A summary of costs for the ventilation, and mining heat and power lifecycle costs are shown in Table 11.

The unit price increase of propane has resulted in an increase in the cost for heating and power to the underground facilities during construction and operations. Details are found in the WEDS in Appendix B.

A significant redesign of the underground ventilation system was carried out by external experts, identifying equipment and specifications based on modelling techniques. The updated ventilation system design is not related to the design change.

Table 11: Ventilation System, and Mining Heat and Power Cost Summary (2015 $ Million)

Ventilation System, and Mining Heat and Power Cost Estimate	2016 Estimate
Emergency Power Generation	18
Ventilation System (Including Decommissioning)	66
Mining Heat and Power	674
Total	**757**

UFC Placement

Prior to underground transfer, the UFC would be pre-packaged into the rectangular buffer box. Concepts for the safe transfer and placement of the UFCs have been developed based on a review of proven nuclear industry material handling concepts, as well as related work by other national radioactive waste management organizations. Additional details are found in the design report and associated WEDS in Appendix B.

Placement of the UFC underground may be less challenging than the much larger IV-25 container design; however, the volume of UFCs requiring placement is greater (i.e., 333 IV-25 UFCs per year versus 2,500 UFCs per year), requiring placement in three rooms concurrently. As a result, the labour required to achieve the annual throughput rate of 120,000 used fuel bundles has not changed significantly. The placement methodology assumes much of the placement will be performed by equipment that is remotely controlled. Remote handling of the UFCs is required because it is assumed that the buffer boxes (with UFCs) must be transferred without shielding inside the placement room. The remote handling placement equipment requires remote communications equipment that will be located in the surface facilities auxiliary building.

The smaller size UFC design results in significant efficiencies in the transfer process from the UFPP to the underground. Also, the estimated operations time is reduced to place the UFC in-room versus the time to place UFCs in the in-floor concept. These operational savings are offset by the 7½ times higher volume of trips to be made to achieve the constant throughput rate of 120,000 used fuel bundles.

The cost estimate for UFC placement includes a set of placement equipment for use in the UDF, as well as the remote communication system, UFC handling systems, UFC placement equipment, and labour and indirects for final panel UFC placement.

5.2.2.4 Operations Management

Operations management encompasses the management and administrative functions covering the day-to-day operation of the DGR facility during the operations phase, as well as the indirect labour and equipment required to operate the DGR during facility operations (excluding indirects accounted for in underground excavation work elements), as well as annual allocation for taxes. Operations management also includes the operation and maintenance of surface buildings and associated facilities (excluding the UFPP, Sealing Materials Compaction Plant, or mining or placement facilities).

Operations management includes operational safety and radiation shielding, with key monitoring programs addressing:

- Worker occupational health and safety;
- Environmental monitoring at the surface and underground;
- Site security and emergency response plans; and
- Support systems, including fire detection and suppression.

Further details and scope of personnel and equipment included in the operations management scope can be found in the WEDS in Appendix B (570.45.10, 570.45.20, 560.45.30, and 570.45.40.40).

5.2.2.5 Extended Operations and Decommissioning

Subsequent to the cessation of used fuel placement activities, there will be a period of extended monitoring. Extended operations includes the operation, maintenance/refurbishment, and management of the DGR for the extended monitoring period (70 years), which includes monitoring and preservation of key surface and underground facilities, monitoring the geotechnical integrity of the DGR, etc.

Following the receipt of regulatory approval, the DGR facility will be decommissioned and the underground repository sealed. Decommissioning and closure encompasses management, construction, and operation of related facilities, and decommissioning and closure of the surface and underground facilities. Included in decommissioning is the operation and management of the DGR for the years during decommissioning, including staffing, as well as all facilities and equipment needed for decommissioning activities. Further details are found in the WEDS in Appendix B.

5.3 USED FUEL TRANSPORTATION SYSTEM (UFTS)

The cost estimating methodology for the update of the UFTS cost estimate assessed that the design basis of the 2011 baseline UFTS estimate has not significantly changed, and the estimate update will be carried out based on a WBS analysis, considering escalation for elements that have not changed. The estimate was updated based on the following:

a) Change in battery limit (scope terminal point) between the waste owners' interim storage and the UFTS estimate;
b) Site-specific fuel inventory and transportation logistics changes; and
c) Additional eight years of program schedule in siting and licensing.

Details of the WBS elements are found in WEDS in Appendix B.

The change in battery limit between interim storage and the transportation work activities was completed to align with the expected licensing responsibilities between the waste owner and the NWMO. The waste owner will own and operate the transfer from interim storage through to loading the transportation package. The NWMO will be the license holder and operator of the transportation package and associated vehicle. The updated UFTS cost estimate assumes the waste owner has retrieved the used fuel from their interim storage facilities and loaded the UFTP, prepared for transport to the DGR Facility. All the costs to transport the UFTP to the repository site are considered in the updated APM estimate.

The used fuel inventories and transportation schedules are based on the most recent fuel waste projections provided by the various waste owners. Quantities of used fuel assumed to be generated by each waste owner are listed in Table 12, including the estimated number of shipments from each site. The fuel inventory is used to allocate the equipment costs of the UFTS (i.e., casks, trailers, vehicle maintenance) between the waste owners. Shipment logistics are used to calculate costs based on number of shipments and assumed distance to the DGR site, as well as the cost schedule. It should be noted that a change in the distribution of shipping from that shown below would not have a material impact on the UFTS estimate, as the fixed assets are based on the total number of shipments required.

Table 12: Used Fuel Inventory and Shipments by Waste Owner

Owner	2016 Base Case	
	Bundles	**Shipments**
OPG	3,134,852	16,331
AECL	32,658	183
HQ	129,941	687
NBPN	260,000	1,454
Total (rounded)	**3,600,000**	**18,655**

5.3.1 UFTS Cost Schedule Estimates

The 2016 cost estimate update is consistent with the NWMO 2016-2020 business planning assumptions and costs. The 2016 UFTS cost estimate update is shown in Table 13 by program phase and in Table 14 by WBS Level 2.

Table 13: UFTS Cost Summary by Phase (2015 $ Million)

Program Phase	2016 Estimate
Siting	37
Detailed Site Characterization and Licensing	55
Construction	131
Operations	544
Extended Monitoring	4
Decommissioning and Closure	-
Total	**771**

5.3.2 UFTS Summary by WBS Level 2

Details within the WBS elements that were assessed to be not affected by the design changes from the 2011 reference estimate, were escalated to constant 2015 dollars. Details are found in WEDS in Appendix B.

In summary, the 2016 lifecycle cost estimate for the UFTS by WBS Level 2 is as follows:

Table 14: UFTS Cost Summary by WBS Level 2 (2015 $ Million)

WBS Level 2	2016 Estimate
Route and System Development	108
Capital Equipment and Facilities	114
Transportation System Operations	385
Environmental Management	8
Decommissioning	15
Program Management	142
Total	**771**

Details of the WBS Level 2 are provided below:

Route and System Development

This WBS comprises the detailed design and route selection process which will depend on the actual inventories and storage locations at the time of commissioning. It includes mode and route development work, such as studies to assess the feasibility of transporting used fuel from the actual future storage facilities to the DGR and identifying preferred shipping routes. This element also includes the near-term cost details, including logistics studies, risk analysis, operational concepts, emergency response plans, and examination of occupational and public radiological safety during the transport of used fuel for transportation system optimization. Results will be used during route and site selection, site licensing, and environmental assessments.

Capital Equipment and Facilities

This covers the design, procurement, construction, testing, and commissioning of all equipment or facilities to implement the transportation system. It includes the transporters, transport packages, maintenance and transfer infrastructures, Included within lower levels of this WBS is the detailed design, procurement, and commissioning of the trailers and tractors for the transportation system. It is further subdivided into work elements for each reactor site and for "non-site specific" (also referred to as "common") components. In addition, the detailed design, documentation for licensing, procurement and manufacturing, testing, and commissioning of the UFTPs and associated equipment are included. Equipment and facilities associated with the DGR receiving facility include equipment for real-time tracking and emergency response.

Transportation System Operations

These elements include all activities to operate the transportation system from loaded UFTP reception at the waste owner's facility to the delivery of the loaded UFTPs at the DGR. This WBS element is subdivided into several components to account for each step, as follows:

- Project management;
- UFTP transportation logistics;
- UFTP transportation logistics at DGR; and
- UFTP transportation vehicles maintenance.

Overall, the operational phase of the transportation system is determined by the fuel inventory and the transportation rate.

- Project management encompasses project-level management of the transportation system, including reporting to program management.
- UFTP transportation logistics addresses the full cycle of trailer loading/unloading and active driving time. The operational sequence covering vehicle preparation and UFTP loading/unloading is expected to be common amongst the various reactor storage sites.
- UFTP transportation logistics at DGR includes real-time tracking and the operation of the emergency response system during the shipping period, which includes completed emergency response plans with all necessary documentation, and staffed emergency system ready to activate needed resources and deploy a recovery system for the transportation package.
- UFTP transportation vehicles maintenance encompasses transportation system vehicle maintenance.

Environmental Management

Environmental management work, as defined under this WBS element, encompasses the following, and continuing throughout system operations:

- The setup and monitoring of transportation aspects within an Environmental Management System in accordance with ISO 14001;
- Auditing of comparable supplier management systems;
- Liaison with regulators regarding associated requirements;
- Assistance with transportation aspects of environmental assessment work; and
- Planning of environmental monitoring activities as needed.

Decommissioning

The decommissioning WBS element includes the development and approval of plans to decommission the transportation systems and associated loading facilities (and undertaking those plans), the decontamination of used fuel auxiliary equipment, and the management/storage of the decommissioning wastes. It is assumed that the UFTS and associated loading facilities will have been well-maintained, and will not have any major contamination or have experienced a major irradiation incident or accident.

Program Management

Program management includes management direction and oversight of the transportation program, including contract management, financial, scheduling, quality assurance, and corporate overheads. Activities are staged accordingly to align with the overall APM schedule.

REFERENCES

NWMO (2016). Deep Geological Repository Design Report Crystalline / Sedimentary Rock Environment Mark II Used Fuel Container. Nuclear Waste Management Organization APM-REP-00440-0015, May 2016.

APPENDIX A: WORK BREAKDOWN STRUCTURE (WBS)

WBS NUMBER	DESCRIPTION
PROGRAM MANAGEMENT	
BUILDING RELATIONSHIPS	
570.05.10	BUILDING RELATIONSHIPS - ADAPTING TO CHANGE
570.05.20	BUILDING RELATIONSHIPS - COMMUNICATIONS
570.05.30	BUILDING RELATIONSHIPS - NATIONAL AND REGIONAL RELATIONSHIPS
570.05.90	BUILDING RELATIONSHIPS - STAFFING
570.05.40	BUILDING RELATIONSHIPS - 2015 BP & 2010 ESTIMATE POST-CONST
SITING	
570.15.90.10	SITING - STAFFING FROM PHASE 2 PLANNING
570.15.20	CENTRE OF EXPERTISE
570.15.30	COMMUNITY ENGAGEMENT
570.15.40	ABORIGINAL ENGAGEMENT
570.15.90.20	ENGAGEMENT STAFFING - COMMUNITY AND ABORIGINAL
570.15.60	SITE ACQUISITION - PURCHASE OF LAND
570.15.70	SITING - PTD ACTUALS AND BP
GEOSCIENCE/DETAILED SITE CHARACTERIZATION	
570.30.10	DETAILED SITE CHARACTERIZATION
570.30.20	GEOSPHERE MONITORING
570.30.90	GEOSCIENCE / DETAILED SITE CHARACTERIZATION - STAFFING
ENVIRONMENTAL	
570.85.10	ENVIRONMENTAL MONITORING
570.85.20	HUMAN HEALTH AND EIS
570.85.90	ENVIRONMENTAL STAFFING
LICENSING	
570.35.10	LICENSING - CNSC FEES
570.35.90	LICENSING STAFFING
570.35.20	SAFEGUARDS
SAFETY ASSESSMENT	
570.10.90	SAFETY ASSESSMENT - STAFFING
570.10.10	SAFETY ASSESSMENT - EA AND PSR
570.10.20	SAFETY ASSESSMENT - SUPPORT FOR REVIEW AND HEARINGS
570.10.30	SAFETY ASSESSMENT - POST CONSTRUCTION SA AND TECHNICAL
TECHNICAL RESEARCH & COLLABORATION	
570.25.10	TECHNICAL RESEARCH & COLLABORATION
570.25.90	TECHNICAL RESEARCH & COLLABORATION - STAFFING

WBS NUMBER	DESCRIPTION
ENGINEERING AND DESIGN	
570.20.90.10	ENGINEERED BARRIER DESIGN & PROOF TESTING - STAFFING
570.20.90.20	ENGINEERING AND DESIGN - GENERAL TECHNICAL SUPPORT STAFFING
570.20.10	ENGINEERING AND DESIGN - REPOSITORY DESIGN AND LICENCE SUPPORT
570.20.20	ENGINEERING AND DESIGN - SEALING AND RETRIEVAL DEMONSTRATIONS
570.20.30	ENGINEERED BARRIER DESIGN & PROOF TESTING
570.20.40	ENGINEERING AND DESIGN - CENTRE OF EXPERTISE ACTIVITIES
570.20.50	ENGINEERING AND DESIGN - TECHNICAL OVERSIGHT OF EPC CONTRACT
570.20.60	TECHNICAL RESEARCH & COLLABORATION - UDF DEMONSTRATIONS
FINANCIAL SURETY	
570.70	FUNDING FORMULA/FINANCIAL SURETY
GOVERNANCE STRUCTURE	
570.80	GOVERNANCE STRUCTURE
COMMON SERVICES	
570.90	COMMON SERVICES
USED FUEL REPOSITORY	
USED FUEL CONTAINER	
570.45.40.20	SUPPLY OF BASKETS AND UFCS
SURFACE FACILITIES	
USED FUEL PACKING PLANT	
570.40.40.10	USED FUEL PACKING PLANT (UFPP)
570.40.40.10.10	UFPP PROJ MAN / BUILDING DESIGN & CONSTRUCTION
570.40.40.10.20	UFPP EQUIPMENT DESIGN SUPPLY AND INSTALL (RECEIVE & TRANSFER)
570.40.40.10.30	UFPP EQUIPMENT DESIGN SUPPLY AND INSTALL (PACKAGE)
570.40.40.10.40	UFPP EQUIPMENT DESIGN SUPPLY AND INSTALL (DISPATCH)
570.40.40.10.45	BUFFER BOX ASSEMBLY (UFPP)
570.40.40.10.50	BUILDING SERVICES DESIGN SUPPLY & INSTALLATION (UFPP)
570.40.40.10.60	COMMISSIONING (UFPP)
570.45.40.10	UFPP OPERATION
SEALING MATERIALS EQUIPMENT AND PRODUCTION	
570.40.10.30.20.20	CONCRETE PLANT
570.40.40.20	SEALING MATERIAL COMPACTION PLANT (SMCP)
570.45.50.60.10	BACKFILL MATERIAL (SMCP & CONCRETE)
SHAFTS, HEADFRAMES & HOISTING SYSTEMS	

WBS NUMBER	DESCRIPTION
570.40.10.30.20.50	SERVICE SHAFT AND HEADFRAME
570.40.60.20	MAIN SHAFT AND HEADFRAME
570.40.60.30	VENTILATION SHAFT AND HEADFRAME
570.45.50.100.10	HOIST ROPE REPLACEMENT
570.45.50.100.20	HOIST ROPE REPLACEMENT
ADDITIONAL SURFACE FACILITIES	
570.40.10.30.20.40	CAMPSITE AND CAMPSITE OPERATIONS
570.40.20	SITE IMPROVEMENTS
570.40.30	CONSTRUCTION PHASE INDIRECTS (INC FIRE & SECURITY)
570.40.50	SURFACE AUXILIARY FACILITIES
570.40.50.100	PUMPHOUSE & INTAKE
570.40.50.110	WATER STORAGE TANK AREA
570.40.50.120	WATER TREATMENT PLANT
570.40.50.130	PROCESS WATER SETTLING POND
570.40.50.140	SERVICE SHAFT WATER SETTLING POND
570.40.50.150	STORM RUN-OFF POND
570.40.50.160	SEWAGE TREATMENT PLANT
570.40.50.170	LOW LEVEL LIQUID WASTE STORAGE BUILDING
570.40.50.180	ACTIVE LIQUID WASTE TREATMENT (ALWT) SYSTEM
570.40.50.190	WASTE MANAGEMENT AREA
570.40.50.20	ADMIN BLDG
570.40.50.220	LOW LEVEL WASTE STORAGE BUILDING
570.40.50.230	ELECTRICAL SWITCHYARD
570.40.50.240	TRANSFORMER AREAS
570.40.50.250	VISITORS CENTRE
570.40.50.30	AUXILIARY OFFICE BUILDING
570.40.50.40	QC OFFICES & LABS
570.40.50.50	GARAGE BUILDING / WAREHOUSE
570.40.50.60	WALKWAYS/SERVICEWAYS
570.40.50.70	FUEL TANK AREA
570.40.50.80	SECURITY CHECKPOINTS
570.40.60.50	SUPPORT SERVICES AND FACILITIES
570.40.70.10	FACILITY ELECTRICAL DISTRIBUTION
570.40.70.30.10	FIRE WATER
570.40.70.30.20	POTABLE WATER
570.40.70.30.30	PROCESS WATER
570.40.70.30.40	SEWERAGE
570.40.70.30.50	STORMWATER AND DRAINAGE

WBS NUMBER	DESCRIPTION
570.40.70.40.10	BREATHING AIR
570.40.70.40.20	SERVICE AIR
570.55	ENVIRONMENTAL MANAGEMENT SYSTEM
570.55.40	ENVIRONMENTAL RESPONSE EQUIPMENT
570.55.50	RADIOLOGICAL MONITORING EQUIPMENT
570.55.60	NON RADIOLOGICAL MONITORING EQUIPMENT
UNDERGROUND FACILITIES	
UNDERGROUND EXCAVATION	
570.40.10.30.20.70	TUNNEL AND SERVICE AREA EXCAVATION
570.40.60.60	PERIMETER AND ACCESS TUNNELS/CROSS CUTS
570.40.60.70	INITIAL PLACEMENT ROOMS (PANEL A)
570.40.60.80	ROOM EXCAVATION (SECOND STAGE) PANEL B
570.45.50.40	ROOM EXCAVATION (THIRD STAGE) PANEL C
570.45.50.50	ROOM EXCAVATION (FOURTH STAGE) PANEL D
570.45.50.150	ROOM EXCAVATION (FIFTH STAGE) PANEL E
570.45.50.160	ROOM EXCAVATION (SIXTH STAGE) PANEL F
570.45.50.170	ROOM EXCAVATION (SEVENTH STAGE) PANEL G
570.45.50.180	ROOM EXCAVATION (EIGHTH STAGE) PANEL H
UNDERGROUND VENTILATION AND MINING HEAT AND POWER	
570.40.50.90	EMERGENCY POWER GENERATION
570.40.60.40	VENTILATION SYSTEM
570.45.50.120	MINING HEAT AND POWER
UFC PLACEMENT	
570.40.10.30.10	UDF EQUIPMENT
570.40.70.20	FACILITY COMMUNICATION SYSTEM(S)
570.45.50.60.20	UFC EQUIPMENT
570.45.50.60.30	PLACEMENT LABOUR
570.45.50.110	INDIRECTS FOR FINAL PANEL UFC PLACEMENT
OPERATIONS MANAGEMENT	
570.45.10	OPERATIONS PROGRAM MANAGEMENT (INC TAX)
570.45.20	DIRECT OPS MANAGEMENT (INC QA)
570.45.30	OPERATIONS INDIRECTS (INC FIRE & SECURITY)
570.45.40.40	O&M OF AUXILIARY SURFACE FACILITIES
EXTENDED OPERATIONS AND DECOMMISSIONING	
570.45.50.130	EXTENDED OPERATIONS (INC SUPPORT SERVICES)
570.45.50.140	EXTENDED OPERATIONS EQUIP REPLACE/REFURB/MAINTAIN
570.60.10	DECOMMISSIONING MANAGEMENT
570.60.120	CRUSHER PLANT DEMO (DECOMM)

WBS NUMBER	DESCRIPTION
570.60.130	SITE CLEANUP (DECOMM)
570.60.150	DECOMM INDIRECTS (INC HEAT, CONSUMABLES)
570.60.160	DECOMM WASTE DISPOSAL
570.60.170	FINAL CLOSURE
570.60.30	DECOMMISSIONING FACILITIES (CONSTRUCTION & OPERATION)
570.60.30.10	BACKFILL MATERIAL PLANT (SUPPLY AND OPERATE)
570.60.30.20	WASTE PROCESSING AND HANDLING FACILITY
570.60.40	AUXILIARY SURFACE FACILITIES DECOMM
570.60.50	USED FUEL PACKING PLANT (UFPP) DECOMM
570.60.60	SEALING MATERIAL COMPACTION PLANT DECOMM
570.60.70	ANCILLARY RAD AREA DECOMM
570.60.70.10	ALWT
570.60.70.20	LLLW STORAGE
570.60.70.30	LLW STORAGE
570.60.80	UFC HANDLING SYSTEMS
570.60.90	PERM VENT FAN REMOVAL (DECOMMISSIONING)
570.60.100	U/G DECOMM AND SEAL
570.60.100.10	ACCESS TUNNELS AND DRIFTS
570.60.100.20	SERVICE SHAFT
570.60.100.30	MAIN SHAFT
570.60.100.50	VENTILATION SHAFT DECOMM
570.45.40.40	O&M OF AUXILIARY SURFACE FACILITIES
TRANSPORTATION	
ROUTE & SYSTEM DEVELOPMENT	
670.20	ROUTE & SYSTEM DEVELOPMENT
CAPITAL EQUIPMENT & FACILITIES	
670.40	CAPITAL EQUIPMENT & FACILITIES
670.40.10	UFTP TRANSPORTATION VEHICLES
670.40.10.10	UFTP TRANSPORTATION VEHICLES FOR NON-SITE-SPECIFIC
670.40.10.100	UFTP TRANSPORTATION VEHICLES FOR DOUGLAS POINT
670.40.10.20.10	UFTP TRANSPORTATION VEHICLES FOR WHITESHELL
670.40.10.30	UFTP TRANSPORTATION VEHICLES FOR BRUCE
670.40.10.40	UFTP TRANSPORTATION VEHICLES FOR PICKERING
670.40.10.50	UFTP TRANSPORTATION VEHICLES FOR DARLINGTON
670.40.10.60	UFTP TRANSPORTATION VEHICLES FOR POINT LEPREAU
670.40.10.70	UFTP TRANSPORTATION VEHICLES FOR CHALK RIVER
670.40.10.80	UFTP TRANSPORTATION VEHICLES FOR GENTILLY 1
670.40.10.90	UFTP TRANSPORTATION VEHICLES FOR GENTILLY 2

WBS NUMBER	DESCRIPTION
670.40.20.10.30	UFTP TRANSPORTATION PACKAGES NON-SITE-SPECIFIC
670.40.20.100	UFTP TRANSPORTATION PACKAGES DOUGLAS POINT
670.40.20.20	UFTP TRANSPORTATION PACKAGES WHITESHELL
670.40.20.30	UFTP TRANSPORTATION PACKAGES BRUCE
670.40.20.40	UFTP TRANSPORTATION PACKAGES PICKERING
670.40.20.50	UFTP TRANSPORTATION PACKAGES DARLINGTON
670.40.20.60	UFTP TRANSPORTATION PACKAGES POINT LEPREAU
670.40.20.70	UFTP TRANSPORTATION PACKAGES CHALK RIVER
670.40.20.80	UFTP TRANSPORTATION PACKAGES GENTILLY 1
670.40.20.90	UFTP TRANSPORTATION PACKAGES GENTILLY 2
670.40.40.10	EQUIPMENT FOR UFTP TRANSPORTATION LOGISTICS FOR REAL TIME TRACKING
670.40.40.20	EQUIPMENT FOR UFTP TRANSPORTATION LOGISTICS FOR EMERGENCY RESPONSE
TRANSPORTATION SYSTEM OPERATIONS	
670.50.10	PROJECT MANAGEMENT
670.50.30.10	UFTP TRANSPORTATION LOGISTICS FROM WHITESHELL TO DGR
670.50.30.20	UFTP TRANSPORTATION LOGISTICS FROM BRUCE TO DGR
670.50.30.30	UFTP TRANSPORTATION LOGISTICS FROM PICKERING TO DGR
670.50.30.40	UFTP TRANSPORTATION LOGISTICS FROM DARLINGTON TO DGR
670.50.30.50	UFTP TRANSPORTATION LOGISTICS FROM POINT LEPREAU TO DGR
670.50.30.60	UFTP TRANSPORTATION LOGISTICS FROM CHALK RIVER TO DGR
670.50.30.70	UFTP TRANSPORTATION LOGISTICS FROM GENTILLY 1 TO DGR
670.50.30.80	UFTP TRANSPORTATION LOGISTICS FROM GENTILLY 2 TO DGR
670.50.30.90	UFTP TRANSPORTATION LOGISTICS FROM DOUGLAS POINT TO DGR
670.50.40.10.10	UFTP TRANSPORTATION LOGISTICS DGR EMERGENCY RESPONSE
670.50.40.10.20	UFTP TRANSPORTATION LOGISTICS DGR REAL TIME TRACKING
670.50.50	UFTP TRANSPORTATION VEHICLES MAINTENANCE
ENVIRONMENTAL MANAGEMENT	
670.55	ENVIRONMENTAL MANAGEMENT
DECOMMISSIONING	
670.60	DECOMMISSIONING
PROGRAM MANAGEMENT	
670.90	PROGRAM MANAGEMENT

APPENDIX B: WORK ELEMENT DEFINITION SHEETS (WEDS)

BUILDING RELATIONSHIPS - ADAPTING TO CHANGE

570.05.10

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	K. Shaver	Prepared by:	D. Wilson	Organization:	NWMO

Description

NWMO activities to adapt plans in response to new knowledge, international best practices, advances in technical learning, insight of Aboriginal Traditional Knowledge, evolving societal expectations and values, and changes in public policies.

Deliverables

Work program activities related to adapting to change are focussed on keeping track of best practices and evolving experience in areas such as:
approaches to community engagement and community capacity building
building and designing communication materials
approaches to assessing environmental, social, economic and cultural effects
approaches to engaging Aboriginal people and interweaving Aboriginal Traditional Knowledge in NWMO's plans and work
approaches to preparing partnership agreements

Includes NWMO participation in international information sharing (e.g., NEA Forum for Stakeholder Confidence); preparation of annual watching briefs on waste management technology; annual updates on used fuel inventory; research on citizen priorities and concerns with APM implementation; assessment of potential impacts of environmental and energy policies on APM including new nuclear build; and other studies and workshops associated with societal values and public policies.

Assumptions

As per NWMO 2015 business plan

Allowance

An overall allowance of 35% has been included for 2024 - 2032; and an allowance of 25% has been included, starting in 2033.

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$6,600,000.00
Subtotal	*$6,600,000.00*
Allowance	$1,695,000.00
Total Cost	**$8,295,000.00**

Start Year	2021
Finish Year	2042
Duration	**22 years**
WBS Type	Fixed

BUILDING RELATIONSHIPS - COMMUNICATIONS

570.05.20

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario

WBS Owner	K. Shaver	Prepared by:	D. Wilson	Organization:	NWMO

Description

NWMO activities in support of NWMO communication and engagement activities through the development and maintenance of corporate material and systems.

Work program activities include writing / copy editing services, media (conventional and social) monitoring, tracking public opinion and the Corporate Social Responsibility Program, NWMO website refinements and maintenance.

Deliverables

Annual reports and triennial reports, backgrounders, fact sheets, trade show exhibits, newsletters, translation services, media relations, mailings, promotional products and gifts.

Assumptions

As per NWMO 2015 business plan

Allowance

An overall allowance of 35% has been included for 2024 - 2032; and an allowance of 25% has been included, starting in 2033.

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$37,400,000.00
Subtotal	*$37,400,000.00*
Allowance	$9,605,000.00
Total Cost	**$47,005,000.00**

Start Year	2021
Finish Year	2042
Duration	**22 years**
WBS Type	Fixed

BUILDING RELATIONSHIPS - NATIONAL AND REGIONAL RELATIONSHIPS

570.05.30

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	K. Shaver	Prepared by:	D. Wilson	Organization:	NWMO

Description

NWMO activities to build sustainable, long-term relationships with interested Canadians and Aboriginal peoples.

Work program activities are focussed on developing and maintaining relationships with elected and department officials in the federal government and provincial governments; federal, regional and municipal associations; nuclear reactor site communities; federal and provincial Aboriginal organizations; Council of Elders and youth groups.

Training and support to ensure capacity building and sustained liaison, especially with Aboriginal organizations.

Deliverables

Briefings, meetings and presentations with government officials, municipal associations and other organizations.

Independent research and studies.

Independent input from these organizations to support NWMO documents and APM project materials.

Assumptions

As per NWMO 2015 Business Plan

Allowance

An overall allowance of 35% has been included for 2024 - 2032; and an allowance of 25% has been included, starting in 2033.

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$57,000,000.00
Subtotal	*$57,000,000.00*
Allowance	$13,800,000.00
Total Cost	**$70,800,000.00**

Start Year	2021
Finish Year	2042
Duration	**22 years**
WBS Type	Fixed

BUILDING RELATIONSHIPS - 2015 BP & 2010 ESTIMATE POST-CONST

570.05.40

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	K. Shaver	Prepared by:	Derek Wilson	Organization:	NWMO

Description

The NWMO will seek and be responsive to a diversity of views and perspectives. The NWMO must communicate and consult actively, promoting thoughtful reflection and facilitating a constructive dialogue in different aspects of APM implementation. During the Business Planning period, APM engagement will focus on establishing relationships that will be important in building confidence in NWMO as implementer and earning the social support required to sustain momentum in siting and build the foundation for future regulatory approvals. A continuum of briefings, collaborative projects and partnerships will be advanced to support the further development and maintenance of relationships with municipal, Aboriginal and federal and provincial governments that will be key to establishing a positive foundation for APM site selection.

Post-construction costs are based on the 2011 Cost Estimate, which included continuing to work with Natural Resources Canada to implement a process to meet the NWMO's statutory obligations with respect to the Crown's duty to consult.
- Implementing communications and learning opportunities to inform young people of NWMO's work.
- Regularly assessing the effectiveness of website, engagement and communication vehicles to identify opportunities for improvement in future initiatives.

Deliverables

Assumptions

As per 2016-2020 Business Plan and 2011 Cost Estimate Post-construction

Allowance

An overall contingency/allowance of 25% has been included for 2043 onwards

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$113,236,531.04
Subtotal	*$113,236,531.04*
Allowance	$22,065,663.47
Total Cost	**$135,302,194.51**

Start Year	2015
Finish Year	2167
Duration	**153 years**
WBS Type	Fixed

BUILDING RELATIONSHIPS - STAFFING

570.05.90

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	K. Shaver	Prepared by:	D. Wilson	Organization:	NWMO

Description

Staffing to support to Building Relationships objective as per 2015 BP & consistent with 2011 Estimate Post-Cont (WED# 570.05.40) through the years of 2015-2020. Through years 2020-2023 it is exclusively related to Building Relationships- Adapting to Change (WED# 570.05.10). It is involved with both through years 2024-2042, and then exclusive to Building Relationships - 2015 BP & 2010 Estimate Post-Cont (WED# 570.05.40) from 2043 to closure.

Deliverables

Assumptions

Allowance

An overall allowance of 35% has been included for 2024 - 2032; and an allowance of 25% has been included, starting in 2033.

Labour Cost	$267,815,511.15	Start Year	2015
Material Cost	$0.00	Finish Year	2133
Other Cost	$0.00	Duration	**119 years**
Subtotal	*$267,815,511.15*	WBS Type	Fixed
Allowance	$60,158,786.51		
Total Cost	**$327,974,297.66**		

SAFETY ASSESSMENT - EA AND PSR

570.10.10

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Derek Wilson	Prepared by:	Paul G	Organization:	NWMO

Description

SAFETY ASSESSMENT FOR SITE PREP AND CONSTRUCTION LICENCE (2024-2028):
This task is to provide preclosure and postclosure safety assessment contributions to both the Environmental Assessment (EA) and the Preliminary Safety Report (PSR) for the reference site. The EA and PSR documents will be submitted in support of the applications for a Licence to Prepare Site and for a Licence to Construct.
The preclosure assessment will address conventional and radiological safety for normal, upset and accident conditions associated with the operating and monitoring phases.
The postclosure assessment will address the anticipated effects on human and non-human biota following decommissioning and abandonment. Both radiological and non-radiological contaminants will be considered.

Deliverables

SAFETY ASSESSMENT FOR SITE PREP AND CONSTRUCTION LICENCE (2024-2028):
Preliminary Safety Report
Preclosure Safety Assessment report.
Postclosure Safety Assessment report.
Preliminary ALARA Assessment.
Conventional Safety Assessment.
Radon Assessment.
Preliminary Flood Hazard Assessment
Preclosure and postclosure contributions to the EA and the PSR.
Computer codes and support documents.
Key supporting reports, including Reference Data; Features, Events and Processes.

Assumptions

SAFETY ASSESSMENT FOR SITE PREP AND CONSTRUCTION LICENCE (2024-2028):
Assessment builds on report(s) produced by 2023 for the selected preferred site.
Work is carried out iteratively, with interim version released in 2026, and final version in 2028.
Preliminary design, Geosynthesis and Descriptive Geosphere Site Model, and Environmental data are fixed at end 2026 (data freeze).
Preliminary ALARA assessment is initial estimate of doses, and does not provide significant ALARA optimization. This will be addressed in Operating Licence stage.
Most work is done with in-house safety assessment staff.
Transportation safety assessment is covered separately.
Preparation of EIS is covered separately.
EA and PSR are submitted end of 2028.

Allowance

An overall contingency/allowance of 35% has been included based on level of design and uncertainty.

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$8,600,000.00
Subtotal	*$8,600,000.00*
Allowance	$3,010,000.00
Total Cost	**$11,610,000.00**

Start Year	2024
Finish Year	2028
Duration	**5 years**
WBS Type	Fixed

SAFETY ASSESSMENT - SUPPORT FOR REVIEW AND HEARINGS

570.10.20

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Derek Wilson	Prepared by:	Paul G.	Organization:	NWMO

Description

SA SUPPORT DURING SITE PREP AND CONSTRUCTION LICENCE REVIEW (2029 - 2032):
This task is to support the public hearings and respond to review panel and regulatory questions on the Environmental Assessment (EA) and Preliminary Safety Report (PSR) submission. It is also anticipated that Safety Assessment staff will attend a variety of sessions with the public, elected representatives and aboriginal groups to provide information on the technical aspects of the project.

Deliverables

SA SUPPORT DURING SITE PREP AND CONSTRUCTION LICENCE REVIEW (2029 - 2032):
Prepare responses to review questions.
Presentation material for public and regulatory review.
Participation in public review of EA and PSR materials.

Assumptions

SA SUPPORT DURING SITE PREP AND CONSTRUCTION LICENCE REVIEW (2029 - 2032):
Public review starts in 2029, with award of licence by end 2032.
2032 is primarily review of recommendations and license condition handbook preparation.
NWMO staff costs are not included here.

Allowance

An overall contingency/allowance of 35% has been included based on level of design and uncertainty

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$1,600,000.00
Subtotal	*$1,600,000.00*
Allowance	$560,000.00
Total Cost	**$2,160,000.00**

Start Year	2029
Finish Year	2032
Duration	**4 years**
WBS Type	Fixed

SAFETY ASSESSMENT - POST CONSTRUCTION SA AND TECHNICAL

570.10.30

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Derek Wilson	Prepared by:	Paul G	Organization:	NWMO

Description

SAFETY ASSESSMENT FOR OPERATING LICENCE (2033-2042):
This task is to provide the preclosure and postclosure safety assessment contributions during the construction phase and ultimately to the Final Safety Report (FSR). The FSR document will be submitted in support of the application for a Licence to Operate.
The preclosure assessment will address conventional and radiological safety for normal, upset and accident conditions associated with the operating and monitoring phases. It will include a final ALARA assessment and flood hazard assessment.
The postclosure assessment will address the anticipated effects on human and non-human biota following decommissioning and abandonment. Both radiological and non-radiological contaminants will be considered.

SA TECHNICAL STUDIES DURING SITE PREP AND CONSTRUCTION (2033-2042):
This task is to confirm the behaviour of key processes for the deep geologic repository at the specific conditions of the selected site.
Tests will be carried out at the selected site, mostly in the UDF or the Centre of Expertise. Some studies would be carried out in universities or at international facilities. The work will focus on:
Measurement of relevant parameters using site-specific materials and conditions.
In-situ integrated experiments that can be used to validate or calibrate computer models.
Some work will be carried to conclusion during the construction period to support the Operating Licence application; however, some experiments will involve the installation of test coupons or assemblies for long-term exposure tests (e.g. up to 100 years). It is anticipated that these tests will:
Provide extended performance data over years to decades, including during the initial transient period with the hottest temperatures, driest materials, and most oxygen.
Help build confidence with the local community (over multiple generations).
Maintain knowledgeable and competent technical staff.

OPERATIONS SAFETY ASSESSMENT (2043 - 2082) Note: not consistent with overall estimating assumptions...should be 30 years:
This task is to provide safety assessment support during the facility operating period. Specific items include:
Preparation of periodic safety assessment reports to support continuation of the site Operating Licence.
Assessment of topical issues as may be required, including any follow-up issues from Operating Licence approval.
Maintenance and improvement of the safety and performance assessment computer codes, including reference databases and tools, under a suitable QA system.
Maintenance of the reference site numerical model.
Planning and management of technical support related to the development and validation of safety and

performance assessment models and codes, and associated databases.
Training of qualified staff to ensure continued capability to support the monitoring and eventual closure of the facility.
Interpretation and application of experiments conducted in the Underground Demonstration Facility (UDF).

EXTENDED MONITORING SAFETY ASSESSMENT (2083 - 2152):
This task is to provide safety assessment activities during the Extended Monitoring period, including:
Preparation of periodic safety assessment reports to support renewal of Operating Licence.
Continuous maintenance and improvement of repository safety assessment models.
Ongoing technical research and support studies, both basic research and in-situ tests in the UDF or Centre of Expertise.
Maintenance of qualified technical staff.

DECOMMISSIONING SAFETY ASSESSMENT (2153 - 2177):
Safety Assessment support for the application for Decommissioning Licence.

ABANDONMENT LICENCE SAFETY ASSESSMENT (2178 +):
Safety Assessment support for an application for Licence to Abandon the facility, and to archive the information.

Deliverables

SAFETY ASSESSMENT FOR OPERATING LICENCE (2033-2042):
Final Safety Report.
Preclosure Safety Assessment report.
Postclosure Safety Assessment report.
Final ALARA Assessment.
Conventional Safety Assessment.
Radon Assessment.
Flood Hazard Assessment
Updated computer codes and support documents.
Key supporting reports, including Reference Data, Features, Events and Processes.

SA TECHNICAL STUDIES DURING SITE PREP AND CONSTRUCTION (2033-2042):
Technical reports and papers, including analysis and recommendations for models and for model parameters.
Contributions to updates to safety report.

OPERATIONS SAFETY ASSESSMENT (2043 - 2072):
30 year operating period.
Up-to-date reference repository safety assessment model.
Periodic updates to the Final Safety Report (FSR) as required for supporting renewal of the site Operating Licence.
Annual report describing ongoing results to further validate or improve the reference safety assessment model.

EXTENDED MONITORING SAFETY ASSESSMENT (2073 - 2142):
Up-to-date reference repository safety assessment model.
Periodic updates to the FSR for supporting renewal of the site Operating Licence.
Technical reports on the program.

DECOMMISSIONING SAFETY ASSESSMENT (2143 - 2167):
The Decommissioning period is assumed to last 25 years, including 3 years licence preparation and 2 years for approval.
Decommissioning will include an Environmental Assessment. Costs for this EA are included here.
The existing FSR will be updated, but is otherwise sufficient to support the decommissioning EA/licence application.
Preparation for the EA/Licence application begins at the start of the Decommissioning phase.
The EA addresses all issues related to obtaining the Decommissioning Licence and the Licence to Abandon.

ABANDONMENT LICENCE SAFETY ASSESSMENT (2168 +):
Preparation of Final Safety Report (FSR).
Archiving of safety assessment data, models and reports.

Assumptions

SAFETY ASSESSMENT FOR OPERATING LICENCE (2033-2042):
The assessment will build on work performed for the Environmental Assessment (EA) and Preliminary Safety Report (PSR); however, information from the Underground Demonstration Facility (UDF) and the final design will be used.
There will be an update to the safety case in 2037 based on initial geological results, and used to obtain CNSC agreement to proceed with the remainder of the underground construction.
Data freeze for the FSR will occur in 2038.
The FSR and related documents will be filed at end 2040. The regulatory review and approval period takes 2 years, with the Operating Licence approved by end 2042.
Most of the postclosure assessment will be done in-house.
NWMO staff costs are not included here.

SA TECHNICAL STUDIES DURING SITE PREP AND CONSTRUCTION (2033-2042):
Engineering demonstration projects are not included.
Geoscience verification projects are not included.
Environmental monitoring is not included.
Costs for constructing and operating the UDF and Cof E are not included.
NWMO staff costs are not included.

