COGEMA

COGEMA LOGISTICS

Logistics of Transportation of Used Fuel to a Centralised Facility

Report of a Study carried out for Ontario Power Generation, New Brunswick Power, Hydro-Québec and Atomic Energy of Canada Limited

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Réf.	**500276-B-009**	**Rév.**	**00**	Approved by	**J.-L. MONDANEL**		

CONTENTS

Appendices

Appendix A

Excel File « D#8 Resources.xls » with the following sheets:
Summary: presents a view of the main results of the study for all modes of transport

All Road – Review of Shipments: view of the number of shipments per site (whole program)

All Road – Resources: Number of persons needed per year for each site (packaging preparation and transportation).

All Road – System of Tpt: Equipment (Tractors, trailers and casks) needed to achieve the program.

Mostly Rail – Review of Shipments: Number of shipments per site and per means of transport

Mostly Rail – System of Tpt: Number of trains, trucks road links, IFTC/BM and DSC Outer Packaging

Mostly Water – Review of Shipments: number of shipments per site and per means of transport

Mostly Water – System of Tpt: Number of vessels, trucks for road links, IFTC/BM and DSCTP Outer Packaging

Distances and Times: presents the distances between sites and the CES/DGR and the transportation times calculated.

Appendix B

OPG Excel File « Fuel Age 2001.xls »:
The sheet “Logistics 40 yr – 2035” was used as a basis for the calculation of shipments.

1. PURPOSES AND BACKGROUND

The purpose of the Used Fuel Transportation System (UFTS) is to transport all the used fuel arising from current Canadian program, consisting of approximately 3.6 million bundles, from their current storage facilities to a centralised long-term management facility (see Appendix A, Figure N°1 of **<4>**). This facility may be a Deep Geologic Repository (DGR) or a Centralised Extended Storage (CES) facility, depending on the option chosen by federal government after the review of options required by the Nuclear Fuel Waste Act (Canada 2001). If continued storage at the current sites is chosen, then no transportation system will be required.

The UFTS will be required on a timescale dependent on the earliest in-service date projected for a centralised facility (~2023 for the CES facility; ~2035 for the DGR). Where needed in the design and logistics, the details of the shipping program applicable to the 2035 in-service date were used. For the purposes of the study, it was assumed that the centralised facility would be located somewhere in Ontario.
The present report, is a Technical and Final Report entitled « Logistics of Transportation of Used Fuel to a Centralised Facility». This report defines the global logistics and organisation of the UFTS, including the assumptions for the cost estimates that will be presented in the “Cost Estimate Report”.

This document is made in accordance with the results and recommendations given in the previous deliverables.
However, it should be noted that the transportation systems presented have not been optimised and that there are a number of alternative ways in which transportation could be carried out.

2. REFERENCES

<1>: Used Fuel Transportation Study Request for Proposal; Attachment 4 of RFP: System Requirements Rev.1a. OPG File N° 06819(UF) - 03789, 29 July 2002

<2>: Used Fuel Transportation Study Request for Proposal; Attachment 3 of RFP: scope of work. OPG File N° 06819(UF) - 03789T5 rev.1

<3>: Garamszeghy, M. 2002. Age of Used Fuel (E-mail and Excel attachment, sent to J.E. Villagran, T.F. Kempe and R. Heystee, 17 April 2002.)

<4>: Cogema Logistics. Conceptual Designs for Transportation of Used Fuel to a Centralised Facility. Reference 500276-B-005 rev.00, May 2003.

<5>: Used Fuel Transportation Study Cost Estimating Requirements. Rev. 1.
OPG File n°06819-00030 (UFM) T5 rev. 1

3. UFTS OVERVIEW

3.1. Origins and destination of the used fuel

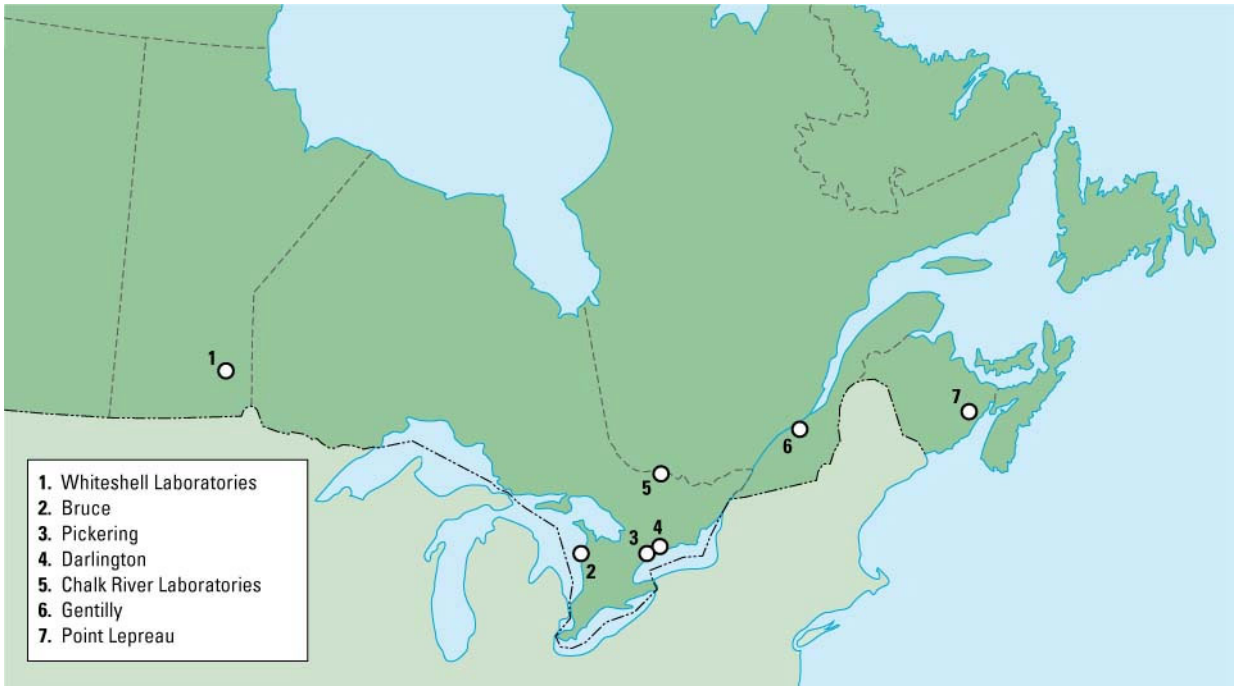
3.1.1. Origins of the used fuel (owners, site, facilities)

3.1.1.1. Current Storage Sites

The reactor sites where used fuel is currently stored in Canada are:

- Whiteshell Laboratories
- Bruce
- Pickering
- Darlington
- Chalk River Laboratories
- Gentilly
- Point Lepreau

Locations of these sites are presented on the map hereafter:



The distances between these sites and the CES/DGR, depending of the chosen mode of transport, are presented in paragraph 3.1.4 of this document.

3.1.1.2. Reactors

For the Current Storage Site of (see Appendix B of **<4>,** Tables N° 1 to 3):

- Whiteshell Laboratories, the fuel is from the Douglas Point reactor (experimental fuel stored at Whiteshell is not included in the scope of the present study),
- Bruce, the reactors are Bruce A, Bruce B and Douglas Point,
- Pickering, the reactors are Pickering A and Pickering B,
- Darlington, the reactor is Darlington,
- Chalk River Laboratories, the fuel is from the Nuclear Power Demonstration reactor (experimental fuel stored at Chalk River is not included in the scope of the present study),
- Gentilly, the reactors are Gentilly 1 and Gentilly 2,
- Point Lepreau, the reactor is Point Lepreau.

All these reactors are CANDU type (Appendix A of **<4>**, Figure N° 3), designed by Atomic Energy Canada Limited (AECL). The Used Fuel belongs to different waste owners.

3.1.1.3. Waste Owners

The waste of the reactors of Pickering A and B, Bruce A and B, Darlington belongs to **Ontario Power Generation (OPG)**.
The waste of the reactors of Gentilly 2 belongs to **Hydro Quebec**.
The waste of the reactors of Douglas Point, Nuclear Power Demonstration, Gentilly 1, Chalk River and Whiteshell belongs to **Atomic Energy of Canada Limited (AECL)**.
The waste of the reactor of Point Lepreau belongs to **New Brunswick Power (NBP)**

This is illustrated in Appendix B of **<4>**, Tables N° 1 to 3.

3.1.1.4. Forms of storage

Five forms of storage will be in use at the time of transportation:

- Baskets in Silos,
- Baskets in CANSTORS,
- Trays in wet bays,
- Modules in wet bays,
- Modules in DSCs.

Modules in wet bays and trays in wet bays are wet storage.
Modules in DSCs, baskets in silo, canisters and baskets in CANSTOR vaults are dry storage.

The forms of storage per site/reactor/facility are given in Appendix B of **<4>**, Tables N° 1 to 3.

3.1.1.5. Facilities of reactors at the time of transportation

Facilities are given in Appendix B of **<4>**, Tables N° 1 to 3:

The waste of **Pickering A and B** will be stored at:
Pickering A and B Facilities for Modules in wet bays,
Pickering Used Fuel Dry Storage Facility for Modules in DSCs.

The waste of **Bruce and Douglas Point** will be stored at:
Bruce B Facility for Trays in wet bays,
Western Used Fuel Dry Storage Facility for Modules in DSCs,
Douglas Point Facility for Baskets in Silo canisters.

The waste of **Darlington** will be stored at:
Darlington Facility for Modules in wet bays,
Darlington Used Fuel Dry Storage Facility for Modules in DSCs.

The waste of **Gentilly 1 and 2** will be stored at:
Gentilly 1 Facility for Baskets in Silo canisters,
Gentilly 2 Facility for Baskets in CANSTOR vaults.

The waste of **Point Lepreau** will be stored at:
Point Lepreau Facility for Baskets in Silo canisters.

The waste of **Chalk River** will be stored at:
Nuclear Power Demonstration (NPD) fuel Facility for Basket in Silo canisters.

The waste of **Whiteshell** will be stored at:
Douglas Point Fuel Facility for Baskets in Silo canisters.

3.1.2. Destination of the used fuel

The used fuel will be sent to a Deep Geologic Repository facility (DGR) or a Centralised Extended Storage facility (CES).

For the purpose of the study, we assume that the destination site will be located in Ontario. The distances between the departure sites and the CES/DGR, depending on the chosen transportation mode, are presented in paragraph 3.1.4 of this document.

3.1.3. Basic parameters of shipments

Cask Type	*Cask Payload*	*Number of casks per shipments*		
		All Road	**Mostly Rail**	**Mostly Water**
IFTC/BM	2 OPG modules = 192 bundles or 3 AECL/HQ/NBP baskets = 180 bundles (HQ/NBP) 120 bundles – Whiteshell 162 bundles – Douglas Point and Chalk River 114 bundles – Gentilly 1	1 cask per shipment	10 casks per shipment (2 casks / railcar) *Road link :* 1 train = 10 truck shipments	32 casks per shipment *Road link :* 1 vessel = 32 truck shipments
DSCTP	4 OPG modules = 384 bundles	The modules from 1 DSC are transferred to 2 IFTC/BMs	5 casks per shipment (1 cask / railcar) *Road link:* 1 train = 5 truck shipments (9 axles trailer)	15 casks per shipment *Road link:* 1 vessel = 15 truck shipments (9 axles trailer)

3.1.4. Reference distances

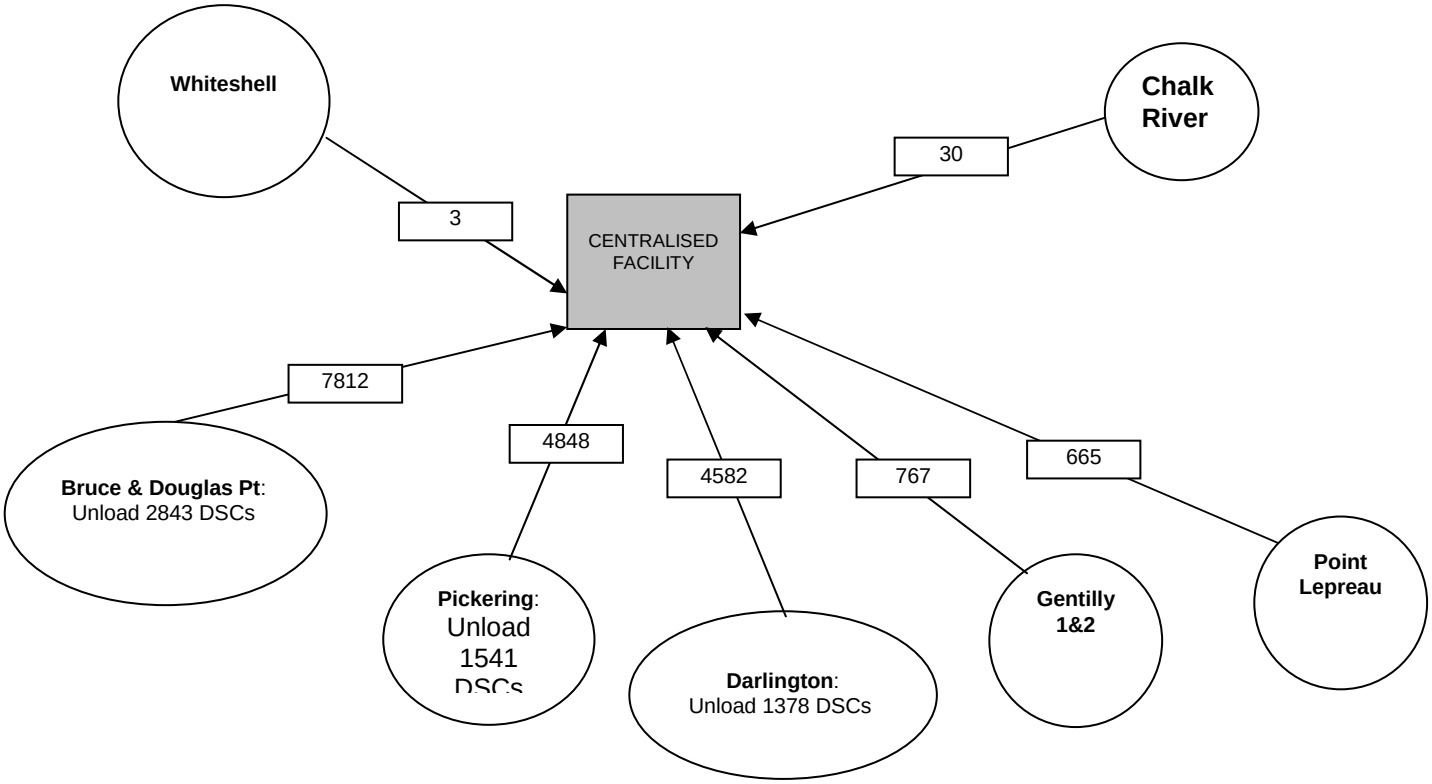
For the purposes of the study, the following distances were used for the calculations presented in this document:

Site	*Reference distance, km*						
	All-road	**Mostly-rail system**			**Mostly-water system**		
		Road	**Rail**	**Road**	**Road**	**Water**	**Road**
Pickering	1000		1000	100		1000	100
Bruce	1000	50	1000	100		500	100
Darlington	1000		1000	100		1000	100
Point Lepreau	2500	100	2000	100		3500	100
Chalk River	1000	1000			1000		
Gentilly	1500		1500	100		1700	100
Whiteshell	1000	1000			1000		

3.2. Logistics for each transport mode

The figures included in the following diagrams show small differences with the figures given in **<4>**. Those differences were arising during further development of the system.

3.2.1. All road

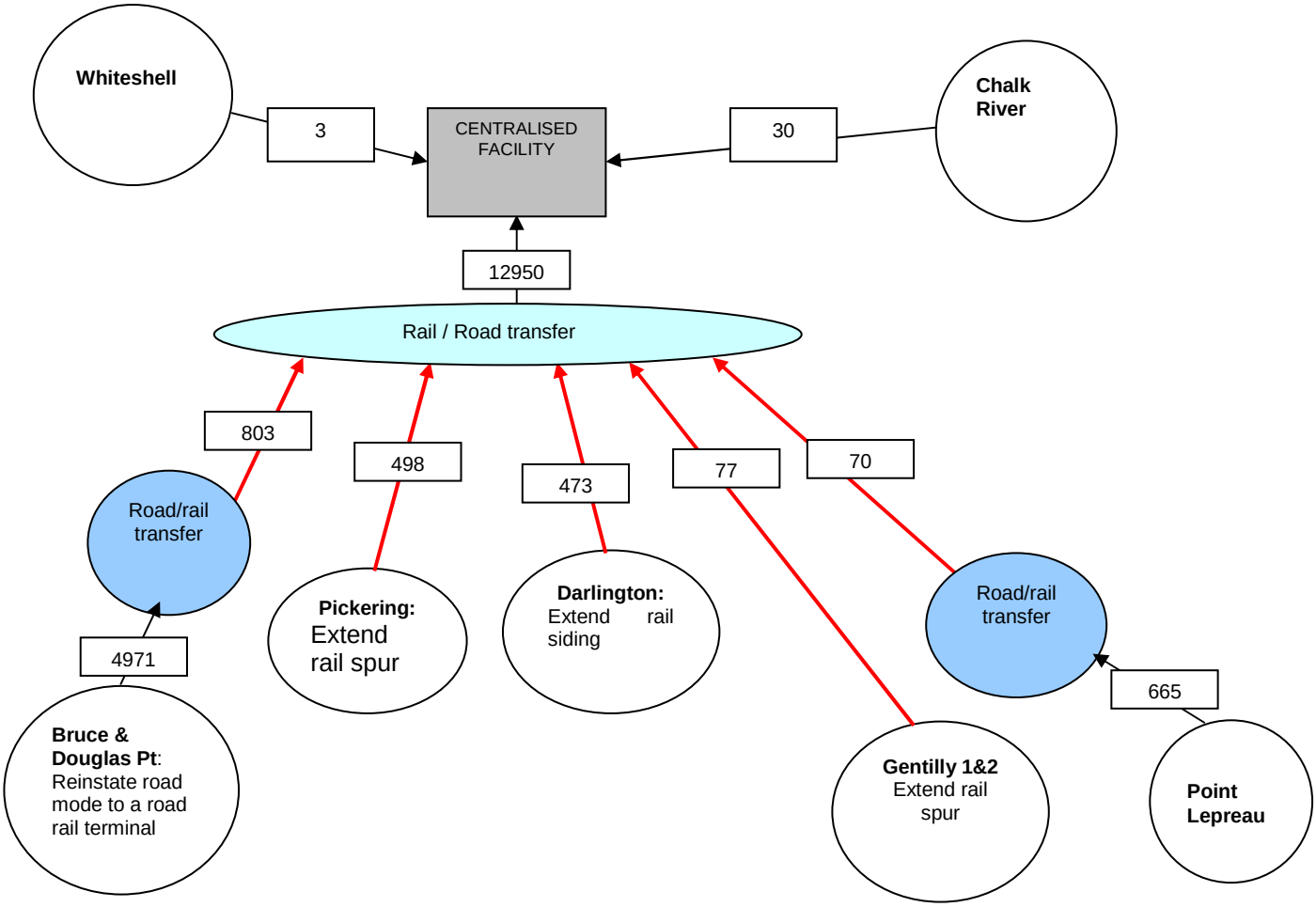


Key:

—— Road number, e.g. 7812 show total number of shipments with IFTC/BM cask:

Road – 1 x 192 bundle IFTC/BMs (modules) for Bruce, Pickering and Darlington
1 x 120 bundle IFTC/BMs (baskets) for Whiteshell
1 x 162 bundle IFTC/BMs (baskets) for Chalk River and Bruce (Douglas Point)
1 x 114 bundle IFTC/BMs (baskets) for Gentilly 1
1 x 180 bundle IFTC/BMs (baskets) for Gentilly 2 and Point Lepreau

3.2.2. Mostly rail



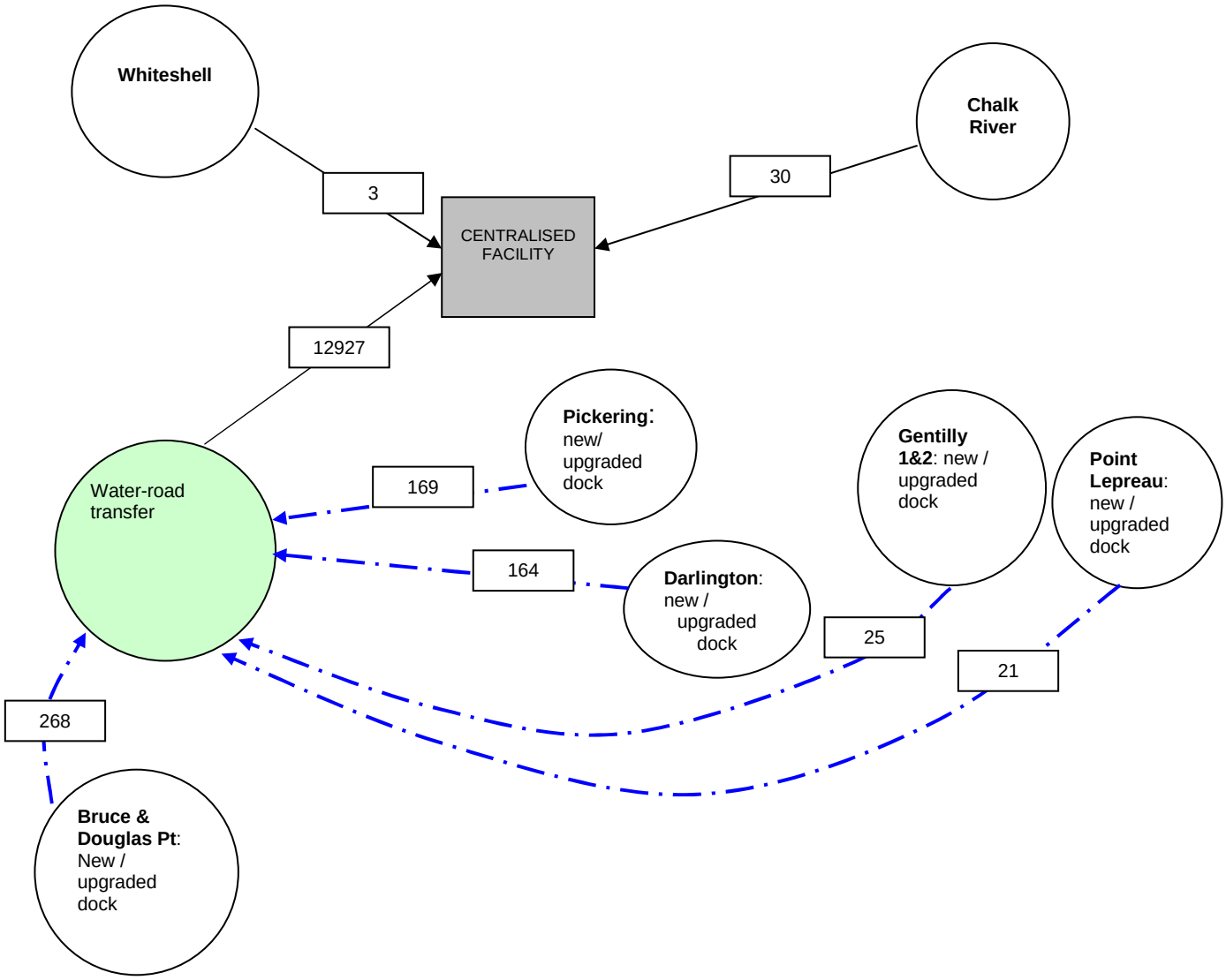
Key:

Road — number, e.g: 814 shows total number of shipments:
Rail

Road – 1 x 120 bundle IFTC/BMs (baskets) for Whiteshell
1 x 162 bundle IFTC/BMs (baskets) for Chalk River and Bruce (Douglas Point)
1 x 114 bundle IFTC/BMs (baskets) for Gentilly 1
1 x 180 bundle IFTC/BMs (baskets) for Gentilly 2 and Point Lepreau
1 x 384 DSCTP for Bruce, Pickering and Darlington
1 x 192 IFTC/BMs (modules) for Bruce, Pickering and Darlington

Rail – 5 x 384 bundle DSCTPs for Bruce, Pickering and Darlington
5 x 2 x IFTC/BMs (baskets) for Point Lepreau and Gentilly 2
5 x 2 x 192 bundle IFTC/BMs (modules) for Bruce, Pickering and Darlington

3.2.3. Mostly water



Key:

—— Road number, e.g. 88 show total number of shipments :

- - - Water

Road – 1 x 120 bundle IFTC/BMs (baskets) for Whiteshell
1 x 162 bundle IFTC/BMs (baskets) for Chalk River and Bruce (Douglas Point)
1 x 114 bundle IFTC/BMs (baskets) for Gentilly 1
1 x 180 bundle IFTC/BMs (baskets) for Gentilly 2 and Point Lepreau
1 x 384 bundle DSCTPs for Bruce, Pickering, Darlington
1 x 192 bundle IFTC/BMs (modules) for Bruce, Pickering, Darlington

Water – 15 x 384 bundle DSCs for Bruce, Pickering, Darlington
32 x IFTC/BMs (modules) for Bruce, Pickering, Darlington
32 x IFTC/BMs (baskets) for Point Lepreau, Gentilly, Douglas Point.

3.3. Regulatory requirements

3.3.1. For transportation

The transportation of the spent fuel will have to be made in accordance with Canadian and International regimes that are listed hereafter. There are regulations related to the transport of Nuclear materials (they are common whatever the mode of transport), and regulations specific to each mode.

3.3.1.1. Common regulations

- Canadian Nuclear Safety Commission. 2001. *Packaging and Transport of Nuclear Substances Regulations.*
- International Atomic Energy Agency. 1996 Edition (Revised). Regulations for the Safe Transport of Radioactive Material, No. TS-R-1 (ST-1, Revised).
- Transport Canada. August 15, 2001. Transportation of Dangerous Goods Regulations
- *U.S. Code of Federal Regulations, Title 49, Transportation*, Revised as of October 1, 2001.

3.3.1.2. All Road

For the road transportation, in addition to the common regulations, the following sets of laws have to be taken into account principally concerning the size and weight limits allowable:

- *Guide to the Agreement on Uniform Vehicle Weights and Dimensions Limits in Atlantic Canada*, October 2001.

- Manitoba Transportation and Government Services, *Manitoba Highway Classifications System*. As reviewed on April 15, 2002.
- Manitoba Transportation & Government Services, *Manitoba's Spring Road Restriction Program*, March 18, 2002.
- Manitoba Transportation and Government Services, *Weights and Dimensions Compliance Guide*, October 2000.

- New Brunswick Department of Transportation. 1973, As Amended. *Motor Vehicle Act*.
- New Brunswick Department of Transportation, *Notice to Transporters: Guidelines for Applying and Obtaining Required Special Permits*, July 2001.

- Québec Ministère des Transports, *Thaw Zones and Periods*, As reviewed April 15, 2002
- Québec Ministère des Transports, *Vehicle Load and Size Limits: The 2000 Edition*, 2002.

- Ontario Ministry of Transportation. 1990. *Ontario Highway Traffic Act*. Regulation 579, "Designation of Highways".

3.3.1.3. Mostly Rail

For the transportation by rail, and in addition to the common rules, the UFTS has to comply with the following regulation:

- Transport Canada. *Railway Safety Act.* June 1, 1999.

3.3.1.4. Mostly Water

In the case of the “Mostly water” mode, and in addition to the common rules, the following regimes are applicable:

- The St. Lawrence Seaway Management Corporation, *The Seaway Handbook, 2002 Edition*, 2002.
- Transport Canada, *Canada Shipping Act*, 1985 as amended.
- Transport Canada, *Canada Shipping Act. Dangerous Goods Regulations*. 1978, as amended.
- Department of Justice Canada. *Navigable Waters Protection Act*. August 31, 2001.
- International Maritime Organisation. *International Convention on the Safety of Life at Sea (SOLAS).* 1974, As Amended.
- International Maritime Organisation. *International Maritime Dangerous Goods Code, 2000 Edition*. 2000.
- International Maritime Organisation. *The International Safety Management Code, IMO Assembly Resolution A.741 (18) - 1993*.

3.3.2. For handling operations

Operations at current storage sites and at the centralised site (DGR or CES) must be made in accordance with the following regulations:

- International Atomic Energy Agency. 1996 Edition (revised). Regulation for the Safe Transport of Radioactive Material, No. TS-R-1 (ST-1, Revised).
- Packaging & Transport of Nuclear Substances Regulations (P&TNS Regs) – June 2000
- Transport Canada. August 15, 2001. Transportation of Dangerous Goods Regulations.

In additions to these regulations, operations will be made in accordance with site – and UFTS – specific nuclear operating procedures, standards and governing documents.

The preparation of packages for transport has to be made in accordance with:

- The conditions specified on the Competent Authority Design Approval Certificate,
- The requirements specified in the Package Safety Analysis Report and,
- The station/facility-approved handling procedures.

All users of licensed packages must be registered with Competent Authority.

4. SHIPPING SCHEDULE

4.1. Shipping schedule for each mode

The number of shipments (for the All Road mode, one shipment = one IFTC/BM) per site is given accordingly to the data available in **<3>** - Table "Logistics 40 years – 2035" (see also Appendix B).

AECL fuel is shipped at the end of the program, except in the case of Gentilly 1. Following the total number of shipments per site given in Appendix B of **<4>**, these shipments were spread uniformly over the last 5 years of the program.

Note that the period of shipments for the fuel of Gentilly 1 (AECL) was move forward from 2060 – 2064 to 2046 – 2050, so that these shipments could be made in the same time as Gentilly 2.

The number of shipments per year is calculated as follow:

$$\frac{\text{Number of bundles to evacuate/year}}{\text{Maximum number of bundles per IFTC/BM (e.g. 192 for Pickering)}}$$

The maximum number of bundles per IFTC/BM will be:

- 192 bundles (modules) for Bruce, Pickering and Darlington 91% of the shipments
- 180 bundles (baskets) for Gentilly 2 and Point Lepreau 7.5% of the shipments
- 162 bundles (baskets) for Chalk River and Douglas Point 0.9% of the shipments
- 114 bundles (baskets) for Gentilly 1 0.16% of the shipments
- 120 bundles (baskets) for Whiteshell 0.02% of the shipments

The Fuel at Chalk River is actually contained in 95 baskets rather than 90, because of empty spaces. This was ignored for the purpose of the study, which was based on the number of bundles at each facility. However, the number of shipments is rounded up in the calculations and the overall number of shipments used is conservative.

For the All Road mode, the average number of casks that will be received at the CES is 624 casks/year, with a maximum of 636 casks in 2041.

Concerning Mostly Rail and Mostly Water modes, the fuel stored in DSCs will be transported in DSCTPs (which are DSCs with an outer packaging used for transportation) and the fuel stored in wet bays is transported in IFTC/BM.
Each DSC can handle 384 bundles.
The number of shipments for these two modes are calculated using the assumptions on number of casks per shipment summarised in Section 3 and with the formula presented above.

These shipping rates are realistic if the human resources (presented in paragraph 5 of this document) and equipment are sized in accordance with the program scale.
But as it is explained in Section 5, the Mostly Water mode requires a high number of casks, due to the logistics for loading a vessel.

Each table presented hereafter shows the total number of shipments per year that have to be sent from each departure site and received per year at the CES/DGR.

The next page presents the basis for all the calculation of shipments (except for AECL sites, for which a detailed program was not given per site). It is an extract from **<3>**, sheet "Logistics 40 yr – 2035" (also presented in Appendix B).

LOGISTICS 40 YEARS - 2035

Year	PNGS 1-4		PNGS 5-8		BNGS 1-4		BNGS 5-8		DNGS 1-4		Other			Total	%Deviation
	A Bay	A Dry	B bay	B Dry	A Bays	A Dry	B bay	B Dry	Bays	Dry	NBP	HQ	AECL	Bundles	from mean
Total #	188934	218554	149051	373085	0	625951	377181	465579	347087	529009	119500	132838	30682	3557451	
2035	47234		24842				41490							113565	-4,230
2036	47234		29810				41490							118534	-0,041
2037	47234		29810				41490							118534	-0,041
2038	47234		29810				41490							118534	-0,041
2039			29810				62864		26699					119373	0,667
2040			4968				55468		28924		17072	12960		119392	0,683
2041							58935	2000	28924		17072	12960		119890	1,104
2042							33956	2000	53398		17072	12960		119386	0,678
2043		10928						12933	64275		17072	12960		118168	-0,349
2044		10928						12933	64275		17072	12960		118168	-0,349
2045		10928				30138		12933	34709		17072	12960		118740	0,133
2046		10928				30138		12933	34709		17068	12960		118736	0,130
2047		10928		20727		34775		13613	11174	14695		12960		118872	0,245
2048		10928		20727		46367		12933		14695		12960		118609	0,023
2049		10928		20727		23183		25866		25191		12960		118854	0,230
2050		10928		20727		28452		25866		29389		3238		118600	0,015
2051		10928		20727		32100		25866		29389				119010	0,361
2052		10928		20727		32100		25866		29389				119010	0,361
2053		10928		20727		32100		25866		29389				119010	0,361
2054		10928		20727		32100		25866		29389				119010	0,361
2055		10928		20727		32100		25866		29389				119010	0,361
2056		10928		20727		32100		25866		29389				119010	0,361
2057		10928		20727		32100		25866		29389				119010	0,361
2058		10928		20727		32100		25866		29389				119010	0,361
2059		10928		20727		32100		25866		29389				119010	0,361
2060		10928		20727		26081		25866		29389			6137	119128	0,461
2061		10928		20727		26081		25866		29389			6137	119128	0,461
2062		10928		20727		26081		25866		29389			6137	119128	0,461
2063				20727		27215		21185		44084			6137	119348	0,646
2064				20727		38537				48283			6134	113681	-4,133
Totals	188934	218554	149051	373085	0	625951	377181	465579	347087	529009	119500	132838	30682	3557451	
Wet + Dry	**407488**		**522136**		**625951**		**842760**		**876096**					118582	

4.1.1. All Road

The following table presents the review of shipments from each site for the All Road mode:

OWNER :	OPG							AECL	OPG		NBP	AECL			HQ	AECL
Site :	Pickering				Bruce				Darlington		Point Lepreau	Chalk River	Gentilly			Whiteshell
Reactor :	Pickering A		Pickering B		Bruce A	Bruce B		Douglas Point	Darlington		Point Lepreau	Chalk River	Gentilly 1	Gentilly 2		Whiteshell
Year	Modules in wet bays	Modules in DSCs	Modules in wet bays	Modules in DSCs	Modules in DSCs	Trays in wet bays	Modules in DSCs	Baskets in silos	Modules in wet bays	Modules in DSCs	Baskets in silo	Baskets in silo	Baskets in silo	Baskets in canstor		Baskets in silo
2035	246	0	130	0	0	217	0	0	0	0						
2036	246	0	156	0	0	217	0	0	0	0						
2037	246	0	156	0	0	217	0	0	0	0						
2038	246	0	156	0	0	217	0	0	0	0						
2039	0	0	156	0	0	328	0	0	140	0						
2040	0	0	26	0	0	289	0	0	151	0	95	0	0	72		0
2041	0	0	0	0	0	307	11	0	151	0	95	0	0	72		0
2042	0	0	0	0	0	177	11	0	279	0	95	0	0	72		0
2043	0	57	0	0	0	0	68	0	335	0	95	0	0	72		0
2044	0	57	0	0	0	0	68	0	335	0	95	0	0	72		0
2045	0	57	0	0	157	0	68	0	181	0	95	0	0	72		0
2046	0	57	0	0	157	0	68	0	181	0	95	0	5	72		0
2047	0	57	0	108	182	0	71	0	59	77	0	0	6	72		0
2048	0	57	0	108	242	0	68	0	0	77	0	0	6	72		0
2049	0	57	0	108	121	0	135	0	0	132	0	0	6	72		0
2050	0	57	0	108	149	0	135	0	0	154	0	0	6	18		0
2051	0	57	0	108	168	0	135	0	0	154	0	0	0	0		0
2052	0	57	0	108	168	0	135	0	0	154	0	0	0	0		0
2053	0	57	0	108	168	0	135	0	0	154	0	0	0	0		0
2054	0	57	0	108	168	0	135	0	0	154	0	0	0	0		0
2055	0	57	0	108	168	0	135	0	0	154	0	0	0	0		0
2056	0	57	0	108	168	0	135	0	0	154	0	0	0	0		0
2057	0	57	0	108	168	0	135	0	0	154	0	0	0	0		0
2058	0	57	0	108	168	0	135	0	0	154	0	0	0	0		0
2059	0	57	0	108	168	0	135	0	0	154	0	0	0	0		0
2060	0	57	0	108	136	0	135	28	0	154	0	6	0	0		0
2061	0	57	0	108	136	0	135	28	0	154	0	6	0	0		0
2062	0	57	0	108	136	0	135	28	0	154	0	6	0	0		0
2063	0	0	0	108	142	0	111	28	0	230	0	6	0	0		0
2064	0	0	0	108	201	0	0	28	0	252	0	6	0	0		3
TOTAL	984	1140	780	1944	3271	1969	2434	138	1812	2770	665	30	29	738		3
TOTAL/REACTOR	2124		2724		3271	4403		138	4582		665	30	29	738		3
TOTAL/SITE	4848				7812				4582		665	30	767			3
								138 (AECL)						738 (HQ)		
TOTAL/OWNER	17104 (OPG)										665 (NBP)	200 (AECL)				

	Pickering			Bruce		Douglas Point	Darlington		Point Lepreau	Chalk River	Gentilly 1	Gentilly 2	Whiteshell
	Modules in wet bays	Modules in DSCs		Modules in DSCs	Trays in wet bays	Baskets in silo (AECL)	Modules in wet bays	Modules in DSCs	Baskets in silo	Baskets in silo	Baskets in silo	Baskets in canstor	Baskets in silo
TOTAL	1764	3084		5705	1969	138	1812	2770	665	30	29	738	3
AVERAGE/YEAR	294	140		238	246	28	201	154	95	6	6	67	3
MAX	402	165		310	328	28	335	252	95	6	6	72	3
PERIOD	2035 - 2040	2043 - 2064		2041 - 2064	2035 - 2042	2060 - 2064	2039 - 2047	2047 - 2064	2040 - 2046	2060 - 2064	2046 - 2050	2040 - 2050	2064

On the previous table, note that the shipments of Gentilly 1, formerly scheduled between 2060 and 2064 where moved forward in 2046, so that the shipments program for Gentilly 1 and 2 could end in the same year (2050).
This move does not have much impact on the number of bundles received at the CES/DGR (refer to paragraph 4.4.1 of this document for details on the number of bundles received at the CES/DGR).