OPERATIONS SAFETY ASSESSMENT (2043 - 2072):
Does not include geoscience monitoring and maintenance of the site geoscience models.
Does not include environmental monitoring, follow-up environmental monitoring, or preparation of annual REMP reports.
Does not include monitoring of repository as needed to support operations, including both the conventional Health, Safety & Environmental program as well as Radiation Protection.
NWMO staff costs are included elsewhere.

EXTENDED MONITORING SAFETY ASSESSMENT (2073 - 2142):
Extended Monitoring period is 70 years duration.
Does not include general operating costs of the Underground Demonstration Facility (UDF).
Does not include geoscience or environmental monitoring and reporting.
There is no used fuel handling activity during this period.

DECOMMISSIONING SAFETY ASSESSMENT (2143 - 2167):
The Decommissioning period is assumed to last 25 years, including 3 years licence preparation and 2 years for

approval.
Decommissioning will include an Environmental Assessment. Costs for this EA are included here.
The existing FSR will be updated, but is otherwise sufficient to support the decommissioning EA/licence application.
Preparation for the EA/Licence application begins at the start of the Decommissioning phase.
The EA addresses all issues related to obtaining the Decommissioning Licence and the Licence to Abandon.

ABANDONMENT LICENCE SAFETY ASSESSMENT (2168 +):
Licence to Abandon is applied for at the end of the Decommissioning and Closure Phase.
3 years to prepare licence application and 2 years for the licence review.
The Environmental Assessment (EA) created for the Decommissioning licence addresses all relevant EA issues.
The FSR will include information obtained during the Decommissioning phase, including if necessary information on the actual seal installation characteristics, and the actual as-decommissioned facility.

Allowance

An overall contingency/allowance of 25% has been included based on level of design and uncertainty.

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$94,500,000.00
Subtotal	*$94,500,000.00*
Allowance	$23,625,000.00
Total Cost	**$118,125,000.00**

Start Year	2033
Finish Year	2167
Duration	**135 years**
WBS Type	Fixed

SAFETY ASSESSMENT - STAFFING

570.10.90

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Derek Wilson	Prepared by:	Paul G.	Organization:	NWMO

Description

All safety assessment related costs from 2015 through 2023 are included in the Phase 2 and Proof Testing project estimates.
Staffing is involved in detailed site characterization and licensing (2024 – 2032) and construction (2033 – 2042), which remains consistent. For all other phases (operations, extended monitoring, decommissioning, closure) consolidated safety assessment staffing levels from the 2011 estimate have been applied.
Staffing is related to the Safety Assessment - EA and PSR (WED# 570.31.10) through years 2024 - 2028, Support for Review and Hearings (WED# 570.31.20) through 2029-3032, and Post Contruction SA and Technnical (WED# 570.31.30) from 2032 until closure.

Deliverables

Staffing required to support deliverables as per WBS# 570.10.10-30

Assumptions

Staffing required to support deliverables as per WBS# 570.10.10-30

Allowance

An overall allowance of 35% has been included for 2024 - 2032; and an allowance of 25% has been included, starting in 2033.

Labour Cost	$85,095,778.95
Material Cost	$0.00
Other Cost	$0.00
Subtotal	*$85,095,778.95*
Allowance	$22,761,148.88
Total Cost	**$107,856,927.83**

Start Year	2024
Finish Year	2167
Duration	**144 years**
WBS Type	Fixed

CENTRE OF EXPERTISE

570.15.20

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Derek Wilson	Prepared by:	D. Wilson	Organization:	NWMO

Description

Centre of Expertise will be located in the preferred siting area (location to be determined in collaboration with the partnership communities) to support the multi-year testing and assessment of the site on technical safety and community well-being related dimensions. It will be home to an active technical and social research and technology demonstration program involving scientists and other experts in a wide variety of disciplines including geoscience, engineering, environmental, socioeconomic and cultural impact assessment.

An engineering test facility will be located within the Centre of Expertise and will include, but not limited to:
- container laser welding and copper coating technology development
- bentonite clay buffer shaping and forming development
- container placement equipment for the underground repository

Centre of Expertise will be expanded to include support to the construction and operation of the deep geological repository. It will become a hub for knowledge sharing across Canada and internationally. It can focus on engaging members of the community to learn more about the APM project via public viewing galleries and interactive displays.

Deliverables

For the purposes of developing a preliminary estimate in support of financial planning (applicable to all elements), the following facility features/areas have been included:
Distinct technical areas providing for used fuel transfer (fuel handling cell, used fuel container processes, buffer box assembly), emplacement, and buffer system demonstrations;
Maintenance/shop area for equipment maintenance, as well as, space for labs in support of field activities;
General warehousing and storage;
Transportation display/storage area;
Building services (i.e. electrical room, HVAC, fire protection, IT/I&C);
Administration and office space for NWMO staff (provision of space for common services);
Geoscience and environmental activities (i.e. core storage, lab equipment, etc);
Visitor's center and display/conference space.

Staffing levels in support of the Centre of Expertise are incremental to those existing FTE’s that would utilize the facility once constructed (e.g. technical, engagement, aboriginal, etc). These are staff required to support the facility function and have been assumed to be one (1) facility manager, two (2) technical resources, and three (3) administration/building operations positions.

Centre of Expertise building in the preferred siting area.

Assumptions

It is assumed that the facility will cost $10M to construct over 2 years, starting 2024. An allowance of $2M has been included in 2023 for detailed design and bid package development.

A $5M allowance for facility equipment/displays (Materials and Equipment) has been included for 2024. This is a placeholder and assumes that much of the equipment in support of the technical areas will be transferred from existing Phase 2 and Proof Testing activities.

Facility Operations costs have been estimated at $750,000 per year. Assumes $400k per year for fixed operating costs (e.g. repair and maintenance, service contracts for site maintenance, security, etc.), and $350k per year for variable operating costs (e.g. heat, water, sewerage, etc).

Centre of Expertise - Build cost is $10 million spread over 2 years (2024 to 2025).
Design details of the facility will be developed with the partnership communities with their preferences in mind.

Schedule/Milestone Assumptions:
- final design is available by year of site selection (2023)
- location of facility has been determined
- permits and approvals have been received (2023)

Allowance

An overall allowance of 35% has been included for 2024 - 2032; and an allowance of 25% has been included, starting in 2033.

Labour Cost	$43,256,808.00
Material Cost	$5,000,000.00
Other Cost	$47,750,000.00
Subtotal	*$96,006,808.00*
Allowance	$26,122,648.80
Total Cost	**$122,129,456.80**

Start Year	2022
Finish Year	2072
Duration	**51 years**
WBS Type	Fixed

COMMUNITY ENGAGEMENT

570.15.30

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	K. Shaver	Prepared by:	D. Wilson	Organization:	NWMO

Description

Community engagement activities to assess the social suitability ("municipal social licence") of the APM project in the preferred siting area and region from the perspective of non-Aboriginal communities (e.g., municipalities). Assessments would address community well-being, interest, potential for partnership and potential for willingness.

Activities also include community-specific communications for local exhibits, Corporate Social Responsibility programs and security; briefings, meetings, Open Houses and workshops for learning and to assess suitability in the communities and region; third party reviews; stakeholder mapping; Resource Program for interested community, neighbouring municipalities, opinion leaders, regional planning groups and partnership group; community visits to waste management facilities; development of confidence and supportive relationships for used fuel transportation amongst experts, opinion leaders, key transportation hubs, corridor communities, polititians and host communities.

Work program includes support for storefront offices in the partnership communities.

Deliverables

Reports on social research, third party reviews, social suitability for the APM project, partnership potential, agreements or MOUs with communities. Maintain storefront offices in the partnership communities.

"Municipal social licence" for detailed site characterization and submission of the environmental assessment and licensing documentation, as well as municipal support for the APM project at the public hearings.

Assumptions

Allowance

An overall contingency/allowance of 35% has been included.

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$13,500,000.00
Subtotal	*$13,500,000.00*
Allowance	$4,725,000.00
Total Cost	**$18,225,000.00**

Start Year	2024
Finish Year	2032
Duration	**9 years**
WBS Type	Fixed

ABORIGINAL ENGAGEMENT

570.15.40

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	K. Shaver	Prepared by:	D, Wilson	Organization:	NWMO

Description

Aboriginal engagement activities to assess the social suitability ("Aboriginal social licence") of the APM project in the preferred siting area and region from the perspective of Aboriginal communities (e.g., First Nation and Métis communities in the siting area). Assessments would address community well-being, interest, potential for partnership and potential for willingness.

Activities also include further identification and mapping of First Nation and Métis interests, land use, positions and influence in the study area; Aboriginal-specific communications for local exhibits, briefings, meetings, Open Houses and workshops for learning and to assess suitability; third party reviews; Resource Program for First Nation and Métis communities in the area; visits to waste management facilities; development of confidence and supportive relationships for used fuel transportation amongst key Aboriginal organizations.

Deliverables

Reports on Aboriginal social research, third party reviews, suitability for the APM project, partnership potential, agreements or MOUs with Aboriginal communities.

"Aboriginal social licence" for detailed site characterization and submission of the environmental assessment and licensing documentation, as well as Aboriginal support for the APM project at the public hearings.

Assumptions

Allowance

An overall contingency/allowance of 35% has been included.

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$13,500,000.00
Subtotal	*$13,500,000.00*
Allowance	$4,725,000.00
Total Cost	**$18,225,000.00**

Start Year	2024
Finish Year	2032
Duration	**9 years**
WBS Type	Fixed

SITE ACQUISITION - PURCHASE OF LAND

570.15.60

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	K. Shaver	Prepared by:	D. Wilson	Organization:	NWMO

Description

This is a placeholder of $5M for crown land purchase and licensing costs.

Deliverables

Land acquisition in time for constuction

Assumptions

Site preparation and access roads are captured as part of geoscience and construction WEDS.

Allowance

No additional Allowance included.

Labour Cost	$0.00	Start Year	2023
Material Cost	$0.00	Finish Year	2023
Other Cost	$5,000,000.00	Duration	**1 years**
Subtotal	*$5,000,000.00*	WBS Type	Fixed
Allowance	$0.00		
Total Cost	**$5,000,000.00**		

SITING - Phase 2 Project PTD ACTUALS and BP

570.15.70

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	K. Shaver	Prepared by:	D Wilson	Organization:	NWMO

Description

This represents the Phase 2 3rd party costs as per the approved Phase 2 Project Execution Plan. A placeholder of $30M has been included in 2023 to close the gap between the Phase 2 schedule and start of detailed site characterization.

The Project is defined as the Adaptive Phased Management (APM) Phase 2 Siting Project. The purpose of the Project is to lead to the selection of a preferred site for detailed site characterization in Step 4 of the APM site selection process.
The Phase 2 siting project involves the conduct of multi-year preliminary assessments in a number of different siting study areas. The project will concentrate resources and studies on the smaller number of siting areas identified as having greater technical and social potential to be suitable for the project based on Phase 1 studies.
Phase 2 work involves a sequenced flow of technical studies beginning with non-intrusive field work and mapping, building to a more intensive program including borehole drilling in preferred areas. Iterations of geoscience field work and modelling, environment assessments, and engineering design will support the development of safety case studies for each siting area.
In parallel with technical assessments, engagement in Phase 2 expands beyond the interested communities to involve neighbouring municipal and Aboriginal communities. During Phase 2 work, NWMO will seek to advance dialogue with Aboriginal and municipal communities in each study area to assess their interest in, and support for, hosting a repository. Through this work the NWMO must understand the potential for establishing mutually beneficial partnership agreements that will be required to support implementation of the APM program.
Throughout the multi-year sequence of Phase 2 engagement and progressively more detailed studies and assessments, the NWMO and communities will continually take stock. The Phase 2 project will inform NWMO's selection of a single preferred site for the APM project.
Communities that enter Phase 2 will not necessarily continue for the entire study period.
There will be ongoing stocktaking by NWMO and the communities throughout Phase 2.
Should early findings signal low potential of being suitable, NWMO would cease studies of those communities.

Refer to the APM-PEP-00120-0201 for more details.

Deliverables

The primary objective of the APM Phase 2 Siting Project is to advance technical and social assessments to the point where a decision can be made to narrow down to one location to be the focus of detailed site characterization (Step 4).

In order to select the preferred location for siting the APM repository, NWMO would need to have a sufficient degree of confidence from Phase 2 work that:
· a deep geological repository can be developed with a strong technical safety case at that location;
· a safe, secure and socially acceptable transportation plan can be developed to transport used nuclear fuel to that location; and
· a strong partnership can be developed with the interested community, First Nation and Métis communities in the area, and surrounding communities.

Assumptions

Related to the APM Phase 2 Baseline Project Cost Estimate (2015 k$) found in APM-PEP-00120-0201.

Allowance

No additional Allowance included.

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$296,031,345.31
Subtotal	*$296,031,345.31*
Allowance	$0.00
Total Cost	**$296,031,345.31**

Start Year	2015
Finish Year	2023
Duration	**9 years**
WBS Type	Fixed

570.15.70

SITING - STAFFING FROM PHASE 2 PLANNING

570.15.90.10

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	K. Shaver	Prepared by:	D. Wilson	Organization:	NWMO

Description

NWMO staff to support Phase 2 site selection

Deliverables

As per business plan and Project Execution Plan APM-PEP-00120-0201

Assumptions

As per business plan and Project Execution Plan APM-PEP-00120-0201. Staffing assumed based on PEP to continue to year 2023, end of Siting phase.

Allowance

No additional Allowance included

Labour Cost	$74,267,746.45	Start Year	2015
Material Cost	$0.00	Finish Year	2023
Other Cost	$0.00	Duration	**9 years**
Subtotal	*$74,267,746.45*	WBS Type	Fixed
Allowance	$0.00		
Total Cost	**$74,267,746.45**		

ENGAGEMENT STAFFING - COMMUNITY AND ABORIGINAL

570.15.90.20

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario

WBS Owner K. Shaver Prepared by: D. Wilson Organization: NWMO

Description

Engagement staffing levels for the detailed site characterization and licensing phase (2024 - 2032) are consistent with the 2011 estimate for the same phase.

Deliverables

Assumptions

Consistent with 2011 estimate for same phase - 20 FTEs; 6 Management, 1 Administration, 13 Engineers/Tech Speclialist/Advisor)

Allowance

An overall contingency/allowance of 35% has been included.

Labour Cost	$16,213,629.60
Material Cost	$0.00
Other Cost	$0.00
Subtotal	*$16,213,629.60*
Allowance	$5,674,770.36
Total Cost	**$21,888,399.96**

Start Year	2024
Finish Year	2032
Duration	**9 years**
WBS Type	Fixed

ENGINEERING AND DESIGN - REPOSITORY DESIGN AND LICENCE SUPPORT

570.20.10

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Derek Wilson	Prepared by:	D. Wilson	Organization:	NWMO

Description

Work activities include the development of repository designs in support of the licensing submission.

Deliverables

Design activities will focus on the repository layouts (i.e. shafts, layout, services, etc) and supporting infrastructure (i.e. surface layout, electrical, support facilities, etc). $12M has been allocated for the first 6 years commencing 2024 for 3rd party design preparation, and an additional $4M ($1M annually from 2029 through 2032) for technical support during the hearings.

Assumptions

Assumes that the Engineered Barrier Design and Proof Testing work is complete and the engineered barrier concept has been demonstrated. There will be no additional 3rd party design support required for the engineered barrier design.

The construction estimate for facilities and structures assumes design/build unit prices. Therefore, costs for detailed design are not included under this WBS.

Allowance

An overall contingency/allowance of 35% has been included.

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$16,000,000.00
Subtotal	*$16,000,000.00*
Allowance	$5,600,000.00
Total Cost	**$21,600,000.00**

Start Year	2024
Finish Year	2032
Duration	**9 years**
WBS Type	Fixed

ENGINEERING AND DESIGN - SEALING AND RETRIEVAL DEMONSTRATIONS

570.20.20

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Derek Wilson	Prepared by:	D. Wilson	Organization:	NWMO

Description

Additional demonstrations and site specific analyses will be undertaken in support of the licensing submission package. This would include site specific corrosion analyses, buffer integrity analyses, etc.

Deliverables

$8M has been allocated over the licence application period for 3rd party contracts, and an additional $2M over the hearing period for contractor support.

Assumptions

Allowance

An overall contingency/allowance of 35% has been included.

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$10,000,000.00
Subtotal	*$10,000,000.00*
Allowance	$3,500,000.00
Total Cost	**$13,500,000.00**

Start Year	2024
Finish Year	2032
Duration	**9 years**
WBS Type	Fixed

ENGINEERED BARRIER DESIGN & PROOF TESTING

570.20.30

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Chris Hatton	Prepared by:	D. Wilson	Organization:	NWMO

Description

Proof Testing is a series of activities undertaken to verify that novel aspects of a design concept can meet Design Requirements and can be implemented in a safe and cost effective manner. It is usually conducted at the Conceptual Design or early Preliminary Design stage in order to minimize licensing and implementation risks.
Proof Testing normally involves fabrication of scale models, mockups and/or prototypes and Testing under simulated operational conditions, resulting in a formal, documented body of knowledge that can be used to illustrate the proof to the regulator, the NWMO Board of Directors and the public. Proof Testing can be related to a variety of aspects of the Design concept, such as confirmation of material properties under expected operational conditions, longterm performance, manufacturability or constructability (including serial production and Quality Control of high-usage components and materials such as containers or buffer/backfill), automation techniques, material and container handling under repository conditions, operational inspection and monitoring techniques, etc.

Deliverables

Used Fuel Container:
Design testing to demonstrate that our computer models correctly predict the performance of the used fuel container. These components include:
Crush test of components including the weld and shell of the used fuel container
Crush test of the complete steel used fuel container
Crush tests of the complete copper coated container.
Radiologic analyses proving the performance of the copper coating.

Buffer Box:
Laboratory analysis of manufactured bricks and blocks as well as the development of manufacturing procedures

Emplacement and Sealing System:
Demonstration that buffer boxes can be emplaced without damage and that the required in-situ dry density within the emplacement room can be achieved.
The design, manufacture and demonstation of the repository emplacement equipment.

Production Demonstration:
Demontrate the repeatability of the process and to provide confidence both to the regulator and Canadians that the process that had been developed can function reliably. Buffer thermal and saturation performances will be demonstrated.

External Reviews:
External reviews will be conducted and consist of both independent technical reviews through the

establishment of international industry experts, as well as, on-going review by the Canadian Nuclear Safety Commission (CNSC).

Assumptions

Refer to Proof Testing PEP APM-PEP-00120-0202 and APM-PLAN-00120-0202 for more.

Schedule aligns with current plans to obtain site. Activities cease at the end of 2022

Allowance

As per PEP

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$94,115,490.10
Subtotal	*$94,115,490.10*
Allowance	$0.00
Total Cost	**$94,115,490.10**

Start Year	2015
Finish Year	2022
Duration	**8 years**
WBS Type	Fixed

ENGINEERING AND DESIGN - CENTRE OF EXPERTISE ACTIVITIES

570.20.40

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Derek Wilson	Prepared by:	D. Wilson	Organization:	NWMO

Description

The equipment used as part of the Proof Testing program will be re-located to the Centre of Expertise to continue demonstrations and further refine UFPP processes. $5M is included in 2023 following the proof testing program to prepare and ready equipment for transfer to the CofE. The equipment costs for the majority of equipment to be used at the Centre of Expertise will have been purchased as part of the Proof Testing program.

Operation of the Centre of Expertise:
- engineering test facility for the Mark 2 container - welding and copper coating technology development and demonstration
- buffer box - bentonine clay shaping and forming technology development and demonstration
- container / buffer box placement technology development and demonstration
- other repository tests and demonstrations (geoscience, environment, safety, engineering, etc.)
- meetings, workshops, conferences and engagement activities
- public and invited guest tours of the facility - viewing galleries and interactive displays
- workshops and courses aimed to expand learning about the APM project
- facility for international visitors and training

Deliverables

Following initial preparation, $1.5M per year is included for the duration of the Centre of Expertise operating period (2024 - 2072) for supporting 3rd party contracts and materials supply.

Assumptions

Allowance

An overall allowance of 35% has been included for 2024 - 2032; and an allowance of 25% has been included, starting in 2033.

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$78,500,000.00
Subtotal	*$78,500,000.00*
Allowance	$19,725,000.00
Total Cost	**$98,225,000.00**

Start Year	2023
Finish Year	2072
Duration	**50 years**
WBS Type	Fixed

ENGINEERING AND DESIGN - TECHNICAL OVERSIGHT OF EPC CONTRACT

570.20.50

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Derek Wilson	Prepared by:	D. Wilson	Organization:	NWMO

Description

Retain 3rd party contracts in support of EPC or EPCM oversight (i.e. specialty engineering services, peer reviewers, independent QS and auditors, etc.).

Deliverables

as per Description

Assumptions

None

Allowance

An overall contingency/allowance of 25% has been included.

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$17,500,000.00
Subtotal	*$17,500,000.00*
Allowance	$4,375,000.00
Total Cost	**$21,875,000.00**

Start Year	2023
Finish Year	2042
Duration	**20 years**
WBS Type	Fixed

TECHNICAL RESEARCH & COLLABORATION - UDF DEMONSTRATIONS

570.20.60

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Derek Wilson	Prepared by:	D. Wilson	Organization:	NWMO

Description

Physical demonstrations of underground processes are assumed to begin in 2035 and continue through the end of operations. Initial demonstrations are expected to be required to receive formal approval from the CNSC to initiate development of the first emplacement panels.

Deliverables

Underground demonstrations and technical development work, including 3rd party contracts.

Assumptions

$11.5M is assumed during the construction phase (2035-2042) and $1M per year has been included for 3rd party contracts over the entire operating period of 2043 through 2072.

Allowance

An overall contingency/allowance of 25% has been included based on level of design and uncertainties

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$41,500,000.00
Subtotal	*$41,500,000.00*
Allowance	$10,375,000.00
Total Cost	**$51,875,000.00**

Start Year	2035
Finish Year	2072
Duration	**38 years**
WBS Type	Fixed

ENGINEERED BARRIER DESIGN & PROOF TESTING - STAFFING

570.20.90.10

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Derek Wilson	Prepared by:	D. Wilson	Organization:	NWMO

Description

NWMO staff required to support and managed Mark 2 Proof Testing Project

Deliverables

As per APM-PLAN-00120-0202

Assumptions

As per APM-PLAN-00120-0202

Allowance

As per APM-PLAN-00120-0202

Labour Cost	$41,629,905.78	Start Year	2015
Material Cost	$0.00	Finish Year	2023
Other Cost	$0.00	Duration	**9 years**
Subtotal	*$41,629,905.78*	WBS Type	Fixed
Allowance	$0.00		
Total Cost	**$41,629,905.78**		

ENGINEERING AND DESIGN - GENERAL TECHNICAL SUPPORT STAFFING

570.20.90.20

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Derek Wilson	Prepared by:	Derek Wilson	Organization:	NWMO

Description

Staffing belongs to the Engineering and Design- Repository Design and Licence Support (WED# 570.20.10), Sealing and Retrieval Demonstrations (WED# 570.20.20), Centre of Expertise Activities (WED# 570.20.40) Technical oversight of EPC Contracts (WED# 570.20.50), and Technical Research & Collaboration- UDF demonstrations (WED # 570.20.60).

Deliverables

Staff to support Engineering and Design activities.

Assumptions

2024 – 2032 staffing levels maintained as per the 2015 – 2019 business plan staffing. 2033-2042 staffing levels subdivided into supporting the Center of Expertise activities and oversight of the EPCM activities. 2043-2072 staffing levels are all in support of the Centre of Expertise. All technical staff required for the operation of the facility are part of the DGR operating staff. Additional staffing is required during 2043 - 2068. Staffing is reduced from 2073 - 2167.

Allowance

An overall allowance of 35% has been included for 2024 - 2032; and an allowance of 25% has been included, starting in 2033.

Labour Cost	$163,432,046.61
Material Cost	$0.00
Other Cost	$0.00
Subtotal	*$163,432,046.61*
Allowance	$44,857,119.16
Total Cost	**$208,289,165.77**

Start Year	2024
Finish Year	2167
Duration	**144 years**
WBS Type	Fixed

TECHNICAL RESEARCH & COLLABORATION

570.25.10

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario

WBS Owner	Derek Wilson	Prepared by:	D. Wilson	Organization:	NWMO

Description

The Technical Research and Collaboration estimate is developed based on the historical spend for like activities, and the current 2016 - 2020 business planning budgets. These activities are separate and distinct from other technical or safety related activities in support of the facility design or safety case.

Deliverables

Activities include:
Collaborating with national and international university programs;
Collaborating with like organizations (e.g. NWMO has 6 collaboration agreements in-place with sister organizations in 2015)
Collaborating on in-situ experiments at international underground research laboratories (URLs) (e.g. Aspo - Sweden, ONKALO – Finland, Mt Terri and Grimsel – Switzerland);
Used fuel modeling;
Evaluation of bentonite buffer and bentonite-based shaft seal properties;
Modelling of deep groundwater systems;
Measuring sorption properties of sedimentary rocks and of bentonite under saline conditions;
Improved methods for characterization of porewaters.
Improved understanding of geomechanical behavior including excavation damage zone.

Assumptions

3rd Party contract costs are as per the 2015 – 2019 business plan, with annual costs being held flat at $4M/annum starting 2020 through 2032.
3rd Part contract costs are reduced to $1M/annum 2033 – 2072 assuming that repository specific technical studies would be conducted following the start of construction.

Allowance

An overall allowance of 35% has been included for 2024 - 2032; and an allowance of 25% has been included, starting in 2033. No additional allowance has been included in the years prior to 2024.

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$109,511,326.40
Subtotal	*$109,511,326.40*
Allowance	$22,600,000.00
Total Cost	**$132,111,326.40**

Start Year	2015
Finish Year	2072
Duration	**58 years**
WBS Type	Fixed

TECHNICAL RESEARCH & COLLABORATION - STAFFING

570.25.90

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Derek Wilson	Prepared by:	D. Wilson	Organization:	NWMO

Description

Staffing levels in support of the Technical Research and Collaboration from 2015 through 2023 are consistent with that of the 2015 – 2019 business plan levels and extended through 2023. For the period of 2024 through 2032, staffing levels reduce to balance the overall available Safety Assessment and Geoscience staff. For the construction and operating periods, staffing levels are reduced, which is reflected in the level of the funding for 3rd party contracts.

Deliverables

Staffing

Assumptions

None identified

Allowance

An overall allowance of 35% has been included for 2024 - 2032; and an allowance of 25% has been included, starting in 2033. No additional allowance has been included in the years prior to 2024 to align with NWMO's business plan.

Labour Cost	$51,086,787.58
Material Cost	$0.00
Other Cost	$0.00
Subtotal	*$51,086,787.58*
Allowance	$8,675,377.43
Total Cost	**$59,762,165.01**

Start Year	2015
Finish Year	2072
Duration	**58 years**
WBS Type	Fixed

DETAILED SITE CHARACTERIZATION

570.30.10

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Derek Wilson	Prepared by:	D. Wilson	Organization:	NWMO

Description

Complete surface based geologic and geotechnical characterization of the site selected through the Phase 2 siting project. This program builds on the geoscience investigations completed as part of the Phase 2 for the selected site. Site characterisation activities would involve laboratory and field investigations to support Geoscience, Safety Assessment and Repository Engineering functions.

Deliverables

Characterization activities would include detailed geologic mapping with a focus on nature and distribution of bedrock lithology and in particular the acquisition of fracture network statistics. A network of borehole seismographs would be established to monitor micro-seismicity in the region around the sites. Field and laboratory activities would be described in a series of supporting reports for the purpose of creating a 3-dimensional Descriptive Site Geosphere Model DGSM.

Surface based investigations will include a coordinated campaign of geophysical surveys (such as 2D seismic, EM, Resistivity) and deep and shallow boreholes. The number of boreholes that will be required is site specific.

Deliverables include the Descriptive Geosphere Site Model (including groundwater flow system modelling), supporting geosphere characterization documentation, and updated Site Database and VR simulations.

Staffing is included in the overall Geoscience labour WBS 570.30.90.

Assumptions

Detailed site characterization activities are assumed to commence in 2024, and be completed in 2028. The estimated cost of $100M has been distributed evenly for each of the 5 years at $20M/year.

Site monitoring costs are included within the estimated $100M during detailed site characterization activities. Refer to WBS 570.30.20 for the on-going site monitoring activities and associated costs post-detailed site characterization.

Allowance

An overall contingency/allowance of 35% has been included.

Labour Cost	$0.00	Start Year	2024

Material Cost	$0.00
Other Cost	$100,000,000.00
Subtotal	*$100,000,000.00*
Allowance	$35,000,000.00
Total Cost	**$135,000,000.00**

Finish Year	2028
Duration	**5 years**
WBS Type	Fixed

GEOSPHERE MONITORING

570.30.20

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario

WBS Owner	Derek Wilson	Prepared by:	Derek Wilson	Organization:	NWMO

Description

Geosphere monitoring is expected to continue at the selected site for all life-cycle phases. It is assumed that no additional monitoring installations will be added beyond those as part of detailed site characterization (WBS# 570.30.10), although some routine maintenance/replacement will be required.

During construction, capability for geoscience characterization and numerical analysis is included.

During the operational period geoscience verification studies will be completed to supplement the descriptive geoscientific model. Geoscience-based monitoring activities will take place throughout the period as well.

During the extended monitoring period, the facility will remain open and accessible. The estimate assumes a maintenance and replacement frequency for monitoring equipment and preparation of annual reports.

Deliverables

Geosphere monitoring installations will consist primarily of shallow groundwater monitoring wells (~ 100 m), multiple-level groundwater monitoring systems in deep boreholes (~ 1000 m), borehole seismographs and GPS stations. Groundwater monitoring will consist of periodic (ex: quarterly) measurements of hydraulic pressures and periodic (semi-annual) collection of groundwater samples for hydrogeochemical analyses for the purpose of establishing background conditions and variability. Seismograph and GPS stations will include automatic data acquisition systems accessed remotely.

The main activities include far-field hydrogeological and seismic monitoring and maintenance of the associated existing monitoring network; geologic mapping, hydrogeological, geochemical and geomechanical characterization activities during construction; reporting and interpretation of hydrogeological/geologic site characterization and monitoring data gathered; maintenance and updating of the DGSM and associated hydrogeologic and geomechanical numerical models; installation and monitoring of underground seismograph and microseismic network; excavation deformation monitoring; in-situ stress measurement.

Assumptions

All geoscience related costs from 2015 through 2023 are included in the Phase 2 estimate (WBS# 570.15.70).

The estimated materials and equipment and 3rd party contract costs of activities from the 2011 estimate have been escalated to 2015 $'s and carried forward for the same period.

Staffing is included in the overall Geoscience labour WBS element (570.30.90).

Allowance

570.30.20

An overall allowance of 35% has been included for 2024 - 2032; and an allowance of 25% has been included, starting in 2033.

Labour Cost	$0.00		Start Year	2029
Material Cost	$10,782,453.75		Finish Year	2168
Other Cost	$152,673,662.06		Duration	**140 years**
Subtotal	*$163,456,115.82*		WBS Type	Fixed
Allowance	$41,717,593.58			
Total Cost	**$205,173,709.40**			

GEOSCIENCE / DETAILED SITE CHARACTERIZATION - STAFFING

570.30.90

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Derek Wilson	Prepared by:	Derek Wilson	Organization:	NWMO

Description

As per Deliverables.

Deliverables

NWMO staff required to support and manage work program objectives.

Assumptions

All geoscience related costs from 2015 through 2023 are included in the Phase 2 estimate (WBS# 570.15.70)

Allowance

An overall allowance of 35% has been included for 2024 - 2032; and an allowance of 25% has been included, starting in 2033.

Labour Cost	$130,922,058.75
Material Cost	$0.00
Other Cost	$0.00
Subtotal	*$130,922,058.75*
Allowance	$35,432,907.56
Total Cost	**$166,354,966.31**

Start Year	2024
Finish Year	2167
Duration	**144 years**
WBS Type	Fixed

LICENSING - CNSC FEES

570.35.10

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Derek Wilson	Prepared by:	Paul G.	Organization:	NWMO

Description

All safety assessment related costs from 2015 through 2023 are included in the Phase 2 and Proof Testing project estimates.

LICENSING COSTS TO SITE PREP AND CONSTRUCTION LICENCE (2024-2032):
Regulatory costs to obtain EA approval and Site Preparation & Construction Licences

LICENSING COSTS DURING CONSTRUCTION (2033-2042):
Regulatory costs during the Site Preparation and Construction period

LICENSING COSTS DURING OPERATIONS (2043-2072):
Regulatory costs during the Operations period

LICENSING COSTS DURING MONITORING,
DECOMMISSIONING AND CLOSURE (2073...):
Regulatory costs during the Extended Monitoring, Decommissioning and Closure periods

Deliverables

LICENSING COSTS TO SITE PREP AND CONSTRUCTION LICENCE (2024-2032):
Regular meetings with CNSC to present the design basis, siting program results and safety case considerations to ensure they are knowledgeable.
Seek CNSC feedback and in some cases formal review of specific aspects of the program, including the 2026 interim Geosynthesis, interim Safety Assessments, interim EA. There will be in general updated interim reports about every 2-3 years as the work progresses.
CNSC meets with interested communities to discuss the role of the regulator.
CNSC expectations regarding security and safeguards.

LICENSING COSTS DURING CONSTRUCTION (2033-2042):
CNSC facility licence maintained.
Approval for complete the underground construction after geological verification.
Annual reports to CNSC as required by licence
Presentation to Commission as requested

LICENSING COSTS DURING OPERATIONS (2043-2072):
CNSC facility licence maintained.
Annual reports to CNSC as required by licence
Presentation to Commission as requested

LICENSING COSTS DURING MONITORING, DECOMMISSIONING AND CLOSURE (2073...):
Operating licence maintained during Extended monitoring period.
Receipt of Decommissioning Licence
Receipt of Abandonment Licence

Assumptions

LICENSING COSTS TO SITE PREP AND CONSTRUCTION LICENCE (2024-2032):
NWMO formally indicates intent to apply for licence in 2024 (like OPG DGR in 2006) to initiate process
NWMO re-imbursement of CNSC costs as a licence applicant
Includes costs for CNSC review group and relevant technical research program.
Includes CNSC charges as a result of their Duty to Consult activities
No costs for Commission (during briefings), or discussions with federal or provincial review agencies (e.g. GSC, OGS, NRCan), or for other (non-CNSC) agency Duty to Consult activities.
NWMO submits licence application at end 2028. This will include an EIS and PSR.
Public review and hearings start early 2029, with licence issued end 2032.
Costs for review from other provincial and federal agencies are not charged to the project.
Other permits would generally be formally requested after the receipt of the EA approval and initial CNSC licence. The estimated amounts are sufficient to cover any licence costs from other regulatory agencies during this period, as these are expected to be relatively small. Technical costs to conduct analyses or prepare reports for submission of EIS, PSR or any other licence application are included in the respective technical program.

LICENSING COSTS DURING CONSTRUCTION (2033-2042):
NWMO re-imbursement of CNSC costs as a licence applicant
Includes costs for CNSC review group and relevant technical research program.
No special Joint Panel is appointed; no EA. Process follows normal CSNC facility licence.
No costs for Commission (during briefings), or discussions with federal or provincial review agencies (e.g. GSC, OGS, NRCan).
The estimated amounts are sufficient to cover any licence costs from other regulatory agencies during this period, as these are expected to be relatively small.
Costs to conduct analyses or prepare reports for submission of FSR or any other licence application are included in the respective technical program.

LICENSING COSTS DURING OPERATIONS (2043-2072):
NWMO re-imbursement of CNSC costs as a licence applicant
Includes costs for CNSC review group and relevant technical research program.
No costs for Commission (during briefings), or discussions with federal or provincial review agencies (e.g. GSC, OGS, NRCan).
The estimated amounts are sufficient to cover any licence costs from other regulatory agencies during this period, as these are expected to be relatively small.
Costs to conduct analyses or prepare reports for submission of FSR or any other licence application are included in the respective technical program.
IAEA safeguard related costs are included, if applicable, within the CNSC costs.

LICENSING COSTS DURING MONITORING, DECOMMISSIONING AND CLOSURE (2073...):
NWMO re-imbursement of CNSC costs as a licence applicant
No costs for Commission (during briefings), or discussions with federal or provincial review agencies (e.g. GSC, OGS, NRCan).
The estimated amounts are sufficient to cover any licence costs from other regulatory agencies during this period, as these are expected to be relatively small.

570.35.10

Costs to conduct analyses or prepare reports for submission of FSR or any other licence application are included in the respective technical program.
IAEA safeguard related costs are included, if applicable, within the CNSC costs.
NWMO applies for Abandonment licence application directly after completion of the 25 year (total) Decommissioning and Closure period.

Although IAEA related safeguards will be collected through the CNSC fees, as these costs will vary depending on used fuel movements, they have been estimated seprately.

Allowance

An overall allowance of 35% has been included for 2024 - 2032; and an allowance of 25% has been included, starting in 2033.

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$349,293,301.59
Subtotal	*$349,293,301.59*
Allowance	$91,523,325.40
Total Cost	**$440,816,626.99**

Start Year	2024
Finish Year	2172
Duration	**149 years**
WBS Type	Fixed

SAFEGUARDS

570.35.20

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Derek Wilson	Prepared by:	Derek Wilson	Organization:	NWMO

Description

Safeguards are primarily a means of nuclear material accounting complimented by containment and surveillance. The safeguards measures applied to the DGR facility will vary for each phase and has been grouped into three basic phases; pre-operations, operations, and post-closure phase. The International Atomic Energy Agency (IAEA) determines the required safeguards based on the design and layout of the APM DGR Facility. The IAEA is responsible for implementing safeguards internationally. While the IAEA may implement safeguards, from the design phase through to post- operations, including providing the labour and material involved in the design and installation of equipment, the IAEA is a non-profit organization and all costs are recovered through contributions made by Member States. The Canadian Nuclear Safety Commission (CNSC) is the Canadian regulatory body and pays the IAEA fees, recovering these costs through licensing fees from the facility owners. The level of effort and scope of safeguards is related to the movement of fuel and therefore is estimated separate from the CNSC Fees which are found in 570.35.10.

Costs included are those that will indirectly be provided to the IAEA, which covers the cost of inspectors, labour, and material for implementing safeguards at the DGR Facility. Details of the labour and equipment required for the DGR Facility are found in 2014 APM Conceptual Design Update - Safeguards Requirements – APM-TDM-21200-0001. NWMO staff will be trained in the procedures for dealing with IAEA inspectors, and NWMO will ensure a staff is on site at all times.

Deliverables

Pre-Operations Phase (2024-2042)
Safeguards related activities commence in the site characterization stage (i.e. after site selection)
- 1 FTE/yr for maintaining interface with CNSC and IAEA as necessary (from years 2024-2043).
- Additional 2 FTE/yr for implementing safeguards at the DGR Facility when construction starts (from years 2034 – 2043).
- 1 FTE/yr of IAEA staffing to support installation/set up activities (2034 – 2043) – a 1:1 correlation of NWMO to IAEA staff is assumed.
- $1M/year IAEA monitoring activities/tools including satellite imagery, aerial photography, geophysical monitoring, starting 5 years before operations.
- Costs for Safeguard equipment, installation, IAEA inspection personnel, data collection/analysis etc. (paid for by IAEA and recovered from Member states through License)

Operations (2043-2072)
-3 FTEs/yr for maintenance of safeguard program.
-Office Space for IAEA inspector ($3500/m2 for 16m2).
-Allowance for lighting, power, data communication (assume 10% of equipment capital costs ($1.4M) per year.)
- 3FTE/yr (IAEA staff) for inspection and analysis – a 1:1 correlation of NWMO to IAEA staff is assumed.
- $1M/year IAEA monitoring activities/tools including satellite imagery, aerial photography, geophysical

monitoring, starting 5 years before operations.

Post-closure Phase (2073 onward)
No safeguard specific requirements – conventional and radiological safety methods are adequate for safeguards post-closure.

Assumptions

Per CNSC assumption - 1 FTE equals 1800 hours at a rate of $280 per hour.
$10k per piece of equipment, including installation and cabling for 141 pieces of equipment identified in TDM.
Assume 10% per year for maintenance/consumables of Safeguard equipment.
A key assumption for this estimate is that the NWMO will obtain approval for integrated safeguards similar to OPG.

Allowance

An overall allowance of 35% has been included for 2024 - 2032; and an allowance of 25% has been included, starting in 2033.

Labour Cost	$69,724,481.40
Material Cost	$0.00
Other Cost	$44,856,000.00
Subtotal	*$114,580,481.40*
Allowance	$28,645,120.35
Total Cost	**$143,225,601.75**

Start Year	2024
Finish Year	2072
Duration	**49 years**
WBS Type	

LICENSING - STAFFING

570.35.90

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Derek Wilson	Prepared by:	Paul G	Organization:	NWMO

Description

All safety assessment related costs from 2015 through 2023 are included in the Phase 2 and Proof Testing project estimates, and therefore not included in Licensing costs.
Staffing for detailed site characterization and licensing (2024 – 2032) and construction (2033 – 2042) to be consistent with the overall Safety and Licensing staffing levels when considering the same period with Safety Assessment.
Staffing for the operations period (2043 – 2072), extended monitoring period (2073 – 2142), decommissioning period (2143 – 2068) all remain constant.

Deliverables

None

Assumptions

None

Allowance

An overall allowance of 35% has been included for 2024 - 2032; and an allowance of 25% has been included, starting in 2033.