4.1.2. Mostly Rail

OWNER :	OPG														AECL		OPG			
Site :	Pickering								Bruce								Darlington			
Reactor :	Pickering A				Pickering B				Bruce A		Bruce B				Douglas Point		Darlington			
	Modules in wet bays		Modules in DSCs		Modules in wet bays		Modules in DSCs		Modules in DSCs		Trays in wet bays		Modules in DSCs		Baskets in silos		Modules in wet bays		Modules in DSCs	
Year	RAIL IFTC/BM	ROAD IFTC/BM	RAIL DSCTP	ROAD DSCTP	RAIL IFTC/BM	ROAD IFTC/BM	RAIL DSCTP	ROAD DSCTP	RAIL DSCTP	ROAD DSCTP	RAIL IFTC/BM	ROAD IFTC/BM	RAIL DSCTP	ROAD DSCTP	RAIL IFTC/BM	ROAD IFTC/BM	RAIL IFTC/BM	ROAD IFTC/BM	RAIL DSCTP	ROAD DSCTP
2035	25	246	0	0	13	130	0	0	0	0	22	217	0	0	0	0	0	0	0	0
2036	25	246	0	0	16	156	0	0	0	0	22	217	0	0	0	0	0	0	0	0
2037	25	246	0	0	16	156	0	0	0	0	22	217	0	0	0	0	0	0	0	0
2038	25	246	0	0	16	156	0	0	0	0	22	217	0	0	0	0	0	0	0	0
2039	0	0	0	0	16	156	0	0	0	0	33	328	0	0	0	0	14	140	0	0
2040	0	0	0	0	3	26	0	0	0	0	29	289	0	0	0	0	16	151	0	0
2041	0	0	0	0	0	0	0	0	0	0	31	307	2	6	0	0	16	151	0	0
2042	0	0	0	0	0	0	0	0	0	0	18	177	2	6	0	0	28	279	0	0
2043	0	0	6	29	0	0	0	0	0	0	0	0	7	34	0	0	34	335	0	0
2044	0	0	6	29	0	0	0	0	0	0	0	0	7	34	0	0	34	335	0	0
2045	0	0	6	29	0	0	0	0	16	79	0	0	7	34	0	0	19	181	0	0
2046	0	0	6	29	0	0	0	0	16	79	0	0	7	34	0	0	19	181	0	0
2047	0	0	6	29	0	0	11	54	19	91	0	0	8	36	0	0	6	59	8	39
2048	0	0	6	29	0	0	11	54	25	121	0	0	7	34	0	0	0	0	8	39
2049	0	0	6	29	0	0	11	54	13	61	0	0	14	68	0	0	0	0	14	66
2050	0	0	6	29	0	0	11	54	15	75	0	0	14	68	0	0	0	0	16	77
2051	0	0	6	29	0	0	11	54	17	84	0	0	14	68	0	0	0	0	16	77
2052	0	0	6	29	0	0	11	54	17	84	0	0	14	68	0	0	0	0	16	77
2053	0	0	6	29	0	0	11	54	17	84	0	0	14	68	0	0	0	0	16	77
2054	0	0	6	29	0	0	11	54	17	84	0	0	14	68	0	0	0	0	16	77
2055	0	0	6	29	0	0	11	54	17	84	0	0	14	68	0	0	0	0	16	77
2056	0	0	6	29	0	0	11	54	17	84	0	0	14	68	0	0	0	0	16	77
2057	0	0	6	29	0	0	11	54	17	84	0	0	14	68	0	0	0	0	16	77
2058	0	0	6	29	0	0	11	54	17	84	0	0	14	68	0	0	0	0	16	77
2059	0	0	6	29	0	0	11	54	17	84	0	0	14	68	0	0	0	0	16	77
2060	0	0	6	29	0	0	11	54	14	68	0	0	14	68	2,60	26	0	0	16	77
2061	0	0	6	29	0	0	11	54	14	68	0	0	14	68	2,80	28	0	0	16	77
2062	0	0	6	29	0	0	11	54	14	68	0	0	14	68	2,80	28	0	0	16	77
2063	0	0	0	0	0	0	11	54	15	71	0	0	12	56	2,80	28	0	0	23	115
2064	0	0	0	0	0	0	11	54	21	101	0	0	0	0	2,80	28	0	0	26	126
Nb of shipments by means of transport	100	984	120	580	80	780	198	972	335	1638	199	1969	255	1226	14,00	138	186	1812	287	1386
TOTAL	984		580		780		972		1638		1969		1226		138		1812		1386	
TOTAL REACTOR	*1564*				*1752*				*1638*		*3195*				*138*		*3198*			
TOTAL SITE	3316								4971								3198			
															138 (AECL)					
TOTAL OWNER	11347 (OPG)																			

	Pickering					Bruce					Douglas Point		Darlington			
	Modules in wet bays		Modules in DSCs			Modules in DSCs		Trays in wet bays			Baskets in silo (AECL)		Modules in wet bays		Modules in DSCs	
	RAIL IFTC/BM	ROAD IFTC/BM	RAIL DSCTP	ROAD DSCTP		RAIL DSCTP	ROAD DSCTP	RAIL IFTC/BM	ROAD IFTC/BM		RAIL IFTC/BM	ROAD IFTC/BM	RAIL IFTC/BM	ROAD IFTC/BM	RAIL DSCTP	ROAD DSCTP
TOTAL	180	1764	318	1552		590	2864	199	1969		14	138	186	1812	287	1386
AVERAGE/YEAR	30	294	14	71		25	119	25	246		2,76	28	21	201	16	77
MAX	41	402	17	83		32	155	33	328		2,80	28	34	335	26	126
PERIOD	2035 - 2040	2035 - 2040	2043 - 2064	2043 - 2064		2041 - 2064	2041 - 2064	2035 - 2042	2035 - 2042		2060 - 2064	2060 - 2064	2039 - 2047	2039 - 2047	2047 - 2064	2047 - 2064

The previous table presents the whole program schedule for the shipments of Pickering, Bruce and Darlington.

The table hereafter presents the schedule for the shipments of New Brunswick Power, AECL and Hydro Quebec sites. As for Douglas Point, the number of rail shipments for sites of Point Lepreau and Gentilly 1 & 2 were rounded to the second decimal. The decimal numbers appearing represent shared and/or consolidated shipments.

OWNER :	NBP		AECL			HQ		AECL
Site :	Point Lepreau		Chalk River	Gentilly				Whiteshell
Reactor :	*Point Lepreau*		*Chalk River*	*Gentilly 1*		*Gentilly 2*		*Whiteshell*
	Baskets in silo		Baskets in silo	Baskets in silo		Baskets in canstor		Baskets in silo
Year	RAIL IFTC/BM	ROAD IFTC/BM	ROAD IFTC/BM	RAIL IFTC/BM	ROAD IFTC/BM	RAIL IFTC/BM	ROAD IFTC/BM	ROAD IFTC/BM
2035			No shipment					
2036								
2037								
2038								
2039								
2040	9,50	95	0	0	0	7,20	72	0
2041	9,50	95	0	0	0	7,20	72	0
2042	9,50	95	0	0	0	7,20	72	0
2043	9,50	95	0	0	0	7,20	72	0
2044	9,50	95	0	0	0	7,20	72	0
2045	9,50	95	0	0	0	7,20	72	0
2046	9,50	95	0	0,50	5	7,20	72	0
2047	0	0	0	0,60	6	7,20	72	0
2048	0	0	0	0,60	6	7,20	72	0
2049	0	0	0	0,60	6	7,20	72	0
2050	0	0	0	0,60	6	1,80	18	0
2051	0	0	0	0	0	0	0	0
2052	0	0	0	0	0	0	0	0
2053	0	0	0	0	0	0	0	0
2054	0	0	0	0	0	0	0	0
2055	0	0	0	0	0	0	0	0
2056	0	0	0	0	0	0	0	0
2057	0	0	0	0	0	0	0	0
2058	0	0	0	0	0	0	0	0
2059	0	0	0	0	0	0	0	0
2060	0	0	6	0	0	0	0	0
2061	0	0	6	0	0	0	0	0
2062	0	0	6	0	0	0	0	0
2063	0	0	6	0	0	0	0	0
2064	0	0	6	0	0	0	0	3
Nb of shipments by means of transport	66,50	665	30	2,90	29	73,80	738	3
TOTAL	665		30	29		738		3
TOTAL REACTOR	*665*		*30*	*29*		*738*		*3*
TOTAL SITE	665		30	29		738		3
						738 (HQ)		
TOTAL OWNER	665 (NBP)		200 (AECL, Douglas Pt included)					

	Point Lepreau		Chalk River	Gentilly 1		Gentilly 2		Whiteshell
	Baskets in silo		Baskets in silo	Baskets in silo		Baskets in canstor		Baskets in silo
	RAIL IFTC/BM	ROAD IFTC/BM	ROAD IFTC/BM	RAIL IFTC/BM	ROAD IFTC/BM	RAIL IFTC/BM	ROAD IFTC/BM	ROAD IFTC/BM
TOTAL	67	665	30	3	29	74	738	3
AVERAGE/YEAR	9,50	95	6	0,58	6	6,71	67	3
MAX	9,50	95	6	0,60	6	7,20	72	3
PERIOD	2040 - 2046	2040 - 2046	2060 - 2064	2046 - 2050	2046 - 2050	2040 - 2050	2040 - 2050	2064

4.1.3. Mostly Water

OWNER :	OPG														AECL		OPG			
Site :	Pickering								Bruce								Darlington			
Reactor :	Pickering A				Pickering B				Bruce A		Bruce B				Douglas Point		Darlington			
Year	Modules in wet bays		Modules in DSCs		Modules in wet bays		Modules in DSCs		Modules in DSCs		Trays in wet bays		Modules in DSCs		Baskets in silos		Modules in wet bays		Modules in DSCs	
	WATER IFTC/BM	ROAD IFTC/BM	WATER DSCTP	ROAD DSCTP	WATER IFTC/BM	ROAD IFTC/BM	WATER DSCTP	ROAD DSCTP	WATER DSCTP	ROAD DSCTP	WATER IFTC/BM	ROAD IFTC/BM	WATER DSCTP	ROAD DSCTP	WATER IFTC/BM	ROAD IFTC/BM	WATER IFTC/BM	ROAD IFTC/BM	WATER DSCTP	ROAD DSCTP
2035	8	246	0	0	5	130	0	0	0	0	7	217	0	0	0	0	0	0	0	0
2036	8	246	0	0	5	156	0	0	0	0	7	217	0	0	0	0	0	0	0	0
2037	8	246	0	0	5	156	0	0	0	0	7	217	0	0	0	0	0	0	0	0
2038	8	246	0	0	5	156	0	0	0	0	7	217	0	0	0	0	0	0	0	0
2039	0	0	0	0	5	156	0	0	0	0	11	328	0	0	0	0	5	140	0	0
2040	0	0	0	0	1	26	0	0	0	0	10	289	0	0	0	0	5	151	0	0
2041	0	0	0	0	0	0	0	0	0	0	10	307	1	6	0	0	5	151	0	0
2042	0	0	0	0	0	0	0	0	0	0	6	177	1	6	0	0	9	279	0	0
2043	0	0	2	29	0	0	0	0	0	0	0	0	3	34	0	0	11	335	0	0
2044	0	0	2	29	0	0	0	0	0	0	0	0	3	34	0	0	11	335	0	0
2045	0	0	2	29	0	0	0	0	6	79	0	0	3	34	0	0	6	181	0	0
2046	0	0	2	29	0	0	0	0	6	79	0	0	3	34	0	0	6	181	0	0
2047	0	0	2	29	0	0	4	54	7	91	0	0	3	36	0	0	2	59	3	39
2048	0	0	2	29	0	0	4	54	9	121	0	0	3	34	0	0	0	0	3	39
2049	0	0	2	29	0	0	4	54	5	61	0	0	5	68	0	0	0	0	5	66
2050	0	0	2	29	0	0	4	54	5	75	0	0	5	68	0	0	0	0	6	77
2051	0	0	2	29	0	0	4	54	6	84	0	0	5	68	0	0	0	0	6	77
2052	0	0	2	29	0	0	4	54	6	84	0	0	5	68	0	0	0	0	6	77
2053	0	0	2	29	0	0	4	54	6	84	0	0	5	68	0	0	0	0	6	77
2054	0	0	2	29	0	0	4	54	6	84	0	0	5	68	0	0	0	0	6	77
2055	0	0	2	29	0	0	4	54	6	84	0	0	5	68	0	0	0	0	6	77
2056	0	0	2	29	0	0	4	54	6	84	0	0	5	68	0	0	0	0	6	77
2057	0	0	2	29	0	0	4	54	6	84	0	0	5	68	0	0	0	0	6	77
2058	0	0	2	29	0	0	4	54	6	84	0	0	5	68	0	0	0	0	6	77
2059	0	0	2	29	0	0	4	54	6	84	0	0	5	68	0	0	0	0	6	77
2060	0	0	2	29	0	0	4	54	5	68	0	0	5	68	0,81	26	0	0	6	77
2061	0	0	2	29	0	0	4	54	5	68	0	0	5	68	0,88	28	0	0	6	77
2062	0	0	2	29	0	0	4	54	5	68	0	0	5	68	0,88	28	0	0	6	77
2063	0	0	0	0	0	0	4	54	5	71	0	0	4	56	0,88	28	0	0	8	115
2064	0	0	0	0	0	0	4	54	7	101	0	0	0	0	0,88	28	0	0	9	126
Nb of shipments by means of transport	32	984	40	580	26	780	72	972	119	1638	65	1969	94	1226	4,31	138	60	1812	106	1386
TOTAL	984		580		780		972		1638		1969		1226		138		1812		1386	
TOTAL REACTOR	*1564*				*1752*				*1638*		*3195*				*138*		*3198*			
TOTAL SITE	3316								4971								3198			
															138 (AECL)					
TOTAL OWNER	11347 (OPG)																			

	Pickering					Bruce					Douglas Point		Darlington			
	Modules in wet bays		Modules in DSCs			Modules in DSCs		Trays in wet bays			Baskets in silo (AECL)		Modules in wet bays		Modules in DSCs	
	WATER IFTC/BM	ROAD IFTC/BM	WATER DSCTP	ROAD DSCTP		WATER DSCTP	ROAD DSCTP	WATER IFTC/BM	ROAD IFTC/BM		WATER IFTC/BM	ROAD IFTC/BM	WATER IFTC/BM	ROAD IFTC/BM	WATER DSCTP	ROAD DSCTP
TOTAL	58	1764	112	1552		213	2864	65	1969		4,31	138	60	1812	106	1386
AVERAGE/YEAR	10	294	5	71		9	119	8	246		0,86	28	7	201	6	77
MAX	13	402	6	83		11	155	11	328		0,88	28	11	335	9	126
PERIOD	2035 - 2040	2035 - 2040	2043 - 2064	2043 - 2064		2041 - 2064	2041 - 2064	2035 - 2042	2035 - 2042		2060 - 2064	2060 - 2064	2039 - 2047	2039 - 2047	2047 - 2064	2047 - 2064

The previous table presents the number of shipments by road and by waterways for Pickering, Bruce and Darlington.
The table hereafter presents the schedule of shipments by road and by waterways for New Brunswick Power, AECL and Hydro Quebec sites. As for Douglas Point, the number of rail shipments for sites of Point Lepreau and Gentilly 1 & 2 were rounded to the second decimal. The decimal numbers appearing represent shared and/or consolidated shipments.