Labour Cost	$79,121,888.63	Start Year	2024
Material Cost	$0.00	Finish Year	2172
Other Cost	$0.00	Duration	**149 years**
Subtotal	*$79,121,888.63*	WBS Type	Fixed
Allowance	$20,409,896.02		
Total Cost	**$99,531,784.66**		

UDF EQUIPMENT

570.40.10.30.10

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Chip Lee	Organization:	NWMO

Description

Underground development facility (UDF) equipment encompasses specialty equipment required for the research functions of the UDF. These functions will be specified in detail as UDF design and licensing proceeds.

The current contracting strategy is to procure the UDF on an Engineer, Procure and Construct, EPC, basis, in which the contractor's price includes detailed design. Facility requirements will be developed by NWMO as part of Repository Engineering, Safety Assessment and allied efforts. Support installations associated with the UDF, such as maintenance shops, located in the main and service shaft complex, are included in work element 570.40.10.30.20.70, "Tunnel and Service Area Excavation")

Deliverables

Initial set of specialized UDF equipment as required for UDF research activities. Set of equipment includes:

UFC Transfer Cask
Trolley for UFC Transfer Cask
Shielding Canopy
Shielding Canopy Trolley
Hydraulic Cylinder Cart
Placement Vehicle
Floor Plate Handling System
Bentonite Spacer Block Trolley
Bentonite Pellet Blowing System
Tow Vehicle
Floor Plate Placement System

Assumptions

Initial cost allotment on the basis of a full set of Used Fuel Container (UFC) emplacement equipment for testing and evaluation.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00	Start Year	2038

Material Cost	$3,205,480.00
Other Cost	$0.00
Subtotal	*$3,205,480.00*
Allowance	$801,370.00
Total Cost	**$4,006,850.00**

Finish Year	2038
Duration	**1 years**
WBS Type	Fixed

CONCRETE PLANT

570.40.10.30.20.20

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Chip (A) Lee	Prepared by:	Isaac Ahmed	Organization:	Golder Associates Ltd.

Description

Construction and commissioning of a concrete batch plant.
The batch plant would include 3 binder storage silos to produce a low heat, high performance (LHHP) concrete. The binders include: cement T50, silica fume and silica flour.
The plant would be outfitted with admixture addition capacity to allow reduced water content LHHP concrete mix design.
Four storage domes are included.

Deliverables

Concrete batch plant includes:

- 75 tonne Cement T50 & Silica Fume Silos
- 150 tonne Silica Flour Silo
- Binder Hopper
- Cement Batcher
- PD Blowers
- Hoppers (Coarse and Fine)
- Belt Feeder
- Short Hop Conveyor
- Internal Transfer Conveyors
- Aggregate Hopper
- Aggregate Batcher
- Hot Water Tank
- Admixture Tanks
- Long Field Conveyor to SMC Plant
- Ready-Mix Truck
- Bin With Transfer Conveyor
- Dust Collection System
- Heated Floor Slabs In Storage Domes
- Storage Domes (4)

Assumptions

Batch plant to be 20 to 25 m3 per hour capacity; sized on a basis of pouring concrete bulkheads at the placement room entrances. Pricing derived from commercially-available (quoted) BMH dry batch plant (9 m3 scales; fills standard truck with single batch). A combination of database values/vendor budget estimates for fixed plant equipment and factored costs for plant direct (infrastructure) and indirect (engineering, commissioning and construction support) costs have been used to build the estimate.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$437,481.00
Material Cost	$4,896,540.88
Other Cost	$1,708,602.00
Subtotal	*$7,042,623.88*
Allowance	$1,760,655.97
Total Cost	**$8,803,279.85**

Start Year	2034
Finish Year	2034
Duration	**1 years**
WBS Type	Fixed

CAMPSITE AND CAMPSITE OPERATIONS

570.40.10.30.20.40

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario

WBS Owner	Jennifer Noronha	Prepared by:	Bernie Hagen	Organization:	SNC-Lavalin

Description

Set up and operation of the temporary camp complex for mine/construction workers during the construction period.

Deliverables

Construction camp complex (maximum capacity of 600-persons) including accommodations; medical centre, airstrip, infrastructure as roads, drains, lighting; kitchen, cafeteria; fuel storage area and recreation facilities. Camp will include all services including potable and fire water, sewage collection and treatment, solid waste collection & disposal and electrical power supply.

Assumptions

Current project concept includes potential development of a Townsite to support DGR operations, subject to discussions between the NWMO and the community.

Campsite specified to provide initial construction area support (sewerage, helipad, water, waste) and accommodation for contract crews.

Pricing based on commercially available genset, trailer and tankage rates; road costs consider representative northern Ontario per-km rates.

Operational costs budgeted as a camp vendor charge of $50 per person/per day (includes food, all camp indirects).

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$44,656,351.82
Material Cost	$72,976,035.08
Other Cost	$67,887,473.60
Subtotal	*$185,519,860.50*
Allowance	$46,379,965.12
Total Cost	**$231,899,825.62**

Start Year	2033
Finish Year	2042
Duration	**10 years**
WBS Type	Fixed

SERVICE SHAFT AND HEADFRAME

570.40.10.30.20.50

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario

WBS Owner	Chip (A) Lee	Prepared by:	Eric Schraml	Organization:	SNC-Lavalin

Description

The construction of the shaft collar, erection of permanent headframe, installation of hoisting system, installation of ventilation fans, the sinking of the Service/Production Shaft and the excavation and construction of rock handling systems.

The shaft will serve as an exploration shaft during underground characterization in the UDF and be 6.5 m diameter. Upon completion of sinking the shaft, construct, install and commission a permanent headframe and hoist house for the shaft.

The work excludes installation of permanent ventilation fans at this facility, both of which is installed on surface. Fan installation is covered by work element .40.60.40.

Deliverables

A 6.5 m finished internal diameter, concrete-lined exploration shaft, complete with associated infrastructure.

Assumptions

The collar is 30 m in depth.

Shaft sinking will utilize the permanent headframe, and the permanent double-drum hoist to be used for later skipping. There will be a tower-mounted Koepe hoist for the main cage to be serviced by an Alimak elevator. An auxiliary hoist will also be provided for a total of three hoists.

The permanent headframe is 64 m in height and constructed of concrete

The shaft depth is assumed to be approximately 550 m to allow for a surge capacity above the loading pocket, and to allow for the overwind/underwind required for safety concerns.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00	Start Year	2033

Material Cost	$0.00
Other Cost	$150,167,624.76
Subtotal	*$150,167,624.76*
Allowance	$37,541,906.19
Total Cost	**$187,709,530.95**

Finish Year	2034
Duration	**2 years**
WBS Type	Fixed

TUNNEL AND SERVICE AREA EXCAVATION

570.40.10.30.20.70

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Richard Heystee	Prepared by:	Joe Carvalho	Organization:	Golder Associates Ltd.

Description

Excavation of the tunnels between the main and service shaft, tunnels interconnecting the services facilities, excavations for the UDF, excavations for support services and outfitting of support facilities.

Deliverables

Provision of tunnels and service areas, including:
• Truck By-pass
• Test Rooms (in UDF)
• Test Access Tunnel
• Tunnels from Main Shaft Station
• Tunnel from office access tunnel to Central Access Tunnel
• Offices (ten) & Access Tunnel
• Refuge Stations (three)
• Washrooms (two)
• Special Equipment Storage
• Instrumenation Shop
• Charging Station & outfitting with chargers & battery racks
• Cask Storage
• Fuel Station
• Maintenance Shop & Ancillary Rooms
• UG Booster Fan Areas
• Rockbreaker & Grizzly
• Bridge Cranes (5 & 15 tonne)
• 3 Tonne Jib Crane
• Clear Water Pumps

Initial underground geosphere characterization assessment work will conducted during excavation of tunnels and rooms, and in the test rooms. UFC placement equipment will be proof-tested in test rooms for design data gathering and design verification.

Assumptions

Work conducted on an Engineer-Procure-Construct Basis by contractor. Estimated on the basis of all-inclusive development and installation rates. Development to be scheduled for 350 days per year, 24 hours per day.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$205,232.00
Other Cost	$41,033,207.10
Subtotal	*$41,238,439.10*
Allowance	$10,309,609.77
Total Cost	**$51,548,048.87**

Start Year	2035
Finish Year	2038
Duration	**4 years**
WBS Type	Fixed

570.40.10.30.20.70

SITE IMPROVEMENTS

570.40.20

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Chip (A) Lee	Prepared by:	Wayne Palmer	Organization:	SNC-Lavalin

Description

Site preparation for surface facilities.

Deliverables

Preparation of the site, including:

• Site civil preparation (clearing, blasting, grading, initial landscaping)
• Allotment for permits
• Main (25 km) access road (inc. drainage ditches and hydro tower allowance)
• Transmission towers (25 m high, every 200 m)
• High voltage lines and grid tie-in
• Inner/outer zone site roads (approx. 4.8 km)
• Road for vent shaft complex (approx. 5 km)
• Parking Lots (Paved, for up to 200 cars, 5 buses, 15 trucks: 120 m x 50 m/6000 m2)
• Two large bus shelters (30 person shelters: 15 m2 ea.)
• Six standard small bus shelters (6 m2)
• Truck weigh scale (25 m long), scale house, and traffic lights.
• Helipad - 30 m dia., include drainage and lighting
• Rail line – up to 1.2 km from sealing materials compaction plant to the service shaft, including switchgear
• Off-site waste rock disposal area, including fencing, gate, access road and storm water runoff pond pond
• Outer perimeter fence, including 2 vehicle gates, 4 person gates, signage and lighting
• Protected area double fence (3 m high, 4 m offset, barbed wire), including signage, lighting and motion sensors.

Assumptions

Site is a flat green area situated in the Canadian Shield, within 25 km of an existing highway. Access road will be 10 m wide and 25 km in length. Rail access to the site is not required.
Land acquisition is accounted for in other work elements as part of the siting process.

Surface preparation is calculated for surface facilities footprint only (0.5 km^2). $175,000 allotted for provincial/federal permits.

All work conducted on a design-build basis, using design-build labour rates that account for typical construction indirects.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$43,364,096.61
Material Cost	$68,121,147.10
Other Cost	$2,091,963.37
Subtotal	*$113,577,207.09*
Allowance	$28,394,301.77
Total Cost	**$141,971,508.86**

Start Year	2033
Finish Year	2034
Duration	**2 years**
WBS Type	Step Fixed

VISITOR CENTRE - OPS DURING CONSTRUCTION

570.40.30

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bernie Hagen	Organization:	SNC-Lavalin

Description

Indirect labour and equipment costs incurred during the facility design and construction stage of the project which are not included in Engineer, Procure, Construct (EPC) price items.

EPC procurement is used comprehensively: construction phase indirects are limited to visitor's centre operations and maintenance of surface facilities after hand-over to owner.

Previously titled : Construction Phase Indirects (Inc Fire & Security) - updated to be representative of scope.

Deliverables

Operation of the Visitor's Centre and incidental care/upkeep for structures after completion by EPC contractor.

Assumptions

Construction is on an EPC Basis - All conventional construction phase indirects are included in pricing for individual work elements. Visitor's centre operation budgeted as six persons, one shift. Incidental maintenance budgeted as crew of 4 surface construction works (surface construction worker labour rate includes janitorial, waste disposal, etc.)

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$16,305,042.00
Material Cost	$0.00
Other Cost	$0.00
Subtotal	*$16,305,042.00*
Allowance	$4,076,260.50
Total Cost	**$20,381,302.50**

Start Year	2033
Finish Year	2042
Duration	**10 years**
WBS Type	Step Fixed

UFPP PROJ MAN / BUILDING DESIGN & CONSTRUCTION

570.40.40.10.10

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Alan Murchison	Prepared by:	Ben Thayer	Organization:	ATS

Description

The Mark 2 Used Fuel Packing Plant (UFPP) concept uses a smaller Used Fuel Container (UFC) than international benchmarks to package 48 used CANDU fuel bundles. The Mark 2 UFPP employs a modular approach in UFC processing by using multiple independent work cells to achieve a throughput of 10+ UFCs per day. The Mark 2 UFPP allows processing to be done in parallel, thus providing a flexible and adaptive plant design that can be scaled for expansion. The modular approach also lends itself to more readily handle off-nominal scenarios and rework.

The UFPP PROJ MAN / BUILDING DESIGN & CONSTRUCTION WED pertains to the project management, design, construction and commissioning management of the UFPP. The UFPP consists of a single-level (with basement) structural steel framed building mounted on a reinforced concrete slab. The building will be a seismically qualified impact-resistant structure, containing radiation shielding cells (hot cells). All facilities within the building that are used to process nuclear materials will be clad with stainless steel, while other areas that may potentially become contaminated will be provided with high-quality surface finishes (for ease of decontamination and housekeeping). The building exterior will be constructed using structural steel and aluminum clad walls.

Deliverables

The UFPP MAN / BUILDING DESIGN & CONSTRUCTION consists of the costs associated with:

- Project management, design and engineering for all areas (i.e. building & civil, mechanical, construction engineering / inspection and process)
- Construction of the building including all permanent fixtures
- Installation of infrastructure relating to radiological protection such as thick concrete hot-cell walls, stainless steel lining, airlocks etc.
- The construction of the ventilation discharge stack
- Preliminaries construction (temporary housing, offices, and services for workers)

To construct a UFPP Facility that includes:

- 22,575 m^2 total floor space
- 2,998 m^2 office space
- 1 Incoming UFC Receiving and Handling area (995 m^2)
- 4 Incoming UFC Inspection and Pre-assembly areas (685 m^2)
- 1 Active Maintenance shop (582 m^2)
- 1 Waste Management facility (605 m^2)
- 1 Incoming UFTP (Used Fuel Transfer Package) Receiving and Handling area (1940 m^2)
- 1 Fuel Module Handling area (838 m^2) (Hot Cell)
- 1 Fuel Module Storage area (395 m^2) (Hot Cell)

- 3 Fuel Loading Areas (708 m^2) (Hot Cell)
- 1 Intra-plant UFC tranfer Hall (3883 m^2)
- 1 Process Contingency Manual Work Cell (250 m^2) (Hot Cell)
- 12 UFC Processing Cells (2652 m^2) (Hot Cell)
- 1 UFC Decontamination and Dispatch Area (1650 m^2)

Assumptions

The general WBS framework and some source costs were taken from the 2002 CTECH UFPP cost estimate. SKB reviewed and updated the UFPP estimate produced by CTECH and validated the appropriateness of the cost estimate based on their reference plant design. SKB escalated the CTECH estimates deeming the 2002 material take-offs appropriate. This ATS estimate credits this baseline work and where used, has scaled 2002$ by 1.25 and 2010$ by 1.054 based on Stats Canada data and projected inflation. For all different or new scope, bottom-up estimates were prepared.

Prices for all costs associated with building design and construction were calculated as rates per unit of area (m^2). These costs were calculated from the initial UFPP costing provided by Aecon. The corresponding costs for the updated plant layout were calculated based on these rates.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$1,987,384.71
Material Cost	$8,987,618.78
Other Cost	$98,727,874.05
Subtotal	*$109,702,877.54*
Allowance	$27,425,719.38
Total Cost	**$137,128,596.92**

Start Year	2037
Finish Year	2041
Duration	**5 years**
WBS Type	Step Fixed

UFPP EQUIPMENT DESIGN SUPPLY AND INSTALL (AREA 1)

570.40.40.10.20

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Alan Murchison	Prepared by:	Ben Thayer	Organization:	ATS

Description

The UFPP Equipment Design Supply and Install (Receive & Transfer) WED pertains to the detailed design, supply, installation and testing of all process equipment, together with local control, electrical and instrumentation (CE&I), for UFTP and Fuel Module reception and transfer.

Deliverables

The following WED consists of the costs associated with the Equipment, CE&I and cell services required for receiving and transferring UFTPs and Fuel Modules with the following UFPP key components:

- 1 Area 1 SCADA (Supervisory Control And Data Acquisition)
- 1 Module Distribution Hall (334 m^2)
- 1 Transport Receiving / Shipping area (UFTP Shipping and Receiving Hall) (1937 m^2)
- 2 Module Cask Receipt areas (UFTP Transfer Cells) (252 m^2)
- 2 Module Receipt Cells (Module Handling Cells) (252 m^2)
- 1 Fuel Module Storage area (Module Dry Storage Area) (395 m^2) (Hot Cell)

This includes pricing for holding areas, cranes, radiation considerations, tele-manipulators, transfer carts, drying booths and specialty area cooling for module storage area.

Assumptions

The general WBS framework and some source costs were taken from the 2002 CTECH UFPP cost estimate. SKB reviewed and updated the UFPP estimate produced by CTECH and validated the appropriateness of the cost estimate based on their reference plant design. SKB escalated the CTECH estimates deeming the 2002 material take-offs appropriate. This estimate credits this baseline work and where used, has scaled 2002$ by 1.25 and 2010$ by 1.054 based on Stats Canada data and projected inflation. For all different or new scope, bottom-up estimates were prepared.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$9,675,207.80
Material Cost	$53,805,074.00
Other Cost	$21,921,096.30
Subtotal	*$85,401,378.09*
Allowance	$21,350,344.52
Total Cost	**$106,751,722.62**

Start Year	2037
Finish Year	2041
Duration	**5 years**
WBS Type	Step Fixed

UFPP EQUIPMENT DESIGN SUPPLY AND INSTALL (AREA 2)

570.40.40.10.30

Case MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario

WBS Owner Alan Murchison Prepared by: Ben Thayer Organization: ATS

Description

The UFPP Equipment Design Supply and Install (Package) WED pertains to the detailed design, supply, installation and testing of all process equipment, together with local control, electrical and instrumentation (CE&I), for UFC reception, transfer and processing.

Deliverables

The following WED consists of the costs associated with required process areas, equipment CE&I and services for processing UFCs with the following UFPP key components:

- 1 Area 2 SCADA (Supervisory Control and Data Acquisition)
- 3 Fuel Handling Cells (236 m^2)
- 3 Fuel Loading Cells (472 m^2) (Hot Cell)
- 1 Empty UFC Receiving / Handling area (995 m^2)
- 4 Empty UFC Incoming Inspection & Pre-assembly areas (685 m^2)
- 1 AGV Transport system (6 AGVs and 30 UFC Flasks)
- 1 Intra-plant UFC Transfer Hall (Transfer Corridor) (3883 m^2)
- 3 UFC Processing Weld Cells (582 m^2)
- 6 UFC Processing Copper Application Cells (1380 m^2)
- 3 UFC Processing Spare Cells (690 m^2)
- 3 In-process UFC Buffer Areas (Inc. In transfer corridor area)

Assumptions

The general WBS framework and some source costs were taken from the 2002 CTECH UFPP cost estimate. SKB reviewed and updated the UFPP estimate produced by CTECH and validated the appropriateness of the cost estimate based on their reference plant design. SKB escalated the CTECH estimates deeming the 2002 material take-offs appropriate. This estimate credits this baseline work and where used, has scaled 2002$ by 1.25 and 2010$ by 1.054 based on Stats Canada data and projected inflation. For all different or new scope, bottom-up estimates were prepared.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$34,764,465.95	Start Year	2037

Material Cost	$238,141,713.20
Other Cost	$99,633,257.66
Subtotal	*$372,539,436.81*
Allowance	$93,134,859.20
Total Cost	**$465,674,296.01**

Finish Year	2041
Duration	**5 years**
WBS Type	Step Fixed

570.40.40.10.30

UFPP EQUIPMENT DESIGN SUPPLY AND INSTALL (AREA 3)

570.40.40.10.40

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Alan Murchison	Prepared by:	Ben Thayer	Organization:	ATS

Description

The UFPP Equipment Design Supply and Install (DECONTAMINATION, RE-WORK, WASTE MANAGEMENT) WED pertains to the detailed design, supply, installation and testing of all process equipment, together with local control and instrumentation (C&I), for decontamination, manual rework and waste management.

Deliverables

The following WED consists of the costs associated with the equipment, CE&I and services for processed UFCs ready for decontamination, re-work, or disposal. The following UFPP key components are identified:

- 1 Area 3 SCADA (Supervisory Control And Data Acquisition)
- 1 UFC Contingency Hot Cell (250 m^2)
- 1 Mechanical Workshop (Active Maintenance Shop) (582 m^2)
- 1 UFC Decontamination area (190 m^2)
- 1 Waste management Facility (605 m^2)

This includes pricing for holding areas, cranes, radiation considerations, decontamination equipment, LLW and ILW containers etc.

Assumptions

The general WBS framework and some source costs were taken from the 2002 CTECH UFPP cost estimate. SKB reviewed and updated the UFPP estimate produced by CTECH and validated the appropriateness of the cost estimate based on their reference plant design. SKB escalated the CTECH estimates deeming the 2002 material take-offs appropriate. This estimate credits this baseline work and where used, has scaled 2002$ by 1.25 and 2010$ by 1.054 based on Stats Canada data and projected inflation. For all different or new scope, bottom-up estimates were prepared.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$9,042,654.59
Material Cost	$65,296,023.84
Other Cost	$26,123,963.72
Subtotal	*$100,462,642.15*
Allowance	$25,115,660.54
Total Cost	**$125,578,302.69**

Start Year	2037
Finish Year	2041
Duration	**5 years**
WBS Type	Step Fixed

BUFFER BOX ASSEMBLY (UFPP)

570.40.40.10.45

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Alan Murchison	Prepared by:	Ben Thayer	Organization:	ATS

Description

The UFPP BUFFER BOX ASSEMBLY WED pertains to the detailed design, supply, installation and testing of all process equipment, together with local control, electrical and instrumentation (CE&I), required for receiving buffer box components, and decontaminated UFCs to create a UFC buffer box assembly for the downstream UFC dispatch process.

Deliverables

The following WED consists of the costs associated with required process areas, equipment CE&I and services for processing UFCs with the following UFPP key components:

- Buffer Box Pre-assembly / staging area (715 m^2)
- Buffer Box Assembly area (560 m^2)
- Buffer Box Transfer to dispatch area (375 m^2)

This includes pricing for holding areas, cranes, radiation considerations, tele-manipulators, transfer carts etc.

Assumptions

Equipment for the Buffer Box Assembly WED was priced based on the WBS framework and some source costs were estimated from similar equipment taken from the 2002 CTECH UFPP cost estimate. This estimate credits the 2002 CTECH cost model and where used, has scaled 2002$ by 1.25 and 2010$ by 1.054 based on Stats Canada data and projected inflation. For all different or new scope, bottom-up estimates were prepared.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$3,208,526.65
Material Cost	$22,845,450.88
Other Cost	$9,269,339.32
Subtotal	*$35,323,316.85*
Allowance	$8,830,829.21
Total Cost	**$44,154,146.06**

Start Year	2037
Finish Year	2037
Duration	**1 years**
WBS Type	Step Fixed

BUILDING SERVICES DESIGN SUPPLY & INSTALLATION (UFPP)

570.40.40.10.50

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Alan Murchison	Prepared by:	Ben Thayer	Organization:	ATS

Description

The BUILDING SERVICES DESIGN SUPPLY & INSTALLATION (UFPP) WED pertains to the detailed design, supply, installation and testing of all UFPP building services. These services include, plumbing, HVAC, ventilation, monitoring systems, electrical and communication systems.

Deliverables

Building services for the plant, equipment and systems, together with their local control and instrumentation, required to operate the UFPP (that are not included in the building and construction estimate). Services covered by this activity include:

Mechanical Services:
- Plumbing and drains
- HVAC System
- Exhaust Stack
- Fire Protection
- Engineered Design

Electrical Services:
- Security Systems
- Criticality Incident Detection System
- Area Monitoring Systems
- Drain Leak Detection
- Lightning protection system
- Personnel Monitoring equipment
- Electrical & Communication cabling
- Engineered Design

Assumptions

The general WBS framework and some source costs were taken from the 2002 CTECH UFPP cost estimate. SKB reviewed and updated the UFPP estimate produced by CTECH and validated the appropriateness of the cost estimate based on their reference plant design. SKB escalated the CTECH estimates deeming the 2002 material take-offs appropriate. This estimate credits this baseline work and where used, has scaled 2002$ by 1.25 and 2010$ by 1.054 based on Stats Canada data and projected inflation. For all different or new scope, bottom-up estimates were prepared.

Prices for all costs associated with building services design supply and installation (UFPP) were calculated as rates per unit of area (m^2). These costs were calculated from the initial ATS UFPP costing provided by Aecon.

The corresponding costs for the updated plant layout were calculated based on these rates.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$12,777,681.99
Material Cost	$34,875,684.78
Other Cost	$7,299,297.71
Subtotal	*$54,952,664.49*
Allowance	$13,738,166.12
Total Cost	**$68,690,830.61**

Start Year	2037
Finish Year	2040
Duration	**4 years**
WBS Type	Step Fixed

COMMISSIONING (UFPP)

570.40.40.10.60

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Alan Murchison	Prepared by:	Ben Thayer	Organization:	ATS

Description

The COMMISSIONING (UFPP) WED pertains to the commissioning of the UFPP building systems and services, in addition to the non-active and active functionality of all plant and equipment contained within the facility.

Deliverables

The following WED pertains to commissioning costs of all building services, equipment and systems together with their local control and instrumentation, required to operate the UFPP.

Commissioning costs are calculated based on a percentages of the overall UFPP cost with the following designations:
- Building Services (7%)
- UFPP Fuel Receive and Transfer Equipment (Area 1) (10%)
- UFPP Design Supply and Install of UFC Processing Equipment (Area 2) (5%)
- UFPP Design Supply and Install of UFC decontamination, re-work and waste management equipment. (Area 3) (10%)
- UFPP Design Supply and Install of UFC Buffer Box Assembly (dispatch) (10%)

Deliverables such as signed and approved schedules, test plans, results and reports will cover all necessary systems, services, plant equipment. These deliverables will serve to demonstrate the operability and safety function under non-active and active operations.

Assumptions

The general WBS framework and some source costs were taken from the 2002 CTECH UFPP cost estimate. SKB reviewed and updated the UFPP estimate produced by CTECH and validated the appropriateness of the cost estimate based on their reference plant design. SKB escalated the CTECH estimates deeming the 2002 material take-offs appropriate. This estimate credits this baseline work and where used, has scaled 2002$ by 1.25 and 2010$ by 1.054 based on Stats Canada data and projected inflation. For all different or new scope, bottom-up estimates were prepared.

Prices for all costs associated with Commissioning were calculated as a percentage of the overall cost of the area of interest.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$54,302,557.75	Start Year	2040

Material Cost	$0.00
Other Cost	$3,272,070.46
Subtotal	*$57,574,628.21*
Allowance	$14,393,657.05
Total Cost	**$71,968,285.26**

Finish Year	2042
Duration	**3 years**
WBS Type	Step Fixed

SEALING MATERIALS COMPACTION PLANT (SMCP)

570.40.40.20

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Chip (A) Lee	Prepared by:	Isaac Ahmed	Organization:	Golder Associates Ltd.

Description

The detailed design, construction, supply, installation, testing and commissioning of a fully operable Sealing Materials Compaction Plant (SMCP), capable of producing bentonite-based sealing materials for Used Fuel Container (UFC) placement.

Deliverables

The design and construction of a multi-story structural steel-framed 60m x 50m x 20m high SMC plant building mounted on a reinforced concrete slab. The design to include supply and installation of all building services. The building ventilation system will primarily provide dust suppression within the building operating areas. The design, supply installation of all process equipment. The process equipment within the SMC plant will include:

• Positive displacement blowers (3)
• Conveyors
• 10 x 150 tonne clay materials silos
• 150 tonne modified Granular A silo
• Weigh hoppers (4)
• Dust collector
• Mixers (3)
• Vacuum pump
• HCB press
• DBF press
• Hydraulic power pack for HCB press
• Hydraulic power pack for DBF press
• Briquetter
• Vacuum Lifting Device (4)
• Locomotive (2)
• Rail Cars (2)

The provision of detailed engineering, construction and other installation indirect costs (labour and equipment) incurred by the contractor to execute the project have been included.

Assumptions

A combination of database values/vendor budget estimates for fixed plant equipment and factored costs for plant direct (infrastructure) and indirect (engineering, commissioning and construction support) costs have been used to build the estimate. Press, briquetter, vacuum lift and mixer costs were developed from vendor budgetary pricing.

Site geotechnical testing and evaluation will be required to specify support needs/foundation requirements for the hydraulic presses.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$1,871,888.40
Material Cost	$89,969,695.60
Other Cost	$23,349,177.00
Subtotal	*$115,190,761.00*
Allowance	$28,797,690.25
Total Cost	**$143,988,451.25**

Start Year	2040
Finish Year	2042
Duration	**3 years**
WBS Type	Fixed

ADMIN BLDG

570.40.50.20

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bernie Hagen	Organization:	SNC-Lavalin

Description

Construction and commissioning of a fully equipped administration building. The administration building will include office space for the administration, management, engineering, maintenance and operation staff. The building will also contain Information Technology (IT) & Communication Centre, Transportation and Logistics Coordination Centre, a Nursing Station and First Aid room, Firehall and a Cafeteria. The various building mechanical and electrical equipment will be located on the main floor.

Deliverables

Fully equipped, 2-storey administration building (2,200 m^2 foot print providing a total gross floor area of 4,400 m^2).

Assumptions

Building size based on space for 200 people. Compliance with National Building Code. Fire trucks quoted by Fenton Fire Equipment of Michigan.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$8,270,795.94
Other Cost	$22,027,192.00
Subtotal	*$30,297,987.94*
Allowance	$7,574,496.99
Total Cost	**$37,872,484.93**

Start Year	2038
Finish Year	2038
Duration	**1 years**
WBS Type	Step Fixed

AUXILIARY OFFICE BUILDING

570.40.50.30

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bernie Hagen	Organization:	SNC-Lavalin

Description

Construction and commissioning of the Auxiliary Building. This facility will include offices, change house and mine dry for DGR personnel, space for campaign mining personnel.

Deliverables

Two-storey Auxiliary Building without basement with 1,140 m^2 foot print & total floor area of 2,280 m^2. Based on similar structures for existing and planned/proposed nuclear power facilities in Ontario.

Building composition similar to Administration Building and other surface facilities for personnel.
Roof: Insulated protected membrane roofing on metal deck.
Exterior walls: Preformed insulated wall metal panels. Insulated masonry cavity dado wall to 2.4m above grade.
Internal walls: Concrete block in traffic areas. Gypsum board on metal studs (demountable in office areas)
Floors: Non-dusting hardener treatment applied to areas with exposed concrete. Quarry tile or similar ceramic tile for change rooms, lockers and health physics areas. Vinyl composite tiles in areas requiring higher degree of finish other than exposed concrete. Carpet in office areas.
Ceilings: Exposed structure with fire protection as required in shops area. Suspended gypsum board in areas requiring fire protection and a higher degree of finish other than exposed structure. Suspended acoustic tile in all other areas.

Assumptions

Building size based on assumed occupancy of 80 permanent DGR personnel, and 25 campaign mining personnel on an intermittent basis. Plus 6 crews for remote operation of underground equipments.
Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$30,017,626.56
Other Cost	$8,675,217.60
Subtotal	*$38,692,844.16*
Allowance	$9,673,211.04
Total Cost	**$48,366,055.20**

Start Year	2038
Finish Year	2038
Duration	**1 years**
WBS Type	Fixed

QC OFFICES & LABS

570.40.50.40

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bernie Hagen	Organization:	SNC-Lavalin

Description

Construction and commissioning of Quality Control Offices and Laboratory building.

Deliverables

Single-storey building with no basement, 825 m² gross floor area. This facility will include offices and laboratories.

Based on similar structures for existing and planned/proposed nuclear power facilities in Ontario.

Building composition similar to Administration Building and other surface facilities for personnel.

Roof: insulated protected membrane roofing on metal deck.

Exterior walls: Preformed insulated modular metal panels with an integrated curtain wall glazing system.
Internal walls: Concrete block in high traffic areas. Gypsum board on metal studs (demountable type in office areas).

Floors: non-dusting hardener treatment applied to areas with exposed concrete. Quarry tile or similar ceramic tile for washrooms and kitchenette areas. Vinyl composite tiles in areas requiring higher degree of finish than exposed concrete. Carpet in office areas.

Ceilings: Suspended gypsum board in areas requiring fire protection and a higher degree of finish than exposed structure. Suspended acoustic tile in all other areas.

Assumptions

33 m by 25 m; equipment similar to similar existing facilities.
Approximately 45 m2 laboratories.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$348,410.53	Start Year	2039

Material Cost	$5,134,937.80
Other Cost	$0.00
Subtotal	*$5,483,348.33*
Allowance	$1,370,837.08
Total Cost	**$6,854,185.41**

Finish Year	2039
Duration	**1 years**
WBS Type	Step Fixed

570.40.50.40

GARAGE BUILDING / WAREHOUSE

570.40.50.50

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bernie Hagen	Organization:	SNC-Lavalin

Description

Construction and commissioning of a vehicle service garage and warehouse. This facility will include maintenance shops, repair bay, truck wash facility, oil separator and warehouse with a space allocated for hazardous materials storage.

Deliverables

Equipped single storey building, no basement, 1,920 m² total gross floor area.
Garage area of 1024 m2 (32 m x 32 m).

Assumptions

Structure to be pre-engineered type steel structure building. Includes garage equipment apportionment for: overhead crane/hoist, vehicle hoist, lube/oil equipment, oil separator, truck wash.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$1,665,659.19
Material Cost	$16,968,407.93
Other Cost	$0.00
Subtotal	*$18,634,067.13*
Allowance	$4,658,516.78
Total Cost	**$23,292,583.91**

Start Year	2033
Finish Year	2033
Duration	**1 years**
WBS Type	Step Fixed

WALKWAYS/SERVICEWAYS

570.40.50.60

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bernie Hagen	Organization:	SNC-Lavalin

Description

Construct and commission covered corridors (all-weather enclosed walkways) 3 m wide and 2.5 m high between specified buildings to facilitate movement of personnel.

Deliverables

Weather protected and fully enclosed grade level pedestrian walkway (corridor).

Assumptions

Composition: steel truss frame system cladded with metal siding and roofing to provide weather tight enclosure with fully glazed windows every 15 m and doors with built-in glazing every 50 m.

One Covered Corridor between Administration Building/Cafeteria and Auxiliary Buildings at 30 m.
One Covered Corridor between Auxiliary Building and Used Fuel Packaging Plant at 45 m.
One Covered Corridor between Auxiliary Building and Service Shaft Complex at 90 m.

Includes power, heat-traced water, hose stations, heat and air conditioning, windows, doors.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$1,721,932.22
Material Cost	$1,113,492.95
Other Cost	$0.00
Subtotal	*$2,835,425.17*
Allowance	$708,856.29
Total Cost	**$3,544,281.46**

Start Year	2038
Finish Year	2038
Duration	**1 years**
WBS Type	Fixed

FUEL TANK AREA

570.40.50.70

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bernie Hagen	Organization:	SNC-Lavalin

Description

Construction and commissioning of a fuel storage area for two tanks capable of holding a two-week supply for site. Unloading of delivered fuel using fuel transfer pumps, with fuel supply pumps system used to supply end users.

Deliverables

One diesel fuel tank at 105 m3 and one gasoline tank at 25 m3. Diesel tank is field erected. Gasoline tank is horizontal shop fabricated. Containment area will be lined with High Density Polyethene (HDPE) Liner.

Assumptions

Site designed to NFPA 30 Flammable and Combustible liquids. Diesel tank is 105 m3 and gasoline tank is 25 m3, installed in a high density polyethylene (HDPE) lined containment area of 12 m x 10 m. Includes base, concrete, tanks, two pumping systems, interconnections, piping, heat tracing, manifolds and instrumentation. Pricing developed with input from ZCL Composites.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$483,779.75
Material Cost	$575,870.69
Other Cost	$0.00
Subtotal	*$1,059,650.44*
Allowance	$264,912.61
Total Cost	**$1,324,563.04**

Start Year	2041
Finish Year	2041
Duration	**1 years**
WBS Type	Step Fixed

SECURITY CHECKPOINTS

570.40.50.80

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bernie Hagen	Organization:	SNC-Lavalin

Description

Construction and commissioning of security buildings and access control points.

This work element was originally referred to as "Fire Hall/Security Building" - Fire hall and equipment is now included in the Administration Building, .40.50.20. Admin building also accommodates central security offices]

Deliverables

Two 8 m x 10 m security buildings (with associated double gates and radiation monitors), one access control point (with gate, biometrics and radiation monitors), two 4 m x 6 m security booths (with gates, biometrics and radiation monitors). Also includes two explosive detectors and four metal detectors as well as a specialized security monitoring room/crisis centre in the Administration Building.

Assumptions

Costing includes turn-key buildings and security monitoring room within administration building. Gates, power, monitoring devices and installation accounted for.

Does not include costing for fence (see .40.20, "Site Improvements") or firehall, fire training facility and fire trucks (.40.50.20, "Administration Building".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$1,196,643.11
Material Cost	$7,553,870.51
Other Cost	$0.00
Subtotal	*$8,750,513.61*
Allowance	$2,187,628.40
Total Cost	**$10,938,142.01**

Start Year	2041
Finish Year	2041
Duration	**1 years**
WBS Type	Fixed

EMERGENCY POWER GENERATION

570.40.50.90

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Chip (A) Lee	Prepared by:	Wayne Palmer	Organization:	SNC-Lavalin

Description

Construct and commission a powerhouse building with emergency power generation equipment.

Deliverables

Single story building, 800 m2 area, with 30 m2 fuel storage pad.
Constructed of concrete block with insulation and cladding.
Steel frame roof with insulation.
Three 2.5 MW diesel generators
Electrical tie-ins to main camp facilities.

Assumptions

Emergency power requirement based on 10% of anticipated total facility requirements.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$4,170,320.77
Material Cost	$9,843,711.45
Other Cost	$0.00
Subtotal	*$14,014,032.23*
Allowance	$3,503,508.06
Total Cost	**$17,517,540.28**

Start Year	2033
Finish Year	2033
Duration	**1 years**
WBS Type	Step Fixed

PUMP HOUSE & INTAKE

570.40.50.100

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bernie Hagen	Organization:	SNC-Lavalin

Description

Construction and commissioning of a water intake of 200 m^3/day capacity, pump house and pipeline Including an intake structure with screen

Deliverables

Functioning system to supply water to the surface facilities of the DGR and also provide fire protection for surface facilities for 3 hours.

Components include:

• Pump house building
• Three sets of 15 hp pumps
• 5 km of 150 mm dia. Conveyance pipeline
• 5 km of gravel access road
• 5 km of above-ground 13 kv electrical supply (incl. 200 poles).

Assumptions

Size based on water requirements for fresh water, fire water and potable water.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$4,376,052.84
Material Cost	$7,059,346.12
Other Cost	$0.00
Subtotal	*$11,435,398.96*
Allowance	$2,858,849.74
Total Cost	**$14,294,248.70**

Start Year	2034
Finish Year	2034
Duration	**1 years**
WBS Type	Step Fixed

WATER STORAGE TANK AREA

570.40.50.110

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bernie Hagen	Organization:	SNC-Lavalin

Description

Construct and commission fire/raw water tank and potable water storage tanks.

Deliverables

Two field fabricated water storage tanks, one for potable water and one for fire/raw water. Includes:

• 300 mm thick reinforced concrete pad, including sub-grade, lighting, etc.
• Fresh/fire water tank (1500 m3)
• Potable water tank (100 m3)
• Monitoring /isolation equipment/submerged mixers

Assumptions

Potable water tank will hold 24 hours at average hourly flow rate. Fire/raw water tank will hold >3 hours of fire fighting at 340 m3/hour plus 24 hours of raw water demand.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$164,307.26
Material Cost	$800,893.03
Other Cost	$0.00
Subtotal	*$965,200.29*
Allowance	$241,300.07
Total Cost	**$1,206,500.36**

Start Year	2038
Finish Year	2038
Duration	**1 years**
WBS Type	Step Fixed

WATER TREATMENT PLANT

570.40.50.120

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bernie Hagen	Organization:	SNC-Lavalin

Description

Construct and commission a water treatment plant and water treatment plant building.

Deliverables

• Skid mounted water treatment plant (treatment rate of 15 gpm, 3 m3/hr)
• 125 m2 single storey building
• Tie ins

Assumptions

Size based on housing water treatment plants and pumps as listed above. Water Treatment Plant verbal quote from Ecologix System of Georgia; skid-mount package system requires daily checks but not full-time operator.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$66,285.00
Material Cost	$3,109,997.00
Other Cost	$0.00
Subtotal	*$3,176,282.00*
Allowance	$794,070.50
Total Cost	**$3,970,352.51**

Start Year	2038
Finish Year	2038
Duration	**1 years**
WBS Type	Step Fixed

PROCESS WATER SETTLING POND

570.40.50.130

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario

WBS Owner	Chip (A) Lee	Prepared by:	Wayne Palmer	Organization:	SNC-Lavalin

Description

Construct and commission a Process Water and storm water Settling Pond to hold 2314 m3 storm runoff. Pond size = 36m x 45 m x 4.1m depth with a freeboard of 0.6 m.

Deliverables

Pond for settling of process water, storm water.

Assumptions

Pond to be excavated in soil; no blasting required. Pond to be 3,775 m^3. Includes geomembrane.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$75,970.90
Material Cost	$154,643.77
Other Cost	$0.00
Subtotal	*$230,614.67*
Allowance	$57,653.67
Total Cost	**$288,268.34**

Start Year	2034
Finish Year	2034
Duration	**1 years**
WBS Type	Fixed

SERVICE SHAFT WATER SETTLING POND

570.40.50.140

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Chip (A) Lee	Prepared by:	Wayne Palmer	Organization:	SNC-Lavalin

Description

Construct and commission a Settling Pond for mine dewatering effluent.