OWNER :	NBP		AECL			HQ		AECL
Site :	Point Lepreau		Chalk River	Gentilly				Whiteshell
Reactor :	*Point Lepreau*		*Chalk River*	*Gentilly 1*		*Gentilly 2*		*Whiteshell*
	Baskets in silo		Baskets in silo	Baskets in silo		Baskets in canstor		Baskets in silo
Year	WATER IFTC/BM	ROAD IFTC/BM	ROAD IFTC/BM	WATER IFTC/BM	ROAD IFTC/BM	WATER IFTC/BM	ROAD IFTC/BM	ROAD IFTC/BM
2035			No shipment					
2036								
2037								
2038								
2039								
2040	2,97	95	0	0	0	2,25	72	0
2041	2,97	95	0	0	0	2,25	72	0
2042	2,97	95	0	0	0	2,25	72	0
2043	2,97	95	0	0	0	2,25	72	0
2044	2,97	95	0	0	0	2,25	72	0
2045	2,97	95	0	0	0	2,25	72	0
2046	2,97	95	0	0,16	5	2,25	72	0
2047	0	0	0	0,19	6	2,25	72	0
2048	0	0	0	0,19	6	2,25	72	0
2049	0	0	0	0,19	6	2,25	72	0
2050	0	0	0	0,19	6	0,56	18	0
2051	0	0	0	0	0	0	0	0
2052	0	0	0	0	0	0	0	0
2053	0	0	0	0	0	0	0	0
2054	0	0	0	0	0	0	0	0
2055	0	0	0	0	0	0	0	0
2056	0	0	0	0	0	0	0	0
2057	0	0	0	0	0	0	0	0
2058	0	0	0	0	0	0	0	0
2059	0	0	0	0	0	0	0	0
2060	0	0	6	0	0	0	0	0
2061	0	0	6	0	0	0	0	0
2062	0	0	6	0	0	0	0	0
2063	0	0	6	0	0	0	0	0
2064	0	0	6	0	0	0	0	3
Nb of shipments by means of transport	20,78	665	30	0,91	29	23,06	738	3
TOTAL	665		30	29		738		3
TOTAL REACTOR	*665*		*30*	*29*		*738*		*3*
TOTAL SITE	665		30	29		738		3
						738 (HQ)		
TOTAL OWNER	665 (NBP)		200 (AECL, Douglas Pt included)					

	Point Lepreau		Chalk River	Gentilly 1		Gentilly 2		Whiteshell
	Baskets in silo		Baskets in silo	Baskets in silo		Baskets in canstor		Baskets in silo
	WATER IFTC/BM	ROAD IFTC/BM	ROAD IFTC/BM	WATER IFTC/BM	ROAD IFTC/BM	WATER IFTC/BM	ROAD IFTC/BM	ROAD IFTC/BM
TOTAL	20,78	665	30	0,91	29	23,06	738	3
AVERAGE/YEAR	2,97	95	6	0,18	6	2,10	67	3
MAX	2,97	95	6	0,19	6	2,25	72	3
PERIOD	2040 - 2046	2040 - 2046	2060 - 2064	2046 - 2050	2046 - 2050	2040 - 2050	2040 - 2050	2064

4.2. Review of on-site operations

4.2.1. All Road

4.2.1.1. Pickering

4.2.1.1.1 Modules in DSCs

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
Phase 0	**Modules in DSC**	Interim storage	Initial phase		
Phase 1	**Internal transfer of the DSC**	Interim storage			
Phase 2	**Unloading modules from DSC**	Interim storage			
Phase 3	**Loading the modules into the packaging**	UFTS	With the hoist N°3, open the lid of the packaging in a hot cell.	Packaging	IFTC/BM : See section 2.4.7.1.3 of **<4>** Appendix A, Figures N°4, N° 5
			With hoist N°2 Load the modules into the packaging		
Phase 4	**Pre-shipment packaging preparation**	UFTS	Drying the cavity	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves,
			Filling the cavity with helium	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves, compressed air line
			Leaktightness check	Leaktightness equipment	
			Installing the impact limiter	Gantry crane	For the impact limiter (10 tons)
			Depressurising the cavity	Vacuum circuit	
Phase 5	**Internal transfer of the Transportation cask**	UFTS	Approach of the Bogie	Bogie	Bogie with pulley drive system
			Radiological control of the Transportation cask and the Bogie	Non contamination, Dose Rate	"Smear test", Radiameter
			Internal transfer	Tie down	
Phase 6	**Loading the Transportation cask on a trailer**	UFTS	Radiological control of the Transportation cask	Non contamination, Dose Rate	"Smear test", Radiameter
			Open the weather cover	Weather cover	
			Loading the packaging on a trailer	Gantry Crane	With 1 hoist (of 60 tons for the IFTC/BM)
				Lifting Beam for packaging	To carry of the IFTC/BM similar to the IFTC, **<4>**)
				Trailer (**<4>** Appendix A, Figures N°13, 14)	- Modified 48 foot flatted trailer with integrated tie-down - Trailer equipped with hydraulic or air ride suspension to cushion the load - Trailer equipped with four axles - One loaded cask per trailer
				Tractor (**<4>** Appendix A, Figure N°14)	- Standard commercial tractor sufficient for the loaded weight - The weight for the fuelled reference tractor is roughly 9,075 kg.
			Packaging tie-down on the trailer	Tie down	Similar to the Tie down of the IFTC. (**<4>** Appendix A, Figure N°15)
			Check the condition of the Transportation cask, trailer		
			Fit the transport seals		
			Close the weather cover	Weather cover	
			Radiological control of the trailer	Non contamination, Dose Rate	"Smear test", Radiameter

4.2.1.1.2 Modules in Wet Bays

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
Phase 0	**Modules in wet bays**	Interim storage	Initial phase		
Phase 1	**Loading the modules into the packaging in the pool**	UFTS	Loading the modules into the packaging in the pool	Gantry crane	Identical as the IFTC in the pool **<3>** Decontamination of the IFTC/BM: identical as IFTC **<3>**
				Packaging	IFTC/BM : See section 2.4.7.1.3 of **<4>** Figure N°5 in Appendix A
Phase 2	**Pre-shipment packaging preparation**	UFTS	Drainage		
			Drying the cavity	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves,
			Filling the cavity with helium	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves, compressed air line
			Leaktightness check	Leaktightness equipment	
			Depressurising the cavity	Vacuum circuit	
Phase 3	**Internal transfer of the packaging**	UFTS	Unloading of the packaging from the trolley	Gantry crane	60 tons
			Radiological control of the packaging	Non contamination, Dose Rate	"Smear test", Radiameter
			Approach of the Trolley	Trolley	Trolley with tractor
			Radiological control of the Trolley	Non contamination, Dose Rate	"Smear test", Radiameter
			Installing the impact limiter	Gantry crane	For the impact limiter (10 tons)
			Loading of the Transportation cask on the Trolley		
			Radiological control of the Transportation cask and the Trolley	Non contamination, Dose Rate	"Smear test", Radiameter
			Internal transfer	Tie down	
Phase 4	**Loading the Transportation cask on a trailer**	UFTS	Radiological control of the Transportation cask	Non contamination, Dose Rate	"Smear test", Radiameter
			Open the weather cover	Weather cover	
			Loading the Transportation cask on a trailer	Gantry Crane	With 1 hoist (of 60 tons for the IFTC/BM)
				Lifting Beam for Transportation cask	To carry of the IFTC/BM similar to the IFTC
				Trailer (**<4>,** Appendix A, Figures N°13, 14)	- Modified 48 foot flatted trailer with integrated tie-down - Trailer equipped with hydraulic or air ride suspension to cushion the load - Trailer equipped with four axles - One loaded cask per trailer
				Tractor (**<4>,** Appendix A, Figure N°14)	- Standard commercial tractor sufficient for the loaded weight - The weight for the fuelled reference tractor is roughly 9,075 kg.
			Packaging tie-down on the trailer	Tie down	Similar to the Tie down of the IFTC (Appendix A, Figure N° 15, **<4>**)
			Check the condition of the Transportation cask, trailer		
			Fit the transport seals		
			Close the weather cover	Weather cover	
			Radiological control of the trailer	Non contamination, Dose Rate	"Smear test", Radiameter

4.2.1.2. Bruce

4.2.1.2.1 Modules in DSCs

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
Phase 0	**Modules in DSC**	Interim storage	Initial phase		
Phase 1	**Internal transfer of the DSC**	Interim storage			
Phase 2	**Unloading modules from DSC**	Interim storage			
Phase 3	**Loading the modules into the packaging**	UFTS	With the hoist N°3, open the lid of the packaging in a hot cell.	Packaging	IFTC/BM : See section 2.4.7.1.3 of **<4>** Figures N°4 **<3>**, N°5 in Appendix A
			With hoist N°2 Load the modules into the packaging		
Phase 4	**Pre-shipment packaging preparation**	UFTS	Drying the cavity	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves,
			Filling the cavity with helium	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves, compressed air line
			Leaktightness check	Leaktightness equipment	
			Depressurising the cavity	Vacuum circuit	
			Installing the impact limiter	Gantry crane	For the impact limiter (10 tons)
Phase 5	**Internal transfer of the packaging**	UFTS	Approach of the Bogie	Bogie	Bogie with pulley drive system
			Radiological control of the Transportation cask and the Bogie	Non contamination, Dose Rate	"Smear test", Radiameter
			Internal transfer	Tie down	
Phase 6	**Loading the Transportation cask on a trailer**	UFTS	Radiological control of the Transportation cask	Non contamination, Dose Rate	"Smear test", Radiameter
			Open the weather cover	Weather cover	
			Loading the Transportation cask on a trailer	Gantry Crane	With 1 hoist (of 60 tons for the IFTC/BM)
				Lifting Beam for the Transportation cask	To carry of the IFTC/BM similar to the IFTC
				Trailer (**<4>,** Appendix A, Figures N°12, 13, 14)	- Modified 48 foot flatted trailer with integrated tie-down - Trailer equipped with hydraulic or air ride suspension to cushion the load - Trailer equipped with four axles - One loaded cask per trailer
				Tractor (**<4>,** Appendix A, Figure N°14)	- Standard commercial tractor sufficient for the loaded weight - The weight for the fuelled reference tractor is roughly 9,075 kg.
			Packaging tie-down on the trailer	Tie down	Similar to the Tie down of the IFTC (Appendix A, Figure N°15, **<4>**)
			Check the condition of the Transportation cask, trailer		
			Fit the transport seals		
			Close the weather cover	Weather cover	
			Radiological control of the trailer	Non contamination, Dose Rate	"Smear test", Radiameter

4.2.1.2.2 Trays in wet bays

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
Phase 0	**Trays in wet bays**	Interim storage	Initial phase		
Phase 1	**Unloading of the bundles from the trays into the modules**	Interim storage			
Phase 2	**Loading the modules into the packaging in the pool**	UFTS	Loading the modules into the packaging in the pool	Gantry crane	Identical than the IFCT in the pool Decontamination of the IFTC/BM: identical as IFTC
				Packaging	IFTC/BM : See section 2.4.7.1.3 of **<4>** Figure N°5 in Appendix A
Phase 3	**Pre-shipment packaging preparation**	UFTS	Unloading of the packaging from the trolley	Gantry crane	60 tons
			Drainage		
			Drying the cavity	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves,
			Filling the cavity with helium	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves, compressed air line
			Leaktightness check	Leaktightness equipment	
			Depressurising the cavity	Vacuum circuit	
Phase 4	**Internal transfer of the packaging**	UFTS	Radiological control of the packaging	Non contamination, Dose Rate	"Smear test", Radiameter
			Approach of the Trolley	Trolley	Trolley with tractor
			Radiological control of the Trolley	Non contamination, Dose Rate	"Smear test", Radiameter
			Loading of the full packaging on the Trolley		
			Installing the impact limiter		
			Radiological control of the Transportation cask and the Trolley	Non contamination, Dose Rate	"Smear test", Radiameter
			Internal transfer	Tie down	Similar to the Tie down of the IFTC
Phase 5	**Loading the Transportation cask on a trailer**	UFTS	Radiological control of the Transportation cask	Non contamination, Dose Rate	"Smear test", Radiameter
			Open the weather cover	Weather cover	
			Loading the Transportation cask on a trailer	Gantry Crane	With hoist (of 60 tons for the IFTC/BM)
				Lifting Beam for Transportation cask	To carry of the IFTC/BM similar to the IFTC
				Trailer (**<4>,** Appendix A, Figures N°13, 14)	- Modified 48 foot flatted trailer with integrated tie-down - Trailer equipped with hydraulic or air ride suspension to cushion the load - Trailer equipped with four axles - One loaded cask per trailer
				Tractor (**<4>,** Appendix A, Figure N°14)	- Standard commercial tractor sufficient for the loaded weight - The weight for the fuelled reference tractor is roughly 9,075 kg.
			Packaging tie-down on the trailer	Tie down	Similar to the Tie down of the IFTC (Appendix A, Figure N°15, **<4>**)
			Check the condition of the Transportation cask, trailer		
			Fit the transport seals		
			Close the weather cover	Weather cover	
			Radiological control of the trailer	Non contamination, Dose Rate	"Smear test", Radiameter

4.2.1.2.3 Douglas Point

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
Phase 0	**Baskets in Silo**	Interim storage	Initial phase		
Phase 1	**Unloading of the baskets from the Silo into the transfer flask**	Interim storage			
Phase 2	**Internal transfer of the transfer flask**	Interim storage			
Phase 3	**Loading the baskets from the transfer flask into the packaging**	UFTS	With a gantry crane , place the transfer flask on the hot cell	Transfer flask	Similar to Gentilly 2 : **<4>,** Appendix A, Figure N°10 - Shielded fuel transfer cask - 26 tons with 60 bundles basket and with irradiated fuel - "Sliding" gate - Electric hoist for lifting or lowering a basket into the IFTC/BM - Chain - Basket lifting grapple - Shielding
				Gantry crane	For the Transfer flask
				Lifting Beam	
			With the hoist N°1, open the lid of the packaging in a hot cell.	Packaging	IFTC/BM : See chapter 2., section 2.4.7.1.3 of **<4>** and Appendix A, Figure N° 6 of **<4>**
			Load the baskets into the packaging		
Phase 4	**Pre-shipment packaging preparation**	UFTS	Drying the cavity	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves, work plate-form for bolt the lid
			Filling the cavity with helium	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves, compressed air line
			Leaktightness check	Leaktightness equipment	
			Depressurising the cavity	Vacuum circuit	
			Installing the impact limiter	Gantry crane	For the impact limiter
Phase 5	**Internal transfer of the Transportation cask**	UFTS	Radiological control of the Transportation cask	Non contamination, Dose Rate	"Smear test", Radiameter
			Approach of the Bogie	Bogie	Bogie with pulley drive system
			Radiological control of the Bogie	Non contamination, Dose Rate	"Smear test", Radiameter
			Loading of the Transportation cask on the Bogie		
			Radiological control of the Transportation cask and the bogie	Non contamination, Dose Rate	"Smear test", Radiameter
			Internal transfer	Tie down	Similar to the Tie down of the IFTC

Douglas Point continued:

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
Phase 6	**Loading the Transportation cask on a trailer**	UFTS	Radiological control of the Transportation cask	Non contamination, Dose Rate	"Smear test", Radiameter
			Open the weather cover	Weather cover	
			Loading the Transportation cask on a trailer	Gantry Crane	With 1 hoist (of 60 tons for the IFTC/BM)
				Lifting Beam for packaging	To carry of the IFTC/BM (similar to the IFTC)
				Trailer (**<4>,** Appendix A, Figures N° 13, 14)	- Modified 48 foot flatted trailer with integrated tie-down - Trailer equipped with hydraulic or air ride suspension to cushion the load - Trailer equipped with four axles - One loaded cask per trailer
				Tractor (**<4>,** Appendix A, Figure 14)	- Standard commercial tractor sufficient for the loaded weight - The weight for the fuelled reference tractor is roughly 9,075 kg.
			Packaging tie-down on the trailer	Tie down	Similar to the Tie down of the IFTC. (Appendix A, Figure N°15, **<4>**)
			Check the condition of the packaging, trailer		
			Fit the transport seals		
			Close the weather cover	Weather cover	
			Radiological control of the trailer	Non contamination, Dose Rate	"Smear test", Radiameter

4.2.1.3. Darlington

4.2.1.3.1 Modules in DSCs

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
Phase 0	**Modules in DSC**	Interim storage	Initial phase		
Phase 1	**Internal transfer of the DSC**	Interim storage			
Phase 2	**Unloading modules from DSC**	Interim storage			
Phase 3	**Loading the modules into the packaging**	UFTS	With the hoist N°3, open the lid of the packaging in a hot cell.	Packaging	IFTC/BM : See section 2.4.7.1.3 of **<4>** Figures N°4, N°5 in Appendix A
			With hoist N°2 Load the modules into the packaging		
Phase 4	**Pre-shipment packaging preparation**	UFTS	Drying the cavity	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves,
			Filling the cavity with helium	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves, compressed air line
			Leaktightness check	Leaktightness equipment	
			Installing the impact limiter	Gantry crane	For the impact limiter (10 tons)
			Depressurising the cavity	Vacuum circuit	
Phase 5	**Internal transfer of the packaging**	UFTS	Approach of the Bogie	Bogie	Bogie with pulley drive system
			Radiological control of the Transportation cask and the Bogie vehicle	Non contamination, Dose Rate	“Smear test”, Radiameter
			Internal transfer	Tie down	
Phase 6	**Loading the Transportation cask on a trailer**	UFTS	Radiological control of the Transportation cask	Non contamination, Dose Rate	“Smear test”, Radiameter
			Open the weather cover	Weather cover	
			Loading the Transportation cask on a trailer	Gantry Crane	With 1 hoist (of 60 tons for the IFTC/BM))
				Lifting Beam for Transportation cask	To carry of the IFTC/BM similar to the IFTC, **<4>**)
				Trailer (**<4>,** Appendix A, Figures N°13, 14)	- Modified 48 foot flatted trailer with integrated tie-down - Trailer equipped with hydraulic or air ride suspension to cushion the load - Trailer equipped with four axles - One loaded cask per trailer
				Tractor **<4>**, (Appendix A, Figure N°14)	- Standard commercial tractor sufficient for the loaded weight - The weight for the fuelled reference tractor is roughly 9,075 kg.
			Packaging tie-down on the trailer	Tie down	Similar to the Tie down of the IFTC (Appendix A, Figure N°15, **<4>**)
			Check the condition of the packaging, trailer		
			Fit the transport seals		
			Close the weather cover	Weather cover	
			Radiological control of the trailer	Non contamination, Dose Rate	“Smear test”, Radiameter

4.2.1.3.2 Modules in Wet Bays

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
Phase 0	**Modules in wet bays**	Interim storage	Initial phase		
Phase 1	**Loading the modules into the packaging in the pool**	UFTS	Loading the modules into the packaging in the pool		Identical than the IFTC in the pool Decontamination of the IFTC/BM: identical as IFTC
Phase 2	**Pre-shipment packaging preparation**	UFTS	Drainage		
				Packaging	IFTC/BM : See section 2.4.7.1.3 of **<4>** Figure N°5 in Appendix A
			Drying the cavity	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves,
			Filling the cavity with helium	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves, compressed air line
			Leaktightness check	Leaktightness equipment	
			Depressurising the cavity	Vacuum circuit	
Phase 3	**Internal transfer of the packaging**	UFTS	Unloading the packaging from the trolley	Gantry crane	60 tons
			Installing the impact limiter	Gantry crane	For the impact limiter
			Radiological control of the Transportation cask	Non contamination, Dose Rate	“Smear test”, Radiameter
			Approach of the Trolley	Trolley	Trolley with tractor
			Radiological control of the Trolley	Non contamination, Dose Rate	“Smear test”, Radiameter
			Loading of the Transportation cask on the Trolley		
			Radiological control of the Transportation cask and the Trolley	Non contamination, Dose Rate	“Smear test”, Radiameter
			Internal transfer	Tie down	
Phase 4	**Loading the Transportation cask on a trailer**	UFTS	Radiological control of the Transportation cask	Non contamination, Dose Rate	“Smear test”, Radiameter
			Open the weather cover	Weather cover	
			Loading the Transportation cask on a trailer	Gantry Crane	With 1 hoist (of 60 tons for the IFTC/BM)
				Lifting Beam for packaging	To carry of the IFTC/BM similar to the IFTC, **<4>**)
				Trailer (**<4>,** Appendix A, Figures N°13, 14)	- Modified 48 foot flatted trailer with integrated tie-down - Trailer equipped with hydraulic or air ride suspension to cushion the load - Trailer equipped with four axles - One loaded cask per trailer
				Tractor (**<4>,** Appendix A, Figure N°14)	- Standard commercial tractor sufficient for the loaded weight - The weight for the fuelled reference tractor is roughly 9,075 kg.
			Packaging tie-down on the trailer	Tie down	Similar to the Tie down of the IFTC (Appendix A, Figure N° 15, **<4>**)
			Check the condition of the packaging, trailer		
			Fit the transport seals		
			Close the weather cover	Weather cover	
			Radiological control of the trailer	Non contamination, Dose Rate	“Smear test”, Radiameter