Pond size = 35 m x 80 m x 2.0 m with a freeboard of 0.5 m
Pond volume = 5 500 m^3
Pumps and piping included
Piping from Service Shaft to the pond and from the pond to Service Shaft.

Deliverables

Water settling pond for water discharged from Service Shaft.

Assumptions

Effluent will discharged either to a local drainage course. Excavation in soil; no rock blasting required. 60-mil HDPE liner installed.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$134,409.41
Material Cost	$250,962.92
Other Cost	$0.00
Subtotal	*$385,372.33*
Allowance	$96,343.08
Total Cost	**$481,715.41**

Start Year	2034
Finish Year	2034
Duration	**1 years**
WBS Type	Fixed

STORM RUN-OFF POND

570.40.50.150

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Chip (A) Lee	Prepared by:	Wayne Palmer	Organization:	SNC-Lavalin

Description

Construction and commissioning of two equal size stormwater run-off detention ponds to collect surface water runoff from across the DGR site. Ponds nominally designed for a 500-year storm event. For conceptual design, total volume of approximately 25,600 m^3 assumed.

Deliverables

Ponds for the collection of stormwater run-off from the DGR site.

Assumptions

Ponds to be designed for 25,600 m^3 total stormwater flow over the site. Two ponds to be constructed in soils with no rock excavation. Pricing includes bedding and geomembrane.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$327,910.24
Material Cost	$633,524.50
Other Cost	$0.00
Subtotal	*$961,434.74*
Allowance	$240,358.68
Total Cost	**$1,201,793.42**

Start Year	2033
Finish Year	2033
Duration	**1 years**
WBS Type	Step Fixed

SEWAGE TREATMENT PLANT

570.40.50.160

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bernie Hagen	Organization:	SNC-Lavalin

Description

Construction and commissioning of a pre-engineered packaged sewage treatment plant, including sewage pumping station.

Deliverables

Package sewage treatment plant complete with steel tank enclosure comprising primary clarifier, final clarifier, ultra-violet disinfection system, controls, switchgear, piping and pumping station. Costs encompass package sewage treatment plant (4m w x 20 m l x 5 m h), hook-ups, manholes and two 5 hp pumps.

Assumptions

No external building required as facility is unmanned requiring only daily/weekly inspection. Wastewater influent quality up to 400 mg/l of BOD5 and Total Suspended Solids loadings. Treated effluent will meet Ontario Discharge standards with an assumed effluent quality of BOD5 and Total Suspended Solids loadings below 20 mg/l and fecal coliform count of 200 MPN/100 ml before effluent is discharged to a local drainage course. Sewage Treatment Plant Quote from Tiff Corp of Oakdale PA.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$237,326.81
Material Cost	$3,718,581.87
Other Cost	$0.00
Subtotal	*$3,955,908.69*
Allowance	$988,977.17
Total Cost	**$4,944,885.86**

Start Year	2038
Finish Year	2038
Duration	**1 years**
WBS Type	Step Fixed

LOW LEVEL LIQUID WASTE STORAGE BUILDING

570.40.50.170

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario
WBS Owner	Jennifer Noronha Prepared by: Derek Elion Organization: SNC-Lavalin

Description

Detail design, construction, equipping and commissioning of a single storey low level liquid waste storage building with a total floor area of 500 m^2.
The building will be steel framed and clad industrial type warehousing mounted on a 1 m thick reinforced concrete base. The concrete area used for tank and drum storage will be sealed using an epoxy resin finish and be graded and bounded to contain and collect active liquid spillages. The building will be heated to help prevent freezing of liquids and drum corrosion/degradation. The building will incorporate a load/unload area and be equipped with radiation monitoring and wash down facilities. Office space will be included for operations personnel.

Deliverables

The provision of all direct and indirect resources for the detail design, construction, supply, installation, testing and commissioning of a fully operable Low Level Liquid Storage Building. These will include:

- Design and Engineering;
- Construction of the building together with all permanent fixtures; and
- Commissioning resources.

Assumptions

The building design and construction will be let on a turnkey contract basis. This contract will include an allowance for ongoing management and co-ordination of all other building plant and equipment installation sub-contracts.

The provision of building services, systems and equipment will be by placement of detail design, supply, installation and testing contracts on individual Mechanical and/or EC&I contractors (or contractor).
All commissioning will be placed on an Engineering Commissioning contractor.

Liquid effluent will be generated from decontamination activities within the UFPP, particularly associated with cleaning sealed modules prior to disposal. There will be a small amount of liquid effluent arising from general washdown of active cells.

Building will be only used as an interim storage facility prior to disposal or transfer and treatment of the inventory at the Active Liquid Waste Treatment (ALWT) building.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$1,393,266.15
Other Cost	$1,946,850.00
Subtotal	*$3,340,116.15*
Allowance	$835,029.04
Total Cost	**$4,175,145.19**

Start Year	2041
Finish Year	2042
Duration	**2 years**
WBS Type	Step Fixed

ACTIVE LIQUID WASTE TREATMENT (ALWT) SYSTEM

570.40.50.180

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Derek Elion	Organization:	SNC-Lavalin

Description

The detail design and construction of an Active Liquid Waste Treatment Building, including the supply and installation of all process equipment and the setting to work and commissioning of the completed facility. The building will be single storey and have an area of 450 m^2. It will not have a basement. The process within the building include evaporation system and associated tanks.

Deliverables

The provision of all direct and indirect resources for the detail design, construction, supply, installation, testing and commissioning of a fully operable Active Liquid Waste Treatment Building. These will include:

- Design and Engineering;
- Construction of the building together with all permanent fixtures; and
- Commissioning resources.

Assumptions

The building design and construction will be let on a turnkey contract basis. This contract will include an allowance for ongoing management and co-ordination of all other building plant and equipment installation sub-contracts.

The provision of building services, systems and equipment within the ALWT building will be by placement of detail design, supply, installation and testing contracts on individual Mechanical and/or EC&I contractors (or contractor).

All commissioning will be placed on an Engineering Commissioning contractor.

Liquid effluent will be generated from decontamination activities within the UFPP, particularly associated with cleaning sealed modules prior to disposal. There will be a small amount of liquid effluent arising from general wash down of active cells.

Plant is based on the processing of 2,500 m^3 of liquid effluent per annum. It is based on using 1 m^3 of liquid to decontaminate a module and an equivalent of 1,250 modules per annum. This total is doubled to account for other liquid waste arisings. It is assumed that processing this volume of liquid by evaporation will produce approximately 100, 200-L drums of solid active residues. Following treatment and satisfactory sampling, condensed evaporator overheads (steam) will be recycled or discharged to a local river or lake.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$953,625.73
Other Cost	$2,252,781.00
Subtotal	*$3,206,406.73*
Allowance	$801,601.68
Total Cost	**$4,008,008.41**

Start Year	2041
Finish Year	2042
Duration	**2 years**
WBS Type	Step Fixed

WASTE MANAGEMENT AREA

570.40.50.190

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bernie Hagen	Organization:	SNC-Lavalin

Description

Detail design, construct and commissioning of a Waste Management Area. This area conceptualized as an approximate 10,000m² graveled yard with 2,500m² of concrete hard standing areas, confined by a 2.5 m high perimeter fence. The area will be used to park both on and off-site waste transport vehicles, be the location for the low level waste storage building and for the storage and maintenance of on-site waste transfer casks and equipment. The latter will comprise a 30m x 40m single storey industrial steel framed and clad warehouse type building to accommodate vehicle/cask decontamination and maintenance. The building will be heated and ventilated and will accommodate waste management offices and staff facilities.

Deliverables

The provision of all direct and indirect resources for the detail design, construction, supply, installation, testing and commissioning of a fully operable Waste Management Area. These will include:

- Design and Engineering
- Construction of the area, fencing and building together with all permanent fixtures
- Commissioning resources.

Assumptions

The Waste Management Area design and construction will be let on a turnkey contract basis. This contract will include an allowance for ongoing management and co-ordination of all other building plant and equipment installation sub-contracts. The provision of building services, systems and equipment within the Waste Management Area will be on a turnkey basis.
The Waste Management Area and the vehicle/cask decontamination and maintenance building will constructed using conventional methods.
Costs include:

• 10,000 m2 graveled yard with 2500 m2 concrete pads
• A 1200 m2, one-storey waste management area building including all equipment for vehicle cask decontamination, waste management offices and staff facilities.
• Area perimeter fence, gates and lighting

The low level waste building is costed in the element .40.50.220.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$1,187,694.63
Material Cost	$8,519,656.49
Other Cost	$0.00
Subtotal	*$9,707,351.12*
Allowance	$2,426,837.78
Total Cost	**$12,134,188.90**

Start Year	2042
Finish Year	2042
Duration	**1 years**
WBS Type	Step Fixed

LOW LEVEL WASTE STORAGE BUILDING

570.40.50.220

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by	Derek Elion	Organization	SNC-Lavalin

Description

Detail design, construction, equipment supply, installation and commissioning of a Low Level Radioactive Solid Waste Storage Facility.
Covering an area 1,000 m^2, the building will be 6 m high, single storey with no basement. The building will be a steel framed and clad structure with no permanent shielding, to accommodate storage of low-level radioactive waste (LLW) and potentially intermediate level waste (ILW). The building will include heating and ventilation, with a load bearing concrete floor suitably sealed using epoxy resin. The building will be seismically qualified to nuclear industry standards and will be served by fork lift truck. The store will be provided with suitable receipt and export areas.

Deliverables

The provision of all direct and indirect resources for the detail design, construction, supply, installation, testing and commissioning of a fully operable Low Level Waste Storage building. These will include:

- Design and Engineering;
- Construction of the building together with all permanent fixtures; and
- Commissioning resources.

Assumptions

The building design and construction will be let on a turnkey contract basis.

All commissioning will be placed on an Engineering Commissioning contractor.

LLW store is provided with forklift truck access.
The LLW store is of conventional construction.
No packaging of materials will be carried out at this facility. It is for interim storage only, prior to dispatch to a separate, off-site processing and disposal facility.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00	Start Year	2041

Material Cos	$1,123,430.71
Other Cost	$3,893,700.00
Subtotal	*$5,017,130.71*
Allowance	$1,254,282.68
Total Cost	**$6,271,413.39**

Finish Year	2042
Duration	**2 years**
Cost Type	Step Fixed

ELECTRICAL SWITCHYARD

570.40.50.230

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Chip (A) Lee	Prepared by	Wayne Palmer	Organization	SNC-Lavalin

Description

Construct and commission main electrical switchyard adjacent to the transformer area and powerhouse. Total area required is 40 m x 50 m with concrete pads for switchgear and breakers.

Deliverables

Electrical switchyard grading, surface preparation, concrete pads, switches, controls, breakers and fencing to provide electrical power for entire facility.

Assumptions

2000 m^2 switchyard including 800 m2 of concrete pads . Estimated cost includes site preparation, fencing and yard foundations.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$933,557.94
Material Cos	$731,415.32
Other Cost	$0.00
Subtotal	*$1,664,973.26*
Allowance	$416,243.31
Total Cost	**$2,081,216.57**

Start Year	2033
Finish Year	2033
Duration	**1 years**
Cost Type	Step Fixed

TRANSFORMER AREAS

570.40.50.240

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Chip (A) Lee	Prepared by:	Wayne Palmer	Organization:	SNC-Lavalin

Description

Construct and commission transformer area.

Deliverables

Transformers, interconnections, gravel base, concrete pad and protective fencing (integrated with switchyard fence).

Assumptions

Estimated on the basis of 120 m² (10 m by 12 m) area with two 20 MW transformers.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$182,448.14
Material Cost	$4,162,802.91
Other Cost	$0.00
Subtotal	*$4,345,251.04*
Allowance	$1,086,312.76
Total Cost	**$5,431,563.81**

Start Year	2033
Finish Year	2033
Duration	**1 years**
WBS Type	Step Fixed

VISITORS CENTRE

570.40.50.250

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bernie Hagen	Organization:	SNC-Lavalin

Description

Construction and commissioning of a fully equipped visitors' centre. The visitors' centre will include office space for the administration staff, exhibition or display room, photograph areas, meeting rooms for groups, change rooms, cafeteria and operation staff. The various building mechanical and electrical equipment will be located on the main floor.

Deliverables

Fully equipped single storey visitors' centre (1,100 m^2 foot print).

Assumptions

Building size based on space for 15 staff and 50 visitors in a meeting room and 40 people in small conference rooms. Includes furnishings and equipment for kitchen, theatre, restaurant and exhibition room. Compliance with National Building Code.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$641,307.38
Material Cost	$7,370,442.13
Other Cost	$0.00
Subtotal	*$8,011,749.50*
Allowance	$2,002,937.38
Total Cost	**$10,014,686.88**

Start Year	2033
Finish Year	2033
Duration	**1 years**
WBS Type	Fixed

MAIN SHAFT AND HEADFRAME

570.40.60.20

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Chip (A) Lee	Prepared by:	Eric Schraml	Organization:	SNC-Lavalin

Description

Construction and commissioning of a shaft and associated infrastructure to convey transfer package from surface to a depth of 500 m underground.
The work will include the following components: Erection of a permanent headframe, set-up of surface plant, sinking a 7 m (finished internal) diameter, concrete lined shaft, change-over from sinking to handling of used fuel in UFCs Waste Shaft hoist installation.

[This element previously referred to as WASTE SHAFT(S) AND UFC HEADFRAME/HOIST]

Deliverables

A functional 500 m deep shaft of 7 m finished internal diameter complete with required services and accessories for transfer of used fuel in UFCs.

Assumptions

Shaft sinking will utilize the permanent headframe. The collar is 35 m in depth. The shaft is nominally 500 m in length, however the shaft depth was assumed to be approximately 525 m to allow for the overwind/underwind required for safety concerns.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$131,160,014.38
Subtotal	*$131,160,014.38*
Allowance	$32,790,003.60
Total Cost	**$163,950,017.98**

Start Year	2033
Finish Year	2034
Duration	**2 years**
WBS Type	Fixed

VENTILATION SHAFT AND HEADFRAME

570.40.60.30

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Chip (A) Lee	Prepared by:	Eric Schraml	Organization:	SNC-Lavalin

Description

Construction and commissioning of the ventilation shaft (exhaust shaft) to provide the DGR's main ventilation exhaust capacity.
To comprise:

Erecting a temporary headframe for sinking.

Setting up temporary sinking hoists.

Sink a 5.6 m internal diameter, concrete lined shaft
Install associated equipment.

Deliverables

A functional 500 m deep x 5.6 m finished internal diameter shaft complete with required services and accessories.

Assumptions

The temporary headframe is 30 m in height.
The collar is 35 m in depth.
The shaft is nominally 525 m in length.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$75,352,759.37
Subtotal	*$75,352,759.37*
Allowance	$18,838,189.84
Total Cost	**$94,190,949.21**

Start Year	2035
Finish Year	2036
Duration	**2 years**
WBS Type	Fixed

VENTILATION SYSTEM

570.40.60.40

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Richard Heystee	Prepared by:	Alex Rawlins	Organization:	SNC-Lavalin

Description

Design, procure, install and commission :

(1) main underground ventilation system, including fans for the main, service and vent shaft, as well as mine air heating
(2) temporary auxiliary ventilation system(s) for the emplacement rooms

Deliverables

Main Fans:
Service Shaft: to exhaust 85 m3/s throughput, one 75 kW fan on surface, and for 54 m3/s throughput undeground, 150 kW fan underground. In addition; one spare surface fan and one spare underground booster fan installed.
Ventilation Shaft: To exhaust 380 m3/s throughput on surface, two 320 kW fans, and for 346 m3/s throughput underground, two 300 kW booster fans. In addition: one installed spare surface fan, and in storage spare motor and fan blades for underground booster fan. HEPA filtration capacity for facility exhaust in case of accident.
Main Shaft: to force 446 m3/s throughput on surface, two 350 kW forcing fans and to force 408 m3/s throughput underground, two 700 kW booster fans underground. In addition: one installed spare surface fan, and in storage spare motor and fan blades for underground booster fan.
Main Shaft air heating (propane gas fired) of 21 MW (71 Mbtu) capacity. Service Shaft and Ventilation Shaft each have 1020 kW heaters installed.
Auxiliary ventilation and development ventilation systems w/ fans and ducts. HEPA filtration for in-room placement auxiliary ventilation in case of accident.

Assumptions

• Main Shaft surface fan package based on 11200 AMF 5500 Half blade. #1 Mine Fan
• Main Shaft U/G booster fan package based on 11200 AMF 6100 Full blade. #2 Mine Fan
• Service Shaft surface fan package based on 7200 VAX 2700 Half blade. #3 Mine Fan
• Service Shaft U/G booster fan package based on 7200 VAX 2700 Half blade. #3 Mine Fan
• Vent shaft surface fan package based on 11200 AMF 5500 Half blade. #1 Mine Fan
• Vent shaft U/G booster fan package based on 11200 AMF 5500 Half blade. #1 Mine Fan
• Burner (airflow 940,678 cfm @ 1" w.c; Burner Capacity 80 MMBTUH - ACI)
• Inlet bells, screens, discharge cones, ducting
• Manually operated fan brakes with limit switches.
• Spare running sections and fans
• Flow, pressure and vibration monitoring
• Control house, controls
• Allocation for in-room and exhaust complex HEPA filtration
• Prime, paint, install, and commission.

Repository-level ducting is included in per metre mine development costs and is not assessed in this cost element. Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$51,839,861.37
Subtotal	*$51,839,861.37*
Allowance	$12,959,965.34
Total Cost	**$64,799,826.72**

Start Year	2033
Finish Year	2035
Duration	**3 years**
WBS Type	Step Fixed

SUPPORT SERVICES AND FACILITIES

570.40.60.50

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Richard Heystee	Prepared by:	Joe Carvalho	Organization:	Golder Associates Ltd.

Description

Underground excavation to accommodate ancillary infrastructure items to support the construction of the DGR. These ancillary items comprise the following:
• Sumps
• Electrical Substation
• Storage Area
• Magazines Access Drift
• Explosives Magazine
• Detonators Magazine

These items are not covered in the Tunnel and Service Area Excavation (.40.10.30.20.70).

Deliverables

Excavations to accommodate ancillary infrastructure to support underground construction.

Assumptions

All-inclusive pricing for per linear metre of mine development as per Golder costing model. Note that per unit ($/m) are worked up from individual crew components and are different between crystalline and sedimentary mine development. Pricing includes waste rock delivered and spread at waste rock pile. Per linear metre costs include conduit, etc.

• Sumps (5 m W X 5 m H) : 60 metres
• Electrical Substation (6 m W X 4 m H) : 20 metres
• Storage Area (20 m W x 5 m H) : 30 metres
• Magazines Access Drift (5 m W X 5 m H) : 110 metres
• Explosives Magazine (7 m W X 7 m H) : 20 metres
• Detonators Magazine (5 m W X 4 m H) : 10 metres

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00	Start Year	2034

Material Cost	$0.00
Other Cost	$3,780,852.96
Subtotal	*$3,780,852.96*
Allowance	$945,213.24
Total Cost	**$4,726,066.20**

Finish Year	2034
Duration	**1 years**
WBS Type	Fixed

570.40.60.50

PERIMETER AND ACCESS TUNNELS/CROSS CUTS

570.40.60.60

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Richard Heystee	Prepared by:	Joe Carvalho	Organization:	Golder Associates Ltd.

Description

Excavation of the central, perimeter and panel access tunnels comprising the DGR's "skeleton" of ventilation and panel access ways. The mining of these tunnels will be by full face drill and blast technique employing control perimeter blasting to minimize creation of an EDZ. Central access tunnels will be 7.0 m width by 5.0 m height. Panel access tunnels will be of 9.0 m width by 4.0 m height and perimeter tunnels will be of 5.0 m width by 5.0 m height.

Deliverables

11,615.4 m of new tunnels comprising the "skeleton" of the DGR and access to the Ventilation Shaft.

Assumptions

All-inclusive pricing for per linear metre of mine development as per previous estimate costing model. Note that per unit ($/m) are worked up from individual crew components and are different between crystalline and sedimentary mine development. Pricing includes waste rock delivered and spread at waste rock pile. Per linear metre costs include conduit, etc.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$127,808,676.55
Subtotal	*$127,808,676.55*
Allowance	$31,952,169.14
Total Cost	**$159,760,845.69**

Start Year	2035
Finish Year	2056
Duration	**22 years**
WBS Type	Step Fixed

INITIAL PLACEMENT ROOMS (PANEL A)

570.40.60.70

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Richard Heystee	Prepared by:	Joe Carvalho	Organization:	Golder Associates Ltd.

Description

Excavate, furnish and prepare the first panel of placement rooms (Panel A – 28 placement rooms). Excavation will proceed from the "east" side of Panel A and retreat westwards towards the central access tunnels.

Deliverables

Construction of 28 placement rooms (~8498.0 m in total). Following tunnel excavation the contractor will install track in each of the placement rooms to facilitate UFC placement As each room is developed, air, water and electrical power will be installed.

Assumptions

The rooms are 3.2 m high by 2.2 m wide, ~304 m in length. The entrance to each room will be perpendicular to the panel access tunnel . The placement rooms and access will be developed by full face drill and blast techniques, with controlled perimeter blasting to minimize creation of an EDZ. All drilling and muck haulage equipment will be rubber tired. The UFC boreholes will be drilled by a purpose built blind boring machine. A total of 5 placement rooms will be under development at a time, therefore ventilation fans will be needed for the actively mined rooms. As each room is completed the ventilation fan will be transferred to the next room to be developed.

• Panel A Rooms (3.2 m W x 2.2 m H): 8498 metres

Pricing includes waste rock delivered and spread at waste rock pile. Per linear metre costs include conduit, etc.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00	Start Year	2038
Material Cost	$0.00	Finish Year	2042
Other Cost	$43,439,483.87	Duration	**5 years**
Subtotal	*$43,439,483.87*	WBS Type	Step Fixed
Allowance	$10,859,870.97		
Total Cost	**$54,299,354.84**		

ROOM EXCAVATION (SECOND STAGE) PANEL B

570.40.60.80

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Richard Heystee	Prepared by:	Richard Heystee	Organization:	SNC-Lavalin Nuclear

Description

Excavate, furnish and prepare the second panel of placement rooms (Panel B – 28 placement rooms). Excavation will proceed from the “east” side of Panel B and retreat westwards towards the central access tunnels.

Deliverables

Construction of 28 placement rooms (~8,498 m in total). Following tunnel excavation the contractor will install track in each of the placement rooms to facilitate UFC placement As each room is developed, air, water and electrical power will be installed.

Assumptions

The rooms are 3.2 m high by 2.2 m wide, ~303.5 m in length. The entrance to each room will be perpendicular to the panel access tunnel . The placement rooms and access will be developed by full face drill and blast techniques, with controlled perimeter blasting to minimize creation of an EDZ. All drilling and muck haulage equipment will be rubber tired. The UFC boreholes will be drilled by a purpose built blind boring machine. A total of 5 placement rooms will be under development at a time, therefore ventilation fans will be needed for the actively mined rooms. As each room is completed the ventilation fan will be transferred to the next room to be developed.

All-inclusive pricing for per linear metre of mine development as per Hwozdyk Inc. costing model:

• Panel A Rooms (3.2 m W x 2.2 m H): 8,498 metres

Pricing includes waste rock delivered and spread at waste rock pile. Per linear metre costs include conduit, etc.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00	Start Year	2041

Material Cost	$0.00
Other Cost	$43,439,483.92
Subtotal	*$43,439,483.92*
Allowance	$10,859,870.98
Total Cost	**$54,299,354.90**

Finish Year	2043
Duration	**3 years**
WBS Type	Variable

570.40.60.80

FACILITY ELECTRICAL DISTRIBUTION

570.40.70.10

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bernie Hagen	Organization:	SNC-Lavalin

Description

Design, construction, installation and commissioning of the electrical system throughout the DGR.

Deliverables

Primary distribution , including medium voltage switchgear, power distribution transformers, low voltage switchgears and motor control centres.

Assumptions

Includes:

- On-site power distribution hydro poles every 25 m (200 poles)
- Med voltage 13 kv cabling on site line coverage (5,000 m)
- Step-down 13.8 kv transformers (40 units – pad mounted, incl. enclosures, locks)
- Interconnects, switch gear, finishing, fire extinguishers, etc.

Verbal quote received from America Wire of Michigan for electrical cable.

Main power supply including 25 km O/H transmission line included in .40.20 (Site Improvements). Powerhouse, emergency diesel-generators and associated equipment under 40.50.90. Underground distribution included in per-metre development costs and in outfitting/finishing costs for specific underground components.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$3,291,050.25
Material Cost	$7,631,747.50
Other Cost	$0.00
Subtotal	*$10,922,797.75*
Allowance	$2,730,699.44
Total Cost	**$13,653,497.19**

Start Year	2037
Finish Year	2037
Duration	**1 years**
WBS Type	Step Fixed

FACILITY COMMUNICATION SYSTEM(S)

570.40.70.20

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Chip (A) Lee	Prepared by:	Wayne Palmer	Organization:	SNC-Lavalin

Description

Design, installation and commissioning of DGR communication system on surface.
Auxiliary building will require expansion by 200 m2.

Deliverables

Communication system to include: Telephone and radio communication systems. Public address system, Clock system, Security system, Fire alarm system.
Remote operation for underground placement room activities where remote operation is necessary.

Assumptions

All process instrumentation and control systems are included:

- Data communication links and inter connections (5,500 m, incl. shielded cable)
- Full data collection system and phone system
- Miscellaneous boxes and software

Routing of power cable along power pole covered under .40.70.10

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$516,622.09
Material Cost	$0.00
Other Cost	$19,074,000.00
Subtotal	*$19,590,622.09*
Allowance	$4,897,655.52
Total Cost	**$24,488,277.62**

Start Year	2037
Finish Year	2037
Duration	**1 years**
WBS Type	Step Fixed

FIRE WATER

570.40.70.30.10

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario

WBS Owner	Jennifer Noronha	Prepared by:	Bernie Hagen	Organization:	SNC-Lavalin

Description

Install buried high density polyethylene (HDPE) pipeline across DGR site including hydrants and connected to fire water pumps located inside water treatment plant building. Pipes will be buried below the frost line. Hydrants are strategically located around the site to ensure all buildings are provided access and fire protection.

Deliverables

Dedicated fire water pipeline, hydrants, and fire water pump package including electric, diesel, and jockey pumps plus controls and test header.

Assumptions

Fire water will be supplied from raw/fire water tank on DGR site. Frost depth is 2 m. System design based on NFPA guidelines.

Includes:

• Main water distribution pumps (125 HP, 1200 usgpm, electrical and diesel)
• Jockey pump (10 hp)
• Electrical, diesel and water tie-ins
• Diesel day tank (5000 litres)
• Fire hydrants (35)
• Underground pipe (1,500 m)

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$753,660.45
Material Cost	$369,285.60
Other Cost	$0.00
Subtotal	*$1,122,946.05*
Allowance	$280,736.51
Total Cost	**$1,403,682.57**

Start Year	2038
Finish Year	2038
Duration	**1 years**
WBS Type	Step Fixed

POTABLE WATER

570.40.70.30.20

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bernie Hagen	Organization:	SNC-Lavalin

Description

Construct and commission a potable water system to serve buildings constructed as part of the DGR facility. Potable water will be distributed through buried pipelines to each building. Pipes will be buried below the frost line.

Deliverables

Buried high density polyethylene (HDPE) water main including isolation valves. Main will distribute potable water to surface buildings.

Assumptions

Water will be supplied from a local river or lake upstream from the facility from the surface facility's watershed (see 40.50.100, Pumphouse and Intake). A frost depth of 2 m is assumed.

Includes:

- Electrical water distribution pumps (two 15 HP units)
- Water and electrical tie ins
- Isolation valves
- Underground pipe (1,500 m)

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$332,087.85
Material Cost	$151,264.11
Other Cost	$0.00
Subtotal	*$483,351.96*
Allowance	$120,837.99
Total Cost	**$604,189.95**

Start Year	2038
Finish Year	2038
Duration	**1 years**
WBS Type	Step Fixed

PROCESS WATER

570.40.70.30.30

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario

WBS Owner	Jennifer Noronha	Prepared by:	Bernie Hagen	Organization:	SNC-Lavalin

Description

Construct and commission a raw water system to serve buildings constructed as part of the DGR facility and specifically for truckwash operations, cleaning, landscaping, rock crushing, concrete batching and other fresh water operations. Fresh water will be distributed through buried pipelines to each building as required. Pipes will be buried below the frost line.

Deliverables

Water system to distribute fresh water to surface buildings.

Assumptions

Water taken form Raw Water / Fire Water Storage Tank. A frost depth of 2 m is assumed.

Includes:

• Electrical return water pump (two 10 HP units)
• Water and electrical tie-ins
• Underground pipe (crushing plant, pond: 250 m)
• Underground pipe (rock crushing and cement plants: 700 m)

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$243,597.38
Material Cost	$166,365.97
Other Cost	$0.00
Subtotal	*$409,963.34*
Allowance	$102,490.84
Total Cost	**$512,454.18**

Start Year	2038
Finish Year	2038
Duration	**1 years**
WBS Type	Step Fixed

SEWERAGE

570.40.70.30.40

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bernie Hagen	Organization:	SNC-Lavalin

Description

Construct and commission a sewage collection system to serve buildings on site.

Deliverables

PVC gravity sewer network with manholes from serviced buildings to sewage treatment plant.

Assumptions

No abnormal constructions issues/problems. Designed based on site work force of 500 persons under normal operations with capability to cater for a further 75 persons during campaign mining.

Includes:

- Underground conveyance pipe (1,500 m)
- Manholes (20)
- Tie-ins

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$656,221.50
Material Cost	$160,840.90
Other Cost	$0.00
Subtotal	*$817,062.40*
Allowance	$204,265.60
Total Cost	**$1,021,328.00**

Start Year	2038
Finish Year	2038
Duration	**1 years**
WBS Type	Step Fixed

STORMWATER AND DRAINAGE

570.40.70.30.50

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bernie Hagen	Organization:	SNC-Lavalin

Description

Construct and commission a stormwater collection system to serve buildings and parking areas and facilities on site.

Deliverables

Storm water ditching and culverts under road crossings. Stormwater will be diverted to any of the three storm run-off holding ponds on site.

Assumptions

No abnormal construction issues/problems. Designed based on nominal 100-year storm event.

Includes:

• Drainage ditch (7,400 m)
• Corrugated, galvanized steel culverts (15)

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$1,355,528.25
Material Cost	$563,802.60
Other Cost	$0.00
Subtotal	*$1,919,330.85*
Allowance	$479,832.71
Total Cost	**$2,399,163.57**

Start Year	2038
Finish Year	2038
Duration	**1 years**
WBS Type	Step Fixed

BREATHING AIR

570.40.70.40.10

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bernie Hagen	Organization:	SNC-Lavalin

Description

Design, procure, install and commission a compressed air system for breathing air both for surface and underground use.

Deliverables

Breathing compressed air supply and distribution systems to UFPP and other surface facilities. Breathing Air at 0.15 m^3 /s (~300 cfm) surface and underground supplied by 2 compressors each supplying 0.15 m^3 /s (~300 cfm)@ 700 kPa .

Assumptions

Breathing Air requirements to be at 0.15 m^3 /s . Verbal quote received from Atlas Copco Mississauga Ontario.
Includes:
• Breathing air supply units (0.15m3/s @ 700 kPa, one on-line, one standby)
• Distribution system (1500 m, includes interconnections, building piping, headers, filtration, manifolds)

Shared service building included under .40.70.40.20 (Service Air).

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$603,193.50
Material Cost	$1,963,929.61
Other Cost	$0.00
Subtotal	*$2,567,123.11*
Allowance	$641,780.78
Total Cost	**$3,208,903.88**

Start Year	2038
Finish Year	2038
Duration	**1 years**
WBS Type	Step Fixed

SERVICE AIR

570.40.70.40.20

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bernie Hagen	Organization:	SNC-Lavalin

Description

Design, procure, install and commission a compressed air system for service air both for surface and underground use. Work includes building to house both service air and breathing air equipment.

Deliverables

Service compressed air supply and distribution systems to UFPP and other surface facilities. Service compressed air supply and distribution systems to the DGR construction and operation phases. Service Air at 1.0 m^3 /s (~2,100 cfm) surface and underground supplied by 3 rotary screw type compressors each supplying 0.5 m^3 /s (~1,050 cfm)@ 900 kPa . Concrete block construction with insulation and cladding. Steel frame roof with sprayed insulation.

Assumptions

Service air requirements to be at 1.0 m^3 /s . Verbal quotation for equipment received from Atlas Copco of Mississauga Ontario.
Includes:

- One storey 20 m by 15 m building (300 m2, furnished and equipped)
- Service air supply units (0.5m3/s @ 900kPa, rotary screw units, two on-line, one on standby)
- Distribution system (1500 m, includes interconnections, building piping, headers, filtration, manifolds)

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$740,734.88
Material Cost	$5,183,811.11
Other Cost	$0.00
Subtotal	*$5,924,545.99*
Allowance	$1,481,136.50
Total Cost	**$7,405,682.49**

Start Year	2038
Finish Year	2038
Duration	**1 years**
WBS Type	Step Fixed

OPERATIONS PROGRAM MANAGEMENT (INC TAX)

570.45.10

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bernie Hagen	Organization:	SNC-Lavalin

Description

The management and administration of the DGR facility during the Operation Phase is encompassed by other work elements. This element has been reduced to an annual allocation for taxes or payments in lieu of taxes.

For the operations of the President`s Office, engineering, finance, purchasing, safety and facility management, see element .45.20 (Direct Operations Management).

Deliverables

Annual tax, payment in lieu of tax or associated payment.

Assumptions

Annual allocation of $6M per year for the duration of operations (Y26 to Y55, inclusive)

Exclusive of contingency.

Allowance

No additional allowance assigned.

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$196,378,560.00
Subtotal	*$196,378,560.00*
Allowance	$49,094,640.00
Total Cost	**$245,473,200.00**

Start Year	2043
Finish Year	2072
Duration	**30 years**
WBS Type	Step Fixed

DIRECT OPS MANAGEMENT (INC QA)

570.45.20

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bernie Hagen	Organization:	SNC-Lavalin

Description

Management and administrative functions covering the day-to-day operation of the DGR facility during the operations phase

Deliverables

DGR-based organization which delivers facility engineering, human resources/human development, external affairs, accounting, procurement, security, emergency response, compliance and licensing, conventional health and safety, health physics, quality assurance, information technology and environmental management.

Assumptions

Management numbers determined on the basis of the staffing plan for site (Y26 to Y55, inclusive).

Includes management and engineering as follows:

• One President
• Five Vice Presidents (Engineering, HR/HD, Society & Sustainability, Finance & Legal, Operations)
• Two Directors of Engineering (Aboveground and Underground)
• Six Engineering Managers
• Six Non-Engineering Managers
• 90 Staff

Line staff for procurement, environmental management, security, fire, housekeeping, etc. are included under .45.30 (Operations Indirects). Line staff for maintenance are included under .45.40.40 (O&M of Auxiliary Surface Facilities).

Mine development, UFC placement, UFPP operations , SMCP, crushing plant and aggregate plant operations (including supervision and incidental engineering) not included in this element. Such costs are accounted for in, for example, .45.40.10 (UFPP Operation) and .45.50.60 (UFC Transport and Place).

NWMO burdened labour rates (and available annual hours) used to construct expenditure estimate. Estimated on a labour basis - related building services/equipment, etc., not included in this work element.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$447,954,570.00	Start Year	2043

570.45.20

Material Cost	$0.00
Other Cost	$0.00
Subtotal	*$447,954,570.00*
Allowance	$111,988,642.50
Total Cost	**$559,943,212.50**

Finish Year	2072
Duration	**30 years**
WBS Type	Step Fixed

OPERATIONS INDIRECTS (INC FIRE & SECURITY)

570.45.30

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bernie Hagen	Organization:	SNC-Lavalin

Description

Indirect labour and equipment required to operate the DGR facility during the Facility Operations phase of the project (Y26 to Y55), excluding the indirect labour and equipment provided for during underground excavation, for O&M of auxiliary facilities (cf. 45.40.40) and during extended operations phase (cf. 45.50.130).

Deliverables

The provision of the following indirect labour and equipment to operate the DGR facility during the Facility Operation stage:

• Security staff including management, administration, 24 hour cover and armed response capability
• Medical staff including paramedics and nurses
• Cleaning personnel including management, building and infrastructure cleaners, waste collection

Assumptions

Based on staffing as follows:

• Visitor Centre Staff (5 FTE)
• Visitor Centre Manager (1 FTE)
• Finance Manager (3 FTE)
• Financial Analyst (6 FTE)
• Buyer (6 FTE)
• I/T Support (10 FTE)
• Procurement Manager (2 FTE)
• Environmental Manager (Technicians in .45.20) (2 FTE)
• Rad. Safety and Monitoring (12 FTE)
• Payroll Officer (4 FTE)
• Fire/Security Manager (2 FTE)
• Security Officer/ Fire Supervisor (6 FTE)
• Security Guard (80 FTE)
• Firemen (16 FTE)
• Paramedic/Doctor/Nurse (8 FTE)
• HR Manager (2 FTE)
• Conventional Safety (and Operations) (20 FTE)
• Administration Manager/Office Manager (2 FTE)
• Administration Support (6 FTE)
• Housekeeping, Janitor support (40 FTE)
• Mess hall staff, cook, cleaners, drivers (40 FTE)

Includes allocation for fire and security equipment with on-going refurbishment or replacement.
NWMO staff pay rates include for sickness benefit, pension contributions, holidays and training therefore these items are not considered as indirect overhead costs.
Mine rescue assumed to be covered by other staff with suitable specialist training.
Dedicated firecrew numbers limited with duties to include supervising and training other DGR staff.
Excludes the indirect labour and equipment provided for during underground excavation, for O&M of auxiliary facilities (cf. 45.40.40) and during extended operations phase (cf. 45.50.130). Also excludes taxes (such as HST), heat and power.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$806,523,291.00
Material Cost	$0.00
Other Cost	$3,491,174.40
Subtotal	*$810,014,465.40*
Allowance	$202,503,616.35
Total Cost	**$1,012,518,081.75**

Start Year	2043
Finish Year	2072
Duration	**30 years**
WBS Type	Step Fixed

UFPP OPERATION

570.45.40.10

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Alan Murchison	Prepared by:	Ben Thayer	Organization:	NWMO

Description

The UFPP operation WED consists of costs labour and materials required for the day-to-day operation of the UFPP.

Deliverables

The following WED consists of the operational costs associated with packaging 3.6M fuel bundles into 10 UFCs per day, 250 days a year for 30 years. Two shifts of 8 hours are considered, thus the number of personnel required for direct labour is doubled. The following key labour costs and consumable costs are considered:

Labour
- UFTP and Module Shipping / Receiving and material handling requires 14 operators for shipping receiving duties, accommodating UFTP preparation and material handling. Two (2) Rad Techs would be required to facilitate the acceptance of UFTPs and prepare incoming / outgoing surveys etc.
- Fuel Handling and UFC Handling Cells require 6 operators for supervisory operation of the automated Fuel Handling cells and 2 First Line managers that oversee both UFC Handling and UFTP Handling operations
- UFC Processing operations require 22 Operators to act as the designated individuals for overseeing automated processes, 6 Technical Specialists / Engineers for in-depth process knowledge and decision making and 2 First Line managers to oversee processing operations and personnel.
- Empty UFC Receiving and Preparation operations require 12 Operators for shipping / receiving, handling
- UFC Decontamination operations require 2 Operators to perform the decontamination operations and 2 radiation technicians to provide the necessary evaluation / surveys for the decontaminated UFCs
- UFC Buffer Box Labour will require 6 operators to pre-assemble the buffer box components and transfer the buffer box to and from each location. Two (2) First Line managers would be required to oversee these operations and assist with overseeing decontamination operations.
- Active Maintenance Shop labour requires 4 operators and two first line managers.
- Waste Management Facility Labour requires 6 operators and two radiation technicians to perform the necessary operations required for contaminated waste removal.
- UFPP operations and support require, 6 Civil Specialists, 8 Mechanical Specialists, 6 Control Specialists, 2 Radiation Technicians, 4 operators (4 custodians) and 6 Tech Specialists (2 Health Physicist and 4 Health Technicians)

Material
The following materials are required for consumables and spares and waste disposal:
- 60 Full Height ISO containers (2 per year)
- 1 ISO transport trailer
- 15000 200L steel drums (500 per year)
- 360 500L stainless steel drums (12 per year)
- Major capital replacement of equipment (20% of material costs)

- Major capital replacement labour (20% of overall major capital replacement cost)
- Spares for routine maintenance (1% per year)
- LLW transport, processing and disposal costs
- ILW transport, processing and disposal costs

Assumptions

The general WBS framework and some source costs were taken from the 2002 CTECH UFPP cost estimate. SKB reviewed and updated the UFPP estimate produced by CTECH and validated the appropriateness of the cost estimate based on their reference plant design. SKB escalated the CTECH estimates deeming the 2002 material take-offs appropriate. ATS' estimates credit this baseline work and where used, has scaled 2002$ by 1.25 and 2010$ by 1.054 based on Stats Canada data and projected inflation. For all different or new scope, bottom-up estimates were prepared.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$600,260,060.14
Material Cost	$0.00
Other Cost	$298,614,411.46
Subtotal	*$898,874,471.60*
Allowance	$224,718,617.90
Total Cost	**$1,123,593,089.50**

Start Year	2043
Finish Year	2072
Duration	**30 years**
WBS Type	Step Fixed

SUPPLY OF BASKETS AND UFCS

570.45.40.20

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Chris Hatton	Prepared by:	Dave Doyle	Organization:	NWMO - Nuclear Waste Management Organization

Description

Supply, packaging and delivery of the required number of Used Fuel Containers (UFCs) and UFC baskets during the operational period.

Deliverables

Supply of 2,500 UFCs per year over the 30 year operational period (total 75,000 UFCs).

- Reusable packaging for UFCs and baskets.

- Transport of UFCs and baskets from assembly plant to DGR facility.

Assumptions

All costs escalated to 2015 $ from 2014 $ with an escalation rate of 2%.
Assume costs distributed uniformly on an annualized basis for a duration of 30 years.
In 2014$:
A total cost per UFC of C$27,413 has been estimated. The UFC is made of a steel vessel and has a 3 mm copper coating over the steel using electro-deposition and cold spray techniques. The steel vessel is made of a steel core, internal baskets, and closure welds. The major cost components are as follows:
Steel Vessel- C$19,210 per UFC.
Copper Coating- C$2,620 per UFC.
Transportation- C$100 per UFC.
Allowance (assumed at 25%)- C$5,483 per UFC.

The steel core and internal baskets used the median estimate received by Niagara Energy Products (NEP) to derive the Mark 2 UFC unit cost estimate. NEP sub-contracted the majority of machining to reduce fixed costs. The estimate for financing cost was based on the average rate of return from May 2009 to May 2014 of the S&P 55 TR CAD of 18.2%, plus a risk premium of 11.8% for operating a specialized, single-product business. Labour, facility and equipment costs associated for the closure weld consumables are accounted for in the Used Fuel Packing Plant (UFPP) estimate (WED# 570.45.40.10).

Unit cost of $4/kg (2010$) assumption used for the cost of copper. An estimated rejection rate of 2% was used and added to consumables and labour. Electro-deposition estimated for a production rate of 86,250 UFCs over 30 years, while production costs, labour and materials were scaled to 75,000 UFCs plus a 2% rejection rate. Manufacturing labour cost estimated using PEO salary, with a 35% mark-up for general costs, administrative costs, and profit. Labour, facility and equipment costs associated for the copper cold spray are accounted for in the UFPP estimate (WED# 570.45.40.10).

Transportation costs provided in this UFC cost estimate are all-inclusive for the transportation of the empty UFCs from the site of manufacture to the UFPP located at the APM DGR site using 2014 shipping rates. Transportation does not include any movement of used fuel.

The UFC manufacturing facilities are assumed to be located near (100 km) the UFPP. UFCs and baskets will be manufactured and assembled off-site and shipped to the DGR as a completed item.

Licensing and approvals sought from relevant authorities will be obtained without significant delay to the agreed schedule.

Refer to APM-REP-00440-0206 for further details.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$1,678,716,000.00
Subtotal	*$1,678,716,000.00*
Allowance	$419,679,000.00
Total Cost	**$2,098,395,000.00**

Start Year	2043
Finish Year	2072
Duration	**30 years**
WBS Type	Variable

O&M OF AUXILIARY SURFACE FACILITIES

570.45.40.40

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bernie Hagen	Organization:	SNC-Lavalin

Description

Operation and maintenance of all surface buildings and associated facilities for the DGR.

Deliverables

Maintenance staff including management, building and civil, mechanical and electrical cover.

Annual electrical power, including UFPP (but excluding hoists, ventilation, aggregate plant, concrete plant and SMCP, which are accounted for in mining costs and in UFC placement costs).

Allocation for the maintenance and management of fixed assets not otherwise covered (i.e., other than for mining equipment, UFC placement equipment, SMCP equipment and UFPP equipment).

Assumptions

Staffing includes 8 maintenance supervisors, 4 administrative staff and 70 maintenance crew. Crew load accounts for general maintenance, water treatment, sewage treatment, switchyard/transformers, active liquid waste treatment, low level waste storage, etc. Electrical includes building HVAC, heat, power and light (47,404,784 KWh). Allocation of $9M/annum accounts for asset management and maintenance activities and materials.

Any townsite operations would be funded through revenues raised by property taxes and therefore no costs are included for these activities.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$218,018,052.00
Material Cost	$0.00
Other Cost	$403,176,144.22
Subtotal	*$621,194,196.22*
Allowance	$155,298,549.06
Total Cost	**$776,492,745.28**

Start Year	2043
Finish Year	2072
Duration	**30 years**
WBS Type	Step Fixed

ROOM EXCAVATION (THIRD STAGE) PANEL C

570.45.50.40

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario

WBS Owner	Richard Heystee	Prepared by:	Joe Carvalho	Organization:	Golder Associates Ltd.

Description

Excavate, furnish and prepare the third panel of placement rooms (Panel C – 27 placement rooms). Excavation will proceed from the "west" side of Panel C and retreat eastwards towards the central access tunnels.

Deliverables

Construction of 27 placement rooms (~8194.5 m in total). Following tunnel excavation the contractor will install track in each of the placement rooms to facilitate UFC placement As each room is developed, air, water and electrical power will be installed.

Assumptions

The rooms are 3.2 m high by 2.2 m wide, ~303.5 m in length. The entrance to each room will be perpendicular to the panel access tunnel . The placement rooms and access will be developed by full face drill and blast techniques, with controlled perimeter blasting to minimize creation of an EDZ. All drilling and muck haulage equipment will be rubber tired. total of 5 placement rooms will be under development at a time, therefore ventilation fans will be needed for the actively mined rooms. As each room is completed the ventilation fan will be transferred to the next room to be developed. At least 3 placement rooms available for placement activities at all times.

All-inclusive pricing for per linear metre of mine development as per previous estimate costing model:

• Panel C Rooms (3.2 m W x 2.2 m H): 8194.5 metres

Pricing includes waste rock delivered and spread at waste rock pile. Per linear metre costs include conduit, etc.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00	Start Year	2044

Material Cost	$0.00
Other Cost	$41,888,071.22
Subtotal	*$41,888,071.22*
Allowance	$10,472,017.80
Total Cost	**$52,360,089.02**

Finish Year	2046
Duration	**3 years**
WBS Type	Variable

570.45.50.40

ROOM EXCAVATION (FOURTH STAGE) PANEL D

570.45.50.50

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Richard Heystee	Prepared by:	Joe Carvalho	Organization:	Golder Associates Ltd.

Description

Excavate, furnish and prepare the fourth panel of placement rooms (Panel D – 27 placement rooms). Excavation will proceed from the “west” side of Panel D and retreat eastwards towards the central access tunnels.

Deliverables

Construction of 27 placement rooms (~8194.5 m in total). Following tunnel excavation the contractor will install track in each of the placement rooms to facilitate UFC placement As each room is developed, air, water and electrical power will be installed.

Assumptions

The rooms are 3.2 m high by 2.2 m wide, ~303.5 m in length. The entrance to each room will be perpendicular to the panel access tunnel . The placement rooms and access will be developed by full face drill and blast techniques, with controlled perimeter blasting to minimize creation of an EDZ. All drilling and muck haulage equipment will be rubber tired. A total of 5 placement rooms will be under development at a time, therefore ventilation fans will be needed for the actively mined rooms. As each room is completed the ventilation fan will be transferred to the next room to be developed. At least 3 placement rooms available for placement activities at all times.

All-inclusive pricing for per linear metre of mine development as per previous estimate costing model:

• Panel D Rooms (3.2 m W x 2.2 m H): 8194.5 metres

Pricing includes waste rock delivered and spread at waste rock pile. Per linear metre costs include conduit, etc.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00	Start Year	2048

Material Cost	$0.00
Other Cost	$41,888,071.22
Subtotal	*$41,888,071.22*
Allowance	$10,472,017.80
Total Cost	**$52,360,089.02**

Finish Year	2050
Duration	**3 years**
WBS Type	Variable

BACKFILL MATERIAL (SMCP & CONCRETE)

570.45.50.60.10

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Chip (A) Lee	Prepared by:	Issac Ahmed	Organization:	Golder Associates Ltd.

Description

Emplacement of all sealing materials and UFCs within the underground placement rooms, together with the construction of the emplacement room bulkhead seal. This activity also includes the transfers of all personnel and materials to and from the placement rooms

Deliverables

Material directly relating to the emplacement of UFCs which are involved in such tasks as:
Personnel and material transfers to / from emplacement rooms including main and service shaft operation:
Placement of compacted bentonite levelling layer;
Placement of buffer blocks containing the UFCs;
Placement of DBF spacer blocks;
Placement of pelletized gap fill; and
Backfill and re-staging to accept the next UFC.

Assumptions

UFC buffer boxes containing the Mark 2 UFC are placed 90 degrees to the length of the placement room. DBF spacer blocks are placed adjacent the UFC buffer boxes. There are two rows of UFC buffer blocks and these are placed in an alternating pattern with the DBF spacer blocks. The lower layer of DBF spacer blocks and UFC buffer blocks rest on top of a compacted layer (levelling) of bentonite. Bentonite pellets are used to fill the remaining voids in the placement room.

Bentonite pellets and DBF spacer blocks for backfilling the placement room and UFC buffer boxes for UFC encapsulation are produced at the SMCP. These are then transported to the repository level; UFCs are placed inside the UFC buffer box at the UFPP. Beforehand, the protective steel UFC buffer box shell will be transported to the SMCP. The bentonite based UFC buffer boxes will be placed inside the protective steel shell. The entire unit will be transported to the UFPP.

Placement estimates take into account buffer box rejection. Based on 2500 UFC installations in the DGR annually, a rate of about 49 UFCs installations per week is required. Considering the weekly UFC placement rate, then the rate of placement room advance can be translated to 42 m based on 49 UFCs centre to centre spacing. On a weekly basis, 49 complete UFC buffer boxes, translates to 196 pieces of UFC buffer box components and about 185 tonnes of bentonite pellets. In addition, about 50 tonnes of bentonite floor material is required.

Following setting up the room for placement of the initial UFC, it has been estimated that the total sequence for placing and backfilling a single UFC will take about 22 hours, including a 20% allowance.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$772,747,248.00
Subtotal	*$772,747,248.00*
Allowance	$193,186,812.00
Total Cost	**$965,934,060.00**

Start Year	2043
Finish Year	2072
Duration	**30 years**
WBS Type	Variable

UFC EQUIPMENT

570.45.50.60.20

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Chip (A) Lee	Prepared by:	Alan Gaensbauer	Organization:	Palladium Product Development & Design

Description

Emplacement of all materials into the Placement Room, EDZ Room and Concrete Bulkhead that includes Buffer Boxes containing the UFCs, Spacer Blocks, Bentonite Pellets, Bentonite Bricks and Concrete. These activities also take account the transfer of all equipment and materials from the UFPP / main hoist surface and underground storage to the placement rooms.

Deliverables

Equipment directly relating to the placement and material handling of Buffer Boxes with Spacer Blocks from the UFPP and main hoist surface to / from the placement rooms and the underground storage. that include:
Positioning of the Shielding Canopy;
Transfer of Buffer Box from UFC Transfer Cask to Placement Vehicle;
Placement of Buffer Box;
Placement of Bentonite Spacer Block;
Blown in Bentonite Pellet as required;
Removal of Floor Plates;
These activities are carried out approximately 2,500 times per year, with a total of 75,000 UFCs placed over the 30-year operations period. Further deliverables during UFC emplacement include the supply and installation of major replacement capital equipment and routine maintenance.
Equipment directly relating to the placement and material handling of EDZ Room (Seal Room) with Spacer Blocks and Bentonite Bricks from the main hoist surface to / from the EDZ Room.

Equipment directly relating to the placement and material handling of Concrete Bulkhead from the underground main hoist to / from the Concrete Bulkhead.

Assumptions

Costing is based on full set of UFC Placement Room equipment with a replacement rate of once over 30 years and yearly maintenance rate.
UFC Transfer Cask
Trolley for UFC Transfer Cask
Shielding Canopy
Shielding Canopy Trolley
Hydraulic Cylinder Cart
Placement Vehicle
Bentonite Spacer Block Trolley
Bentonite Pellet Blowing System

Floor Plate Handling System
Tow Vehicle
Concrete Mixer Truck
Underground Hopper
Concrete Pump
Concrete Forms
Exclusive of contingency

Costing includes a 10% allowance and equipment quantities are based on information currently available and engineering judgement.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$39,075,685.12
Other Cost	$42,243,789.60
Subtotal	*$81,319,474.72*
Allowance	$20,329,868.68
Total Cost	**$101,649,343.40**

Start Year	2043
Finish Year	2072
Duration	**30 years**
WBS Type	Step Fixed

PLACEMENT LABOUR

570.45.50.60.30

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Chip (A) Lee	Prepared by:	Alan Gaensbauer	Organization:	Palladium Product Development & Design

Description

Labour for the emplacement of all materials into the Placement Room, EDZ Room and Concrete Bulkhead that includes Buffer Boxes containing the UFCs, Spacer Blocks, Bentonite Pellets, Bentonite Bricks and Concrete. These activities also take into account transfer of all equipment and materials from the UFPP / main hoist surface and underground storage to the placement rooms.

Deliverables

Labour effort for the placement and material handling of Buffer Boxes with Spacer Blocks from the UFPP and main hoist surface to / from the placement rooms and the underground storage that include:

Positioning of the Shielding Canopy;
Transport UFC/Buffer Box Transfer Cask from UFPP to entrance of emplacement room;
Transfer of Buffer Box from UFC Transfer Cask to Placement Vehicle;
Placement of Buffer Box;
Placement of Bentonite Spacer Block;
Blown in Bentonite Pellets as required;
Removal of Floor Plates;
Re-staging to accept the next Buffer Box.These activities are carried out approximately 2,500 times per year, with a total of 75,000 UFCs placed over the 30-year operations period. Further deliverables during UFC emplacement include the supply and installation of major replacement capital equipment and routine maintenance.

Labour effort for the placement and material handling of EDZ Room (Seal Room) with Spacer Blocks and Bentonite Bricks from the main hoist surface to / from the EDZ Room that include:
Transfer of Spacer Block to Placement Vehicle;
Placement of Bentonite Spacer Block;
Blown in Bentonite Pellet as required;
Removal of Floor Plates;
Placement of Bentonite Bricks;
Blown in Bentonite Pellet as required.

Labour effort for the placement and material handling of Concrete Bulkhead from the underground main hoist to / from the Concrete Bulkhead that include:
Transfer of Concrete Mixer Truck;
Placement of Cement.

Assumptions

Labour effort is based on utilizing the full set of Buffer Box/UFC placement equipment.
UFC Transfer Cask
Trolley for UFC Transfer Cask
Shielding Canopy
Shielding Canopy Trolley
Hydraulic Cylinder Cart
Placement Vehicle
Bentonite Spacer Block Trolley
Bentonite Pellet Blowing System
Floor Plate Handling System
Tow Vehicle
Concrete Mixer Truck
Underground Hopper
Concrete Pump
Concrete Forms
Exclusive of contingency
It has been estimated that the total sequence for placing and backfilling a single Buffer Box/UFC will take 4.3 hours, including a 20% labour contingency.
Total labour effort is based on an all-inclusive per UFC emplacement rate.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$178,772,757.36
Material Cost	$0.00
Other Cost	$0.00
Subtotal	*$178,772,757.36*
Allowance	$44,693,189.34
Total Cost	**$223,465,946.70**

Start Year	2043
Finish Year	2072
Duration	**30 years**
WBS Type	Variable

HOIST ROPE REPLACEMENT

570.45.50.100

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Chip (A) Lee	Prepared by:	Eric Schraml	Organization:	SNC-Lavalin

Description

Replacement of the ropes in the Service Shaft and Main Shaft as often as every three years; set-aside for replacement of vent shaft rope (not scheduled for use) as often as every nine years.

Deliverables

Replacement hoist ropes: hoists ready for use.

Assumptions

Stretch and deterioration of the ropes used in hoisting results in the requirement to replace a complete set of ropes every three years. Therefore, an allowance of 33% of the original purchase price of the hoisting ropes for the main and service shafts is applied annually for the hoisting life of the project. The vent shaft hoist is not scheduled for use; emergency hoist capacity in the vent shaft will be maintained.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$14,249,158.60
Subtotal	*$14,249,158.60*
Allowance	$3,562,289.65
Total Cost	**$17,811,448.25**

Start Year	2034
Finish Year	2072
Duration	**39 years**
WBS Type	Step Fixed

INDIRECTS FOR FINAL PANEL UFC PLACEMENT

570.45.50.110

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Richard Heystee	Prepared by:	RPC	Organization:	SNC-Lavalin Nuclear

Description

Underground indirect costs for placement of UFCs in the final panel (Underground indirect costs are built into EPC-basis mine development per metre costs; this work element covers indirects for the brief period of UFC emplacement in the final panel when development is not proceeding on a per metre basis elsewhere in the repository).

Deliverables

Support for underground operations.

Assumptions

Indirects for periods w/o drilling/blasting derived from previous estimate mine development cost model to include:

• Lifts and trucks
• Fuel & Lube Vehicles
• Sanitary Vehicle
• Ventilation and water pumping
• Mine Lights & Chargers
• Shop Tools
• Safety Gear
• Mine Superintendent
• Safety Coordinator
• Administrative functions (Clerk, Shifter etc.)
• Maintenance General Foreman and staff
• Chief Engineer

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00	Start Year	2066

Material Cost	$0.00
Other Cost	$56,364,999.78
Subtotal	*$56,364,999.78*
Allowance	$14,091,249.94
Total Cost	**$70,456,249.72**

Finish Year	2072
Duration	**7 years**
WBS Type	Variable

MINING HEAT AND POWER

570.45.50.120

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Richard Heystee	Prepared by:	Alex Rawlins	Organization:	SNC-Lavalin

Description

Mine heating and electrical costs (other mining indirects are incorporated in EPC-basis per metre underground development costs).

Deliverables

Support for underground operations.

Assumptions

Electrical loads include:
Main Ventilation Fans
Underground Auxiliary Ventilation Fans
Miscellaneous Demand
Hoisting
Mine Dewatering

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$539,224,011.91
Subtotal	*$539,224,011.91*
Allowance	$134,806,002.98
Total Cost	**$674,030,014.88**

Start Year	2033
Finish Year	2072
Duration	**40 years**
WBS Type	Variable

EXTENDED OPERATIONS (INC SUPPORT SERVICES)

570.45.50.130

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Richard Heystee	Prepared by:	Leo Hwozdyk	Organization:	Hwozdyk Inc.

Description

Operation and management of the DGR facility for 70 years (Y56 to Y125, inclusive) following the completion of UFC emplacement operations. Tasks to include monitoring and preservation of key surface and underground facilities, monitoring the geotechnical integrity of the DGR, collection and maintenance of monitoring records, preparation of the case for the closure of the DGR and the application for authority to close.

Deliverables

• DGR-based organization which maintains the NWMO structure, facilities and knowledge base in anticipation of decommissioning and closure.

• Asset management to maintain DGR infrastructure and surface facilities integrity against the prevailing environment.

Assumptions

The DGR site infrastructure, surface buildings and underground works will be held in a care and maintenance regime for 70 years (extended operations) following the completion of UFC emplacement operations.

Staffing plan includes:

• President (1 FTE)
• Engineering Manager (1 FTE)
• Facility Manager (1 FTE)
• Security Manager (1 FTE)
• Finance Manager (1 FTE)
• HR Manager (1 FTE)
• Procurement Manager (1 FTE)
• Admin Assist (5 FTE)
• Conventional Safety (2 FTE)
• Engineering Support (2 FTE)
• Finance Analyst (1 FTE)
• Housekeeping (8 FTE)
• I/T Support (2 FTE)
• Payroll (1 FTE)
• Nurse (1 FTE)
• Rad Safety (2 FTE)
• Security Guard (20 FTE)

• Security/Fire Supervisor (2 FTE)
• Tech Support (2 FTE)

Surface facility maintenance accounted for in an asset management expenditure of approximately $3M/annum.

Power provided at an average annual consumption of 36M KWhr/yr.
Placeholder for annual taxes or payments in lieu of taxes carried at $250,000 per annum.

Maintenance crew, hoist rope replacement and associated costs are addressed in element .45.50.140 (EXTENDED OPERATIONS EQUIP REPLACE/REFURB/MAINTAIN)

No specific line items included for other taxes (HST), insurance, engineering and surveying supplies, maintenance supplies, fire protection equipment, safety and first aid equipment, mine rescue supplies, training (rescue, fire, medical.). Operating pickups, loaders, forklifts, small tools and shop supplies. IT systems lease and supply and periodic upgrade, vehicle purchase and leasing, special clothing, stores, spares and consumables including general stores, building materials and plant maintenance spares.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$429,423,309.00
Material Cost	$0.00
Other Cost	$445,267,252.94
Subtotal	*$874,690,561.94*
Allowance	$218,672,640.48
Total Cost	**$1,093,363,202.42**

Start Year	2073
Finish Year	2142
Duration	**70 years**
WBS Type	Step Fixed

EXTENDED OPERATIONS EQUIP REPLACE/REFURB/MAINTAIN

570.45.50.140

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Richard Heystee	Prepared by:	Leo Hwozdyk	Organization:	Hwozdyk Inc.

Description

Maintenance of the DGR facility for 70 years (Y56 to Y155, inclusive) following the completion of UFC emplacement operations in conjunction with the corporate function defined in element .45.50.130.

Deliverables

The ongoing maintenance and refurbishment of the DGR infrastructure and surface facilities to ensure their continued operability and integrity against the prevailing environment.

Assumptions

The DGR site infrastructure, surface buildings and underground works will be held in a care and maintenance regime for 70 years (extended operations) following the completion of UFC emplacement operations.

Maintenance functions included in this estimate include 2 full-time (2 shifts) maintenance managers and 12 maintenance personnel. Hoist rope inspection and maintenance for potential use carried forward at 1/10 the applicable rate for the operational period. Small equipment, incidentals and consumables included in the assigned allowance.

.45.50.130 includes annual asset management allocations for major structural work.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$89,261,634.00
Material Cost	$0.00
Other Cost	$2,063,147.15
Subtotal	*$91,324,781.15*
Allowance	$22,831,195.29
Total Cost	**$114,155,976.44**

Start Year	2073
Finish Year	2142
Duration	**70 years**
WBS Type	Step Fixed

ROOM EXCAVATION (FIFTH STAGE) PANEL E

570.45.50.150

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Richard Heystee	Prepared by:	Joe Carvalho	Organization:	Golder Associates Ltd.

Description

Excavate, furnish and prepare the fifth panel of placement rooms (Panel E – 28 placement rooms). Excavation will proceed from the “east” side of Panel E and retreat westwards towards the central access tunnels.

Deliverables

Construction of 28 placement rooms (~8,498 m in total). Following tunnel excavation the contractor will install track in each of the placement rooms to facilitate UFC placement As each room is developed, air, water and electrical power will be installed.

Assumptions

The rooms are 3.2 m high by 2.2 m wide, ~303.5 m in length. The entrance to each room will be perpendicular to the panel access tunnel . The placement rooms and access will be developed by full face drill and blast techniques, with controlled perimeter blasting to minimize creation of an EDZ. All drilling and muck haulage equipment will be rubber tired. A total of 5 placement rooms will be under development at a time, therefore ventilation fans will be needed for the actively mined rooms. As each room is completed the ventilation fan will be transferred to the next room to be developed. At least 3 placement rooms available for placement activities at all times.

All-inclusive pricing for per linear metre of mine development as per previous estimate costing model:

• Panel E Rooms (3.2 m W x 2.2 m H): 8,498.0 metres

Pricing includes waste rock delivered and spread at waste rock pile. Per linear metre costs include conduit, etc.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$43,439,483.92
Subtotal	*$43,439,483.92*
Allowance	$10,859,870.98
Total Cost	**$54,299,354.90**

570.45.50.150

Start Year	2051
Finish Year	2053
Duration	**3 years**
WBS Type	Variable

ROOM EXCAVATION (SIXTH STAGE) PANEL F

570.45.50.160

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario

WBS Owner	Richard Heystee	Prepared by:	Joe Carvalho	Organization:	Golder Associates Ltd.

Description

Excavate, furnish and prepare the sixth panel of placement rooms (Panel F – 28 placement rooms). Excavation will proceed from the "east" side of Panel F and retreat westwards towards the central access tunnels.

Deliverables

Construction of 28 placement rooms (~8,498 m in total). Following tunnel excavation the contractor will install track in each of the placement rooms to facilitate UFC placement As each room is developed, air, water and electrical power will be installed.

Assumptions

The rooms are 3.2 m high by 2.2 m wide, ~303.5 m in length. The entrance to each room will be perpendicular to the panel access tunnel . The placement rooms and access will be developed by full face drill and blast techniques, with controlled perimeter blasting to minimize creation of an EDZ. All drilling and muck haulage equipment will be rubber tired. A total of 5 placement rooms will be under development at a time, therefore ventilation fans will be needed for the actively mined rooms. As each room is completed the ventilation fan will be transferred to the next room to be developed. At least 3 placement rooms available for placement activities at all times.

All-inclusive pricing for per linear metre of mine development as per previous estimate costing model:

• Panel F Rooms (3.2 m W x 2.2 m H): 8,498 metres

Pricing includes waste rock delivered and spread at waste rock pile. Per linear metre costs include conduit, etc.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00	Start Year	2054

Material Cost	$0.00
Other Cost	$43,439,483.92
Subtotal	*$43,439,483.92*
Allowance	$10,859,870.98
Total Cost	**$54,299,354.90**

Finish Year	2056
Duration	**3 years**
WBS Type	Variable

570.45.50.160

ROOM EXCAVATION (SEVENTH STAGE) PANEL G

570.45.50.170

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Richard Heystee	Prepared by:	Joe Carvalho	Organization:	Golder Associates Ltd.

Description

Excavate, furnish and prepare the seventh panel of placement rooms (Panel G – 27 placement rooms). Excavation will proceed from the "west" side of Panel G and retreat eastwards towards the central access tunnels.

Deliverables

Construction of 27 placement rooms (~8,194.5 m in total). Following tunnel excavation the contractor will install track in each of the placement rooms to facilitate UFC placement As each room is developed, air, water and electrical power will be installed.

Assumptions

The rooms are 3.2 m high by 2.2 m wide, ~303.5 m in length. The entrance to each room will be perpendicular to the panel access tunnel . The placement rooms and access will be developed by full face drill and blast techniques, with controlled perimeter blasting to minimize creation of an EDZ. All drilling and muck haulage equipment will be rubber tired. A total of 5 placement rooms will be under development at a time, therefore ventilation fans will be needed for the actively mined rooms. As each room is completed the ventilation fan will be transferred to the next room to be developed. At least 3 placement rooms available for placement activities at all times.

• Panel G Rooms (3.2 m W x 2.2 m H): 8,194.5 metres

Pricing includes waste rock delivered and spread at waste rock pile. Per linear metre costs include conduit, etc.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$41,888,071.22
Subtotal	*$41,888,071.22*
Allowance	$10,472,017.80
Total Cost	**$52,360,089.02**

Start Year	2047
Finish Year	2059
Duration	**13 years**
WBS Type	Variable

ROOM EXCAVATION (EIGHTH STAGE) PANEL H

570.45.50.180

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Richard Heystee	Prepared by:	Joe Carvalho	Organization:	Golder Associates Ltd.

Description

Excavate, furnish and prepare the eighth panel of placement rooms (Panel H – 27 placement rooms). Excavation will proceed from the "west" side of Panel H and retreat eastwards towards the central access tunnels.

Deliverables

Construction of 27 placement rooms (~8194.5 m in total). Following tunnel excavation the contractor will install track in each of the placement rooms to facilitate UFC placement As each room is developed, air, water and electrical power will be installed.

Assumptions

The rooms are 3.2 m high by 2.2 m wide, ~303.5 m in length. The entrance to each room will be perpendicular to the panel access tunnel . The placement rooms and access will be developed by full face drill and blast techniques, with controlled perimeter blasting to minimize creation of an EDZ. All drilling and muck haulage equipment will be rubber tired. A total of 5 placement rooms will be under development at a time, therefore ventilation fans will be needed for the actively mined rooms. As each room is completed the ventilation fan will be transferred to the next room to be developed. At least 3 placement rooms available for placement activities at all times.

• Panel H Rooms (3.2 m W x 2.2 m H): 8195 metres

Pricing includes waste rock delivered and spread at waste rock pile. Per linear metre costs include conduit, etc.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00	Start Year	2060

Material Cost	$0.00
Other Cost	$41,888,071.22
Subtotal	*$41,888,071.22*
Allowance	$10,472,017.80
Total Cost	**$52,360,089.02**

Finish Year	2062
Duration	**3 years**
WBS Type	Variable

ENVIRONMENTAL RESPONSE EQUIPMENT

570.55.40

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bassam Ahmad	Organization:	SNC-Lavalin Nuclear

Description

Procurement, delivery, installation and commissioning of environmental response equipment

(Note that this element was formerly named "RAD & NON-RAD GROUNDWATER MONITORING". However, in the current cost estimate, NWMO costs for other cost elements include all necessary radiological and non-radiological groundwater monitoring.)

Deliverables

Procurement, installation, and commissioning for the following items:

• Environmental Protection Control System (1)
• Environmental Protection Control System Software (1)
• Environmental Protection measuring devices (500)
• Contamination kits (100)
• Environmental cleaning kits (50)
• Mobile rapid response units (6)
• Environmental assessment laboratory (1)

Assumptions

Materials Costs Assumptions:

• The cost of materials is based on past experience with OPG & Bruce Power projects
• Cost Estimates for Environmental Protection Control System and Environmental Assessment Laboratory includes installation
• Operating labour, maintenance, refurbishment and replacement covered under on-going operational costs (operations indirects, etc.)

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00	Start Year	2042

Material Cost	$6,339,443.76
Other Cost	$0.00
Subtotal	*$6,339,443.76*
Allowance	$1,584,860.94
Total Cost	**$7,924,304.70**

Finish Year	2042
Duration	**1 years**
WBS Type	Fixed

RADIOLOGICAL MONITORING EQUIPMENT

570.55.50

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bassam Ahmad	Organization:	SNC-Lavalin Nuclear

Description

Procurement, delivery, installation and commissioning of radiological monitoring equipment.

The radiological monitoring system will include:

• Passive (badge) personal dosimeters that will be sent offsite for measuring up to four times annually.
• Personal electronic dosimeters for personnel with high probability of being exposed to radiation sources and download terminals.
• Hand and Foot Monitors for personnel leaving higher level Radiation Defined Zone (RDZ) to a lower RDZ.
• Hand-held radiation monitors (“Friskers”) to monitor articles leaving higher level RDZ to a lower RDZ.
• Whole Body Monitors and Small Article Monitors for personnel leaving higher RDZ to a lower RDZ.
• Personal Portable Monitor personnel higher level RDZ to a lower RDZ and for personnel leaving the PA into the Public Domain.
• Whole Body Counter for personnel in the health physics program to use annually or quarterly.
• Fixed Area Gamma Monitors (FAGM) to be located throughout the facility for monitoring the local dose rate at places routinely occupied by operating personnel.
• Air radiation Monitors located throughout the facility for measuring the activity of radioactive substances in the atmosphere.
• Radiation Vehicle Monitor, Whole Body Monitor and Small Article Monitor for personnel to be located at the vehicle access point.
• Radiation Portable Vehicle Monitor to be located at the unloading area.
• Radiation, Chemistry and Health Physics laboratory to be located medium RDZ to help personnel with all radiation related issues.
• Radiation Protection Control System that include connections (wired or wireless) to all monitors, computers and dedicated software to ensure all devices are functioning and all alarms are captured and recorded.
• Gas & Kinetic Sampler Monitors to be placed in vent stack to detect if there is any radiological contamination being exhausted from the facility

(Note that this element was formerly named "RADIOLOGICAL BIOSPHERE MONITORING". However, in the current cost estimate, costs for other cost elements include all necessary radiological monitoring. For example, radiation safety and monitoring staff are included in .45.30, Operations Indirects)

Deliverables

Procurement, installation and commissioning for the following items:

• Radiation Protection Control System and software(1)
• Rock Monitor (for excavated rock out-flow & in-flow of backfill materials: 1)

- Dosimetery device (4 per person/per year, 25 persons: 100)
- Electronic Dosimetery device (50)
- Hand and Foot Monitor (5)
- Whole Body Monitor (6)
- Whole Body Counter (2)
- Frisker (articles scanner) (40)
- Fixed Air Monitor (45)
- Mobile Air Monitor (7)
- Fixed Area Gamma Monitor (25)
- Vehicle Monitor (2)
- Vent Stack Gas Monitor (2)
- Kinetic sampler (2)
- Water Monitors (for water in-flow, out-flow & unloading area water out-flow: 4)
- Out-flow Water Monitor (2)
- Portable Monitor (6)
- Chemistry and Health Physics laboratory (1)

Assumptions

Materials Costs Assumptions:

• The cost of materials is based on past experience with OPG & Bruce Power projects

• Cost Estimates for Chemistry and Health Physics laboratory, and Radiation Protection Control System includes installation

• Operating labour, maintenance, refurbishment and replacement covered under on-going operational costs (operations indirects, etc.)

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$6,969,053.47
Other Cost	$0.00
Subtotal	*$6,969,053.47*
Allowance	$1,742,263.37
Total Cost	**$8,711,316.84**

Start Year	2042
Finish Year	2042
Duration	**1 years**
WBS Type	Fixed

570.55.50

NON RADIOLOGICAL MONITORING EQUIPMENT

570.55.60

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bassam Ahmad	Organization:	SNC-Lavalin Nuclear

Description

Procurement, delivery, installation, and commissioning of non-radiological air monitoring equipment.

The Air Quality Monitoring system will detect, monitor and record air quality from various site locations.

Air Quality Monitoring system will include specific measuring detectors installed at various locations in the facility that are capable of detecting specific gases and the concentrations of key analytes. Additional parameters like barometric pressure, air temperature, relative humidity, and air velocity will be continuously monitored. A Central Air Monitoring system will be used to integrate the local air quality information and will identify gas concentrations, temperature, pressure & humidity for each area. Local data loggers can provide output signals to energize a suitable local warning devices if required.

Deliverables

Procurement, installation, and commissioning for the following items:

• Central Air Monitoring System and software (1)
• O2 Detectors (25)
• CO2 Detectors (25)
• CO Detectors (50)
• Radon Detectors (25)
• Explosive Gas Detectors (25)
• H2S Detectors (25)
• Fixed Air Monitors (20)
• N2O Detectors (25)
• NO Detectors (25)
• SO2 Detectors (25)
• Alarm sound amplifiers (25)
• Battery powered emergency lights (25)
• Temperature Monitors (50)
• Pressure Monitors (50)
• Humidity Monitors (50)
• Stack Monitors (3)

Assumptions

Materials Costs Assumptions:

• The cost of materials is based on past experience with OPG & Bruce Power projects

• Cost estimates for central air monitoring system includes installation

• Operating labour, maintenance, refurbishment and replacement covered under on-going operational costs (operations indirects, etc.)

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$1,986,088.13
Other Cost	$0.00
Subtotal	*$1,986,088.13*
Allowance	$496,522.03
Total Cost	**$2,482,610.16**

Start Year	2042
Finish Year	2042
Duration	**1 years**
WBS Type	Fixed

DECOMMISSIONING MANAGEMENT

570.60.10

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bob Brewer	Organization:	SNC-Lavalin Nuclear

Description

NWMO operation and management of the DGR facility for 10 years (Y126 to Y135, inclusive) following the completion of extended operations/monitoring.
The major function of decommissioning management will be the management of decommissioning contracts for the backfill of remaining mine openings and the demolition/salvage of surface facilities.

Note that this element does not include final closure (Y136 to Y150), the anticipated period between the completion of major decommissioning work and obtaining the facility license to abandon.

Deliverables

DGR-based corporate organisation which applies for necessary instruments, lets contracts and manages contract delivery to decommission underground works and major surface facilities.

Assumptions

Staffing plan includes:

• President (1 FTE)
• Director of Engineering (2 FTE)
• Building Manager (1 FTE)
• Finance Manager (1 FTE)
• HR Manager (1 FTE)
• Maintenance Manager (2 FTE)
• Security Manager (1 FTE)
• Engineering Support (6 FTE)
• Finance Analyst (2 FTE)
• IT Support (2 FTE)
• Nurse (1 FTE)
• Conventional Safety and Health Physics Staff (6 FTE)
• Security Guard (20 FTE)
• Technical Support (3 FTE)
• Administrative Staff (10 FTE)
• Janitorial and Maintenance (8 FTE)

Power and utilities provided as approximately $680K/annum; fleet assessed as $120K/annum. Other incidentals and consumables allocated to allowance (25%).

Placeholder for taxes or payments in lieu of taxes at $250,000 per annum.

No specific allocation for sales taxes (HST), insurance, engineering and surveying supplies, maintenance supplies, fire protection equipment, safety and first aid equipment, mine rescue supplies, training (rescue, fire, medical.), IT systems lease and supply and periodic upgrade, special clothing, stores, spares and consumables including general stores, building materials and plant maintenance spares.

This element encompasses NMWO's own engineering; contractor engineering is accounted for in turnkey (design-build) pricing for individual decommissioning actions.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$76,410,159.00
Material Cost	$1,300,398.72
Other Cost	$10,146,225.60
Subtotal	*$87,856,783.32*
Allowance	$21,964,195.83
Total Cost	**$109,820,979.15**

Start Year	2143
Finish Year	2152
Duration	**10 years**
WBS Type	Step Fixed

BACKFILL MATERIALS PLANT (SUPPLY AND OPERATE)

570.60.30.10

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bob Brewer	Organization:	SNC-Lavalin

Description

The design, construction, installation, commissioning and operation of a facility for the handling and preparation of backfill (sealing materials) required to decommission the DGR.

Deliverables

The backfill materials plant includes a steel framed 4,000 m² insulated building with office, process, storage and personnel areas including all services. Also included are the backfill materials processing equipment/plant - silos, rock crusher, mixing and delivery systems. Operating management, engineering, QA, technical support, admin support, operations and maintenance staff are included.

Assumptions

Facility design, construction, installation and commissioning will be on a turnkey contract basis. Management and operation will be done by contract labour as follows:

• Plant Admin (days only) (2 FTE)
• Plant Mgr - 1 per shift (5 FTE)
• Plant technical - 2 per shift (10 FTE)
• Operators - 8 per shift (40 FTE)
• Maintenance - 2 per shift (10 FTE)

Non-labour costs include:

• Design and construct steel framed, insulated building with office, process, storage and personnel areas incl services - 4000m² ($7.8M, escalated from $7.2M 2010$, turn-key)
• Design, supply and install to site new backfill materials processing plant, capacity of 500 tonnes/day (incl. Silos / delivery systems, rock crushing, mixing, processing, delivery systems) ($32.5M, escalated from $30M 2010$, turn-key).
• Spares and consumables ($1.3M/year, escalated from $1.2M/year 2010$)
• Accommodation, travel and incidentals ($2.4M/year, escalated from $2.2 M/year 2010$)

Materials costs and additional operating costs are not included here, but are built into the blended materials costs used for individual backfill/decommissioning work elements.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$150,380,107.20
Material Cost	$40,312,360.32
Other Cost	$33,325,441.65
Subtotal	*$224,017,909.17*
Allowance	$56,004,477.29
Total Cost	**$280,022,386.46**

Start Year	2143
Finish Year	2151
Duration	**9 years**
WBS Type	Step Fixed

570.60.30.10

WASTE PROCESSING AND HANDLING FACILITY

570.60.30.20

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bob Brewer	Organization:	SNC-Lavalin

Description

The design, construction, installation, commissioning and operation of a facility for handling, sorting, volume reduction and packaging of the various waste arisings produced during the decommissioning of the DGR.

Deliverables

The waste processing and handling facility includes an insulated pre-engineered 1,500 m² building with office, process, storage and personnel areas including services. It also includes size reduction equipment, cropping, burning, crushing, compaction, and articulated hammer equipment for use in the plant and on the site. Waste handling and crane equipment, loaders and conveyors are included, as are ventilated enclosures for sorting and packing of waste generated on site during decommissioning. Operating management, QA, admin and technical support, operation and maintenance staff are also covered here.

Assumptions

Facility design, construction, installation and commissioning will be on a turnkey contract basis, with management and operation of the facility carried out using contract labour as follows:

• Plant Mgr (1 FTE)
• Plant Administrator (1 FTE)
• Tech Specialist/Quality assurance (1 FTE)
• Operators - Phase 1 (12 FTEs, first 5 years)
• Operators - Phase 2 (6 FTEs, second 5 years)
• Maintainer (1 FTE)

Non-labour costs include:

• Design and construct steel framed, insulated building with office, process, storage and personnel areas including services - 1500m² ($12.19M, escalated from $11.251M 2010$, turn-key)
• Size reduction equipment (equipment for use within the facility and on site as needed for cropping, burning, crushing and compaction) ($6.5M, escalated from $6M 2010$, turn-key).
• Materials handling equipment, including building crane, loaders and materials conveyors ($2.6M, escalated from $2.4M 2010$, turn-key)
• Ventilated enclosure for the sorting and packing of waste into ISO containers ($975K, escalated from $900K 2010$, turn-key)
• Operating spares and consumable ($325K/year, escalated from $300K/year 2010$)
• Accommodation, travel and incidentals ($460K.year, escalated from $422K/year 2010$)

Transport, disposal and other operating costs are not included here, but are built into per tonne and per m3 rates for waste disposal line items.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$32,040,174.00
Material Cost	$25,521,408.55
Other Cost	$4,603,986.20
Subtotal	*$62,165,568.75*
Allowance	$15,541,392.19
Total Cost	**$77,706,960.94**

Start Year	2143
Finish Year	2152
Duration	**10 years**
WBS Type	Step Fixed

570.60.30.20

AUXILIARY SURFACE FACILITIES DECOMM

570.60.40

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bob Brewer	Organization:	SNC-Lavalin

Description

Decommissioning (demolition and removal) of the auxiliary Surface Facilities. These facilities do not include those facilities which are the subject of other work elements, such as the UFPP, the Waste Processing and Handling facility, the Backfill Materials Plant and the Sealing Materials Compaction Plant. The Waste Storage Areas, the Permanent Vent Fan, and the Decommissioning Facilities put in place specifically for the D&C period are also excluded from this WEDS.