4.2.1.4. Point Lepreau

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
Phase 0	**Baskets in Silo**	Interim storage	Initial phase		
Phase 1	**Unloading of the baskets from the Silo into the transfer flask**	Interim storage			
Phase 2	**Internal transfer of the transfer flask**	Interim storage			
Phase 3	**Loading the baskets from the transfer flask into the packaging**	UFTS	With a gantry crane , place the transfer flask on the hot cell	Transfer flask	Similar to Gentilly 2: **<4>,** Appendix A, Figure N°10 - Shielded fuel transfer cask - 26 tons with 60 bundles basket and with irradiated fuel - "Sliding" gate - Electric hoist for lifting or lowering a basket into the IFTC/BM - Chain - Basket lifting grapple - Shielding
				Gantry crane	For the Transfer flask
				Lifting Beam	For the Transfer flask
			With the hoist N°1, open the lid of the packaging in a hot cell.	Packaging	IFTC/BM: See chapter 2., section 2.4.7.1.3 of **<4>** Appendix A, Figure N° 6
			With hoist N°2 Load the baskets into the packaging		
Phase 4	**Pre-shipment packaging preparation**	UFTS	Drying the cavity	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves, work plate-form for bolt the lid
			Filling the cavity with helium	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves, compressed air line
			Leaktightness check	Leaktightness equipment	
			Depressurising the cavity	Vacuum circuit	
			Installing the impact limiter		
Phase 5	**Internal transfer of the Transportation cask**	UFTS	Radiological control of the Transportation cask	Non contamination, Dose Rate	"Smear test", Radiameter
			Approach of the Bogie	Bogie	Bogie with pulley drive system
			Radiological control of the Bogie	Non contamination, Dose Rate	"Smear test", Radiameter
			Loading of the Transportation cask on the Bogie		
			Radiological control of the Transportation cask and the bogie	Non contamination, Dose Rate	"Smear test", Radiameter
			Internal transfer	Tie down	Similar to the Tie down of the IFTC

Point Lepreau follow-up:

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
Phase 6	**Loading the Transportation cask on a trailer**	UFTS	Radiological control of the Transportation cask	Non contamination, Dose Rate	"Smear test", Radiameter
			Open the weather cover	Weather cover	
			Loading the Transportation cask on a trailer	Gantry Crane	With 1 hoist (of 60 tons for the IFTC/BM)
				Lifting Beam for packaging	To carry of the IFTC/BM (similar to the IFTC)
				Trailer (**<4>,** Appendix A, Figures N°13, 14)	- Modified 48 foot flatted trailer with integrated tie-down - Trailer equipped with hydraulic or air ride suspension to cushion the load - Trailer equipped with four axles - One loaded cask per trailer
				Tractor (**<4>,** Appendix A, Figure 14)	- Standard commercial tractor sufficient for the loaded weight - The weight for the fuelled reference tractor is roughly 9,075 kg.
			Packaging tie-down on the trailer	Tie down	Similar to the Tie down of the IFTC. (Appendix A, Figure N°15, **<4>**)
			Check the condition of the packaging, trailer		
			Fit the transport seals		
			Close the weather cover	Weather cover	
			Radiological control of the trailer	Non contamination, Dose Rate	"Smear test", Radiameter

4.2.1.5. Chalk River

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
Phase 0	**Baskets in Silo**	Interim storage	Initial phase		
Phase 1	**Unloading of the baskets from the Silo into the transfer flask**	Interim storage			
Phase 2	**Internal transfer of the transfer flask**	Interim storage			
Phase 3	**Loading the baskets from the transfer flask into the packaging**	UFTS	With a gantry crane , place the transfer flask on the hot cell	Transfer flask	Similar to Gentilly 2 : Appendix A, Figure N°10 - Shielded fuel transfer cask - 26 tons with 60 bundles basket and with irradiated fuel - "Sliding" gate - Electric hoist for lifting or lowering a basket into the IFTC/BM - Chain - Basket lifting grapple - Shielding
				Gantry crane	For the Transfer flask
				Lifting Beam	For the Transfer flask
			With the hoist N°1, open the lid of the packaging in a hot cell.	Packaging	IFTC/BM: See chapter 2., section 2.4.7.1.3 of **<4>** Appendix A, Figure N° 6
			With hoist N°2 Load the baskets into the packaging		
Phase 4	**Pre-shipment packaging preparation**	UFTS	Drying the cavity	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves, work plate-form for bolt the lid
			Filling the cavity with helium	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves, compressed air line
			Leaktightness check	Leaktightness equipment	
			Depressurising the cavity	Vacuum circuit	
			Installing the impact limiter		
Phase 5	**Internal transfer of the Transportation cask**	UFTS	Radiological control of the Transportation cask	Non contamination, Dose Rate	"Smear test", Radiameter
			Approach of the Bogie	Bogie	Bogie with pulley drive system
			Radiological control of the Bogie	Non contamination, Dose Rate	"Smear test", Radiameter
			Loading of the Transportation cask on the Bogie		
			Radiological control of the Transportation cask and the bogie	Non contamination, Dose Rate	"Smear test", Radiameter
			Internal transfer	Tie down	Similar to the Tie down of the IFTC

Chalk River follow-up:

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
Phase 6	**Loading the Transportation cask on a trailer**	UFTS	Radiological control of the Transportation cask	Non contamination, Dose Rate	"Smear test", Radiameter
			Open the weather cover	Weather cover	
			Loading the Transportation cask on a trailer	Gantry Crane	With 1 hoist (of 60 tons for the IFTC/BM)
				Lifting Beam for packaging	To carry of the IFTC/BM (similar to the IFTC)
				Trailer (**<4>,** Appendix A, Figures N°13, 14)	- Modified 48 foot flatted trailer with integrated tie-down - Trailer equipped with hydraulic or air ride suspension to cushion the load - Trailer equipped with four axles - One loaded cask per trailer
				Tractor (**<4>,** Appendix A, Figure 14)	- Standard commercial tractor sufficient for the loaded weight - The weight for the fuelled reference tractor is roughly 9,075 kg.
			Packaging tie-down on the trailer	Tie down	Similar to the Tie down of the IFTC. (Appendix A, Figure N°15, **<4>**)
			Check the condition of the packaging, trailer		
			Fit the transport seals		
			Close the weather cover	Weather cover	
			Radiological control of the trailer	Non contamination, Dose Rate	"Smear test", Radiameter

4.2.1.6. Gentilly

4.2.1.6.1 Baskets in Silo

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
Phase 0	**Baskets in Silo**	Interim storage	Initial phase		
Phase 1	**Unloading of the baskets from the Silo into the transfer flask**	Interim storage			
Phase 2	**Internal transfer of the transfer flask**	Interim storage			
Phase 3	**Loading the baskets from the transfer flask into the packaging**	UFTS	With a gantry crane , place the transfer flask on the hot cell	Transfer flask	Similar to Gentilly 2 : **<4>,** Appendix A, Figure N°10 - Shielded fuel transfer cask - 26 tons with 60 bundles basket and with irradiated fuel - "Sliding" gate - Electric hoist for lifting or lowering a basket into the IFTC/BM - Chain - Basket lifting grapple - Shielding
				Gantry crane	For the Transfer flask
				Lifting Beam	For the Transfer flask
			With the hoist N°1, open the lid of the packaging in a hot cell.	Packaging	IFTC/BM : See chapter 2., section 2.4.7.1.3 of **<4>** Appendix A, Figure N° 6
			Load the baskets into the packaging		
Phase 4	**Pre-shipment packaging preparation**	UFTS	Drying the cavity	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves, work plate-form for bolt the lid
			Filling the cavity with helium	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves, compressed air line
			Leaktightness check	Leaktightness equipment	
			Depressurising the cavity	Vacuum circuit	
			Installing the impact limiter		
Phase 5	**Internal transfer of the Transportation cask**	UFTS	Radiological control of the Transportation cask	Non contamination, Dose Rate	"Smear test", Radiameter
			Approach of the Bogie	Bogie	Bogie with pulley drive system
			Radiological control of the Bogie	Non contamination, Dose Rate	"Smear test", Radiameter
			Loading of the Transportation cask on the Bogie		
			Radiological control of the Transportation cask and the bogie	Non contamination, Dose Rate	"Smear test", Radiameter
			Internal transfer	Tie down	Similar to the Tie down of the IFTC

Gentilly baskets in silo follow-up:

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
Phase 6	**Loading the Transportation cask on a trailer**	UFTS	Radiological control of the Transportation cask	Non contamination, Dose Rate	"Smear test", Radiameter
			Open the weather cover	Weather cover	
			Loading the Transportation cask on a trailer	Gantry Crane	With 1 hoist (of 60 tons for the IFTC/BM)
				Lifting Beam for packaging	To carry of the IFTC/BM (similar to the IFTC)
				Trailer (**<4>,** Appendix A, Figures N°13, 14)	- Modified 48 foot flatted trailer with integrated tie-down - Trailer equipped with hydraulic or air ride suspension to cushion the load - Trailer equipped with four axles - One loaded cask per trailer
				Tractor (**<4>,** Appendix A, Figure 14)	- Standard commercial tractor sufficient for the loaded weight - The weight for the fuelled reference tractor is roughly 9,075 kg.
			Packaging tie-down on the trailer	Tie down	Similar to the Tie down of the IFTC. (Appendix A, Figure N°15, **<4>**)
			Check the condition of the packaging, trailer		
			Fit the transport seals		
			Close the weather cover	Weather cover	
			Radiological control of the trailer	Non contamination, Dose Rate	"Smear test", Radiameter

4.2.1.6.2 Baskets in Canstor

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
Phase 0	**Baskets in Canstor**	Interim storage	Initial phase		
Phase 1	**Unloading of the baskets from the Silo into the transfer flask**	Interim storage			
Phase 2	**Internal transfer of the transfer flask**	Interim storage			
Phase 3	**Loading the baskets from the transfer flask into the packaging**	UFTS	With a gantry crane , place the transfer flask on the hot cell	Transfer flask	Similar to Gentilly 2: Appendix A, Figure N°10 - Shielded fuel transfer cask - 26 tons with 60 bundles basket and with irradiated fuel - "Sliding" gate - Electric hoist for lifting or lowering a basket into the IFTC/BM - Chain - Basket lifting grapple - Shielding
				Gantry crane	For the Transfer flask
				Lifting Beam	For the Transfer flask
			With the hoist N°1, open the lid of the packaging in a hot cell.	Packaging	IFTC/BM : See chapter 2., section 2.4.7.1.3 of **<4>** Appendix A, Figure N° 6
			Load the baskets into the packaging		
Phase 4	**Pre-shipment packaging preparation**	UFTS	Drying the cavity	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves, work plate-form for bolt the lid
			Filling the cavity with helium	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves, compressed air line
			Leaktightness check	Leaktightness equipment	
			Depressurising the cavity	Vacuum circuit	
			Installing the impact limiter		
Phase 5	**Internal transfer of the Transportation cask**	UFTS	Radiological control of the Transportation cask	Non contamination, Dose Rate	"Smear test", Radiameter
			Approach of the Bogie	Bogie	Bogie with pulley drive system
			Radiological control of the Bogie	Non contamination, Dose Rate	"Smear test", Radiameter
			Loading of the Transportation cask on the Bogie		
			Radiological control of the Transportation cask and the bogie	Non contamination, Dose Rate	"Smear test", Radiameter
			Internal transfer	Tie down	Similar to the Tie down of the IFTC

Gentilly baskets in Canstor continued:

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
Phase 6	**Loading the Transportation cask on a trailer**	UFTS	Radiological control of the Transportation cask	Non contamination, Dose Rate	"Smear test", Radiameter
			Open the weather cover	Weather cover	
			Loading the Transportation cask on a trailer	Gantry Crane	With 1 hoist (of 60 tons for the IFTC/BM)
				Lifting Beam for packaging	To carry of the IFTC/BM (similar to the IFTC)
				Trailer (**<4>,** Appendix A, Figures N°13, 14)	- Modified 48 foot flatted trailer with integrated tie-down - Trailer equipped with hydraulic or air ride suspension to cushion the load - Trailer equipped with four axles - One loaded cask per trailer
				Tractor (**<4>,** Appendix A, Figure 14)	- Standard commercial tractor sufficient for the loaded weight - The weight for the fuelled reference tractor is roughly 9,075 kg.
			Packaging tie-down on the trailer	Tie down	Similar to the Tie down of the IFTC. (Appendix A, Figure N°15, **<4>**)
			Check the condition of the packaging, trailer		
			Fit the transport seals		
			Close the weather cover	Weather cover	
			Radiological control of the trailer	Non contamination, Dose Rate	"Smear test", Radiameter

4.2.1.6.3 Whiteshell

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
Phase 0	**Baskets in Silo**	Interim storage	Initial phase		
Phase 1	**Unloading of the baskets from the Silo into the transfer flask**	Interim storage			
Phase 2	**Internal transfer of the transfer flask**	Interim storage			
Phase 3	**Loading the baskets from the transfer flask into the packaging. Note (1)**	UFTS	With the gantry, take the impact limiter handling tool of the packaging.	Packaging	IFTC/BM : See chapter 2., section 2.4.7.1.3 of **<4>** Appendix A, Figure N° 6
				Impact limiter handling tool of the packaging	
				Gantry crane	With 1 hoist (of 60 tons for the IFTC/BM)
			Raise the impact limiter and store it in a place		
			With the gantry, take the lid-handling tool of the packaging.	Lid handling tool of the Transportation cask	
			Raise the lid and store it in a place		
			With the gantry, take the transfer flask	Transfer flask	Similar to Gentilly 2: **<4>,** Appendix A, Figure N°10 - Shielded fuel transfer cask, - 26 tons with 60 bundles basket and with irradiated fuel - "Sliding" gate - Electric hoist for lifting or lowering a basket into the IFTC/ BM - Chain - Basket lifting grapple - Shielding
				Lifting Beam for the Transfer flask	
			Mate the transfer flask with the flask lid of the packaging.		**<4>,** Appendix A, Figure N°9
			Load the baskets.		
			With the gantry, take off the transfer flask		
			With the gantry, close the packaging with the lid. Bolting of the lid with the associated platform		

Note (1): The removal of the flask and the replacement of the lid have to be co-ordinated, as it is done at present (throughout). The IFTC/BM lid could be designed to be suitable for this operation.

This operation has to be repeated three times.

Whiteshell follow up:

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
Phase 4	**Pre-shipment packaging preparation**	UFTS	Drying the cavity	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves,
			Filling the cavity with helium	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves, compressed air line
			Leaktightness check	Leaktightness equipment	
			Depressurising the cavity	Vacuum circuit	
Phase 5	**Internal transfer of the packaging**	UFTS	Radiological control of the packaging	Non contamination, Dose Rate	"Smear test", Radiameter
			Approach of the trolley	Trolley	Trolley with tractor
			Radiological control of the trolley	Non contamination, Dose Rate	"Smear test", Radiameter
			Installing the impact limiter		
			Loading of the full Transportation cask on the trolley		
			Radiological control of the Transportation cask and the trolley	Non contamination, Dose Rate	"Smear test", Radiameter
			Internal transfer	Tie down	
Phase 6	**Loading the Transportation cask on a trailer**	UFTS	Radiological control of the Transportation cask	Non contamination, Dose Rate	"Smear test", Radiameter
			Open the weather cover	Weather cover	
			Loading the Transportation cask on a trailer	Gantry Crane	With 1 hoist (of 60 tons for the IFTC/BM)
				Lifting Beam for packaging	To carry of the IFTC/BM (similar to the IFTC, **<4>**)
				Trailer (**<4>,** Appendix A, Figures N°13, 14)	- Modified 48 foot flatted trailer with integrated tie-down - Trailer equipped with hydraulic or air ride suspension to cushion the load - Trailer equipped with four axles - One loaded cask per trailer
				Tractor (**<4>,** Appendix A, Figure N°14)	- Standard commercial tractor sufficient for the loaded weight - The weight for the fuelled reference tractor is roughly 9,075 kg.
			Packaging tie-down on the trailer	Tie down	Similar to the Tie down of the IFTC (Appendix A, Figure N°15, **<4>**)
			Check the condition of the packaging, trailer		
			Fit the transport seals		
			Close the weather cover	Weather cover	
			Radiological control of the trailer	Non contamination, Dose Rate	"Smear test", Radiameter

4.2.2. MOSTLY RAIL

4.2.2.1. Loading an IFTC/BM from a wet bay

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
Phase 0	**Modules in wet bays**	Interim storage	Initial phase		
Phase 1	**Loading the modules into the packaging in the pool**	UFTS			Identical than the IFCT in the pool Decontamination of the IFTC/BM: identical as IFTC **<3>**
				Packaging	IFTC/BM: See chapter 2., section 2.4.7.1.3 of **<4>** Appendix A, Figure N° 5
Phase 2	**Pre-shipment packaging preparation**	UFTS	Unloading the packaging from the trolley	Gantry crane	60 tons
			Drainage		
			Drying the cavity	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves,
			Filling the cavity with helium	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves, compressed air line
			Leaktightness check	Leaktightness equipement	
			Depressurising the cavity	Vacuum circuit	
Phase 3	**Internal transfer of the packaging**	UFTS	Radiological control of the packaging	Non contamination, Dose Rate	“Smear test”, Radiameter
			Approach of the Trolley	Trolley	Trolley with tractor
			Radiological control of the Trolley	Non contamination, Dose Rate	“Smear test”, Radiameter
			Installing the impact limiter	Lifting beam for the impact limiter	
			Loading of the full Transportation cask on the Trolley		
			Radiological control of the Transportation cask and the Trolley	Non contamination, Dose Rate	“Smear test”, Radiameter
			Internal transfer	Tie down	

4.2.2.2. Loading an IFTC/BM from a silo

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
Phase 0	**Baskets in Silo**	Interim storage	Initial phase		
Phase 1	**Unloading of the baskets from the Silo into the transfer flask**	Interim storage			
Phase 2	**Internal transfer of the transfer flask**	Interim storage			
Phase 3	**Loading the baskets from the transfer flask into the packaging**	UFTS	With a gantry crane , place the transfer flask on the hot cell	Transfer flask	Similar to Gentilly 2, Appendix A, Figure N°10 of **<4>**: - Shielded fuel transfer cask - 26 tons with 60 bundles basket and with irradiated fuel - "Sliding" gate - Electric hoist for lifting or lowering a basket into the IFTC/BM - Chain - Basket lifting grapple - Shielding
				Gantry crane	For the Transfer flask
				Lifting Beam for Transfer flask	
			With the hoist N°1, open the lid of the packaging in a hot cell.	Packaging	IFTC/BM : See chapter 2., section 2.4.7.1.3 of **<4>** Appendix A, Figure N° 6
			Load the baskets into the packaging		
Phase 4	**Pre-shipment packaging preparation**	UFTS	Drying the cavity	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves,
			Filling the cavity with helium	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves, compressed air line
			Leaktightness check	Leaktightness equipement	
			Depressurising the cavity	Vacuum circuit	
			Installing the impact limiter		
Phase 5	**Internal transfer of the packaging**	UFTS	Radiological control of the Transportation cask	Non contamination, Dose Rate	"Smear test", Radiameter
			Approach of the Bogie	Bogie	Bogie with pulley drive system
			Radiological control of the Bogie	Non contamination, Dose Rate	"Smear test", Radiameter
			Loading of the full Transportation cask on the Bogie		
			Radiological control of the Transportation cask and the Bogie	Non contamination, Dose Rate	"Smear test", Radiameter
			Internal transfer	Tie down	