Deliverables

A fully decommissioned DGR site, and a decommissioned off-site Waste Rock Storage/Disposal area. The site will be ready for the beginning of the Closure period, which runs for 15 years after the end of Decommissioning.

Assumptions

Costing is based on a single lump-sum turn-key decommissioning contract assessed as approximately 2.5% of initial costs for items not incorporated in other work elements. Specifically, the total contract value is derived from the following breakout (note that actual per-item costs are likely to vary according to item-specific decommissioning attributes):

• Remaining site improvements - approximately $2,046,000
• Pumphouse and intake - approximately $221,000
• Water storage tank area - approximately $19,000
• Water treatment plant - approximately $66,000
• Process water settling pond - approximately $29,000
• Service shaft water settling pond - approximately $7,000
• Storm water run-off ponds - approximately $29,000
• Sewage treatment plant - approximately $81,000
• Administration building including firewall / cafeteria - approximately $582,000
• Switchyard - approximately $29,000
• Transformer areas - approximately $90,000
• Auxiliary building - approximately $528,000
• Quality control offices and laboratories - approximately $110,000
• Garage building/warehouse/hazardous matls storage - approximately $371,000
• Walkways and serviceways - approximately $49,000
• Fuel storage tanks - approximately $19,000
• Fire hall / security - approximately $85,000
• Emergency power generation - approximately $290,000
• Facility electrical distribution - approximately $208,000
• Facility communication system (s) - approximately $14,000

- Firewater system - approximately $19,000
- Potable water system - approximately $8,000
- Process water system - approximately $7,000
- Sewerage system - approximately $13,000
- Storm water and drainage system - approximately $32,000
- Service air system - approximately $123,000
- Breathing air system - approximately $50,000
- Camp site remnants - approximately $402,000

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$6,027,730.80
Subtotal	*$6,027,730.80*
Allowance	$1,506,932.70
Total Cost	**$7,534,663.50**

Start Year	2143
Finish Year	2152
Duration	**10 years**
WBS Type	Step Fixed

USED FUEL PACKAGING PLANT (UFPP) DECOMM

570.60.50

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bob Brewer	Organization:	SNC-Lavalin

Description

Labour and equipment for the decontamination, decommissioning, dismantling and removal of the Used Fuel Packaging Plant.

Deliverables

Used Fuel Packaging Plant site restored to a "green" state.

Assumptions

It is assumed that post-operations clean out (POCO) is carried out after operations are complete.

Decommissioning is estimated as requiring approximately 1430 person-hours each for a decommissioning manager and an administrator. Decommissioning will be carried out with approximately 33,000 person-hours of direct labour and 5,800 person-hours of support. The cost estimate also includes a $260K (escalated from $240K 2010$) annual assignment for operating spares and consumables over a three-year period, as well as a $573.8K (escalated from $526K 2010$) annual assignment for accommodation, incidentals and travel over the same three year period.

It is assumed no ILW will arise due to decommissioning activities, all arisings not LLW will be classified as conventional wastes.

A facility for handling, sorting, volume reduction and packaging of the various waste arisings produced during the decommissioning of the DGR, is to be constructed on site (.60.30.20). The cost of waste containers, transport and disposal is also covered elsewhere.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$14,748,837.64
Material Cost	$780,239.23
Other Cost	$1,721,585.37
Subtotal	*$17,250,662.24*
Allowance	$4,312,665.56
Total Cost	**$21,563,327.80**

Start Year	2145
Finish Year	2147
Duration	**3 years**
WBS Type	Step Fixed

SEALING MATERIALS COMPACTION PLANT DECOMM

570.60.60

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Chip (A) Lee	Prepared by:	Isaac Ahmed	Organization:	Golder Associates Ltd.

Description

Labour and equipment for the decommissioning, dismantling and removal of the Sealing Materials Compaction Plant.

Deliverables

Sealing Materials Compaction Plant site restored to a "green" state.

Assumptions

There will be no need to decontaminate from a radiological viewpoint.

All equipment and materials will be disposed of as conventional waste.

Volumes of waste emanating from this facility and the cost of waste containers, transport and disposal are covered elsewhere.

On-site managerial team for the decommissioning of the SMCP will comprise a project manager (about 500 hours) supported by a technical specialist (about 1000 hours). Decommissioning will be carried out using approximately 25,000 person-hours, an annual operating spares and consumables budget of about $120K and an annual allocation for accommodations, incidentals and travel of about $200k.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$3,434,567.44
Material Cost	$260,079.74
Other Cost	$411,958.58
Subtotal	*$4,106,605.76*
Allowance	$1,026,651.44
Total Cost	**$5,133,257.21**

Start Year	2148
Finish Year	2149
Duration	**2 years**
WBS Type	Step Fixed

ALWT

570.60.70.10

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bob Brewer	Organization:	SNC-Lavalin

Description

Labour and equipment for the decontamination, decommissioning, dismantling and removal of the Active Liquid Waste Treatment Building.

Deliverables

The return of the ALWT building site to a 'green' state.

Assumptions

It is assumed that POCO (post operation clean out) is done after operations are complete.

Decommissioning is estimated as requiring approximately 780 person-hours for a decommissioning manager. Decommissioning will be carried out with approximately 8,100 person-hours of direct labour. The cost estimate also includes a $35.7K (escalated from $33K 2010$) annual assignment for operating spares and consumables over a three-year period, as well as a $48.5K (escalated from $44K 2010$) annual assignment for accommodation, incidentals and travel over the same three year period.

It is assumed no ILW will arise due to decommissioning activities, all arisings not LLW will be classified as conventional wastes.

A facility for handling, sorting, volume reduction and packaging of the various waste arisings produced during the decommissioning of the DGR, is to be constructed on site (.60.30.20). The cost of waste containers, transport and disposal is also covered elsewhere.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$1,213,351.08
Material Cost	$107,282.89
Other Cost	$145,320.12
Subtotal	*$1,465,954.09*
Allowance	$366,488.52
Total Cost	**$1,832,442.62**

Start Year	2144
Finish Year	2146
Duration	**3 years**
WBS Type	Step Fixed

LLLW STORAGE

570.60.70.20

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bob Brewer	Organization:	SNC-Lavalin

Description

Labour and equipment for the decontamination, decommissioning, dismantling and removal of the Low Level Liquid Waste Storage Building.

Deliverables

The return of the LLLW building site to a 'green' state.

Assumptions

It is assumed that POCO (post operation clean out) is done after operations are complete.

Decommissioning is estimated as requiring approximately 390 person-hours for a decommissioning manager. Decommissioning will be carried out with approximately 3,360 person-hours of direct labour. The cost estimate also includes a $15K (escalated from $14K 2010$) annual assignment for operating spares and consumables over a three-year period, as well as a $18K (escalated from $17K 2010$) annual assignment for accommodation, incidentals and travel over the same three year period.

A facility for handling, sorting, volume reduction and packaging of the various waste arisings produced during the decommissioning of the DGR, is to be constructed on site (.60.30.20). The cost of waste containers, transport and disposal is also covered elsewhere.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$515,202.24
Material Cost	$45,513.96
Other Cost	$55,313.28
Subtotal	*$616,029.48*
Allowance	$154,007.37
Total Cost	**$770,036.84**

Start Year	2144
Finish Year	2146
Duration	**3 years**
WBS Type	Step Fixed

LLW STORAGE

570.60.70.30

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bob Brewer	Organization:	SNC-Lavalin

Description

Labour and equipment for the decontamination, decommissioning , dismantling and removal of the Low Level Waste (LLW) storage building.

Deliverables

The return of the LLW storage building site to a 'green' state.

Assumptions

It is assumed that POCO (post operation clean out) is done after operations are complete.

Decommissioning is estimated as requiring approximately 780 person-hours for a decommissioning manager. Decommissioning will be carried out with approximately 8,160 person-hours of direct labour. The cost estimate also includes a $35.7K (escalated from $33K 2010$) annual assignment for operating spares and consumables over a three-year period, as well as a $48.8K (escalated from $45K 2010$) annual assignment for accommodation, incidentals and travel over the same three year period.

A facility for handling, sorting, volume reduction and packaging of the various waste arisings produced during the decommissioning of the DGR, is to be constructed on site (.60.30.20). The cost of waste containers, transport and disposal is also covered elsewhere.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$1,221,305.28
Material Cost	$107,282.89
Other Cost	$146,465.67
Subtotal	*$1,475,053.84*
Allowance	$368,763.46
Total Cost	**$1,843,817.31**

Start Year	2144
Finish Year	2146
Duration	**3 years**
WBS Type	Step Fixed

UFC HANDLING SYSTEMS

570.60.80

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Chip (A) Lee	Prepared by:	Alan Gaensbauer	Organization:	Palladium Product Development & Design

Description

Labour and equipment for the decontamination, decommissioning, dismantling and removal of UFC Transfer Cask, Shielding Canopy, Hydraulic Cylinder Cart, Placement Vehicle, Floor Plate Handling System, Bentonite Pellet Blowing System, Tow Vehicles, Floor Plate Placement System, Concrete Mixer Truck, Underground Hopper, Concrete Pump, Concrete Forms

Deliverables

The removal from site of UFC Transfer Cask for Buffer Box, Shielding Canopy, Hydraulic Cylinder Cart, Placement Vehicle, Floor Plate Handling System, Bentonite Pellet Blowing System, Tow Vehicles, Floor Plate Placement System, Concrete Mixer Truck, Underground Hopper, Concrete Pump, Concrete Forms

Assumptions

Estimate is based on the following actions:
• Decontaminate 15 UFC Transfer Casks
• Decontaminate 12 Placement Vehicles
• Size reduction and load for disposal - 15 UFC Transfer Casks
• Size reduction and load for disposal - 15 trolley for UFC Transfer Casks
• Size reduction and load for disposal - 9 Shielding Canopy's
• Size reduction and load for disposal - 9 Shielding Canopy Trolley's
• Size reduction and load for disposal - 12 Hydraulic Cylinder Cart
• Size reduction and load for disposal - 12 Placement Vehicles
• Size reduction and load for disposal - 12 Floor Plate Handling System
• Size reduction and load for disposal - 12 Bentonite Spacer Block Trolley
• Size reduction and load for disposal - 12 Bentonite Pellet Blowing System
• Size reduction and load for disposal - 15 Tow Vehicles
Size reduction and load for disposal for 6 Floor Plate Placement System
Size reduction and load for disposal for 8 Concrete Mixer Truck
Size reduction and load for disposal for 4 Underground Hopper
Size reduction and load for disposal for 4 Concrete Pump
Size reduction and load for disposal for 4 Concrete Forms
• Material for disposal– 560 tonne
• Scrap metal credit for salvage – 2,240 tonne

Components will be size reduced and packaged in a form suitable for transport from site, to a facility for final disposal.

A total of 125 m^3 produced from decommissioning these items will be conventional waste.
Conventional waste will be transported 200 km by road in 30 tonne loads to a disposal facility.
The cost of waste containers, transport and disposal is covered included.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$593,434.83
Other Cost	$332,112.00
Subtotal	*$925,546.83*
Allowance	$231,386.71
Total Cost	**$1,156,933.54**

Start Year	2144
Finish Year	2144
Duration	**1 years**
WBS Type	Step Fixed

PERM VENT FAN REMOVAL (DECOMMISSIONING)

570.60.90

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario

WBS Owner	Jennifer Noronha	Prepared by:	Bob Brewer	Organization:	SNC-Lavalin

Description

Temporary ventilation as required during shaft back-filling operations as well as decommissioning aspects of ventilation equipment, accessories, heating penthouses, HEPA units and associated electrical gear not encompassed in shaft decommissioning work elements.

Deliverables

Complete (greenfield) decommissioning of ventilation systems.

Assumptions

Costs estimated as 4000 hours of direct labour and a $52K (escalated from $48K 2010$) allocation for special materials and equipment.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$530,280.00
Material Cost	$52,015.95
Other Cost	$0.00
Subtotal	*$582,295.95*
Allowance	$145,573.99
Total Cost	**$727,869.94**

Start Year	2143
Finish Year	2143
Duration	**1 years**
WBS Type	Fixed

ACCESS TUNNELS

570.60.100.10

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Richard Heystee	Prepared by:	Joe Carvalho	Organization:	SNC-Lavalin

Description

Decommissioning of access tunnels and drifts to comprise:

• Removal of road bed, etc.
• Removal of rock handling equipment.
• Removal of all fuels and lubricants.
• Removal of personnel and material transporting equipment.
• Removal of all infrastructure.
• Backfilling and sealing of all tunnels and drifts comprising the repository and underground shaft complexes.

Deliverables

Tunnels backfilled with dense backfill (70% crushed granite, 25% glacial lake clay and 5% bentonite) from the tunnel floor elevation to a height of 2.4 m. The upper portion of the tunnels from 2.4 m to the full height (5.0 m in the case of the Central Access and Perimeter tunnels and 4.0 m in the case of the Panel Access tunnels), will be filled with light backfill (50% crushed granite and 50% bentonite). Tunnels to be sealed with an assemblage of sealing material blocks placed in conjunction with a concrete bulkhead at regular intervals and/or structural discontinuities approximately every 500 m of tunnel for an approximate total of 50 seals.

Assumptions

Total length of tunnels and rooms to be backfilled to be 16,714 m. Initially the dense backfill will be placed utilizing placement, positioning and compaction utilizing load-haul-dump vehicles with suitable rollers. Light backfill will be placed by pneumatic placement methods. The combined density of the dense and light backfill will be 1.88 tonnes/m^3. The backfill plant will be expanded to meet drift and tunnel backfilling demands. New slick lines will be installed in the shaft to provide the increased backfill production requirements. Access tunnels and drifts backfilled over a period of 6 years based on multi-face working.

Includes:

• Dense backfill, 70% crushed granite, 25% glacial lake clay and 5% bentonite - 189,190 m3
• Light backfill, 50% crushed granite and 50% bentonite - 198,450 m3
• Concrete bulkhead in Access Tunnel
• Removal of fuels and lubricants
• Removal and haulage of rail ballast
• Removal and haulage of debris (cables, air ducts, drain pipes, etc)
• Removal and transport of salvageable ferrous and non-ferrous materials
• Nonferrous metals credit for salvage - 50 tonne
• Copper from 4160 V cable for salvage - 264 tonne

Labour rates used include contractor indirects.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$23,409,548.38
Material Cost	$85,279,533.78
Other Cost	$10,178,761.44
Subtotal	*$118,867,843.61*
Allowance	$29,716,960.90
Total Cost	**$148,584,804.51**

Start Year	2143
Finish Year	2147
Duration	**5 years**
WBS Type	Step Fixed

SERVICE SHAFT DECOMMISSIONING

570.60.100.20

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Chip (A) Lee	Prepared by:	Eric Schraml	Organization:	SNC-Lavalin

Description

Strip and dismantle the Service Shaft and backfill the shaft in a retreat fashion, including the removal of all concrete and damaged rock annulus, then remove headframe, collar house and hoist room.

Deliverables

A backfilled and sealed Service Shaft.

Assumptions

No further requirement to access the underground facility. Upon removal of the concrete and damaged rock annulus, the shaft will be filled with a compacted dense backfill material. A new slick line will be installed in the Service Shaft for dense backfill placement. A typical shaft seal consists of:

0 – 20 m Low heat high performance concrete (LHHPC) – concrete cap at surface,
20 – 150 m 70/30 bentonite / sand shaft seal compacted in-situ and/or highly compacted bentonite blocks
150 – 170 m LHHPC for concrete bulkhead keyed into rock / overburden to a distance of 0.5 times the original radius of the shaft
170 – 330 m 70/30 bentonite / sand shaft seal compacted in-situ and/or highly compacted bentonite blocks
330 – 380 m Asphalt seal
380 – 480 m 70/30 bentonite / sand shaft seal compacted in-situ and/or highly compacted bentonite blocks
480 – 500 m Concrete monolith - LHHPC

Estimate includes:

• Shaft lining removal
• Reinforced Low Heat High Performance Concrete (LHHPC) - 9,262.5 m3
• Bentonite and Sand Seal – 18,761.25 m3
• Asphalt Seal – 2,405 m3
• Removal, haulage and disposal of hazardous and non-hazardous waste materials
• Removal and haulage of salvageable metals.
• Steel credit for salvage - 690 tonne
• Non-ferrous credit for salvage - 10 tonne
• Hoist credit for salvage (Credit)
• Dismantling of dewatering, electrical, compressed air, water, alarm and IT systems.
• Dismantling of headframe production hoist, service hoist, auxiliary hoist, service crane and ventilation systems.

Labour rates used include contractor indirects.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$27,476,657.92
Material Cost	$14,048,816.20
Other Cost	$4,741,419.26
Subtotal	*$46,266,893.39*
Allowance	$11,566,723.35
Total Cost	**$57,833,616.73**

Start Year	2147
Finish Year	2149
Duration	**3 years**
WBS Type	Fixed

MAIN SHAFT DECOMMISSIONING

570.60.100.30

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Chip (A) Lee	Prepared by:	Ecric Schraml	Organization:	SNC-Lavalin

Description

Strip and dismantle the Main Shaft and backfill the shaft in a retreat fashion, including the removal of all concrete and damaged rock annulus, then remove headframe, collar house and hoist room.

Deliverables

A backfilled and sealed Main Shaft.

Assumptions

No further requirement to access the underground facility.

Upon removal of the concrete and damaged rock annulus, the shaft will be filled with a compacted dense backfill material.

A new slick line will be installed for dense backfill placement.

A typical shaft seal consists of:

0 – 20 m Low heat high performance concrete (LHHPC) – concrete cap at surface,
20 – 150 m 70/30 bentonite / sand shaft seal compacted in-situ and/or highly compacted bentonite blocks
150 – 170 m LHHPC for concrete bulkhead keyed into rock / overburden to a distance of 0.5 times the original radius of the shaft
170 – 330 m 70/30 bentonite / sand shaft seal compacted in-situ and/or highly compacted bentonite blocks
330 – 380 m Asphalt seal
380 – 480 m 70/30 bentonite / sand shaft seal compacted in-situ and/or highly compacted bentonite blocks
480 – 500 m Concrete monolith - LHHPC

Estimate includes:

- Shaft lining removal
- Reinforced Low Heat High Performance Concrete (LHHPC) - 5,657.5 m3
- Bentonite and Sand Seal – 21,537.5 m3
- Asphalt Seal – 2,761.25 m3
- Removal, haulage and disposal of hazardous and non-hazardous waste materials
- Removal and haulage of salvageable metals.
- Steel credit for salvage - 473 tonne
- Non-ferrous credit for salvage - 10 tonne
- Hoist credit for salvage (Credit)

• Dismantling of dewatering, electrical, compressed air, water, alarm and IT systems.
• Dismantling of headframe production hoist, service hoist, auxiliary hoist, service crane and ventilation systems.

Labour rates used include contractor indirects.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$24,573,964.12
Material Cost	$11,547,927.12
Other Cost	$2,612,722.69
Subtotal	*$38,734,613.94*
Allowance	$9,683,653.48
Total Cost	**$48,418,267.42**

Start Year	2148
Finish Year	2150
Duration	**3 years**
WBS Type	Fixed

VENTILATION SHAFT DECOMMISSIONING

570.60.100.50

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Chip (A) Lee	Prepared by:	Eric Schraml	Organization:	SNC-Lavalin

Description

Install a sinking hoist and refurbish the Ventilation Shaft so that the shaft can be back filled in a retreat fashion, including the removal of all concrete and damaged rock annulus, then remove the sinking hoist and headframe. Install a backfill slick line in the Maintenance Area Ventilation Shaft for shaft sealing.

Deliverables

A backfilled and sealed ventilation shaft.

Assumptions

No further requirement to access the underground facility.

Upon removal of the concrete and damaged rock annulus, the shaft will be filled with a compacted dense backfill material.

A new slick line will be installed for dense backfill placement.

A typical shaft seal consist of:

0 – 20 m Low heat high performance concrete (LHHPC) – concrete cap at surface,
20 – 150 m 70/30 bentonite / sand shaft seal compacted in-situ and/or highly compacted bentonite blocks
150 – 170 m LHHPC for concrete bulkhead keyed into rock / overburden to a distance of 0.5 times the original radius of the shaft
170 – 330 m 70/30 bentonite / sand shaft seal compacted in-situ and/or highly compacted bentonite blocks
330 – 380 m Asphalt seal
380 – 480 m 70/30 bentonite / sand shaft seal compacted in-situ and/or highly compacted bentonite blocks
480 – 500 m Concrete monolith - LHHPC

Estimate includes:

- Shaft lining removal
- Reinforced Low Heat High Performance Concrete (LHHPC) - 4,463.7 m3
- Bentonite and Sand Seal – 13,783.75 m3
- Asphalt Seal – 1,767.5 m3
- Removal, haulage and disposal of hazardous and non-hazardous waste materials
- Removal and haulage of salvageable metals.
- Steel credit for salvage - 224 tonne
- Non-ferrous credit for salvage - 10 tonne

• Hoist credit for salvage (Credit)
• Dismantling of dewatering, electrical, compressed air, water, alarm and IT systems.
• Dismantling of headframe production hoist, service hoist, auxiliary hoist, service crane and ventilation systems.

Labour rates used include contractor indirects.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$21,393,047.70
Material Cost	$8,166,768.02
Other Cost	$2,739,183.23
Subtotal	*$32,298,998.95*
Allowance	$8,074,749.74
Total Cost	**$40,373,748.68**

Start Year	2143
Finish Year	2145
Duration	**3 years**
WBS Type	Fixed

CRUSHER PLANT DEMO (DECOMM)

570.60.120

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario

WBS Owner	Jennifer Noronha	Prepared by:	Kris Hojka	Organization:	SNC-Lavalin

Description

Due to low aggregate consumption, the need for a fixed aggregate plant can not be justified. Required aggregate will either be produced by a contractor with host rock or imported from an external source.

Deliverables

Assumptions

Allowance

Labour Cost	$86,170.50	Start Year	2151
Material Cost	$0.00	Finish Year	2151
Other Cost	$145,498.00	Duration	**1 years**
Subtotal	*$231,668.50*	WBS Type	Fixed
Allowance	$57,917.13		
Total Cost	**$289,585.63**		

SITE CLEANUP (DECOMM)

570.60.130

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Bob Brewer	Organization:	SNC-Lavalin

Description

Dismantle and dispose of remaining non-building surface infrastructure as part of the completion of decommissioning and preparation for subsequent closure. This work would be performed during the last two years of the decommissioning period. Only an access road would be left, and only to the extent required to support closure activities such as monitoring.

Deliverables

Restored site surface to a state suitable for public use (with the provision that subsurface use be restricted). If required to support closure, a graveled access road would be left in place to access monitoring and power-related equipment.

Assumptions

Cost estimate uses 1.8 Design-Build Surface Labour Full Time Equivalents over a two-year period. DB07 labour rate includes contractor indirects, including equipment and waste disposal.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$885,567.60
Material Cost	$0.00
Other Cost	$0.00
Subtotal	*$885,567.60*
Allowance	$221,391.90
Total Cost	**$1,106,959.50**

Start Year	2151
Finish Year	2152
Duration	**2 years**
WBS Type	Fixed

DECOMM INDIRECTS (INC HEAT, CONSUMABLES)

570.60.150

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Kris Hojka	Organization:	SNC-Lavalin

Description

This work element covers decommissioning indirects not encompassed in turn-key (design-build) labour rates or NWMO host functions (see, e.g., .60.10 Decommissioning Management), such as major utilities.

Deliverables

Contractor plant indirects for decommissioning.

Assumptions

Estimate based on support costs modified from operations phase as follows:

- Mine Heating - $1,530,661/ year (escalated from $1,403,000/year 2010$)
- Surface Building Heat - $1,008,076/ year (escalated from $924,000/year 2010$)
- Electricity - $1,406,288/year (escalated from $1,289,000/year 2010$)
- Water and Sewerage - $9100/year (escalated from $9,125/year 2010$)

Other work elements and the labour rates used for specific decommissioning tasks include all other contractor indirects, such as:

- Waste Disposal
- Telecom/Office Expenses
- Engineering / Surveying Supplies
- Maintenance Supplies
- Safety and First Aid
- Mine Rescue/Fire Safety Supplies
- Operating Equipment (pick up trucks, forklifts)
- Small Tools Allowance

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00	Start Year	2143

Material Cost	$2,654,980.72
Other Cost	$36,886,213.08
Subtotal	*$39,541,193.80*
Allowance	$9,885,298.45
Total Cost	**$49,426,492.24**

Finish Year	2152
Duration	**10 years**
WBS Type	Step Fixed

DECOMM WASTE DISPOSAL

570.60.160

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	RPC	Organization:	SNC-Lavalin

Description

Packaging, transport and disposal of itemised conventional waste, very low level waste (VLLW) and low level waste (LLW) resulting from DGR decommissioning activities.

Deliverables

• Containerisation of decommissioning waste arisings.

• Transport of all decommissioning waste arisings from the DGR to suitable disposal facilities.

• Disposal of all decommissioning waste arisings at suitable disposal facilities.

Assumptions

Waste disposal costs include 1130 m3 (formerly 1125 m3) of low level radioactive waste at $1,400/m3 over 10 years from the following sources:

• Waste management area - 750 m3
• Used fuel packaging plant - 375 m3

With regards to LLW, the following has been assumed:

• Concrete volumes based on a 25 mm surface layer of each cell within the UFPP, assumed to be LLW. The remaining concrete assumed to be disposed of as conventional waste.
• All stainless steel cladding within cells regarded as LLW Equipment in various areas assumed to be:
• All equipment within the Fuel Handling Cells will be treated as LLW for disposal purposes
• All equipment within the Basket Cutting Cells will be treated as LLW for disposal purposes
• All equipment that becomes submerged within the Storage Pool will be treated as LLW, the remainder will be treated as conventional waste
• Equipment in Basket and Module receipt cells will be taken as LLW
• Equipment in the Waste Management facility will be treated as LLW
• Equipment in the UFC Receipt Cells will be treated as LLW
• Equipment in all other cells will be treated as conventional waste

Waste disposal costs include 129,779 tonnes of conventional (free-release) waste at $200/tonne (load/transport/dispose) over 10 years, from the following sources.

• Main (protected area) fence - 45 tonnes
• Perimeter security fence - 225 tonnes

• Pumphouse and intake - 137.5 tonnes
• Water storage tank area - 400 tonnes
• Water treatment plant - 375 tonnes
• Process water settling pond - 50 tonnes
• Service shaft water settling pond - 25 tonnes
• Storm water run-off ponds - 25 tonnes
• Sewage treatment plant - 1075 tonnes
• Waste management area - 12700 tonnes
• Administration building including firehall / cafeteria - 3872 tonnes
• Switchyard - 620 tonnes
• Transformer areas - 685 tonnes
• Auxiliary building - 1830.4 tonnes
• Quality control offices and laboratories - 726 tonnes
• Garage building/warehouse - 4083.2 tonnes
• Security - 625 tonnes
• Emergency power generation - 1200 tonnes
• Facility communication system (s) - 150 tonnes
• Potable water - 10450 tonnes
• Sewerage - 70.4 tonnes
• Service air - 264 tonnes
• Three headframes for the shafts - 12000 tonnes
• Permanent vent fan removal - 680 tonnes
• Main shaft complex - 5568.75 tonnes
• Vent shaft complex - 4455 tonnes
• Service shaft complex - 3564 tonnes
• Concrete batching plant - 1525 tonnes
• Rock crushing plant - 1650 tonnes
• Used fuel packaging plant - 59300 tonnes
• UFC handling systems - 1400 toes

A single waste disposal coordinator (one NWMO FTE) and $109,099/annum (escalated from $100,000/annum 2010$) in ISO containesr, re-handling and temporary storage have been assumed.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$1,222,305.00
Material Cost	$0.00
Other Cost	$31,134,131.36
Subtotal	*$32,356,436.36*
Allowance	$8,089,109.09
Total Cost	**$40,445,545.45**

Start Year	2143
Finish Year	2152
Duration	**10 years**
WBS Type	Step Fixed

570.60.160

FINAL CLOSURE

570.60.170

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Jennifer Noronha	Prepared by:	Kris Hojka	Organization:	SNC-Lavalin

Description

Following the decommissioning and backfilling of all underground tunnels and shafts, and the decommissioning and removal from site of all redundant surface facilities, the DGR will remain under institutional management control until a license to abandon the site is obtained. During this 15 year period site security will remain in place, albeit at reduced levels, with facilities also available to accommodate monitoring personnel and the management and administration infrastructure to support their ongoing activities.

Once a license to abandon the site has been obtained all remaining staff will vacate the site to allow the decommissioning and removal of remaining surface facilities, site fences, utilities and access roads. The site will then be made good to a level consistent with the surrounding environment.

Deliverables

This activity covers all labour, plant, equipment and services required to undertake the final closure phase of the DGR project using a combination of an NWMO corporate structure and turn-key contracts for Site services.

Assumptions

The duration of the Closure Phase is 15 years, and costs are based on working one shift/day, 230 days/year.

The management and operation of the DGR during this phase of the project will be carried out using NWMO staff, as follows:

• President (part-time), duties to include closure and public affairs (0.5 FTE)
• Technical Director (President part-time) (0.5 FTE)
• Pre closure/closure reports and license applications (2 FTE)
• Resources / Finance /Business Services (1 FTE)
• Secretarial / Clerical (2 FTE)
• QA / Safety Manager (1 FTE)
• Environmental monitoring / coordination / assessment (2 FTE)
• Site general helper / driver / medic (4 FTE)

Other costs include:
• Contracts for ecological restoration -$4,091,200 (escalated from $3,750,000 2010$);
• Contracts for signage and landmarking - $545,500 (escalated from $500,000 2010$);
• Contracts for final dismantling, removal, and disposals - $2,190,000 (escalated from $2,000,000 2010$);

- Contracts for security - $3,272,976 (escalated from $3,000,000 2010$);
- Contracts for final sealing of deep boreholes - $2,727,480 (escalated from $2,500,000 2010$);
- Contracts for maintenance - $2,045,610 (escalated from $1,875,000 2010$);
- Other contracts - $2,181,984 (escalated from $2,000,000 2010$);
- Equipment, spares, and consumables - $850,973 (escalated from $780,000 2010$);
- Vehicle leases - $572,770 (escalated from $525,000 2010$);
- Energy consumption - $818,244 (escalated from $750,000 2010$);
- Conventional Insurance - $327,297 (escalated from $300,000 2010$);
- Vehicle Insurance - $68,732 (escalated from $63,000 2010$); and
- Taxes or community compensation -$272,748 per year (escalated from $725,000 per year 2010$)

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$25,023,795.30	Start Year	2153
Material Cost	$0.00	Finish Year	2167
Other Cost	$23,775,988.66	Duration	**15 years**
Subtotal	*$48,799,783.96*	WBS Type	Fixed
Allowance	$12,199,945.99		
Total Cost	**$60,999,729.95**		

FUNDING FORMULA/FINANCIAL SURETY

570.70

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Derek Wilson	Prepared by:	Derek Wilson	Organization:	NWMO

Description

As APM is implemented, the NWMO will continue to ensure that the cost estimates remain updated and that the funding formula supports the financing of all aspects of APM. Contributions will be adjusted periodically to reflect updated projections of overall costs of APM and the number of fuel bundles expected to be produced by each used fuel owner. The funding formula will be further developed when specific circumstances related to new owners and new reactors arise.

Financial Surety has been included in the 2016 life-cycle estimate to align with the current and future NWMO WBS structure.

Deliverables

Deliverables associated with this activity include:
Annually, assess all factors that impact the APM cost estimates and funding requirements.
Disclose and deal with any material change in the implementation of APM.
Update total cost estimate for APM as per the requirements of the NFWA.

Assumptions

Annaul 3rd party contract costs are as per the 2015 – 2019 business plan, and carried constant from 2020 through the end of the operations phase at the 2019 level of $196k/year.

Staffing for the construction and operations period (2033 – 2172) are not included as it is assumed that this would be undertaken by the Common Services during construction and DGR operations staff during operations.

Allowance

An overall allowance of 35% has been included for 2024 - 2032; and an allowance of 25% has been included, starting in 2033. No additional allowance has been included in the years prior to 2024.

Labour Cost	$5,324,441.82	Start Year	2015

Material Cost	$0.00
Other Cost	$10,711,046.37
Subtotal	*$16,035,488.19*
Allowance	$3,473,424.90
Total Cost	**$19,508,913.10**

Finish Year	2072
Duration	**58 years**
WBS Type	Fixed

GOVERNANCE STRUCTURE

570.80

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Derek Wilson	Prepared by:	Derek Wilson	Organization:	NWMO

Description

Governance has been included in the 2016 life-cycle estimate to align with the current and future NWMO WBS structure

Activities in support of Governance include:
· Convene meetings of NWMO Members, Board, Board Committees and Advisory Council as required in the respective charters.
· Ensure membership of Advisory Council is updated as required to reflect expertise and representation required by the Nuclear Fuel Waste Act (NFWA).
· Coordinate annual technical program reviews.
· Interact with the Canadian Nuclear Safety Commission on APM in the pre-project period consistent with the agreed project agreement terms relating to provision of regulatory information and reviews.
· Maintain certification to ISO 9001:2008 and conformance with the requirements of CSA N286-12 as it applies to the development of a DGR.
· On an annual basis, report on plans and progress through publication of APM Implementation Plans and NWMO Annual Reports.
· Submit to government and make public NWMO's triennial report on APM implementation as required by NFWA.

Deliverables

none

Assumptions

Annual 3rd party contract costs are as per the 2015 – 2019 business plan, and carried constant from 2020 through the end of the operations phase at the 2019 level of $657/year.

Staffing for the construction and operations period (2033 – 2172) are not included as it is assumed that this would be undertaken by the Common Services during construction and DGR operations staff during operations.

Allowance

An overall allowance of 35% has been included for 2024 - 2032; and an allowance of 25% has been included, starting in 2033. No additional allowance has been included in the years prior to 2024.

Labour Cost	$10,117,746.95	Start Year	2015

Material Cost	$0.00
Other Cost	$37,828,339.52
Subtotal	*$47,946,086.48*
Allowance	$10,205,907.85
Total Cost	**$58,151,994.32**

Finish Year	2072
Duration	**58 years**
WBS Type	Fixed

570.80

ENVIRONMENTAL MONITORING

570.85.10

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario

WBS Owner	Derek Wilson	Prepared by:	J. Jacyk	Organization:	NWMO

Description

Baseline information will be used to support the EIS by providing site specific information which can be used as the basis for predicting anticipated effects of the APM Project activities throughout the life of the project. Field data will be analyzed and reported in an Ecological Risk Assessment and an Environmental Risk Assessment. Future monitoring results will be compared with baseline in order to determine that effects are either present or absent. Data collected at this stage will be used to input site specific biosphere data in the safety assessment models.

The types of data required include: Lake discharge area, Lake aquatic discharge fraction, Lake terrestrial discharge fraction, Mean Lake depth, Sedimentation Rate, General sediment layer thickness, Mixed sediment thickness, Thickness of sediment removed for use in fields,Sediment dry bulk density, Dry Deposition velocity, Atmospheric dust load, Atmospheric aerosol load, washout Ratio, Soil Types and soil bulk density, Active surface soil depth, Upland soil leach rate fraction, Fraction of runoff entering the overburden, Surface soil moisture content fraction, Surface soil summer water deficit, Groundwater upflow exponent, Bioturbation rate, Soil Kd values, Plant/Soil Concentration Ratios, Transfer Factors, List of representative species.

Weight of representative species, Dimensions of representatives species, Food fractions, Ingestion rates (food, soil, water, sediment) and Occupancy Factors.

Deliverables

Environmental Risk Assessment (ERA) Report and Ecological Risk Assessment (EcoRA) Report.

Baseline Monitoring Programs for: Surface Water; Shallow groundwater; Wetlands; Air quality; Noise; Soil quality and moisture; Transfer Factors (tissue concentration plant and animal); Population and density assessments of VECs; Sediments (characterization and analysis); Surface Water Assessment (flow, quantity, baseflow, discharge, recharge) and Water Balance; Weather; and Toxicity testing. Habitat assessments of VECs and Species at risk. Pathways analysis (local ingestion rates).

Environmental Risk Assessment. Ecological Risk Assessment. Water Balance.

Assumptions

Selection of VECs has been completed (assume 12 VECs and 1 rare VEC)
Local and Aboriginal community information has been used to avoid areas with high archeological potential.
For planned submission of Operation licence documents, baseline Radiological Environmental Monitoring Program (REMP) should start in 2031 (estimated at $1,000,000 per year).
Environmental Assessment documents captured in separate WED.

Allowance

An overall allowance of 35% has been included based on level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$1,284,000.00
Other Cost	$10,503,200.00
Subtotal	*$11,787,200.00*
Allowance	$4,125,520.00
Total Cost	**$15,912,720.00**

Start Year	2024
Finish Year	2032
Duration	**9 years**
WBS Type	Fixed

HUMAN HEALTH AND EIS

570.85.20

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	Derek Wilson	Prepared by:	J.Jacyk	Organization:	NWMO

Description

Collect siting area specific data to support human health risk assessment, and for use in analysis models for preclosure and postclosure safety assessments.

Types of data include Farming Yield Data (Forest renewal time, Forest yield in fire, Forest Yield for wood, Soil contamination of plants, Plant yield (plant), Plant yield (milk, meat and bird).

Types of data also include: People per household, Domestic Water demand per person, air inhalation rate, water ingestion rate, total energy need, meat ingestion rate, milk ingestion rate,poultry ingestion rate, fish ingestion rate, Soil ingestion rate, Probability of irrigation, Irrigation period, Probability of using fresh lake sediments on fields, Dredged sediment thickness, Cropping Frequency, Cropping period, non irrigated field, Cropping soil contaminant loss fraction, Annual energy consumption per household.

Contractor will prepare Environmental Technical Supporting Documents (TSDs) for the EIS submission, and provide environmental contractor support at the public hearing for the EIS and licence application.

The Environmental TSDs - Aquatic TSD, Terrestrial TSD, Atmospheric Environment TSD, Human Health Risk Assessment TSD - describe the assessment of environmental effects of the APM Project on different aspects or ecological components (terrestrial, aquatic, human health) of the environment using representative sub-components and associated Valued Ecosystem Components (VECs) that are potentially susceptible to effects of the Project and/or are pathways or mechanisms for transfer of an effect to another environmental component.

This work will draw from the field work and analyses completed for the EcoRA, ERA and Human Health Monitoring.

Deliverables

Human Health Risk Assessment reports.

Environmental Technical Support Documents (TSDs) (e.g., Aquatic TSD, Terrestrial TSD, Atmospheric Environment TSD, Human Health Risk Assessment TSD).

Assumptions

EIS (including project description, methods, alternative means, etc.) and other technical supporting documents (e.g., Geology, Community Well-being, Aboriginal Engagement TSD) to be completed under seperate WED.

Human Health Risk Assessment reports are assumed to be prepared once every 5 years at a cost of $500,000 for field studies in the siting area and preparation of a report:

- first report in 2024
- second report in 2028

EIS (including project description, methods, alternative means, etc.) and other technical supporting documents (e.g., Geology, Community Well-being, Aboriginal Engagement TSD) to be completed under separate WED.

Assume environmental data freeze by December 2026.

Assume completion of EcoRA Report and ERA Report by December 2027.

Assume submission of EIS and supporting documentation by December 2028.

Assume EIS review and public hearings from 2029 to 2031.

Assume receipt of site development licence in 2032.

Allowance

An overall allowance of 35% has been included based on level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$3,288,000.00
Subtotal	*$3,288,000.00*
Allowance	$1,150,800.00
Total Cost	**$4,438,800.00**

Start Year	2024
Finish Year	2031
Duration	**8 years**
WBS Type	Fixed

ENVIRONMENTAL - STAFFING

570.85.90

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario

WBS Owner	Derek Wilson	Prepared by:	Derek Wilson	Organization:	NWMO

Description

Staffing related to Evironmental Monitoring (WED# 570.50.10) and Human Health and EIS (WED# 570.50.20)

Deliverables

(2015-2023): Staffing levels are captured as part of the Phase 2 totals.
(2024-2032): Total of 4 FTE's per year, made up of 1 NWMO1, and 3 NWMO3.
(2033 through completion of decommissioning): 1 NWMO3 as part of NWMO home office per year. All other environmental activities in support of the construction and operations are included in those estimate.

Assumptions

Allowance

An overall allowance of 35% has been included for 2024 - 2032; and an allowance of 25% has been included, starting in 2033.