4.2.2.3. DSCTP pre-shipment and loading operations

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
Phase 0	**Modules in DSC**	Interim storage	Initial phase		
Phase 1	**Internal transfer of the DSC**	Interim storage			DSC, **<4>** Appendix A, Figure N°7
Phase 2	**Pre-shipment packaging preparation**	UFTS	Radiological control of the packaging	Non contamination, Dose Rate	"Smear test", Radiameter
				Transportation cask	DSCTP, Appendix A, Figure N° 8
				Weather cover	
			Load impact limiter onto rotation frame	Gantry crane	With 1 hoist (of 120 tons for the DSCTP)
				Rotation frame	
				Lifting Beam impact limiter	
			Place DSC in bottom impact limiter	Lifting Beam for packaging	
			Place Top impact limiter		
			Attach wire rape assemblies		
			Rotate frame	Rotation equipment to rotate the frame	

4.2.2.4. On site loading of the casks on railcars

4.2.2.4.1 DSCTP

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
(DSCTP)	**Loading the Transportation cask on a rail car**	UFTS	Open the weather cover of the railcar	Rail car (Appendix A, Figures N°16)	• The train is dedicated to movement of used fuel under exclusive use conditions; • Use of depressed center, flat bed car • Each flat car is loaded with one DSCTP; • Each train equipped with locomotive and caboose; • The locomotive is assumed to have sufficient power to safely and efficiently haul the load.
			Lift package in horizontal position	Gantry crane	120 tons
			Lower package onto railcar and tiedowns		**<4>** Appendix A, Figure N°17
			Package loaded on railcar and tiedowns secured		
			Check the condition of the packaging, rail car		
			Close the weather cover	Weather cover	
			Fit the transport seals		
			Radiological control of the rail car	Non contamination, Dose Rate	"Smear test", Radiameter

4.2.2.4.2 IFTC/BM

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
(IFTC/BM)	**Loading the Transportation cask on a rail car**	UFTS	Radiological control of the Transportation cask and the rail car	Non contamination, Dose Rate	"Smear test", Radiameter
			Open the weather cover	Weather cover	
			Loading the Transportation cask on a rail car	Gantry Crane	With 1 hoist (of 60 tons for the IFTC/BM)
				Lifting Beam for Transportation cask	To carry of the IFTC/BM (similar to the IFTC)
				Rail car (Appendix A, Figure 16 **<4>**)	- The train is dedicated to movement of used fuel under exclusive use conditions; - Use of depressed centre, flat bed car; - Each flat car is loaded with two Transportation casks; - Each train equipped with locomotive and caboose; - The locomotive is assumed to have sufficient power to safely and efficiently haul the load.
			Packaging tie-down on the rail car	Tie down	Similar to the Tie down of the IFTC (Appendix A, Figure N°15, **<4>**) but for the rail
			Check the condition of the Transportation cask, rail car		
			Fit the transport seals		
			Close the weather cover	Weather cover	
			Radiological control of the rail car and the Transportation cask	Non contamination, Dose Rate	"Smear test", Radiameter

4.2.2.5. On site loading of the casks on trailers

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
(IFTC/BM)	**Loading the Transportation cask on a trailer**	UFTS	Radiological control of the Transportation cask and the trailer	Non contamination, Dose Rate	"Smear test", Radiameter
			Open the weather cover	Weather cover	
			Loading the Transportation cask on a trailer	Gantry Crane	With 1 hoist (of 60 tons for the IFTC/BM)
				Lifting Beam for the Transportation cask	To carry of the IFTC/BM (similar to the IFTC, **<3>)**
				Trailer (Appendix A, Figures N°12, 13, 14 of **<4>**)	- Modified 48 foot flatted trailer with integrated tie-down - Trailer equipped with hydraulic or air ride suspension to cushion the load - Trailer equipped with four axles - One loaded cask per trailer
				Tractor (Appendix A, Figure N°14 of **<4>**)	- Standard commercial tractor sufficient for the loaded weight - The weight for the fuelled reference tractor is roughly 9,075 kg.
			Packaging tie-down on the trailer	Tie down	Similar to the Tie down of the IFTC (Appendix A, Figure N°15, **<3>**)
			Check the condition of Transportation cask, trailer		
			Fit the transport seals		
			Close the weather cover	Weather cover	
			Radiological control of the trailer and the Transportation cask	Non contamination, Dose Rate	"Smear test", Radiameter

(DSCTP)	**Loading the Transportation cask on a trailer**	UFTS	Radiological control of the packaging and the trailer	Non contamination, Dose Rate	"Smear test", Radiameter
			Open the weather cover	Weather cover	
			Loading the packaging on a trailer	Trailer (Appendix A, Figure N°12)	- Modified 48 foot flatted trailer with integrated tie-down - Trailer equipped with hydraulic or air ride suspension to cushion the load - Trailer equipped with nine axles - One loaded cask per trailer
				Tractor (Appendix A, Figure N°14)	- Standard commercial tractor sufficient for the loaded weight - The weight for the fuelled reference tractor is roughly 11 t.
				Gantry crane	With 1 hoist (of 120 tons for the DSCTP)
			Packaging tie-down on the trailer	Tie-down	Similar to the Tie-down of the DSCTP for the rail (Appendix A, Figure N°17 , <**4>**)
			Check the condition of the packaging, trailer		
			Fit the transport seals		
			Close the weather cover	Weather cover	
			Radiological control of the trailer and of the Transportation cask	Non contamination, Dose Rate	"Smear test", Radiameter

Note that these operations are needed for the road link from Bruce (DSCTP and IFTC/BM) and Point Lepreau (IFTC/BM), and for the road-only transportation from Chalk River and Whiteshell (IFTC/BM).

4.2.2.6. Operations at Rail/Road transfer sites

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
(IFTC/BM)	**Rail/Road transfer of the Transportation cask**	UFTS	Radiological control of the Transportation cask, the rail car and the trailer	Non contamination, Dose Rate	"Smear test", Radiameter
			Open the weather covers of the trailer and of the rail car	Weather covers	
			Loading the packaging from the rail car to the trailer	Gantry Crane	With 2 hoists (of 60 tons for the IFTC/BM)
				Lifting Beam for Transpor-tation cask	To carry of the IFTC/BM (similar to the IFTC)
				Trailer (Appendix A, Figures N°13 , 14)	- Modified 48 foot flatted trailer with integrated tie-down - Trailer equipped with hydraulic or air ride suspension to cushion the load - Trailer equipped with for axles - One loaded cask per trailer
				Tractor (Appendix A, Figure N°14)	- Standard commercial tractor sufficient for the loaded weight - The weight for the fuelled reference tractor is roughly 9,075 kg.
			Packaging tie-down on the trailer	Tie down	Similar to the Tie down of the IFTC (Appendix A, Figure N°15, **<4>**)
			Check the condition of the packaging, trailer		
			Fit the transport seals		
			Close the weather cover	Weather cover	
			Radiological control of the trailer and the Transportation cask	Non contamination, Dose Rate	"Smear test", Radiameter

(DSCTP)	**Rail/Road transfer of the Transportation cask**	UFTS	Radiological control of the Transportation cask, the rail car and the trailer	Non contamination, Dose Rate	"Smear test", Radiameter
			Open the weather covers of the trailer and of the rail car	Weather covers	
			Loading the packaging from the rail car to the trailer	Gantry Crane	With 1 hoist (of 120 tons for the DSCTP)
				Lifting Beam for Transportation cask	
				Trailer (Appendix A, Figure N°12,)	- Modified 48 foot flatted trailer with integrated tie-down - Trailer equipped with hydraulic suspension to cushion the load - Trailer equipped with nine axles - One loaded cask per trailer
				Tractor (Appendix A, Figure N°14)	- Standard commercial tractor sufficient for the loaded weight - The weight for the fuelled reference tractor is roughly 11 t.
			Packaging tie-down on the trailer	Tie down	Similar to the Tie down of the DSCTP for the rail (Appendix A, Figure N°17 , **<4>**)
			Check the condition of the packaging, trailer		
			Fit the transport seals		
			Close the weather cover	Weather cover	
			Check the condition of the packaging, rail car		
			Fit the transport seals		
			Close the weather cover	Weather cover	
			Radiological control of the trailer and of the Transportation cask	Non contamination, Dose Rate	"Smear test", Radiameter

4.2.3. MOSTLY WATER

4.2.3.1. On site loading of the casks into a vessel

Loading of a DSCTP:

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
Phase 0	**Modules in DSC**	Interim storage	Initial phase		
Phase 1	**Internal transfer of the DSC**	Interim storage			DSC, **<4>**, Appendix A, Figure N°7
Phase 2	**Pre-shipment packaging preparation**	UFTS	Radiological control of the packaging	Non contamination, Dose Rate	"Smear test", Radiameter
				Transportation cask	DSCTP,**<4>** Appendix A, Figure N° 8
				Weather cover	
			Load impact limiter onto rotation frame	Gantry crane	With 1 hoist (of 120 tons for the DSCTP)
				Rotation frame	
				Lifting Beam impact limiter	
			Place DSC in bottom impact limiter	Lifting Beam for packaging	
			Place Top impact limiter		
			Attach wire rape assemblies		
			Rotate frame	Rotation equipment to rotate the frame	
Phase 3	**Loading the Transportation cask on a vehicle and internal transfer**	UFTS		Trolley	Trolley with tractor
Phase 4	**Loading the Transportation cask on a vessel**	UFTS	Radiological control of the hold and of the Transportation cask	Non contamination, Dose Rate	"Smear test", Radiameter
			Lift package in horizontal position	Gantry Crane (on the vessel)	With 1 hoist (of 120 tons for the DSCTP)
			Lower package onto the hold of the vessel and tie-downs	Vessel	**<4>** Section 3.7.1 of Chapter 3 Appendix A, Figure N°18
			Package loaded onto the hold of the vessel and tie-downs secured		
			Check the condition of the packaging, hold		
			Close the upper deck		
			Fit the transport seals		
			Radiological control of the hold and of the Transportation cask	Non contamination, Dose Rate	"Smear test", Radiameter

Loading of the IFTC/BM, with the example of the Bruce site (Trays in Wet Bays):

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
Phase 0	**Trays in wet bays**	Interim storage	Initial phase		
Phase 1	**Unloading of the bundles from the trays into the modules**	Interim storage			
Phase 2	**Loading the modules into the packaging in the pool**	UFTS	Loading the modules into the packaging in the pool		Identical than the IFCT in the pool Decontamination of the IFTC/BM: identical as IFTC **<4>**
				Packaging	IFTC/BM : See chapter 2., section 2.4.7.1.3 of **<4>** Appendix A, Figure N° 5
Phase 3	**Pre-shipment packaging preparation**	UFTS	Drainage		
			Drying the cavity	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves,
			Filling the cavity with helium	Vacuum circuit	Air/water separator , pump, vacuum gauges, valves, compressed air line
			Leaktightness check	Leaktightness equipement	
			Depressurising the cavity	Vacuum circuit	
			Unloading of the packaging from the trolley	Gantry Crane	With 2 hoists (of 60 tons for the IFTC/BM and 10 tons for the impact limiter)
Phase 4	**Internal transfer of the packaging**	UFTS	Radiological control of the packaging	Non contamination, Dose Rate	“Smear test”, Radiameter
			Approach of the Trolley	Trolley	Trolley with tractor
			Radiological control of the Trolley	Non contamination, Dose Rate	“Smear test”, Radiameter
			Installing the impact limiter		
			Loading of the full Transportation cask on Trolley		
			Radiological control of the Transportation cask and the Trolley	Non contamination, Dose Rate	“Smear test”, Radiameter
			Internal transfer	Tie down	
Phase 5	**Loading the Transportation cask on a vessel**	UFTS	Radiological control of the Transportation cask and the hold	Non contamination, Dose Rate	“Smear test”, Radiameter
			Loading the Transportation cask on the hold of the vessel	Gantry Crane (on the vessel)	With 1 hoist (of 60 tons for the IFTC/BM
				Lifting Beam for packaging	To carry of the IFTC/BM (similar to the IFTC, **<4>)**
				Vessel	Section 3.7.1 of Chapter 3 Appendix A, Figure N°18
			Transportation cask tie-down on the hold	Tie down	Similar to the Tie down of the IFTC (Appendix A, Figure N°15, **<4>**)
			Check the condition of the Transportation cask, hold		
			Fit the transport seals		
			Close the upper deck		
			Radiological control of the hold and the Transportation cask	Non contamination, Dose Rate	“Smear test”, Radiameter

4.2.3.2. On site loading of the casks on a trailer

In the Mostly Water system, on site loading of casks on trailers only applies for Chalk River and Whiteshell, for which the transportation mode is road only.

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
(IFTC/BM)	**Loading the Transportation cask on a trailer**	UFTS	Radiological control of the Transportation cask and the trailer	Non contamination, Dose Rate	"Smear test", Radiameter
			Open the weather cover	Weather cover	
			Loading the Transportation cask on a trailer	Gantry Crane	With 1 hoist (of 60 tons for the IFTC/BM)
				Lifting Beam for the Transportation cask	To carry of the IFTC/BM (similar to the IFTC)
				Trailer (Appendix A, Figures N°12, 13, 14 of **<4>**)	- Modified 48 foot flatted trailer with integrated tie-down - Trailer equipped with hydraulic or air ride suspension to cushion the load - Trailer equipped with four axles - One loaded cask per trailer
				Tractor (Appendix A, Figure N°14 of **<4>**)	- Standard commercial tractor sufficient for the loaded weight - The weight for the fuelled reference tractor is roughly 9,075 kg.
			Packaging tie-down on the trailer	Tie down	Similar to the Tie down of the IFTC (Appendix A, Figure N°15, **<4>**)
			Check the condition of Transportation cask, trailer		
			Fit the transport seals		
			Close the weather cover	Weather cover	
			Radiological control of the trailer and the Transportation cask	Non contamination, Dose Rate	"Smear test", Radiameter

4.2.3.3. Water/Road transfer operations

PHASE	DESIGNATION	STUDIED IN	DESCRIPTION OF PHASE	COMPONENTS	DESCRIPTION OF COMPONENTS
DSCTP Water/Road Transfer	**Transfer of the Transportation cask from the vessel to a trailer**	UFTS	Radiological control of the hold, the Transportation cask and the trailer		"Smear test", Radiameter
			Open the weather covers of the trailer	Weather covers	
			Loading the packaging from the vessel to the trailer	Gantry Crane (on the vessel)	With 1 hoist (of 120 tons for the DSCTP)
				Lifting Beam for Transportation cask	**<4>**
				Trailer (Appendix A, Figure N°12,)	- Modified 48 foot flatted trailer with integrated tie-down - Trailer equipped with hydraulic suspension to cushion the load - Trailer equipped with nine axles - One loaded cask per trailer
				Tractor (Appendix A, Figure N°14)	- Standard commercial tractor sufficient for the loaded weight - The weight for the fuelled reference tractor is roughly 11 t.
			Packaging tie-down on the trailer	Tie down	Similar to the Tie down of the DSCTP for the rail (Appendix A, Figure N°17 , **<4>**)
			Check the condition of the packaging, trailer		
			Fit the transport seals		
			Close the weather cover	Weather cover	
			Radiological control of the hold , the trailer and of the Transportation cask	Non contamination, Dose Rate	"Smear test", Radiameter

IFTC/BM Water/Road Transfer	**Transfer of the Transportation cask from the vessel to a trailer**	UFTS	Radiological control of the hold, the Transportation cask and the trailer		"Smear test", Radiameter
			Open the weather covers of the trailer	Weather covers	
			Loading the packaging from the vessel to the trailer	Gantry Crane (on the vessel)	With 1 hoist (of 60 tons for the IFTC/BM
				Lifting Beam for Transportation cask	To carry of the IFTC/BM (similar to the IFTC, **<4>)**
				Trailer (**<4>**, Appendix A, Figures N°13, 14)	- Modified 48 foot flatted trailer with integrated tie-down - Trailer equipped with hydraulic suspension to cushion the load - Trailer equipped with four axles - One loaded cask per trailer
				Tractor (**<4>**, appendix A, Figure N°14)	- Standard commercial tractor sufficient for the loaded weight - The weight for the fuelled reference tractor is roughly 9,075 kg.
			Packaging tie-down on the trailer	Tie down	Similar to the Tie down of the IFTC for the trailer (Appendix A, Figure N°15 , **<4>**)
			Check the condition of the packaging, trailer		
			Fit the transport seals		
			Close the weather cover	Weather cover	
			Radiological control of the hold , the trailer and of the Transportation cask	Non contamination, Dose Rate	"Smear test", Radiameter

Note that these operations are not applicable for the transportation of the bundles from Chalk River and Whiteshell, for which the transportation mode is road only.

4.3. Operations times at each departure site

The following tables presents the estimated times required to prepare a cask for a shipment, to load a cask on a trailer and the transportation times from the departure site to the CES/DGR, for the All Road mode. These times are given in days.

The number of person (on site personnel and drivers for the All Road mode) needed per year to accomplish the program is also given in these tables.

The calculation of the needed time for the road transportation phase (All Road mode only) includes:

- The presence of the drivers during the loading of the cask on the trailer (0.5 day),
- The time needed for the journey to the CES (depending on the departure site – See appendix A – Table “Distances and Times”),
- The unloading time at the CES and the loading of an empty IFTC/BM, with the presence of the drivers (0.5 day for unloading and 0.5 day for loading),
- The return journey to the departure site (depending on the departure site – See appendix A – Table “Distances and Times”),
- The unloading time of the empty IFTC/BM from the trailer at the departure site, with the presence of the drivers (0.5 day).

Although the detailed turn around times are not presented for Mostly Rail and Mostly water, the calculations for these two modes were made following the same principles.
The detailed calculations are given in Appendix A – sheets “Mostly Rail – System of Tpt” and “Mostly Water – System of Tpt”.

4.3.1. Pickering

4.3.1.1. Modules in DSCs

PICKERING MODULES IN DSC 2043 - 2064			Total number of shipments :			3084
			Number of shipments / year (average) :		140	
	PHASE	DESIGNATION	TIME REQUIRED for 1 CASK (days)	TOTAL TIME for 1 YEAR (days)	RESOURCES - 1 CASK (person/day)	TOTAL RESOURCES - 1 YEAR (person/day)
Preparation of shipment	Phase 3	Loading the modules into the packaging	1,00	140,18	2,00	280,36
	Phase 4	Pre-shipment packaging preparation	1,50	210,27	2,00	420,55
	Phase 5	Internal transfer of the Transportation cask	0,50	70,09	3,00	210,27
		Sub-total for preparation of shipment :	3,00	420,55	7,00	911,18
Transportation	Phase 6	Loading the Transportation cask on a trailer	0,50	70,09	3,00	210,27
	Phase 7	Road transportation	8,00	1 121,45	2,00	2 242,91
		Sub-total for transportation :	8,50	1 191,55	5,00	2 453,18
		Total :	**11,50**	**1 612,09**	**12,00**	**3 364,36**

resources (number of persons) for 211 days of work per year : 13,46
including : 4,49 operators (1 shift)
and : 8,97 drivers

4.3.1.2. Modules in wet bays

PICKERING MODULES IN WET BAYS 2035 - 2040			Total number of shipments :			1764
			Number of shipments / year (average) :		294	
	PHASE	DESIGNATION	TIME REQUIRED for 1 CASK (days)	TOTAL TIME for 1 YEAR (days)	RESOURCES - 1 CASK (person/day)	TOTAL RESOURCES - 1 YEAR (person/day)
Preparation of shipment	Phase 1	Loading the modules into the packaging in the pool	1,00	294,01	2,00	588,01
	Phase 2	Pre-shipment packaging preparation	2,00	588,01	2,00	1 176,03
	Phase 3	Internal transfer of the packaging	0,50	147,00	3,00	441,01
		Sub-total for preparation of shipment :	3,50	1 029,02	7,00	2 205,05
Transportation	Phase 4	Loading the Transportation cask on a trailer	0,50	147,00	3,00	441,01
	Phase 5	Road transportation	8,00	2 352,06	2,00	4 704,11
		Sub-total for transportation :	8,50	2 499,06	5,00	5 145,12
		Total :	**12,00**	**3 528,08**	**12,00**	**7 350,17**

resources (number of persons) for 211 days of work per year : 29,40
including : 10,58 operators (1 shift)
and : 18,82 drivers

4.3.2. Bruce

4.3.2.1. Modules in DSCs

BRUCE MODULES IN DSC 2041 - 2064			Total number of shipments :			5705
			Number of shipments / year (average) :		238	
	PHASE	DESIGNATION	TIME REQUIRED for 1 CASK (days)	TOTAL TIME for 1 YEAR (days)	RESOURCES - 1 CASK (person/day)	TOTAL RESOURCES - 1 YEAR (person/day)
Preparation of shipment	Phase 3	Loading the modules into the packaging	1,00	237,71	2,00	475,42
	Phase 4	Pre-shipment packaging preparation	1,50	356,56	2,00	713,13
	Phase 5	Internal transfer of the packaging	0,50	118,85	3,00	356,56
		Sub-total for preparation of shipment :	3,00	713,13	7,00	1 545,10
Transportation	Phase 6	Loading the Transportation cask on a trailer	0,50	118,85	3,00	356,56
	Phase 7	Road transportation	8,00	1 901,67	2,00	3 803,33
		Sub-total for transportation :	8,50	2 020,52	5,00	4 159,90
		Total :	**11,50**	**2 733,65**	**12,00**	**5 705,00**
			resources (number of persons) for 211 days of work per year :			***22,82***
					including :	***7,61 operators (1 shift)***
					and :	***15,21 drivers***

4.3.2.2. Modules in wet bays

BRUCE TRAYS IN WET BAYS 2035 - 2042			Total number of shipments :			1969
			Number of shipments / year (average) :		246	
	PHASE	DESIGNATION	TIME REQUIRED for 1 CASK (days)	TOTAL TIME for 1 YEAR (days)	RESOURCES - 1 CASK (person/day)	TOTAL RESOURCES - 1 YEAR (person/day)
Preparation of shipment	Phase 2	Loading the modules into the packaging in the pool	1,00	246,13	2,00	492,25
	Phase 3	Pre-shipment packaging preparation	2,00	492,25	2,00	984,50
	Phase 4	Internal transfer of the packaging	0,50	123,06	3,00	369,19
		Sub-total for preparation of shipment :	2,50	615,31	7,00	1 353,69
Transportation	Phase 5	Loading the Transportation cask on a trailer	0,50	123,06	3,00	369,19
	Phase 6	Road transportation	8,00	1 969,00	2,00	3 938,00
		Sub-total for transportation :	8,50	2 092,06	5,00	4 307,19
		Total :	**11,00**	**2 707,38**	**12,00**	**5 660,88**
			resources (number of persons) for 211 days of work per year :			***22,64***
					including :	***6,89 operators (1 shift)***
					and :	***15,75 drivers***

4.3.2.3. Douglas Point

BRUCE (DOUGLAS POINT) BASKETS IN SILOS
2060 - 2064

			Total number of shipments :			138
			Number of shipments / year (average) :		28	
	PHASE	*DESIGNATION*	*TIME REQUIRED for 1 CASK (days)*	*TOTAL TIME for 1 YEAR (days)*	*RESOURCES - 1 CASK (person/day)*	*TOTAL RESOURCES - 1 YEAR (person/day)*
Preparation of shipment	Phase 3	Loading the baskets from the transfer flask into the packaging	1,00	27,60	2,00	55,20
	Phase 4	Pre-shipment packaging preparation	1,50	41,40	2,00	82,80
	Phase 5	Internal transfer of the Transportation cask	0,50	13,80	3,00	41,40
		Sub-total for preparation of shipment :	3,00	82,80	7,00	179,40
Transportation	Phase 6	Loading the Transportation cask on a trailer	0,50	13,80	3,00	41,40
	Phase 7	Road transportation	8,00	220,80	2,00	441,60
		Sub-total for transportation :	8,50	234,60	5,00	483,00
		Total :	**11,50**	**317,40**	**12,00**	**662,40**

resources (number of persons) for 211 days of work per year : 2,65
including : 0,88 operators (1 shift)
and : 1,77 drivers

4.3.3. Darlington

4.3.3.1. Modules in DSCs

DARLINGTON MODULES IN DSC 2047 - 2064			Total number of shipments :			2770
			Number of shipments / year (average) :		154	
	PHASE	DESIGNATION	TIME REQUIRED for 1 CASK (days)	TOTAL TIME for 1 YEAR (days)	RESOURCES - 1 CASK (person/day)	TOTAL RESOURCES - 1 YEAR (person/day)
Preparation of shipment	Phase 3	Loading the modules into the packaging	1,00	153,89	2,00	307,78
	Phase 4	Pre-shipment packaging preparation	1,50	230,83	2,00	461,67
	Phase 5	Internal transfer of the packaging	0,50	76,94	3,00	230,83
		Sub-total for preparation of shipment :	3,00	461,67	7,00	1 000,28
Transportation	Phase 6	Loading the Transportation cask on a trailer	0,50	76,94	3,00	230,83
	Phase 7	Road transportation	8,00	1 231,11	2,00	2 462,22
		Sub-total for transportation :	8,50	1 308,06	5,00	2 693,06
		Total :	**11,50**	**1 769,72**	**12,00**	**3 693,33**
			resources (number of persons) for 211 days of work per year :			***14,77***
					including :	***4,92 operators (1 shift)***
					and :	***9,85 drivers***

4.3.3.2. Modules in wet bays

DARLINGTON MODULES IN WET BAYS 2039 - 2047			Total number of shipments :			1812
			Number of shipments / year (average) :		201	
	PHASE	DESIGNATION	TIME REQUIRED for 1 CASK (days)	TOTAL TIME for 1 YEAR (days)	RESOURCES - 1 CASK (person/day)	TOTAL RESOURCES - 1 YEAR (person/day)
Preparation of shipment	Phase 1	Loading the modules into the packaging in the pool	1,00	201,33	2,00	402,67
	Phase 2	Pre-shipment packaging preparation	2,00	402,67	2,00	805,33
	Phase 3	Internal transfer of the packaging	0,50	100,67	3,00	302,00
		Sub-total for preparation of shipment :	3,50	704,67	7,00	1 510,00
Transportation	Phase 4	Loading the Transportation cask on a trailer	0,50	100,67	3,00	302,00
	Phase 5	Road transportation	8,00	1 610,67	2,00	3 221,33
		Sub-total for transportation :	8,50	1 711,33	5,00	3 523,33
		Total :	**12,00**	**2 416,00**	**12,00**	**5 033,33**
			resources (number of persons) for 211 days of work per year :			***20,13***
					including :	***7,25 operators (1 shift)***
					and :	***12,89 drivers***

4.3.4. Point Lepreau

POINT LEPREAU BASKETS IN SILOS 2040 - 2046			Total number of shipments :			665
			Number of shipments / year (average) :		95	
	PHASE	DESIGNATION	TIME REQUIRED for 1 CASK (days)	TOTAL TIME for 1 YEAR (days)	RESOURCES - 1 CASK (person/day)	TOTAL RESOURCES - 1 YEAR (person/day)
Preparation of shipment	Phase 3	Loading the baskets from the transfer flask into the packaging	1,00	95,00	2,00	190,00
	Phase 4	Pre-shipment packaging preparation	1,50	142,50	2,00	285,00
	Phase 5	Internal transfer of the Transportation cask	0,50	47,50	3,00	142,50
		Sub-total for preparation of shipment :	3,00	285,00	7,00	617,50
Transportation	Phase 6	Loading the Transportation cask on a trailer	0,50	47,50	3,00	142,50
	Phase 7	Road transportation	14,00	1 330,00	2,00	2 660,00
		Sub-total for transportation :	14,50	1 377,50	5,00	2 802,50
		Total :	**17,50**	**1 662,50**	**12,00**	**3 420,00**
			resources (number of persons) for 211 days of work per year :			***13,68***
					including :	***3,04 operators (1 shift)***
					and :	***10,64 drivers***

4.3.5. Chalk River

CHALK RIVER BASKETS IN SILOS 2060 - 2064			Total number of shipments :			30
			Number of shipments / year (average) :		6	
	PHASE	DESIGNATION	TIME REQUIRED for 1 CASK (days)	TOTAL TIME for 1 YEAR (days)	RESOURCES - 1 CASK (person/day)	TOTAL RESOURCES - 1 YEAR (person/day)
Preparation of shipment	Phase 3	Loading the baskets from the transfer flask into the packaging	1,00	6,00	2,00	12,00
	Phase 4	Pre-shipment packaging preparation	1,50	9,00	2,00	18,00
	Phase 5	Internal transfer of the Transportation cask	0,50	3,00	3,00	9,00
		Sub-total for preparation of shipment :	3,00	18,00	7,00	39,00
Transportation	Phase 6	Loading the Transportation cask on a trailer	0,50	3,00	3,00	9,00
	Phase 7	Road transportation	8,00	48,00	2,00	96,00
		Sub-total for transportation :	8,50	51,00	5,00	105,00
		Total :	**11,50**	**69,00**	**12,00**	**144,00**
			resources (number of persons) for 211 days of work per year :			***0,58***
					including :	***0,19 operators (1 shift)***
					and :	***0,38 drivers***

4.3.6. Gentilly

4.3.6.1. Baskets in Silos

GENTILLY BASKETS IN SILOS 2046 - 2050			Total number of shipments :			29
			Number of shipments / year (average) :		6	
	PHASE	DESIGNATION	TIME REQUIRED for 1 CASK (days)	TOTAL TIME for 1 YEAR (days)	RESOURCES - 1 CASK (person/day)	TOTAL RESOURCES - 1 YEAR (person/day)
Preparation of shipment	Phase 3	Loading the baskets from the transfer flask into the packaging	1,00	5,80	2,00	11,60
	Phase 4	Pre-shipment packaging preparation	1,50	8,70	2,00	17,40
	Phase 5	Internal transfer of the Transportation cask	0,50	2,90	3,00	8,70
		Sub-total for preparation of shipment :	3,00	17,40	7,00	37,70
Transportation	Phase 6	Loading the Transportation cask on a trailer	0,50	2,90	3,00	8,70
	Phase 7	Road transportation	9,50	55,10	2,00	110,20
		Sub-total for transportation :	10,00	58,00	5,00	118,90
		Total :	**13,00**	**75,40**	**12,00**	**156,60**
			resources (number of persons) for 211 days of work per year :			***0,63***
					including :	***0,19 operators (1 shift)***
					and :	***0,44 drivers***

4.3.6.2. Baskets in Canstor

GENTILLY BASKETS IN CANSTOR 2040 - 2050			Total number of shipments :			738
			Number of shipments / year (average) :		67	
	PHASE	DESIGNATION	TIME REQUIRED for 1 CASK (days)	TOTAL TIME for 1 YEAR (days)	RESOURCES - 1 CASK (person/day)	TOTAL RESOURCES - 1 YEAR (person/day)
Preparation of shipment	Phase 3	Loading the baskets from the transfer flask into the packaging	1,00	67,09	2,00	134,18
	Phase 4	Pre-shipment packaging preparation	1,50	100,64	2,00	201,27
	Phase 5	Internal transfer of the Transportation cask	0,50	33,55	3,00	100,64
		Sub-total for preparation of shipment :	3,00	201,27	7,00	436,09
Transportation	Phase 6	Loading the Transportation cask on a trailer	0,50	33,55	3,00	100,64
	Phase 7	Road transportation	9,50	637,36	2,00	1 274,73
		Sub-total for transportation :	10,00	670,91	5,00	1 375,36
		Total :	**13,00**	**872,18**	**12,00**	**1 811,45**
			resources (number of persons) for 211 days of work per year :			***7,25***
					including :	***2,15 operators (1 shift)***
					and :	***5,10 drivers***

4.3.7. Whiteshell

WHITESHELL 2064			Total number of shipments :			3
			Number of shipments / year (MAX) :		3	
	PHASE	DESIGNATION	TIME REQUIRED for 1 CASK (days)	TOTAL TIME for 1 YEAR (days)	RESOURCES - 1 CASK (person/day)	TOTAL RESOURCES - 1 YEAR (person/day)
Preparation of shipment	Phase 3	Loading the baskets from the transfer flask into the packaging.	1,00	3,00	2,00	6,00
	Phase 4	Pre-shipment packaging preparation	1,50	4,50	2,00	9,00
	Phase 5	Internal transfer of the packaging	0,50	1,50	3,00	4,50
		Sub-total for preparation of shipment :	3,00	9,00	7,00	19,50
Transportation	Phase 6	Loading the Transportation cask on a trailer	0,50	1,50	3,00	4,50
	Phase 7	Road transportation	8,00	24,00	2,00	48,00
		Sub-total for transportation :	8,50	25,50	5,00	52,50
		Total :	**11,50**	**34,50**	**12,00**	**72,00**

resources (number of persons) for 211 days of work per year : 0,29
including : 0,10 operators (1 shift)
and : 0,19 drivers

4.4. Reception at the centralised site

4.4.1. Numbers of shipments received/year

4.4.1.1. All Road

The following table presents the number of shipments (with one IFTC/BM cask per shipment) received at the CES or DGR per year:

Year	Reception at CES/DGR	Reception at CES/DGR (OPG Fuel)	Reception at CES/DGR (Other waste owners)
2035	**593**	593	0
2036	**619**	619	0
2037	**619**	619	0
2038	**619**	619	0
2039	**624**	624	0
2040	**633**	466	167
2041	**636**	469	167
2042	**634**	467	167
2043	**627**	460	167
2044	**627**	460	167
2045	**630**	463	167
2046	**635**	463	172
2047	**632**	554	78
2048	**630**	552	78
2049	**631**	553	78
2050	**627**	603	24
2051	**622**	622	0
2052	**622**	622	0
2053	**622**	622	0
2054	**622**	622	0
2055	**622**	622	0
2056	**622**	622	0
2057	**622**	622	0
2058	**622**	622	0
2059	**622**	622	0
2060	**624**	590	34
2061	**624**	590	34
2062	**624**	590	34
2063	**625**	591	34
2064	**598**	561	37
TOTAL	**18707**	**17104**	**1603**

Refer to Appendix A – Table “ALL ROAD - Review of shipments” for the detailed calculation, which also presents the number of shipments per site.
For the number of bundles sent and received per year, see Appendix B of the present document.

4.4.1.2. Mostly Rail

The following table presents the number of shipments (casks) that will be received at the CES or DGR per year. The shipments are made with IFTC/BM and DSCTP casks (for the bundles stored in DSCs).

The shipments are received from the Rail/Road transfer terminal located near the CES/DGR, except for Whiteshell and Chalk River for which the spent fuel is sent directly by road.

Year	Reception at CES/DGR (OPG Fuel)			Reception at CES/DGR (Other waste owners)	Reception at CES/DGR (OPG and other waste owners)		
	IFTC/BM	DSCTP	Total	IFTC/BM	IFTC/BM	DSCTP	Total
2035	593	0	593	0	593	0	593
2036	619	0	619	0	619	0	619
2037	619	0	619	0	619	0	619
2038	619	0	619	0	619	0	619
2039	624	0	624	0	624	0	624
2040	466	0	466	167	633	0	633
2041	458	6	464	167	625	6	631
2042	456	6	462	167	623	6	629
2043	335	63	398	167	502	63	565
2044	335	63	398	167	502	63	565
2045	181	142	323	167	348	142	490
2046	181	142	323	172	353	142	495
2047	59	249	308	78	137	249	386
2048	0	277	277	78	78	277	355
2049	0	278	278	78	78	278	356
2050	0	303	303	24	24	303	327
2051	0	312	312	0	0	312	312
2052	0	312	312	0	0	312	312
2053	0	312	312	0	0	312	312
2054	0	312	312	0	0	312	312
2055	0	312	312	0	0	312	312
2056	0	312	312	0	0	312	312
2057	0	312	312	0	0	312	312
2058	0	312	312	0	0	312	312
2059	0	312	312	0	0	312	312
2060	0	296	296	32	32	296	328
2061	0	296	296	34	34	296	330
2062	0	296	296	34	34	296	330
2063	0	296	296	34	34	296	330
2064	0	281	281	37	37	281	318
TOTAL :	5545	5802	11347	1603	7148	5802	12950

Refer to Appendix A – Table “MOSTLY RAIL - Review of shipments” for the detailed calculation, which also presents the number of shipments per site.

4.4.1.3. Mostly Water

The following table presents the number of shipments that will be received at the CES or DGR per year. The shipments are made with IFTC/BM and DSCTP casks.

As for the Mostly Rail mode, The shipments are received from the Water/Road transfer terminal located near the CES/DGR, except for Whiteshell and Chalk River for which the spent fuel is sent directly by road.