Labour Cost	$28,023,389.10
Material Cost	$0.00
Other Cost	$0.00
Subtotal	*$28,023,389.10*
Allowance	$7,663,735.49
Total Cost	**$35,687,124.59**

Start Year	2024
Finish Year	2167
Duration	**144 years**
WBS Type	Fixed

COMMON SERVICES

570.90

Case	MARK 2 - 3.6 Million Fuel Bundles, Crystalline Scenario				
WBS Owner	M. Hung	Prepared by:	Chris Vardy	Organization:	NWMO

Description

An overall business, administrative and management function that will provide the necessary backoffice support to the project including the provision and or management of finances, systems, people, infrastructure, supplies and includes:

· Finance, Pension Administration and Business Services: Account management, reporting, invoicing, contract payments, staff payments, buyer and IT support.
· Human Resources: Recruitment, staff management, purchase of payroll services, general support.
· Legal, Procurement and Insurance – Internal and external legal counsel, procurement services and conventional insurance coverage for work during the pre-operations phase.
· Office and IT costs,office accommodation, supplies and staff expenses.
· Quality services: internal audit and governance.
· President's office

Deliverables

none

Assumptions

Costs include internal NWMO headcounts as well as other costs such as pension administration fees, office rent, purchase and maintenance of IT infrastructure, etc.

Allowance

n overall allowance of 35% has been included for 2024 - 2032; and an allowance of 25% has been included, starting in 2033. No additional allowance has been included in the years prior to 2024.

Labour Cost	$153,066,634.25
Material Cost	$0.00
Other Cost	$94,787,988.28
Subtotal	*$247,854,622.53*
Allowance	$50,600,363.95
Total Cost	**$298,454,986.48**

Start Year	2015
Finish Year	2042
Duration	**28 years**
WBS Type	Fixed

ROUTE AND SYSTEM DEVELOPMENT

670.20

Case	670 MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Preparer Organizatio	NWMO - Nuclear Waste Management Organization	Prepared by	U. Stahmer

Description

The used fuel transportation package (UFTP) prototype road cask is based on 25 year old technology and is not optimal for the rail option. Based on design developed over next 2 years, a certificate of approval for new road and rail packages will be obtained. Acquisition and testing of the equipment will follow.
A multi-year program of engagement planning and dialogue will continue to support the transportation program

System Development
-Definition and advancement of the transportation conceptual design reflective of site specificity
-Advancement of the transportation preliminary and detailed design reflective of site specificity
-Manufacture and commissioning of the used fuel transportation system reflective of site specificity

Deliverables

Identify and assess preferred and alternative road and rail routes between each of the interim storage sites and each of the four siting regions.
Identification and design of the necessary transportation equipment and facilities, including local access infrastructure, inter-modal transfer facilities and equipment, transportation packages (including the optimization of the DSC-TP, BTP and UFTP packages) trailers, vessels and rail cars.
Maintain all licenses and certificates current for packages and transport vehicles.
Prepare a full transportation risk assessment, including public and worker dose assessments.
Prepare a conceptual emergency response analysis and approach for the seven points of origin to the four siting regions that addresses the requirements of CNSC and relevant authorities.
Establish a conceptual approach for addressing first responder, law enforcement and emergency medical personnel risk, and preparing emergency responders, law enforcement and emergency medical personnel to respond to transportation accidents involving used nuclear fuel.
Ensure the lifecycle capital and operating costs have been quantified at a conceptual level.
Prepare a conceptual security approach which addresses the requirements of the road and rail modes and CNSC as described in Regulatory Guide 208 or successor requirements.
Prepare a transportation system description and development plan that is recognized as meeting regulatory standards by relevant regulators and will serve as a basis for the environmental assessment process.
Communicate and coordinate as appropriate with the transportation agencies, carriers and their associations and with Engagement and Site Selection to ensure they are informed and that all options remain available for the transport of used nuclear fuel by road, rail and water modes.
Provide technical support to the siting team in their engagement processes.
Creation of Security, Emergency Response and Transportation Logistics programs

Implementation / Test / Oversight (2033 - 2042)
Prototype Used Fuel Transportation Packages
Engineering support for the manufacturing, testing and commissioning of all components of the used fuel transportation system
Commissioning of Security, Emergency Response and Transportation Logistics programs

Assumptions

Deliverables based on Transportation PEP for 2015 onward and carried forward to 2032.
-Transport System Manufacture and Commissioning (2033 to 2042)
Oversight of transportation system equipment manufacture and commissioning in years 2033 through 2042.
Travel assumption: trips (2) per year to existing vendors/contractors at $2,000 per trip.
-Logistical Infrastructure Implementation Design (2033 to 2042)
Development, implementation and commissioning of logistics system.
-Security and Emergency Response Implementation
Oversee the creation of training programs and implementation. Meet with governmental representatives for final design and implementation establish security and emergency response programs based on requirements previously defined. Continue liaisons with security and emergency response forces along routes.
Misc. Travel assumptions: 2 trips annually to vendors (logistics, in 2033 to 2042 at $2,000 per trip. One trip annually to regulator years 2033 through 2042 at $1,500 per trip.
Exclusive of contingency.

Allowance

An overall contingency/allowance of 25% has been included, starting in 2024.

Labour Cost	$20,302,370.28
Material Cos	$0.00
Other Cost	$70,373,917.04
Subtotal	*$90,676,287.32*
Allowance	$17,367,383.35
Total Cost	**$108,043,670.68**

Start Year	2015
Finish Year	2042
Duration	**28 years**
Cost Type	Fixed

UFTP Transportation Vehicle for non-Site-Specific

670.40.10.10

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The design, procurement, testing and commissioning of Used Fuel Transportation Packages (UFTP) Transportation Vehicles for mock-up.

Deliverables

- Completed system design basis documentation.
- Completed detailed design of the UFTP Transport Vehicles.
Completed testing and licensing documentation, the Safety Analysis Report, for submission to the Competent Authority.
- An approved Design Package Approval Certificate issued by the Competent Authority as per 670.90.
- A licensed UFTP Transport Vehicle system and the approved commissioning plans.

UFTP Transportation Vehicle - Escort Vehicle (customized security vehicle), including:
- Anti-theft electronic immobilizer system.
- On board real-time tracking system.
- On-board biometrics system (biometric fingerprint and/or retinal scan).
- Vehicle security enhancements (e.g., typical customization done to RCMP, Police and Homeland security vehicles).

UFTP Transportation Vehicle - Tractor, including:
- Customized tractor similar to those used by US Department of Energy (DOE) "safeguards transporter".
- Electronic Speed Limiter for Ontario- Limits speed to 80km/hr.
- On board real-time tracking system.
- OnGuard Collision Safety System.
- Anti-theft electronic immobilizer system.
- Passenger-mounted LCD touch-screen PC.
- Sleeping berth to accommodate 2 persons.
- On-board biometrics system (biometric fingerprint and/or retinal scan).

UFTP Transportation Vehicle - Trailer (Customized Trailer), including:
- Marking and labeling.
- Hazardous Material Placards.
- On board real-time tracking system.
- Modified 48-foot flatbed trailer with integrated tie-down.
- Trailer equipped with hydraulic or air ride suspension to cushion the load.
- Trailer equipped with four axles.

- Weather cover.
- One frame for UFTP Transportation Packages.
- A set of specific equipment (GPS, turning lights, tool box)

Assumptions

- The Standard UFTP Transport Vehicle and Escort Vehicle will be used for UFTP (Transportation Packages) Mock-up
- The total cost of the UFTP Transport Vehicles with Escort Vehicle mock-up is not specific to Reactor Storage Facility
- UFTP Transport Vehicles with Escort Vehicle for mock-up is allocated to the licensing requirement for services and testing
- See 670.40.40.10 (Equipment for UFTP Transportation Logistics for Real Time Tracking) for acquisition of satellite phones and GPS systems.
- Pricing basis is commercial, off-the-shelf items verbally confirmed with vendors in the Toronto region by PDD, November 2009 to April 2010. Pricing is representative for most of Ontario and in current (2010) dollars, escalated to 2015 dollars.
- Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$419,840.00
Material Cost	$561,337.79
Other Cost	$0.00
Subtotal	*$981,177.79*
Allowance	$245,294.45
Total Cost	**$1,226,472.24**

Start Year	2039
Finish Year	2040
Duration	**2 years**
WBS Type	Step-Fixed

UFTP Transportation Vehicles for Whiteshell

670.40.10.20.10

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The procurement, test and commissioning of UFTP Transportation Vehicles for Whiteshell.

Deliverables

UFTP Transportation Vehicle - Escort Vehicle (customized security vehicle), including:
- Anti-theft electronic immobilizer system.
- On board real-time tracking system.
- On-board biometrics system (biometric fingerprint and/or retinal scan).
- Vehicle security enhancements (e.g., typical customization done to RCMP, Police and Homeland security vehicles).

UFTPC Transportation Vehicle - Tractor, including:
- Customized tractor similar to those used by US Department of Energy (DOE) "safeguards transporter".
- Electronic Speed Limiter for Ontario- Limits speed to 80km/hr.
- On board real-time tracking system.
- OnGuard Collision Safety System.
- Anti-theft electronic immobilizer system.
- Passenger-mounted LCD touch-screen PC.
- Sleeping berth to accommodate 2 persons.
- On-board biometrics system (biometric fingerprint and/or retinal scan).

UFTPTC Transportation Vehicle - Trailer (Customized Trailer), including:
- Marking and labeling.
- Hazardous Material Placards.
- On board real-time tracking system.
- Modified 48-foot flatbed trailer with integrated tie-down.
- Trailer equipped with hydraulic or air ride suspension to cushion the load.
- Trailer equipped with four axles.
- Weather cover.
- One frame for UFTP Transportation Package.
- A set of specific equipment (GPS, turning lights, tool box)

Assumptions

- UFTP Transport Vehicles with Escort Vehicles will be used to ship all Used Fuel from owner Reactor Storage Facilities ins Escort Vehicle design life is assumed to be 4 years. After initial purchase, units are replaced 7 times over 30 years from initial service date.
- UFTP Transportation Vehicle Tractor design life is assumed to be 7 years. After initial purchase, units are replaced 4 times over 30 years from initial service date.

- UFTP Transportation Vehicles Trailer design life is assumed to be 10 years. After initial purchase, units are replaced 2 times over the 30 years from initial service date.
- No allowance for remaining useful life/salvage at time of replacement or retirement.
- See 670.40.40.10 (Equipment for UFTP Transportation Logistics for Real Time Tracking) for acquisition of satellite phones and GPS systems.
- Pricing based on commercial off-the-shelf items verbally confirmed with vendors in the Toronto region by PDD, November 2009 to April 2010. Pricing representative for most of Ontario and in current (2010) dollars, escalated to 2015 dollars. UFTPs (Transportation Packages).
- Total Project Fleet costs calculated separately and allocated to work element based on share of total fuel bundle count. Derivation of fleet costs and relative allocations attached as .xls under "Multi Element Supporting Information"
- UFTP Transportation Vehicle
- Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$29,076.92
Other Cost	$0.00
Subtotal	*$29,076.92*
Allowance	$7,269.23
Total Cost	**$36,346.16**

Start Year	2042
Finish Year	2072
Duration	**31 years**
WBS Type	Step-Fixed

UFTP Transportation Vehicles for Bruce

670.40.10.30

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The procurement, test and commissioning of UFTP Transportation Vehicles for Bruce.

Deliverables

UFTP Transportation Vehicle - Escort Vehicle (customized security vehicle), including:
- Anti-theft electronic immobilizer system.
- On board real-time tracking system.
- On-board biometrics system (biometric fingerprint and/or retinal scan).
- Vehicle security enhancements (e.g., typical customization done to RCMP, Police and Homeland security vehicles).

UFTP Transportation Vehicle - Tractor, including:
- Customized tractor similar to those used by US Department of Energy (DOE) "safeguards transporter".
- Electronic Speed Limiter for Ontario- Limits speed to 80km/hr.
- On board real-time tracking system.
- OnGuard Collision Safety System.
- Anti-theft electronic immobilizer system.
- Passenger-mounted LCD touch-screen PC.
- Sleeping berth to accommodate 2 persons.
- On-board biometrics system (biometric fingerprint and/or retinal scan).

UFTP Transportation Vehicle - Trailer (Customized Trailer), including:
- Marking and labeling.
- Hazardous Material Placards.
- On board real-time tracking system.
- Modified 48-foot flatbed trailer with integrated tie-down.
- Trailer equipped with hydraulic or air ride suspension to cushion the load.
- Trailer equipped with four axles.
- Weather cover.
- One frame for UFTP Transportation Package.
- A set of specific equipment (GPS, turning lights, tool box)

Assumptions

- UFTP Transport Vehicles with Escort Vehicles will be used to ship all Used Fuel from owner Reactor Storage Facilities in UFTPs (Transportation Packages).
- Total Project Fleet costs calculated separately and allocated to work element based on share of total fuel bundle count. Derivation of fleet costs and relative allocations attached as .xls under "Multi Element Supporting Information"

- UFTP Transportation Vehicles Escort Vehicle design life is assumed to be 4 years. After initial purchase, units are replaced 7 times over 30 years from initial service date.
- UFTP Transportation Vehicle Tractor design life is assumed to be 7 years. After initial purchase, units are replaced 4 times over 30 years from initial service date.
- UFTP Transportation Vehicles Trailer design life is assumed to be 10 years. After initial purchase, units are replaced 2 times over the 30 years from initial service date.
- No allowance for remaining useful life/salvage at time of replacement or retirement.
- See 670.40.40.10 (Equipment for UFTP Transportation Logistics for Real Time Tracking) for acquisition of satellite phones and GPS systems.
- Pricing based on commercial off-the-shelf items verbally confirmed with vendors in the Toronto region by PDD, November 2009 to April 2010. Pricing representative for most of Ontario and in current (2010) dollars, escalated to 2015 dollars.
- Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$19,316,024.71
Other Cost	$0.00
Subtotal	*$19,316,024.71*
Allowance	$4,829,006.18
Total Cost	**$24,145,030.89**

Start Year	2042
Finish Year	2072
Duration	**31 years**
WBS Type	Step-Fixed

UFTP Transportation Vehicles for Pickering

670.40.10.40

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The procurement, test and commissioning of UFTP Transportation Vehicles for Pickering.

Deliverables

UFTP Transportation Vehicle - Escort Vehicle (customized security vehicle), including:
- Anti-theft electronic immobilizer system.
- On board real-time tracking system.
- On-board biometrics system (biometric fingerprint and/or retinal scan).
- Vehicle security enhancements (e.g., typical customization done to RCMP, Police and Homeland security vehicles).

UFTPC Transportation Vehicle - Tractor, including:
- Customized tractor similar to those used by US Department of Energy (DOE) "safeguards transporter".
- Electronic Speed Limiter for Ontario- Limits speed to 80km/hr.
- On board real-time tracking system.
- OnGuard Collision Safety System.
- Anti-theft electronic immobilizer system.
- Passenger-mounted LCD touch-screen PC.
- Sleeping berth to accommodate 2 persons.
- On-board biometrics system (biometric fingerprint and/or retinal scan).

UFTPTC Transportation Vehicle - Trailer (Customized Trailer), including:
- Marking and labeling.
- Hazardous Material Placards.
- On board real-time tracking system.
- Modified 48-foot flatbed trailer with integrated tie-down.
- Trailer equipped with hydraulic or air ride suspension to cushion the load.
- Trailer equipped with four axles.
- Weather cover.
- One frame for UFTP Transportation Package.
- A set of specific equipment (GPS, turning lights, tool box)

Assumptions

- UFTP Transport Vehicles with Escort Vehicles will be used to ship all Used Fuel from owner Reactor Storage Facilities in UFTPs (Transportation Packages).
- Total Project Fleet costs calculated separately and allocated to work element based on share of total fuel bundle count. Derivation of fleet costs and relative allocations attached as .xls under "Multi Element Supporting Information"

- UFTP Transportation Vehicles Escort Vehicle design life is assumed to be 4 years. After initial purchase, units are replaced 7 times over 30 years from initial service date.
- UFTP Transportation Vehicle Tractor design life is assumed to be 7 years. After initial purchase, units are replaced 4 times over 30 years from initial service date.
- UFTP Transportation Vehicles Trailer design life is assumed to be 10 years. After initial purchase units are replaced 2 times over the 30 years from initial service date.
- No allowance for remaining useful life/salvage at time of replacement or retirement.
- See 670.40.40.10 (Equipment for UFTP Transportation Logistics for Real Time Tracking) for acquisition of satellite phones and GPS systems.
- Pricing based on commercial off-the-shelf items verbally confirmed with vendors in the Toronto region by PDD, November 2009 to April 2010. Pricing representative for most of Ontario and in current (2010) dollars, escalated to 2015 dollars.
- Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$9,369,479.80
Other Cost	$0.00
Subtotal	*$9,369,479.80*
Allowance	$2,342,369.95
Total Cost	**$11,711,849.75**

Start Year	2042
Finish Year	2072
Duration	**31 years**
WBS Type	Step-Fixed

UFTP Transportation Vehicles for Darlington

670.40.10.50

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The procurement, test and commissioning of UFTP Transportation Vehicles for Darlington.

Deliverables

UFTP Transportation Vehicle - Escort Vehicle (customized security vehicle), including:
- Anti-theft electronic immobilizer system.
- On board real-time tracking system.
- On-board biometrics system (biometric fingerprint and/or retinal scan).
- Vehicle security enhancements (e.g., typical customization done to RCMP, Police and Homeland security vehicles).

UFTPC Transportation Vehicle - Tractor, including:
- Customized tractor similar to those used by US Department of Energy (DOE) "safeguards transporter".
- Electronic Speed Limiter for Ontario- Limits speed to 80km/hr.
- On board real-time tracking system.
- OnGuard Collision Safety System.
- Anti-theft electronic immobilizer system.
- Passenger-mounted LCD touch-screen PC.
- Sleeping berth to accommodate 2 persons.
- On-board biometrics system (biometric fingerprint and/or retinal scan).

UFTPTC Transportation Vehicle - Trailer (Customized Trailer), including:
- Marking and labeling.
- Hazardous Material Placards.
- On board real-time tracking system.
- Modified 48-foot flatbed trailer with integrated tie-down.
- Trailer equipped with hydraulic or air ride suspension to cushion the load.
- Trailer equipped with four axles.
- Weather cover.
- One frame for UFTP Transportation Package.
- A set of specific equipment (GPS, turning lights, tool box)

Assumptions

- UFTP Transport Vehicles with Escort Vehicles will be used to ship all Used Fuel from owner Reactor Storage Facilities in UFTPs (Transportation Packages).
- Total Project Fleet costs calculated separately and allocated to work element based on share of total fuel bundle count. Derivation of fleet costs and relative allocations attached as .xls under "Multi Element Supporting Information"

- UFTP Transportation Vehicles Escort Vehicle design life is assumed to be 4 years. After initial purchase, units are replaced 7 times over 30 years from initial service date.
- UFTP Transportation Vehicle Tractor design life is assumed to be 7 years. After initial purchase, units are replaced 4 times over 30 years from initial service date.
- UFTP Transportation Vehicles Trailer design life is assumed to be 10 years. After initial purchase units are replaced 2 times over the 30 years from initial service date.
- No allowance for remaining useful life/salvage at time of replacement or retirement.
- See 670.40.40.10 (Equipment for UFTP Transportation Logistics for Real Time Tracking) for acquisition of satellite phones and GPS systems.
- Pricing based on commercial off-the-shelf items verbally confirmed with vendors in the Toronto region by PDD, November 2009 to April 2010. Pricing representative for most of Ontario and in current (2010) dollars, escalated to 2015 dollars.
- Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$7,841,822.91
Other Cost	$0.00
Subtotal	*$7,841,822.91*
Allowance	$1,960,455.73
Total Cost	**$9,802,278.64**

Start Year	2042
Finish Year	2072
Duration	**31 years**
WBS Type	Step-Fixed

UFTP Transportation Vehicles for Point Lepreau

670.40.10.60

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The procurement, test and commissioning of UFTP Transportation Vehicles for Point Lepreau

Deliverables

UFTP Transportation Vehicle - Escort Vehicle (customized security vehicle), including:
- Anti-theft electronic immobilizer system.
- On board real-time tracking system.
- On-board biometrics system (biometric fingerprint and/or retinal scan).
- Vehicle security enhancements (e.g., typical customization done to RCMP, Police and Homeland security vehicles).

UFTPC Transportation Vehicle - Tractor, including:
- Customized tractor similar to those used by US Department of Energy (DOE) "safeguards transporter".
- Electronic Speed Limiter for Ontario- Limits speed to 80km/hr.
- On board real-time tracking system.
- OnGuard Collision Safety System.
- Anti-theft electronic immobilizer system.
- Passenger-mounted LCD touch-screen PC.
- Sleeping berth to accommodate 2 persons.
- On-board biometrics system (biometric fingerprint and/or retinal scan).

UFTPTC Transportation Vehicle - Trailer (Customized Trailer), including:
- Marking and labeling.
- Hazardous Material Placards.
- On board real-time tracking system.
- Modified 48-foot flatbed trailer with integrated tie-down.
- Trailer equipped with hydraulic or air ride suspension to cushion the load.
- Trailer equipped with four axles.
- Weather cover.
- One frame for UFTP Transportation Package.
- A set of specific equipment (GPS, turning lights, tool box).

Assumptions

- UFTP Transport Vehicles with Escort Vehicles will be used to ship all Used Fuel from owner Reactor Storage Facilities in UFTPs (Transportation Packages).
- Total Project Fleet costs calculated separately and allocated to work element based on share of total fuel bundle count. Derivation of fleet costs and relative allocations attached as .xls under "Multi Element Supporting Information"

- UFTP Transportation Vehicles Escort Vehicle design life is assumed to be 4 years. After initial purchase, units are replaced 7 times over 30 years from initial service date.
- UFTP Transportation Vehicle Tractor design life is assumed to be 7 years. After initial purchase, units are replaced 4 times over 30 years from initial service date.
- UFTP Transportation Vehicles Trailer design life is assumed to be 10 years. After initial purchase, units are replaced 2 times over the 30 years from initial service date.
- No allowance for remaining useful life/salvage at time of replacement or retirement.
- See 670.40.40.10 (Equipment for UFTP Transportation Logistics for Real Time Tracking) for acquisition of satellite phones and GPS systems.
- Pricing based on commercial off-the-shelf items verbally confirmed with vendors in the Toronto region by PDD, November 2009 to April 2010. Pricing representative for most of Ontario and in current (2010) dollars, escalated to 2015 dollars.
- Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$3,252,142.19
Other Cost	$0.00
Subtotal	*$3,252,142.19*
Allowance	$813,035.55
Total Cost	**$4,065,177.73**

Start Year	2042
Finish Year	2072
Duration	**31 years**
WBS Type	Step-Fixed

UFTP Transportation Vehicles for Chalk River

670.40.10.70

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The procurement, test and commissioning of UFTP Transportation Vehicles for Chalk River.

Deliverables

UFTP Transportation Vehicle - Escort Vehicle (customized security vehicle), including:
- Anti-theft electronic immobilizer system.
- On board real-time tracking system.
- On-board biometrics system (biometric fingerprint and/or retinal scan).
- Vehicle security enhancements (e.g., typical customization done to RCMP, Police and Homeland security vehicles).

UFTPC Transportation Vehicle - Tractor, including:
- Customized tractor similar to those used by US Department of Energy (DOE) "safeguards transporter".
- Electronic Speed Limiter for Ontario- Limits speed to 80km/hr.
- On board real-time tracking system.
- OnGuard Collision Safety System.
- Anti-theft electronic immobilizer system.
- Passenger-mounted LCD touch-screen PC.
- Sleeping berth to accommodate 2 persons.
- On-board biometrics system (biometric fingerprint and/or retinal scan).

UFTP Transportation Vehicle - Trailer (Customized Trailer), including:
- Marking and labeling.
- Hazardous Material Placards.
- On board real-time tracking system.
- Modified 48-foot flatbed trailer with integrated tie-down.
- Trailer equipped with hydraulic or air ride suspension to cushion the load.
- Trailer equipped with four axles.
- Weather cover.
- One frame for UFTP Transportation Package.
- A set of specific equipment (GPS, turning lights, tool box).

Assumptions

- UFTP Transport Vehicles with Escort Vehicles will be used to ship all Used Fuel from owner Reactor Storage Facilities in UFTPs (Transportation Packages).
- Total Project Fleet costs calculated separately and allocated to work element based on share of total fuel bundle count. Derivation of fleet costs and relative allocations attached as .xls under "Multi Element Supporting Information"

- UFTP Transportation Vehicles Escort Vehicle design life is assumed to be 4 years. After initial purchase, units are replaced 7 times over 30 years from initial service date.
- UFTP Transportation Vehicle Tractor design life is assumed to be 7 years. After initial purchase, units are replaced 4 times over 30 years from initial service date.
- UFTP Transportation Vehicles Trailer design life is assumed to be 10 years. After initial purchase, units are replaced 2 times over the 30 years from initial service date.
- No allowance for remaining useful life/salvage at time of replacement or retirement.
- See 670.40.40.10 (Equipment for UFTP Transportation Logistics for Real Time Tracking) for acquisition of satellite phones and GPS systems.
- Pricing based on commercial off-the-shelf items verbally confirmed with vendors in the Toronto region by PDD, November 2009 to April 2010. Pricing representative for most of Ontario and in current (2010) dollars, escalated to 2015 dollars, escalated to 2015 dollars.
- Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$62,627.22
Other Cost	$0.00
Subtotal	*$62,627.22*
Allowance	$15,656.81
Total Cost	**$78,284.03**

Start Year	2042
Finish Year	2072
Duration	**31 years**
WBS Type	Step-Fixed

UFTP Transportation Vehicles for Gentilly 1

670.40.10.80

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The procurement, test and commissioning of UFTP Transportation Vehicles for Gentilly 1.

Deliverables

UFTP Transportation Vehicle - Escort Vehicle (customized security vehicle), including:
- Anti-theft electronic immobilizer system.
- On board real-time tracking system.
- On-board biometrics system (biometric fingerprint and/or retinal scan).
- Vehicle security enhancements (e.g., typical customization done to RCMP, Police and Homeland security vehicles).

UFTPC Transportation Vehicle - Tractor, including:
- Customized tractor similar to those used by US Department of Energy (DOE) "safeguards transporter".
- Electronic Speed Limiter for Ontario- Limits speed to 80km/hr.
- On board real-time tracking system.
- OnGuard Collision Safety System.
- Anti-theft electronic immobilizer system.
- Passenger-mounted LCD touch-screen PC.
- Sleeping berth to accommodate 2 persons.
- On-board biometrics system (biometric fingerprint and/or retinal scan).

UFTPTC Transportation Vehicle - Trailer (Customized Trailer), including:
- Marking and labeling.
- Hazardous Material Placards.
- On board real-time tracking system.
- Modified 48-foot flatbed trailer with integrated tie-down.
- Trailer equipped with hydraulic or air ride suspension to cushion the load.
- Trailer equipped with four axles.
- Weather cover.
- One frame for UFTP Transportation Packages.
- A set of specific equipment (GPS, turning lights, tool box).

Assumptions

- UFTP Transport Vehicles with Escort Vehicles will be used to ship all Used Fuel from owner Reactor Storage Facilities in UFTPs (Transportation Packages).
- Total Project Fleet costs calculated separately and allocated to work element based on share of total fuel bundle count. Derivation of fleet costs and relative allocations attached as .xls under "Multi Element Supporting Information"

- UFTP Transportation Vehicles Escort Vehicle design life is assumed to be 4 years. After initial purchase, units are replaced 7 times over 30 years from initial service date.
- UFTP Transportation Vehicle Tractor design life is assumed to be 7 years. After initial purchase, units are replaced 4 times over 30 years from initial service date.
- UFTP Transportation Vehicles Trailer design life is assumed to be 10 years. After initial purchase, units are replaced 2 times over the 30 years from initial service date.
- No allowance for remaining useful life/salvage at time of replacement or retirement.
- See 670.40.40.10 (Equipment for UFTP Transportation Logistics for Real Time Tracking) for acquisition of satellite phones and GPS systems.
- Pricing based on commercial off-the-shelf items verbally confirmed with vendors in the Toronto region by PDD, November 2009 to April 2010. Pricing representative for most of Ontario and in current (2010) dollars, escalated to 2015 dollars.
- Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$40,260.36
Other Cost	$0.00
Subtotal	*$40,260.36*
Allowance	$10,065.09
Total Cost	**$50,325.45**

Start Year	2042
Finish Year	2072
Duration	**31 years**
WBS Type	Step-Fixed

UFTP Transportation Vehicles for Gentilly 2

670.40.10.90

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The design, procurement, test and commissioning of UFTP Transportation Vehicles for Gentilly 2

Deliverables

UFTP Transportation Vehicle - Escort Vehicle (customized security vehicle), including:
- Anti-theft electronic immobilizer system.
- On board real-time tracking system.
- On-board biometrics system (biometric fingerprint and/or retinal scan).
- Vehicle security enhancements (e.g., typical customization done to RCMP, Police and Homeland security vehicles).

UFTPC Transportation Vehicle - Tractor, including:
- Customized tractor similar to those used by US Department of Energy (DOE) "safeguards transporter".
- Electronic Speed Limiter for Ontario- Limits speed to 80km/hr.
- On board real-time tracking system.
- OnGuard Collision Safety System.
- Anti-theft electronic immobilizer system.
- Passenger-mounted LCD touch-screen PC.
- Sleeping berth to accommodate 2 persons.
- On-board biometrics system (biometric fingerprint and/or retinal scan).

UFTPTC Transportation Vehicle - Trailer (Customized Trailer), including:
- Marking and labeling.
- Hazardous Material Placards.
- On board real-time tracking system.
- Modified 48-foot flatbed trailer with integrated tie-down.
- Trailer equipped with hydraulic or air ride suspension to cushion the load.
- Trailer equipped with four axles.
- Weather cover.
- One frame for UFTP Transportation Package.
- A set of specific equipment (GPS, turning lights, tool box).

Assumptions

- UFTP Transport Vehicles with Escort Vehicle will be used to ship all Used Fuel from owner Reactor Storage Facilities in UFTP Transportation Packages.
- Total Project Fleet costs calculated separately and allocated to work element based on share of total fuel bundle count. Derivation of fleet costs and relative allocations attached as .xls under "Multi Element Supporting Information".

- UFTP Transportation Vehicles Escort Vehicle design life is assumed to be 4 years. After initial purchase, units are replaced 7 times over 30 years from initial service date.
- UFTP Transportation Vehicle Tractor design life is assumed to be 7 years. After initial purchase, units are replaced 4 times over 30 years from initial service date.
- UFTP Transportation Vehicles Trailer design life is assumed to be 10 years. After initial purchase units are replaced 3 times over the 30 years from initial service date.
- No allowance for remaining useful life/salvage at time of replacement or retirement.
- See also 670.40.10
- Pricing based on commercial off-the-shelf items verbally confirmed with vendors in the Toronto region by PDD, November 2009 to April 2010. Pricing representative for most of Ontario and in current (2010) dollars, escalated to 2015 dollars.
- Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$1,536,603.63
Other Cost	$0.00
Subtotal	*$1,536,603.63*
Allowance	$384,150.91
Total Cost	**$1,920,754.54**

Start Year	2042
Finish Year	2072
Duration	**31 years**
WBS Type	Step-Fixed

UFTP Transportation Vehicles for Douglas Point

670.40.10.100

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The procurement, test and commissioning of UFTP Transportation Vehicles for Douglas Point.

Deliverables

UFTP Transportation Vehicle - Escort Vehicle (customized security vehicle), including:
- Anti-theft electronic immobilizer system.
- On board real-time tracking system.
- On-board biometrics system (biometric fingerprint and/or retinal scan).
- Vehicle security enhancements (e.g., typical customization done to RCMP, Police and Homeland security vehicles).

UFTPC Transportation Vehicle - Tractor, including:
- Customized tractor similar to those used by US Department of Energy (DOE) "safeguards transporter".
- Electronic Speed Limiter for Ontario- Limits speed to 80km/hr.
- On board real-time tracking system.
- OnGuard Collision Safety System.
- Anti-theft electronic immobilizer system.
- Passenger-mounted LCD touch-screen PC.
- Sleeping berth to accommodate 2 persons.
- On-board biometrics system (biometric fingerprint and/or retinal scan).

UFTPTC Transportation Vehicle - Trailer (Customized Trailer), including:
- Marking and labeling.
- Hazardous Material Placards.
- On board real-time tracking system.
- Modified 48-foot flatbed trailer with integrated tie-down.
- Trailer equipped with hydraulic or air ride suspension to cushion the load.
- Trailer equipped with four axles.
- Weather cover.
- One frame for UFTP Transportation Package.
- A set of specific equipment (GPS, turning lights, tool box).

Assumptions

- UFTP Transport Vehicles with Escort Vehicles will be used to ship all Used Fuel from owner Reactor Storage Facilities in UFTPs (Transportation Packages).
- Total Project Fleet costs calculated separately and allocated to work element based on share of total fuel bundle count. Derivation of fleet costs and relative allocations attached as .xls under "Multi Element Supporting Information"

- UFTP Transportation Vehicles Escort Vehicle design life is assumed to be 4 years. After initial purchase, units are replaced 7 times over 30 years from initial service date.
- UFTP Transportation Vehicle Tractor design life is assumed to be 7 years. After initial purchase, units are replaced 4 times over 30 years from initial service date.
- UFTP Transportation Vehicles Trailer design life is assumed to be 10 years. After initial purchase, units are replaced 2 times over the 30 years from initial service date.
- No allowance for remaining useful life/salvage at time of replacement or retirement.
- See 670.40.40.10 (Equipment for UFTP Transportation Logistics for Real Time Tracking) for acquisition of satellite phones and GPS systems.
- Pricing based on commercial off-the-shelf items verbally confirmed with vendors in the Toronto region by PDD, November 2009 to April 2010. Pricing representative for most of Ontario and in current (2010) dollars, escalated to 2015 dollars.
- Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$277,349.13
Other Cost	$0.00
Subtotal	*$277,349.13*
Allowance	$69,337.28
Total Cost	**$346,686.41**

Start Year	2042
Finish Year	2072
Duration	**31 years**
WBS Type	Step-Fixed

UFTP Transportation Packages non-Site-Specific

670.40.20.10

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The design, procurement, test and commissioning of Used Fuel Transportation Package (UFTP) system Transportation Package and Impact Limiter for mock-up.

Deliverables

- Completed system design basis documentation.
- An approved Design Package Approval Certificate issued by the Competent Authority as per Program Management (670.90).
- A licensed UFTP system and the approved commissioning plans.

UFTP Transportation Packages and Impact Limiter, including:
- Marking and labeling
- Real-time tracking system
- Design features for repeat usage
- Design features for mounting on UFTP Transport Vehicle Trailer Frame

Assumptions

- One UFTP Transportation Package and Impact Limiter will be used for mock-up/demonstration
- UFTP Transportation Package and Impact Limiter design life is assumed to be 30 years from initial service date
- The total cost of the Transportation Package and Impact Limiter mock-up is not specific to Reactor Storage Facility
- Transportation Package and Impact Limiter mock-up is allocated to the licensing requirement for services and testing
- See 670.40.40.10 (Equipment for UFTP Transportation Logistics for Real Time Tracking) for acquisition of satellite phones and GPS systems.
- See 670.40.40.20 (Equipment for UFTP Transportation Logistics for Emergency Response) for acquisition of emergency response equipment, including spare set of transportation equipment.
- Pricing based on costs for specialty items identified by Cogema (2003) adjusted for new requirements, location and current dollars by PDD using professional judgement.
- Also subject to overall UFTS assumptions.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$314,880.00
Material Cost	$2,302,785.35
Other Cost	$0.00
Subtotal	*$2,617,665.35*
Allowance	$654,416.34
Total Cost	**$3,272,081.69**

Start Year	2039
Finish Year	2039
Duration	**1 years**
WBS Type	Step-Fixed

UFTP Transportation Packages for Whiteshell

670.40.20.20

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The procurement, test and commissioning of UFTP Transportation Packages and Impact Limiters for Whiteshell.

Deliverables

UFTP Transportation Packages and Impact Limiter, including:
- Marking and labeling
- Real-time tracking system
- Design features for repeat usage
- Design features for mounting on UFTP Transport Vehicle Trailer Frame

Assumptions

- The UFTP Transportation Package and Impact Limiter will be used to ship all Used Fuel in Modules from owner Reactor Storage Facilities
- UFTP Transportation Package and Impact Limiter design life is assumed to be approximately 30 years (no replacement during shipping period).
- See 670.40.40.10 (Equipment for UFTP Transportation Logistics for Real Time Tracking) for acquisition of satellite phones and GPS systems.
- See 670.40.40.20 (Equipment for UFTP Transportation Logistics for Emergency Response) for acquisition of emergency response equipment, including spare set of transportation equipment.
- Pricing for specialty items identified by Cogema (2003) adjusted for new requirements, location and current dollars by PDD using professional judgement.
- Total Project fleet costs calculated separately and allocated to work element based on share of total fuel bundle count. - Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00	Start Year	2041

Material Cost	$27,185.99
Other Cost	$0.00
Subtotal	*$27,185.99*
Allowance	$6,796.50
Total Cost	**$33,982.49**

Finish Year	2041
Duration	**1 years**
WBS Type	Step-Fixed

UFTP Transportation Packages for Bruce

670.40.20.30

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The procurement, test and commissioning of UFTP Transportation Packages and Impact Limiters for Bruce.

Deliverables

UFTP Transportation Packages and Impact Limiter, including:
- Marking and labeling
- Real-time tracking system
- Design features for repeat usage
- Design features for mounting on UFTP Transport Vehicle Trailer Frame

Assumptions

- The UFTP Transportation Package and Impact Limiter will be used to ship all Used Fuel in Modules from owner Reactor Storage Facilities
- UFTP Transportation Package and Impact Limiter design life is assumed to be approximately 30 years (no replacement during shipping period).
- See 670.40.40.10 (Equipment for UFTP Transportation Logistics for Real Time Tracking) for acquisition of satellite phones and GPS systems.
- See 670.40.40.20 (Equipment for UFTP Transportation Logistics for Emergency Response) for acquisition of emergency response equipment, including spare set of transportation equipment.
- Pricing for specialty items identified by Cogema (2003) adjusted for new requirements, location and current dollars by PDD using professional judgement.
- Total Project fleet costs calculated separately and allocated to work element based on share of total fuel bundle count. - Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00	Start Year	2041

Material Cost	$18,059,861.04
Other Cost	$0.00
Subtotal	*$18,059,861.04*
Allowance	$4,514,965.26
Total Cost	**$22,574,826.30**

Finish Year	2041
Duration	**1 years**
WBS Type	Step-Fixed

UFTP Transportation Packages for Pickering

670.40.20.40

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The procurement, test and commissioning of UFTP Transportation Packages and Impact Limiters for Pickering.

Deliverables

UFTP Transportation Packages and Impact Limiter, including:
- Marking and labeling
- Real-time tracking system
- Design features for repeat usage
- Design features for mounting on UFTP Transport Vehicle Trailer Frame

Assumptions

- The UFTP Transportation Package and Impact Limiter will be used to ship all Used Fuel in Modules from owner Reactor Storage Facilities
- UFTP Transportation Package and Impact Limiter design life is assumed to be approximately 30 years (no replacement during shipping period).
- See 670.40.40.10 (Equipment for UFTP Transportation Logistics for Real Time Tracking) for acquisition of satellite phones and GPS systems.
- See 670.40.40.20 (Equipment for UFTP Transportation Logistics for Emergency Response) for acquisition of emergency response equipment, including spare set of transportation equipment.
- Pricing for specialty items identified by Cogema (2003) adjusted for new requirements, location and current dollars by PDD using professional judgement.
- Total Project fleet costs calculated separately and allocated to work element based on share of total fuel bundle count. - Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00	Start Year	2041

Material Cost	$8,760,161.87
Other Cost	$0.00
Subtotal	*$8,760,161.87*
Allowance	$2,190,040.47
Total Cost	**$10,950,202.34**

Finish Year	2041
Duration	**1 years**
WBS Type	Step-Fixed

UFTP Transportation Packages for Darlington

670.40.20.50

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The procurement, test and commissioning of UFTP Transportation Packages and Impact Limiters for Darlington.

Deliverables

UFTP Transportation Packages and Impact Limiter, including:
- Marking and labeling
- Real-time tracking system
- Design features for repeat usage
- Design features for mounting on UFTP Transport Vehicle Trailer Frame

Assumptions

- The UFTP Transportation Packages and Impact Limiter will be used to ship all Used Fuel in Modules from owner Reactor Storage Facilities Transportation Package and Impact Limiter design life is assumed to be approximately 30 years (no replacement during shipping period).
- See 670.40.40.10 (Equipment for UFTP Transportation Logistics for Real Time Tracking) for acquisition of satellite phones and GPS systems.
- See 670.40.40.20 (Equipment for UFTP Transportation Logistics for Emergency Response) for acquisition of emergency response equipment, including spare set of transportation equipment.
- Pricing for specialty items identified by Cogema (2003) adjusted for new requirements, location and current dollars by PDD using professional judgement.
- Total Project fleet costs calculated separately and allocated to work element based on share of total fuel bundle count. - Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00	Start Year	2041

Material Cost	$7,331,851.88
Other Cost	$0.00
Subtotal	*$7,331,851.88*
Allowance	$1,832,962.97
Total Cost	**$9,164,814.85**

Finish Year	2041
Duration	**1 years**
WBS Type	Step-Fixed

UFTP Transportation Packages for Point Lepreau

670.40.20.60

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The procurement, test and commissioning of UFTP Transportation Packages and Impact Limiters for Point Lepreau.

Deliverables

UFTP Transportation Packages and Impact Limiter, including:
- Marking and labeling
- Real-time tracking system
- Design features for repeat usage
- Design features for mounting on UFTP Transport Vehicle Trailer Frame

Assumptions

- The UFTP Transportation Packages and Impact Limiter will be used to ship all Used Fuel in Modules from owner Reactor Storage Facilities Transportation Package Cask and Impact Limiter design life is assumed to be approximately 30 years (no replacement during shipping period).
- See 670.40.40.10 (Equipment for UFTP Transportation Logistics for Real Time Tracking) for acquisition of satellite phones and GPS systems.
- See 670.40.40.20 (Equipment for UFTP Transportation Logistics for Emergency Response) for acquisition of emergency response equipment, including spare set of transportation equipment.
- Pricing for specialty items identified by Cogema (2003) adjusted for new requirements, location and current dollars by PDD using professional judgement.
- Total Project fleet costs calculated separately and allocated to work element based on share of total fuel bundle count. - Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00	Start Year	2041

Material Cost	$3,040,648.21
Other Cost	$0.00
Subtotal	*$3,040,648.21*
Allowance	$760,162.05
Total Cost	**$3,800,810.26**

Finish Year	2041
Duration	**1 years**
WBS Type	Step-Fixed

UFTP Transportation Packages for Chalk River

670.40.20.70

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The design, procurement, test and commissioning of UFTP Transportation Packages and Impact Limiters for Chalk River.

Deliverables

UFTP Transportation Packages and Impact Limiter, including:
- Marking and labeling
- Real-time tracking system
- Design features for repeat usage
- Design features for mounting on UFTP Transport Vehicle Trailer Frame

Assumptions

- The UFTP Transportation Packages and Impact Limiter will be used to ship all Used Fuel in Modules from owner Reactor Storage Facilities Transportation Package and Impact Limiter design life is assumed to be approximately 30 years (no replacement during shipping period).
- See 670.40.40.10 (Equipment for UFTP Transportation Logistics for Real Time Tracking) for acquisition of satellite phones and GPS systems.
- See 670.40.40.20 (Equipment for UFTP Transportation Logistics for Emergency Response) for acquisition of emergency response equipment, including spare set of transportation equipment.
- Pricing for specialty items identified by Cogema (2003) adjusted for new requirements, location and current dollars by PDD using professional judgement.
- Total Project fleet costs calculated separately and allocated to work element based on share of total fuel bundle count. - Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00	Start Year	2041

Material Cost	$58,554.44
Other Cost	$0.00
Subtotal	*$58,554.44*
Allowance	$14,638.61
Total Cost	**$73,193.05**

Finish Year	2041
Duration	**1 years**
WBS Type	Step-Fixed

UFTP Transportation Packages for Gentilly 1

670.40.20.80

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The procurement, test and commissioning of the UFTP Transportation Packages and Impact Limiter for Gentilly 1.

Deliverables

UFTP Transportation Packages and Impact Limiter, including:
- Marking and labeling
- Real-time tracking system
- Design features for repeat usage
- Design features for mounting on UFTP Transport Vehicle Trailer Frame

Assumptions

- The UFTP Transportation Packages and Impact Limiter will be used to ship all Used Fuel in Modules from owner Reactor Storage Facilities Transportation Package and Impact Limiter design life is assumed to be approximately 30 years (no replacement during shipping period).
- See 670.40.40.10 (Equipment for UFTP Transportation Logistics for Real Time Tracking) for acquisition of satellite phones and GPS systems.
- See 670.40.40.20 (Equipment for UFTP Transportation Logistics for Emergency Response) for acquisition of emergency response equipment, including spare set of transportation equipment.
- Pricing for specialty items identified by Cogema (2003) adjusted for new requirements, location and current dollars by PDD using professional judgement.
- Total Project fleet costs calculated separately and allocated to work element based on share of total fuel bundle count. - Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00	Start Year	2041

Material Cost	$37,642.14
Other Cost	$0.00
Subtotal	*$37,642.14*
Allowance	$9,410.53
Total Cost	**$47,052.67**

Finish Year	2041
Duration	**1 years**
WBS Type	Step-Fixed

UFTP Transportation Packages for Gentilly 2

670.40.20.90

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The design, procurement, test and commissioning of UFTP Transportation Packages and Impact Limiters for Gentilly 2.

Deliverables

UFTP Transportation Packages and Impact Limiter, including:
- Marking and labeling
- Real-time tracking system
- Design features for repeat usage
- Design features for mounting on UFTP Transport Vehicle Trailer Frame

Assumptions

- The UFTP Transportation Packages and Impact Limiter will be used to ship all Used Fuel in Modules from owner Reactor Storage Facilities Transportation Package and Impact Limiter design life is assumed to be approximately 30 years (no replacement during shipping period).
- See 670.40.40.10 (Equipment for UFTP Transportation Logistics for Real Time Tracking) for acquisition of satellite phones and GPS systems.
- See 670.40.40.20 (Equipment for UFTP Transportation Logistics for Emergency Response) for acquisition of emergency response equipment, including spare set of transportation equipment.
- Pricing for specialty items identified by Cogema (2003) adjusted for new requirements, location and current dollars by PDD using professional judgement.
- Total Project fleet costs calculated separately and allocated to work element based on share of total fuel bundle count. - Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00	Start Year	2041

Material Cost	$1,436,674.91
Other Cost	$0.00
Subtotal	*$1,436,674.91*
Allowance	$359,168.73
Total Cost	**$1,795,843.64**

Finish Year	2041
Duration	**1 years**
WBS Type	Step-Fixed

UFTP Transportation Packages for Douglas Point

670.40.20.100

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The procurement, test and commissioning of UFTP Transportation Packages and Impact Limiters for Douglas Point.

Deliverables

UFTP Transportation Packages and Impact Limiter, including:
- Marking and labeling
- Real-time tracking system
- Design features for repeat usage
- Design features for mounting on UFTP Transport Vehicle Trailer Frame

Assumptions

- The UFTP Transportation Package and Impact Limiter will be used to ship all Used Fuel in Modules from owner Reactor Storage Facilities
- UFTP Transportation Package and Impact Limiter design life is assumed to be approximately 30 years (no replacement during shipping period).
- See 670.40.40.10 (Equipment for UFTP Transportation Logistics for Real Time Tracking) for acquisition of satellite phones and GPS systems.
- See 670.40.40.20 (Equipment for UFTP Transportation Logistics for Emergency Response) for acquisition of emergency response equipment, including spare set of transportation equipment.
- Pricing for specialty items identified by Cogema (2003) adjusted for new requirements, location and current dollars by PDD using professional judgement.
- Total Project fleet costs calculated separately and allocated to work element based on share of total fuel bundle count. - Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00	Start Year	2041

Material Cost	$259,312.50
Other Cost	$0.00
Subtotal	*$259,312.50*
Allowance	$64,828.13
Total Cost	**$324,140.63**

Finish Year	2041
Duration	**1 years**
WBS Type	Step-Fixed

Equipment for UFTP Transportation Logistics for Real Time Tracking

670.40.40.10

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The development, procurement, testing and commissioning of Real Time Tracking System equipment and procedures, including:
- Development of specifications for Real Time Tracking System
- Preparation of tendering documentation and issue of Requests for Proposals (RFPs)
- Selection of design/build contractors
- Placing of orders/letting of contracts
- Review of design/build contractor engineering documentation & engineering drawings
- Supervision/inspection of equipment installation
- Preparation, supervision and performance of tests and commissioning

Deliverables

- Complete system design for the Real Time Tracking System
- Communication center located at the DGR and fully equipped with communication means (Vehicle Tracking System, Telephones, Teleconference System, etc.)
- Central GPS Tracking System at DGR, including tracking system software customization for central system and vehicle mounted systems, surge protection, un-interruptible power supply (UPS) emergency power backup and GPS Monthly System Access Fees

- Real Time Tracking Equipment in the Vehicle and UFTP Fleet:

UFTP Transport Vehicle Tractors:
- Satellite phone: Cab
- GPS no.1 : main unit available to driver and passenger
- GPS no.2: hidden back-up on tractor

UFTP Transport Vehicle Trailers:
- GPS no.3: On trailer
- GPS no.4: hidden back-up on trailer

UFTP Transportation Packages:
- GPS no. 5: on Transportation Package
- GPS no.6: hidden back-up on Transportation Package

Escort Vehicle:

- Satellite phone: Cab
- GPS no.7 : Escort vehicle
- GPS no.8 : Escort vehicle backup

Assumptions

- Communication center for Real Time Tracking will be combined with Crisis Centre for Emergency Response (see 670.40.40.20, Equipment for UFTP Transportation Logistics for Emergency Response) to form one Communication and Crisis Centre at DGR fully equipped with communication equipment and emergency response equipment.
- Design is conceptual: minor and incidental costs up to and including aspects such as a physical space for the central system at the DGR are included in "Allowance".
- Weather conditions on roads used for travel to and from the DGR will be monitored 12 hours ahead of planned shipments.
- Includes GPS system access fee for 32 years (years 32 to 63)
- Pricing for commercial off-the-shelf items verbally confirmed with vendors in the Toronto region by PDD, November 2009 to April 2010. Pricing representative for most of Ontario and in current (2010) dollars, escalated to 2015 dollars.
- Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$209,920.00
Material Cost	$2,091,362.56
Other Cost	$1,984,484.85
Subtotal	*$4,285,767.42*
Allowance	$1,071,441.85
Total Cost	**$5,357,209.27**

Start Year	2041
Finish Year	2072
Duration	**32 years**
WBS Type	Fixed

Equipment for UFTP Transportation Logistics for Emergency Response

670.40.40.20

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The development, procurement, testing and commissioning of the Emergency Response System, including:
- Development of specifications for the Emergency Response System
- Preparation of tendering documentation and issue of Requests for Proposals (RFPs)
- Selection of design/build contractors
- Placing of orders/letting of contracts
- Review of design/build contractor engineering documentation & engineering drawings
- Supervision/inspection of equipment installation
- Preparation, supervision and performance of tests and commissioning

Deliverables

- Complete system design for the Emergency Response System
- Emergency means designed to protect and/ or recover one element of the transportation system in the event of incident or accident.
- Crisis center located at the DGR and fully equipped with communication means (interface with Vehicle Tracking System, telephones, teleconference system, etc.)

Emergency Response Equipment Located at DGR:
- 100 ton portable crane, max. speed 85km/hr
- UFTP Transport Vehicle Tractor (not counted as part of operating fleet)
-UFTPC Transport Vehicle Trailer (weather cover, frame, turning light, etc) (not counted as part of operating fleet)
- Impact Limiters (not counted as part of operating fleet)
- Escort Vehicle (not counted as part of operating fleet)
- Lifting Beam for UFTP Transportation Packages
- Lifting Beam for Impact limiter of the UFTP
- Misc. Equipment

Emergency Response Equipment Located at Bruce:
- Lifting Beam for UFTP Transportation Package
- Lifting Beam for Impact limiter of the UFTP
- Misc. Equipment

Emergency Response Equipment Located at Darlington:

- Lifting Beam for UFTP Transportation Package
- Lifting Beam for Impact limiter of the UFTP
- Misc. Equipment

Emergency Response Equipment Located at Gentilly:
- Lifting Beam for UFTP Transportation Package
- Lifting Beam for Impact limiter of UFTP
- Misc. Equipment

Assumptions

- Crisis Centre for Emergency Response will be combined with Communication Centre for Real Time Tracking (see 670.40.40.20, Equipment for UFTP Transportation Logistics for Emergency Response) to form one Communication and Crisis Centre at DGR, fully equipped with communication equipment and emergency response equipment.
- Three sites (Bruce, Darlington and Gentilly) have been chosen along the transportation route to house extra handling equipment. This equipment can be used with an available UFTP Transport Vehicle and Escort and with local contracted portable crane if deemed necessary.
- Working areas at Bruce, Darlington and Gentilly are assumed to be provided by Owners at no cost to Project.
- Design is conceptual: minor and incidental costs up to and including aspects such as housing/designation of the central system at the DGR and related staging areas at Bruce, Darlington and Gentilly are included in "Allowance".
- Pricing for commercial off-the-shelf items verbally confirmed with vendors in the Toronto region by PDD, November 2009 to April 2010. Pricing representative for most of Ontario and in current (2010) dollars, escalated to 2015 dollars.
- Pricing for custom equipment based on recent (2000 to 2010) PDD project data, adjusted by PDD for unique requirements, location and current dollars using professional judgement.
- Pricing for specialty items identified by Cogema (2003) adjusted for new requirements, location and current dollars by PDD using professional judgement.
- Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$419,840.00
Material Cost	$2,293,032.38
Other Cost	$0.00
Subtotal	*$2,712,872.38*
Allowance	$678,218.09
Total Cost	**$3,391,090.47**

Start Year	2041
Finish Year	2042
Duration	**2 years**
WBS Type	Fixed

PROJECT MANAGEMENT

670.50.10

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

Management of UFTS components and reporting on the project’s progress to Program Management, including:
- Preparation of project management documentation.
- Interfacing with engineering, procurement, operations and contractors to ensure that milestones are obtained as planned.
- Project Close Out

Deliverables

Management of UFTS components and reporting on the project’s progress to Program Management, including:
- Project management documentation (Project Charters, Project Execution Plans, Business Case Summaries, Release Quality Estimates, Scope Sheets, Change Control Forms and Schedules),
- Approved project schedules and information on the project costs throughout its duration.
- Regular Project Meetings to discuss schedule, project status, issues, and cash flows.
- Reporting to Program Management on the project’s progress.

Assumptions

- Project management is carried out by a core team including a project manager, a scheduler/cost controller, and a contract administrator. Additional roles include co-ordinators for current storage types (DSC, Wet Bay, silo/CANSTOR), administrative assistant(s), quality assurance/control staff and legal assistance.
- See labour costs for detailed hours/FTEs
- Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

15% covers Allowance of 25% added to reflect the level of design and uncertainties.and incidentals

Labour Cost	$15,258,071.71	Start Year	2033

Material Cost	$0.00
Other Cost	$0.00
Subtotal	*$15,258,071.71*
Allowance	$3,814,517.93
Total Cost	**$19,072,589.64**

Finish Year	2033
Duration	**1 years**
WBS Type	Fixed

UFTP Transportation Logistics from Whiteshell to DGR

670.50.30.10

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The operation of the Transportation System from Whiteshell to DGR, including:
- Transportation to DGR
- Return empty UFTP Transportation Packages Assembly and UFTP Transportation Vehicles to owner Reactor Storage Facility

Deliverables

- UFTP/M delivered at DGR Used Fuel Packing Plant (UFPP)
- Empty UFTP assembly delivered at reactor site

The complete operation includes:

Tractor-Trailer and Escort Vehicle Operation from the DGR to the reactor site and back

Preparation of UFTP Transport Vehicle
- Identify Empty UFTP Transport Vehicle
- Conduct Pre-Loading Inspection of Empty UFTP Transport Vehicle
- Position UFTP Transport Vehicle

Transfer of UFTP/M ("UFTP/M" denotes UFTP loaded with modules) Transportation Packages onto UFTP Transport Vehicle
-Observe post-loading inspection
-Conduct pre-departure inspection of loaded UFTP transport vehicle

Assumptions

- Distance from Whiteshell to DGR site: 1,000 km
- Number of shipments = 13
- Approx. 89 hrs effort per shipment for driving cycle (4 person crew)
- Costs based on average shipment effort. Slight variation in individual shipment effort due to, e.g., pre-loaded trailer swaps.
- Includes fuel and insurance.
- Does not include fleet maintenance - See 670.50.50 (UFTP Transportation Vehicles Maintenance)
- Does not include operation of Emergency Response System - See 670.50.40.10 (UFTP Transportation System Logistics DGR Emergency Response)
- Does not include operation of Real-Time Tracking System - See 670.50.40.20 (UFTP Transportation System Logistics DGR Real Time Tracking)

- Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$109,718.31
Material Cost	$0.00
Other Cost	$20,183.05
Subtotal	*$129,901.36*
Allowance	$32,475.34
Total Cost	**$162,376.70**

Start Year	2068
Finish Year	2068
Duration	**1 years**
WBS Type	Variable

UFTP Transportation Logistics from Bruce to DGR

670.50.30.20

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The operation of the Transportation System from Bruce to DGR, including:
- Transportation to DGR
- Return empty UFTP Transportation Packages Assembly and UFTP Transportation Vehicles to owner Reactor Storage Facility

Deliverables

- UFTP/M delivered at DGR Used Fuel Packing Plant (UFPP)
- Empty UFTP assembly delivered at reactor site

The complete operation includes:

Tractor-Trailer and Escort Vehicle Operation from the DGR to the reactor site and back

Preparation of UFTP Transport Vehicle
- Identify Empty UFTP Transport Vehicle
- Conduct Pre-Loading Inspection of Empty UFTP Transport Vehicle
- Position UFTP Transport Vehicle

Transfer of UFTP/M ("UFTP/M" denotes UFTP loaded with modules) Transportation Packages onto UFTP Transport Vehicle
- Observe Post-Loading Inspection
- Conduct pre-departure inspection of loaded UFTP transport vehicle

Assumptions

- Distance from Bruce A/B to DGR site: 1,000 km
- Number of shipments = 8,636
- Approx. 89 hrs effort per shipment for driving cycle (4 person crew)
- Costs based on average shipment effort. Slight variation in individual shipment effort due to, e.g., pre-loaded trailer swaps.
- Includes fuel and insurance.
- Does not include fleet maintenance - See 670.50.50 (UFTP Transportation Vehicles Maintenance)
- Does not include operation of Emergency Response System - See 670.50.40.10 (UFTP Transportation System Logistics DGR Emergency Response)
- Does not include operation of Real-Time Tracking System - See 670.50.40.20 (UFTP Transportation System Logistics DGR Real Time Tracking)

- Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$72,886,717.32
Material Cost	$0.00
Other Cost	$13,407,757.89
Subtotal	*$86,294,475.21*
Allowance	$21,573,618.80
Total Cost	**$107,868,094.02**

Start Year	2043
Finish Year	2072
Duration	**30 years**
WBS Type	Variable

UFTP Transportation Logistics from Pickering to DGR

670.50.30.30

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The operation of the Transportation System from Pickering to DGR, including:
- Transportation to DGR
- Return empty UFTP Transportation Packages Assembly and UFTP Transportation Vehicles to owner Reactor Storage Facility

Deliverables

- UFTP/M delivered at DGR Used Fuel Packing Plant (UFPP)
- Empty UFTP assembly delivered at reactor site

The complete operation includes:

Tractor-Trailer and Escort Vehicle Operation from the DGR to the reactor site and back

Preparation of UFTP Transport Vehicle
- Identify Empty UFTP Transport Vehicle
- Conduct Pre-Loading Inspection of Empty UFTP Transport Vehicle
- Position UFTP Transport Vehicle

Transfer of UFTP/M ("UFTP/M" denotes UFTP loaded with modules) Transportation Packages onto UFTP Transport Vehicle
- Observe Post-Loading Inspection
- Conduct pre-departure inspection of loaded UFTP transport vehicle

Assumptions

- Distance from Pickering A/B to DGR site: 1,000 km
- Number of shipments = 4,189
- Approx. 89 hrs effort per shipment for driving cycle (4 person crew)
- Costs based on average shipment effort. Slight variation in individual shipment effort due to, e.g., pre-loaded trailer swaps.
- Includes fuel and insurance.
- Does not include fleet maintenance - See 670.50.50 (UFTP Transportation Vehicles Maintenance)
- Does not include operation of Emergency Response System - See 670.50.40.10 (UFTP Transportation System Logistics DGR Emergency Response)
- Does not include operation of Real-Time Tracking System - See 670.50.40.20 (UFTP Transportation System Logistics DGR Real Time Tracking)

- Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$35,354,615.43
Material Cost	$0.00
Other Cost	$6,503,600.95
Subtotal	*$41,858,216.38*
Allowance	$10,464,554.10
Total Cost	**$52,322,770.48**

Start Year	2043
Finish Year	2072
Duration	**30 years**
WBS Type	Variable

UFTP Transportation Logistics from Darlington to DGR

670.50.30.40

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The operation of the Transportation System from Darlington to DGR, including:
- Transportation to DGR
- Return empty UFTP Transportation Packages Assembly and UFTP Transportation Vehicles to owner Reactor Storage Facility

Deliverables

- UFTP/M delivered at DGR Used Fuel Packing Plant (UFPP)
- Empty UFTP assembly delivered at reactor site

The complete operation includes:

Tractor-Trailer and Escort Vehicle Operation from the DGR to the reactor site and back

Preparation of UFTP Transport Vehicle
- Identify Empty UFTP Transport Vehicle
- Conduct Pre-Loading Inspection of Empty UFTP Transport Vehicle
- Position UFTP Transport Vehicle

Transfer of UFTP/M ("UFTP/M" denotes UFTP loaded with modules) Transportation Packages onto UFTP Transport Vehicle
- Observe Post-Loading Inspection
- Conduct pre-departure inspection of loaded UFTP transport vehicle

Assumptions

- Distance from Darlington to DGR site: 1,000 km
- Number of shipments = 3,506
- Approx. 89 hrs effort per shipment for driving cycle (4 person crew)
- Costs based on average shipment effort. Slight variation in individual shipment effort due to, e.g., pre-loaded trailer swaps.
- Includes fuel and insurance.
- Does not include fleet maintenance - See 670.50.50 (UFTP Transportation Vehicles Maintenance)
- Does not include operation of Emergency Response System - See 670.50.40.10 (UFTP Transportation System Logistics DGR Emergency Response)
- Does not include operation of Real-Time Tracking System - See 670.50.40.20 (UFTP Transportation System Logistics DGR Real Time Tracking)

- Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$29,590,184.22
Material Cost	$0.00
Other Cost	$5,443,214.36
Subtotal	*$35,033,398.58*
Allowance	$8,758,349.64
Total Cost	**$43,791,748.22**

Start Year	2043
Finish Year	2072
Duration	**30 years**
WBS Type	Variable

UFTP Transportation Logistics from Point Lepreau to DGR

670.50.30.50

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The operation of the Transportation System from Point Lepreau to DGR, including:
- Transportation to DGR
- Return empty UFTP Transportation Packages Assembly and UFTP Transportation Vehicles to owner Reactor Storage Facility

Deliverables

- UFTP/M delivered at DGR Used Fuel Packing Plant (UFPP)
- Empty UFTP assembly delivered at reactor site

The complete operation includes:

Tractor-Trailer and Escort Vehicle Operation from the DGR to the reactor site and back

Preparation of UFTP Transport Vehicle
- Identify Empty UFTP Transport Vehicle
- Conduct Pre-Loading Inspection of Empty UFTP Transport Vehicle
- Position UFTP Transport Vehicle

Transfer of UFTP/M ("UFTP/M" denotes UFTP loaded with modules) Transportation Packages onto UFTP Transport Vehicle
- Observe Post-Loading Inspection
- Conduct pre-departure inspection of loaded UFTP transport vehicle

Assumptions

- Distance from Pt. Lepreau to DGR site: 2,500 km
- Number of shipments = 1,454
- Approx. 162 hr effort per shipment for driving cycle (4 person crew)
- Costs based on average shipment effort. Slight variation in individual shipment effort due to, e.g., pre-loaded trailer swaps.
- Includes fuel and insurance.
- Does not include fleet maintenance - See 670.50.50 (UFTP Transportation Vehicles Maintenance)
- Does not include operation of Emergency Response System - See 670.50.40.10 (UFTP Transportation System Logistics DGR Emergency Response)
- Does not include operation of Real-Time Tracking System - See 670.50.40.20 (UFTP Transportation System Logistics DGR Real Time Tracking)

- Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$22,337,016.84
Material Cost	$0.00
Other Cost	$5,643,492.35
Subtotal	*$27,980,509.19*
Allowance	$6,995,127.30
Total Cost	**$34,975,636.49**

Start Year	2058
Finish Year	2072
Duration	**15 years**
WBS Type	Variable

UFTP Transportation Logistics from Chalk River to DGR

670.50.30.60

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The operation of the Transportation System from Chalk River to DGR, including:
- Transportation to DGR
- Return empty UFTP Transportation Packages Assembly and UFTP Transportation Vehicles to owner Reactor Storage Facility

Deliverables

- UFTP/M delivered at DGR Used Fuel Packing Plant (UFPP)
- Empty UFTP assembly delivered at reactor site

The complete operation includes:

Tractor-Trailer and Escort Vehicle Operation from the DGR to the reactor site and back

Preparation of UFTP Transport Vehicle
- Identify Empty UFTP Transport Vehicle
- Conduct Pre-Loading Inspection of Empty UFTP Transport Vehicle
- Position UFTP Transport Vehicle

Transfer of UFTP/M ("UFTP/M" denotes UFTP loaded with modules) Transportation Packages onto UFTP Transport Vehicle
- Observe Post-Loading Inspection
- Conduct pre-departure inspection of loaded UFTP transport vehicle

Assumptions

- Distance from Chalk River to DGR site: 1,000 km
- Number of shipments = 28
- Approx. 89 hrs effort per shipment for driving cycle (4 person crew)
- Costs based on average shipment effort. Slight variation in individual shipment effort due to, e.g., pre-loaded trailer swaps.
- Includes fuel and insurance.
- Does not include fleet maintenance - See 670.50.50 (UFTP Transportation Vehicles Maintenance)
- Does not include operation of Emergency Response System - See 670.50.40.10 (UFTP Transportation System Logistics DGR Emergency Response)
- Does not include operation of Real-Time Tracking System - See 670.50.40.20 (UFTP Transportation System

Logistics DGR Real Time Tracking)
- Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$236,316.36
Material Cost	$0.00
Other Cost	$43,471.19
Subtotal	*$279,787.55*
Allowance	$69,946.89
Total Cost	**$349,734.44**

Start Year	2069
Finish Year	2072
Duration	**4 years**
WBS Type	Variable

670.50.30.60

UFTP Transportation Logistics from Gentilly 1 to DGR

670.50.30.70

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The operation of the Transportation System from Gentilly 1 to DGR, including:
- Transportation to DGR
- Return empty UFTP Transportation Packages Assembly and UFTP Transportation Vehicles to owner Reactor Storage Facility

Deliverables

- UFTP/M delivered at DGR Used Fuel Packing Plant (UFPP)
- Empty UFTP assembly delivered at reactor site

The complete operation includes:

Tractor-Trailer and Escort Vehicle Operation from the DGR to the reactor site and back

Preparation of UFTP Transport Vehicle
- Identify Empty UFTP Transport Vehicle
- Conduct Pre-Loading Inspection of Empty UFTP Transport Vehicle
- Position UFTP Transport Vehicle

Transfer of UFTP/M ("UFTP/M" denotes UFTP loaded with modules) Transportation Packages onto UFTP Transport Vehicle
- Observe Post-Loading Inspection
- Conduct pre-departure inspection of loaded UFTP transport vehicle

Assumptions

- Distance from Gentilly 1 to DGR site: 1,500 km
- Number of shipments = 18
- Approx. 112 hr effort per shipment for driving cycle (4 person crew)
- Costs based on average shipment effort. Slight variation in individual shipment effort due to, e.g., pre-loaded trailer swaps.
- Includes fuel and insurance.
- Does not include fleet maintenance - See 670.50.50 (UFTP Transportation Vehicles Maintenance)
- Does not include operation of Emergency Response System - See 670.50.40.10 (UFTP Transportation System Logistics DGR Emergency Response)
- Does not include operation of Real-Time Tracking System - See 670.50.40.20 (UFTP Transportation System

Logistics DGR Real Time Tracking)
- Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$191,177.28
Material Cost	$0.00
Other Cost	$41,918.65
Subtotal	*$233,095.93*
Allowance	$58,273.98
Total Cost	**$291,369.91**

Start Year	2069
Finish Year	2072
Duration	**4 years**
WBS Type	Variable

UFTP Transportation Logistics from Gentilly 2 to DGR

670.50.30.80

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The operation of the Transportation System from Gentilly 2 to DGR, including:
- Transportation to DGR
- Return empty UFTP Transportation Packages Assembly and UFTP Transportation Vehicles to owner Reactor Storage Facility

Deliverables

- UFTP/M delivered at DGR Used Fuel Packing Plant (UFPP)
- Empty UFTP assembly delivered at reactor site

The complete operation includes:

Tractor-Trailer and Escort Vehicle Operation from the DGR to the reactor site and back

Preparation of UFTP Transport Vehicle
- Identify Empty UFTP Transport Vehicle
- Conduct Pre-Loading Inspection of Empty UFTP Transport Vehicle
- Position UFTP Transport Vehicle

Transfer of UFTP/M ("UFTP/M" denotes UFTP loaded with modules) Transportation Packages onto UFTP Transport Vehicle
- Observe Post-Loading Inspection
- Conduct pre-departure inspection of loaded UFTP transport vehicle

Assumptions

- Distance from Gentilly 2 to DGR site: 1,500 km
- Number of shipments = 687
- Approx. 112 hr effort per shipment for driving cycle (4 person crew)
- Costs based on average shipment effort. Slight variation in individual shipment effort due to, e.g., pre-loaded trailer swaps.
- Includes fuel and insurance.
- Does not include fleet maintenance - See 670.50.50 (UFTP Transportation Vehicles Maintenance)
- Does not include operation of Emergency Response System - See 670.50.40.10 (UFTP Transportation System Logistics DGR Emergency Response)
- Does not include operation of Real-Time Tracking System - See 670.50.40.20 (UFTP Transportation System

Logistics DGR Real Time Tracking)
- Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$7,296,599.52
Material Cost	$0.00
Other Cost	$1,599,895.15
Subtotal	*$8,896,494.67*
Allowance	$2,224,123.67
Total Cost	**$11,120,618.34**

Start Year	2058
Finish Year	2072
Duration	**15 years**
WBS Type	Variable

UFTP Transportation Logistics from Douglas Point to DGR

670.50.30.90

Case MARK 2 ALL ROAD TRANSPORT SYSTEM

WBS Owner Chris Hatton Prepared by: R. Scheps Organization: Palladium Product Development & Design

Description

The operation of the Transportation System from Douglas Point to DGR, including:
- Transportation to DGR
- Return empty UFTP Transportation Packages Assembly and UFTP Transportation Vehicles to owner Reactor Storage Facility

Deliverables

- UFTP/M delivered at DGR Used Fuel Packing Plant (UFPP)
- Empty UFTP assembly delivered at reactor site

The complete operation includes:

Tractor-Trailer and Escort Vehicle Operation from the DGR to the reactor site and back

Preparation of UFTP Transport Vehicle
- Identify Empty UFTP Transport Vehicle
- Conduct Pre-Loading Inspection of Empty UFTP Transport Vehicle
- Position UFTP Transport Vehicle

Transfer of UFTP/M ("UFTP/M" denotes UFTP loaded with modules) Transportation Packages onto UFTP Transport Vehicle
- Observe Post-Loading Inspection
- Conduct pre-departure inspection of loaded UFTP transport vehicle

Assumptions

- Distance from Douglas Point to DGR site: 1,000 km
- Number of shipments = 124
- Approx. 89 hrs effort per shipment for driving cycle (4 person crew)
- Costs based on average shipment effort. Slight variation in individual shipment effort due to, e.g., pre-loaded trailer swaps.
- Includes fuel and insurance.
- Does not include fleet maintenance - See 670.50.50 (UFTP Transportation Vehicles Maintenance)
- Does not include operation of Emergency Response System - See 670.50.40.10 (UFTP Transportation System Logistics DGR Emergency Response)
- Does not include operation of Real-Time Tracking System - See 670.50.40.20 (UFTP Transportation System Logistics DGR Real Time Tracking)

- Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$1,046,543.88
Material Cost	$0.00
Other Cost	$192,509.69
Subtotal	*$1,239,053.57*
Allowance	$309,763.39
Total Cost	**$1,548,816.96**

Start Year	2058
Finish Year	2067
Duration	**10 years**
WBS Type	Variable

UFTP Transportation Logistics DGR Emergency Response

670.50.40.10.10

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The implementation and maintenance of the Emergency Response System, including communications, operations and documentation for the duration for the UFTS.

Deliverables

- An on-going Emergency Response System ready to respond to any accident or incident during the operation of the transportation system.

Operation of the Emergency Response System includes:
- Completed emergency response plan with all the necessary documentation (references to applicable regulations, emergency procedures, maps, safety files, Transport Emergency Response Plan (TERP), emergency response assistance plan (ERAP), etc.).
- Staffed emergency system ready to raise alarm, conduct situation analysis, activate response agencies, notify authorities, activate part-time personnel and deploy a recovery system for the Transportation Packages.

When required, core staff will activate emergency response teams, such as:

Command and Decision Team:
- Logistic and technical assistance to Authorities
- Decision on proper technical means to be implemented
- Management of other teams

Technical Analysis Team:
- Estimation of the technical state of the packaging and of associated impacts
- Proposition of technical emergency and assistance solutions

Mobile Command Team:
- Implementation of command, information and expertise near the incident
- First intervention equipment (satellite communication system, radio or chemical protection, equipment, camera, and computers). (This team implements processes to minimize consequences or to bring a solution to the situation)

Communications Team:
- Preparation and development of crisis communication especially dedicated to the media situation
- Provision of a specific communication plan

- Provide incident information to regulator
- Provide information for the press and for other communication entities
- Accept information from the press

Assumptions

- One annual emergency exercise/year (600 person-hours)
- One actual emergency exercise/year (600 person-hours)
- Two full-time equivalent (FTE) technicians to maintain and operate the recovery equipment and to update the necessary documentation (~3280 hr/yr)
- Minor incidentals, including working area services, consumables, conventional and radiological waste handling, etc., accommodated in "Allowance".
- Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$12,745,152.00
Material Cost	$0.00
Other Cost	$0.00
Subtotal	*$12,745,152.00*
Allowance	$3,186,288.00
Total Cost	**$15,931,440.00**

Start Year	2043
Finish Year	2072
Duration	**30 years**
WBS Type	Variable

UFTP Transportation Logistics DGR Real Time Tracking

670.50.40.10.20

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM

WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The implementation and maintenance of the Real Time Tracking System for the duration of the UFTS.

Deliverables

- Secure, real-time reporting on the current position of transportation system components

Operation of the Real Time Tracking System includes:
- Real time information on UFTP Transportation Packages, UFTP Transport Vehicle and Escort locations
- Provision of progress information for transport operations
- Maintaining the security of transmitted information

Assumptions

- Real Time Tracking System operates 24 hr per day, 7 days a week (8760 hrs/year)
- System uses three shifts of two controllers
- System management requires one full-time-equivalent (FTE) supervisor and one FTE administrative individual
- Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$60,323,856.00
Material Cost	$0.00
Other Cost	$0.00
Subtotal	*$60,323,856.00*
Allowance	$15,080,964.00
Total Cost	**$75,404,820.00**

Start Year	2043
Finish Year	2072
Duration	**30 years**
WBS Type	Variable

UFTP Transportation Vehicles Maintenance

670.50.50

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

UFTP Transportation Vehicle Maintenance.

Deliverables

Perform preventive maintenance of the Transportation Vehicle Trailers, Tractors and Escorts.

Assumptions

- The maintenance of the UFTP Transport Vehicles will be contracted to a third party specializing in maintenance of long haul transport vehicles.
-The maintenance cost of Transportation Vehicles is equivalent to 5% of one-time fleet procurement cost per year
-The tire replacement cost for Transportation Vehicles is equivalent to 2% one-time fleet procurement cost per year
- Every 3.5 years a complete overhaul of the UFTP Transport Vehicle Tractor and Trailers is performed
- Incidental maintenance of low-mileage non-fleet vehicles (mock-ups, emergency response fleet) accounted for under "allowance".
- Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$0.00
Material Cost	$0.00
Other Cost	$17,501,862.39
Subtotal	*$17,501,862.39*
Allowance	$4,375,465.60
Total Cost	**$21,877,327.99**

Start Year	2043
Finish Year	2072
Duration	**30 years**
WBS Type	Variable

ENVIRONMENTAL MANAGEMENT

670.55

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The set-up, and monitoring, of transportation aspects within an Environmental Management System (EMS) for NWMO in accordance with ISO 14001, including:
- Auditing of supplier EMSs, and review of proposals.
- Liaison with regulators regarding environmental and other regulatory requirements.
- Assistance with transportation aspects of Environmental Assessment (EA).
- Planning of environmental monitoring activities as needed.
- Ensuring that all environmental requirements are met by transportation system equipment and facilities.

Deliverables

- Input to NWMO EMS.
- Communications with regulators.
- Plans, audits and reports as required by EMS.

Assumptions

- Work starts at the time engineering work starts on the transportation system (year 16) and continues throughout operation.
- Approximately two full-time equivalents (FTEs) from commencement of engineering work to start of operations.
- 1640 hr/yr labour during Transport Operations.
- Expenses and incidentals included in "Allowance".
- Preparation of material for application for UFTP Transportation Packages approval certificate(s) and approvals for Equipment for UFTP Transport Case are included in the cost estimates for those components (WBS 670.40.20).
- Administrative support is covered by Program Management (WBS 670.50.10).
- Also subject to overall UFTS assumptions. Major assumptions table attached as "Multi Element Supporting Documentation".

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$6,114,034.80	Start Year	2033

Material Cost	$0.00
Other Cost	$0.00
Subtotal	*$6,114,034.80*
Allowance	$1,528,508.70
Total Cost	**$7,642,543.50**

Finish Year	2074
Duration	**42 years**
WBS Type	Fixed

DECOMMISSIONING

670.60

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	R. Scheps	Organization:	Palladium Product Development & Design

Description

The development and implementation of plans to decommission the Used Fuel Transportation System (UFTS) and associated loading facilities.

Decommissioning includes:
- Decommission the UFTS and associated loading facilities.
- Consigning controlled decommissioning waste to a suitable disposal facility

Deliverables

- A deactivated and decommissioned UFTS

Decommissioning includes:
- An approved plan for decommissioning the Used Fuel Transportation Systems and associated loading facilities
- Dismantled and decommissioned UFTS and associated loading facilities
- Decommissioning waste stored in an owner disposal facility

Assumptions

- Estimate adapted from Cogema (2003)
- It is assumed that the Used Fuel Transportation System and associated loading facilities do not have any major contamination and have not experienced a major irradiation incident or accident.
- It is assumed that the Used Fuel Transportation System and associated loading facilities have been maintained according to procedures and will be decommissioned without any difficulties.
- Contractor, non-permanent equipment and non-permanent material costs ("Other") of decommissioning is estimated as 10% (approx. $8M) of the capital cost sum for UFTP Transportation Packages, Impact Limiters, UFTP Transport Vehicles. An allowance for disposal operation cost of decommissioning waste is included in this sum.
- Labour hours are estimated by taking an allowance of 30% of "Other" decom. costs discussed above and dividing this by a nominal hourly rate of approximately $59, resulting in an estimate of approx. 39,267 hrs.
- No credit for remaining useful life or salvage value at time of decommissioning.
- Also subject to overall UFTS assumptions.

Exclusive of contingency.

Allowance

Allowance of 25% added to reflect the level of design and uncertainties.

Labour Cost	$3,401,719.35
Material Cost	$0.00
Other Cost	$8,416,809.60
Subtotal	*$11,818,528.95*
Allowance	$2,954,632.24
Total Cost	**$14,773,161.18**

Start Year	2066
Finish Year	2074
Duration	**9 years**
WBS Type	Step-Fixed

PROGRAM MANAGEMENT

670.90

Case	MARK 2 ALL ROAD TRANSPORT SYSTEM				
WBS Owner	Chris Hatton	Prepared by:	U. Stahmer	Organization:	NWMO - Nuclear Waste Management Organization

Description

Organizational structure to support / manage transportation program.

Deliverables

- Manufacturing (2033 to 2042)
- Oversight of Project Management team
- Project schedule
- Program business plan inputs on a yearly basis
- objectives
- Resourcing plan
- Certificate for Transport Package Design (Y20) recertification (Y24)
- Licence to Transport Category II Nuclear Material

- Operations (2043 to 2072)
- Manage resources, facilities and infrastructures required for operating and maintaining the Used Fuel Transportation System
- Organizational structure to support / manage transportation program
- Operate, manage and administer the Used Fuel Transportation System.
- Project schedule
- Project business plan inputs on a yearly basis
- Program definition required to achieve implementation objectives
- Resourcing plan

Assumptions

- The Program Management includes 2 FTE persons during the entire period of Used Fuel Transportation Packages manufacturing assumed to span 10 years and includes:
  - One program director,
  - One program administrator,
- Travel assumption: 10 trips annually to DGR site and manufacturing facilities at $1,500 per trip
- Lump sum allocation for new Production Package Certificate application(s) $24,000 in Year 2036.
- Lump sum allocation for Package Design Certificate recertification(s) in 2041 at $1,000.
- Licence to Transport in 2041 and renewals as required by the regulator
- The team to manage the Used Fuel Transportation System includes a staffed team of 14 FTE persons during the entire period of Used Fuel transportation assumed to span 31 years and includes:
  - One transport manager,
  - One maintenance supervisor,

- Three engineers (one design/regulatory responsible, one package maintenance engineer and one equipment maintenance engineer)- Four Transportation Officers (one per main storage site (3) and one at the UFPP),
- One scheduler,
- One secretary,
- Two forwarding technicians,
- One Quality Assurance and Inspection technician,
• Travel assumption: 10 trips annually between UFPP and sites at $1,500 per trip.
• Certificate recertifications (7) every 4 years at $1,000 per recertification

Exclusive of contingency.

Allowance

An allowance of 25% has been included based on level of design detail and uncertainties.

Labour Cost	$112,717,938.90
Material Cost	$0.00
Other Cost	$735,340.28
Subtotal	*$113,453,279.18*
Allowance	$28,363,319.80
Total Cost	**$141,816,598.98**

Start Year	2033
Finish Year	2072
Duration	**40 years**
WBS Type	Fixed