Year	Reception at CES/DGR (OPG Fuel)			Reception at CES/DGR (Other waste owners)	Reception at CES/DGR (OPG and other waste owners)		
	IFTC/BM	DSCTP	Total	IFTC/BM	IFTC/BM	DSCTP	Total
2035	593	0	593	0	593	0	593
2036	619	0	619	0	619	0	619
2037	619	0	619	0	619	0	619
2038	619	0	619	0	619	0	619
2039	624	0	624	0	624	0	624
2040	466	0	466	167	633	0	633
2041	458	6	464	167	625	6	631
2042	456	6	462	167	623	6	629
2043	335	63	398	167	502	63	565
2044	335	63	398	167	502	63	565
2045	181	142	323	167	348	142	490
2046	181	142	323	172	353	142	495
2047	59	249	308	78	137	249	386
2048	0	277	277	78	78	277	355
2049	0	278	278	78	78	278	356
2050	0	303	303	24	24	303	327
2051	0	312	312	0	0	312	312
2052	0	312	312	0	0	312	312
2053	0	312	312	0	0	312	312
2054	0	312	312	0	0	312	312
2055	0	312	312	0	0	312	312
2056	0	312	312	0	0	312	312
2057	0	312	312	0	0	312	312
2058	0	312	312	0	0	312	312
2059	0	312	312	0	0	312	312
2060	0	296	296	32	32	296	328
2061	0	296	296	34	34	296	330
2062	0	296	296	34	34	296	330
2063	0	296	296	34	34	296	330
2064	0	281	281	37	37	281	318
TOTAL :	5545	5802	11347	1603	7148	5802	12950

4.4.2. Constraints and transportation times for each mode

The results given in the following tables are based on the following average speeds, and driving times:

AVGE SPEEDS	ROAD	RAIL	WATER
Empty IFTC/BM	60 km/h	60 km/h	10 km/h
Loaded IFTC/BM	50 km/h	60 km/h	10 km/h
DSCTP	25 km/h	60 km/h	10 km/h
Nb of drivers/crew :	2	3	
Total driving time/day	10 h	24 h	24 h

All the distances are given in kilometres; times are given in days.
It is assumed that the 3 persons shown here for the rail mode are rail-company employees.

Concerning the crew for Mostly Water, we assume that they will be contracted as part of the vessel lease, and for that reason, they are not shown in the previous table.

The average speed indicated for water transportation includes time passing through locks and canals.

4.4.2.1. All Road

Constraints:

- Difficult circulation during winter and thaw periods
- Limited capacity of loading (one cask at a time)
- Limited driving times due to regulatory boundaries
- Overnight stops have to be made on secured areas.

Distances and times (handling times are not included):

SITE	ALL ROAD SYSTEM		
	Distances	**Times empty cask**	**Times loaded cask**
Pickering IFTC/BM	**1000**	2,00	2,00
Pickering DSCTP			
Bruce IFTC/BM	**1000**	2,00	2,00
Bruce DSCTP			
Darlington IFTC/BM	**1000**	2,00	2,00
Darlington DSCTP			
Point Lepreau	**2500**	5,00	5,00
Chalk River	**1000**	2,00	2,00
Gentilly	**1500**	2,50	3,00
Whiteshell	**1000**	2,00	2,00

4.4.2.2. Mostly Rail

As mentioned for the All Road mode, note that the following figures only present the transportation times. Loading, unloading and transfer times are not included here.

Distances and times for the “Mostly Rail” mode:

SITE	MOSTLY RAIL SYSTEM							
	ROAD			RAIL		ROAD		
	Distances	Times empty cask	Times loaded cask	Distances	Times	Distances	Times empty cask	Times loaded cask
Pickering IFTC/BM				1000	1	100	0,17	0,20
Pickering DSCTP							0,25	
Bruce IFTC/BM	50	0,09	0,1	1000	1	100	0,17	0,20
Bruce DSCTP		0,13					0,25	
Darlington IFTC/BM				1000	1	100	0,17	0,20
Darlington DSCTP							0,25	
Point Lepreau	100	0,17	0,2	2000	1,5	100	0,17	0,20
Chalk River	1000	1,67	2,00					
Gentilly				1500	1,5	100	0,17	0,20
Whiteshell	1000	1,67	2,00					

4.4.2.3. Mostly Water

Distances and times for the “Mostly Water” mode:

SITE	MOSTLY WATER SYSTEM							
	ROAD			WATER		ROAD		
	Distances	Times empty cask	Times loaded cask	Distances	Times	Distances	Times empty cask	Times loaded cask
Pickering IFTC/BM				1000	4,5	100	0,17	0,20
Pickering DSCTP							0,25	
Bruce IFTC/BM				500	2,5	100	0,17	0,20
Bruce DSCTP							0,25	
Darlington IFTC/BM				1000	4,5	100	0,17	0,20
Darlington DSCTP							0,25	
Point Lepreau				3500	15	100	0,17	0,2
Chalk River	1000	1,67	2,00					
Gentilly				1700	7,5	100	0,17	0,2
Whiteshell	1000	1,67	2,00					

The main constraint for the Mostly Water mode is the long turn around time due to the loading of the vessel, which last about 16 days for IFTC/BM (2 casks loaded per day and 32 casks to transport) and 15 days for DSCTP (1 cask loaded per day and 15 casks to transport).
Refer to Section 5 for detailed handling assumptions.
As it is presented in Section 5 of this document, there is a need for a large amount of cask to accomplish the program as presented in **<3>**.
The seasonal window for water shipping is 245 days per year.

4.4.3. Unloading times at destination

For the purpose of the study, it is assumed that the unloading of a cask from a trailer takes half a day to be completed for the case of the IFTC/BM.

It is assumed that one day is needed to unload the DSC (with its Outer Packaging) from the trailer at the centralised site.
As soon as the DSCTP is unloaded, the Outer Packaging will be prepared to be sent back to the departure site for the next DSC transport.

5. NEEDED RESOURCES AND MANAGEMENT SYSTEM

5.1. Number of vehicles

5.1.1. All Road

For the calculation of the number of trucks (tractor and trailer) required to achieve the program, the following assumptions were taken:

- The calculation of the total time for one transportation cycle includes:
  - The presence of the drivers during the loading of the cask on the trailer (0,5 day),
  - The time needed for the journey to the CES (depending on the departure site – See appendix A – Table “Distances and Times” or paragraph 4.4.2 of the present document),
  - The unloading time at the CES and the loading of an empty IFTC/BM, with the presence of the drivers (0,5 day for unloading and 0,5 day for loading),
  - The return journey to the departure site (depending on the departure site – See appendix A – Table “Distances and Times” or paragraph 4.4.2 of the present document),
  - The unloading time of the empty IFTC/BM from the trailer at the departure site, with the presence of the drivers (0,5 day).
  - The cycle times allow for winter hazards.
  - Due to driving times over one day, the shipments stop overnight in a secure area.

- The number of casks to sent per day from one site (or received at the CES/DGR) is given by the formula:
  $$\frac{\text{Total number of shipments/year}}{\text{Number of worked days/year}}$$ (NB: there are 250 days of work per year)

- The number of trucks needed for one year is given by the formula:
  (Total number of casks to sent/day) * (total time for 1 transport cycle)

- The maintenance of the trucks (tractors and trailers) is estimated to be about 3 days every 40000 km. As the trucks will do less than 40000 km a year (except for Point Lepreau), it is assumed that the maintenance time over the program could be negligible on the calculation of the number of transportation systems.

The detailed calculation is given in Appendix A of the present document – Table “ALL ROAD – Systems of transport”. Below is a summary, which presents the number of trucks needed per site. This sharing is based on the total number of shipments per site over the shipments for the whole program.

Total number of trucks ** : 24

OPG	Pickering	Modules in wet bays	2,26	6,22
		Modules in DSC	3,96	
	Bruce	Trays in wet bays	2,53	9,85
		Modules in DSC	7,32	
	Darlington	Modules in wet bays	2,32	5,88
		Modules in DSC	3,55	
AECL	Douglas Point	Baskets in silos	0,18	2,06
NBP	Point Lepreau	Baskets in silos	0,85	
AECL	Chalk River	Baskets in silos	0,04	
HQ	Gentilly 1	Baskets in silos	0,04	
AECL	Gentilly 2	Baskets in canstor	0,95	
AECL	Whiteshell	Baskets in silos	0,00	
			24,00	

** this number does not include a renewal of the fleet

5.1.2. Mostly Rail

The assumptions taken to determine the number of trucks and trains are presented hereafter:

- Average speed: 60 km/h with a total “train driving” time of 24h/day. The average speed includes eventual stops that could occur during a train journey. The average speed is the same for the transportation of IFTC/BM and DSCTP,
- The rail distance will be 1000 km for Pickering, Bruce and Darlington, 1500 km for Gentilly, and 2000 km for Point Lepreau (Appendix A – sheet “Distances and Times”).
- There will be road links from the Bruce and Point Lepreau sites to the railhead, assumed to be 50 km and 100 km respectively (Appendix A – sheet “Distances and Times”).
- The road distance from the rail/road transfer terminal to the DGR/CES will be 100 km,
- There will be 10 IFTC/BM per train (2 IFTC/BM per rail car and 5 rail car per train),
- There will be 5 DSCTP per train (1 DSCTP per rail car and 5 rail car per train),
- The time required to load (or unload) an IFTC/BM on a rail car or a trailer will be 0.5 day,
- The time required to load (or unload) a DSCTP on a rail car or a trailer will be 1 day,
- Due to the number of prepared IFTC/BM casks per day, we assumed that a maximum of two IFTC/BM casks could be loaded on a train the same day,
- The rail/road transfer time for an IFTC/BM will be 0.5 day and 1 day for a DSCTP (conservative basis).
- The train will include a caboose with 2 security personnel.

Hazards for train transportation were also included, 10% of the total turn around trip.

When a cask is taken off the train, it will reach the CES/DGR and then, an unloaded cask will be taken back to the transfer facility and loaded to an empty space of the same train (full casks being unloaded at the same time). For that reason, we assume that there will not be buffer stores at Rail/Road transfer sites and that empty casks (or Outer Packaging) will be ready to be loaded on the trailer when a full cask is unloaded at the CES/DGR.

Hazards for road transportation will be 10 % of the total turn around trip.

The assumptions for the road part are the same as the assumption presented in the All Road mode (except the average speed for the DSCTP transportation, which will be about 25 km/h as for the way back of the Outer Packaging).

The following table shows a summary of the number of trains needed for the Mostly Rail Mode and the apportionment between sites.

Total number of trains : **4**

OPG	Pickering	Modules in wet bays	0,38	1,04
		Modules in DSC	0,66	
	Bruce	Trays in wet bays	0,42	1,65
		Modules in DSC	1,23	
	Darlington	Modules in wet bays	0,39	0,99
		Modules in DSC	0,60	
AECL	Douglas Point	Baskets in silos	0,03	0,33
NBP	Point Lepreau	Baskets in silos	0,14	
AECL	Chalk River	Baskets in silos	/	
HQ	Gentilly 1	Baskets in silos	0,01	
AECL	Gentilly 2	Baskets in canstor	0,15	
AECL	Whiteshell	Baskets in silos	/	

The railcars will be compatible for IFTC/BM and DSCTP.
The total number of trains for the whole program will be 4 trains (each with 5 railcars, 1 caboose and 1 locomotive, and with buffer cars as indicated in **<4>**). Please refer to Appendix A, Excel file "D#8 Resources", sheet "Mostly Rail – system of tpt", for calculation details.

Chalk River and Whiteshell are not concerned in sharing the costs of trains because all of their shipments will be made by road.

The table hereafter shows the number of trucks needed and the apportionment per waste owner, depending on the number of shipments:

Number of trucks:		**10 for IFTC/BM transportation** **10 for DSCTP transportation**		
OPG	Pickering	Modules in wet bays	2,52	5,14
		Modules in DSC	2,62	
	Bruce	Trays in wet bays	2,81	7,65
		Modules in DSC	4,84	
	Darlington	Modules in wet bays	2,59	4,93
		Modules in DSC	2,34	
AECL	Douglas Point	Baskets in silos	0,20	2,29
NBP	Point Lepreau	Baskets in silos	0,95	
AECL	Chalk River	Baskets in silos	0,04	
HQ	Gentilly 1	Baskets in silos	0,04	
AECL	Gentilly 2	Baskets in canstor	1,05	
AECL	Whiteshell	Baskets in silos	0,004	

5.1.3. Mostly Water

The following assumptions were taken into account for the calculation of the required number of trucks and vessels:

- Average speed: 10 km/h with a total navigation time of 24h/day including passages trough locks and canals.
- The water distance for Pickering and Darlington will be 1000 km.
- The water distance for Bruce will be 500 km,
- The water distance for Point Lepreau will be 3500 km
- The water distance for Gentilly will be 1700 km
- The road distance from the water/road terminal to the CES is assumed to be 100 km,
- There will be 32 IFTC/BM per vessel for 1 transport,
- There will be 15 DSCTP per vessel for 1 transport,
- The loading times for the casks will be the same as for the Mostly Rail mode,
- The water/road transfer times will be the same as for a rail/road transfer,
- Due to the number of prepared IFTC/BM casks per day (see tables in Appendix A – Excel file "D#8 Resources"), we assumed that a maximum of two casks could be loaded on a vessel the same day,
- A trained officer of the crew acts as the required security person,
- The system operates during the 245 day Great Lakes shipping season.

Hazards for water transportation were also included, 5% of the total turn around trip. Hazards for the road part are the same as for the Mostly Rail mode.

When a cask is taken off the vessel, it will reach the CES/DGR and then, an unloaded cask will be taken back to the transfer facility and loaded to an empty space of the same vessel (full casks being unloaded at the same time). For that reason, we assume that there will not be buffer stores at Water/Road transfer sites and that empty casks (or Outer Packaging) will be ready to be loaded on the trailer when a full cask is unloaded at the CES/DGR.

The assumptions for the road part are the same as the assumptions presented in the All Road mode (except the average speed for the DSCTP transportation, which will be about 25 km/h as for the way back of the Outer Packaging).

There is a need of 4 vessels for the whole program, and the apportionment is made accordingly to the number of shipments by waterways. For that reason, Chalk River and Whiteshell are not concerned in the vessels cost sharing:

Total number of vessels : **4**

OPG	Pickering	Modules in wet bays	0,35	1,03
		Modules in DSC	0,68	
	Bruce	Trays in wet bays	0,39	1,68
		Modules in DSC	1,28	
	Darlington	Modules in wet bays	0,36	1,00
		Modules in DSC	0,64	
AECL	Douglas Point	Baskets in silos	0,03	0,30
NBP	Point Lepreau	Baskets in silos	0,13	
AECL	Chalk River	Baskets in silos	/	
HQ	Gentilly 1	Baskets in silos	0,01	
AECL	Gentilly 2	Baskets in canstor	0,14	
AECL	Whiteshell	Baskets in silos	/	

The table hereafter shows the number of trucks (tractor + trailer) needed for the whole program and the apportionment between waste owners:

Number of trucks: **7 for IFTC/BM transportation**
7 for DSCTP transportation

OPG	Pickering	Modules in wet bays	1,66	3,46
		Modules in DSC	1,80	
	Bruce	Trays in wet bays	1,86	5,17
		Modules in DSC	3,32	
	Darlington	Modules in wet bays	1,71	3,31
		Modules in DSC	1,61	
AECL	Douglas Point	Baskets in silos	0,13	1,51
NBP	Point Lepreau	Baskets in silos	0,63	
AECL	Chalk River	Baskets in silos	0,03	
HQ	Gentilly 1	Baskets in silos	0,03	
AECL	Gentilly 2	Baskets in canstor	0,70	
AECL	Whiteshell	Baskets in silos	0,003	

5.2. Number of casks

5.2.1. All Road

To estimate accurately the number of IFTC/BM needed for the whole program, the following assumptions were taken:

- For the All Road mode, there is one cask per shipment. Each shipment is made with one truck and one trailer.
- Following the aforementioned statement, the number of casks is based on the number of trucks calculated in paragraph 5.1.1 of this document.
- A ratio for the maintenance time of the cask was added to that number, this ratio is determined with the following considerations:
  - It is assumed that an IFTC/BM cask has to be checked during 7 days every 15 transports and 15 days every 60 transports. (The formula is (7*3)+15= 36 days of maintenance every 60 transports).
  - Depending on the concerned departure site and the corresponding cycle time*, the number of days that represents 60 transports was calculated (= total time for 1 transport cycle * 60).
  - The final ratio is obtained by the formula:
    $$\frac{\text{Number of days for 60 transports} * 36}{\text{Number of days for 60 transports}} = \text{maintenance ratio added to the number of trucks.}$$
    36 represent the number of days of maintenance that will take place every 60 transports.
    For the All Road mode, one shipment means one truck and one cask. To take into account casks maintenance times, the ratio is added to the number of trucks needed.
    E.g. a ratio of 1.05 means that if 20 trucks are needed, 21 casks will be needed for the program (taking into account casks maintenance times).

For the “All Road Mode”, the number of casks needed is presented hereafter, with the sharing between sites (depending on the total number of shipments, and with the maximum number of cask required):

Total number of IFTC/BM: **25**

OPG	Pickering	Modules in wet bays	2,36	6,48
		Modules in DSC	4,12	
	Bruce	Trays in wet bays	2,63	10,26
		Modules in DSC	7,62	
	Darlington	Modules in wet bays	2,42	6,12
		Modules in DSC	3,70	
AECL	Douglas Point	Baskets in silos	0,18	2,14
NBP	Point Lepreau	Baskets in silos	0,89	
AECL	Chalk River	Baskets in silos	0,04	
HQ	Gentilly 1	Baskets in silos	0,04	
AECL	Gentilly 2	Baskets in canstor	0,99	
AECL	Whiteshell	Baskets in silos	0,00	
			25,00	

The complete calculation including the details per site is given in Appendix A of this document – Table “ALL ROAD – Systems of Transport”.

5.2.2. Mostly Rail

5.2.2.1. IFTC/BM

The number of casks is derived from the total number of trains needed, and from the number days required to complete the loading of a 5 railcars train.
The calculation is made on the basis of 2 IFTC/BM loaded/day.
For each year and each site, the following formula was used to determine the number of IFTC/BM needed:

➔ Nb of trains needed * $\frac{\text{Max nb of IFTC/BM per train}}{\text{Nb of IFTC/BM loaded per day}}$ * Maintenance ratio

As for the All Road mode, a maintenance ratio is added, to cover maintenance periods without impact on the program (see 5.2.1 of this document for detailed calculation of this ratio).

The apportionment is made over the total number of IFTC/BM shipments for all the concerned sites and depends on the shipments from each site.

Total number of IFTC/BM **18**				
OPG	Pickering	Modules in wet bays	4,47	4,47
		Modules in DSC	/	
	Bruce	Trays in wet bays	4,99	4,99
		Modules in DSC	/	
	Darlington	Modules in wet bays	4,59	4,59
		Modules in DSC	/	
AECL	Douglas Point	Baskets in silos	0,35	4,06
NBP	Point Lepreau	Baskets in silos	1,68	
AECL	Chalk River	Baskets in silos	0,08	
HQ	Gentilly 1	Baskets in silos	0,07	
AECL	Gentilly 2	Baskets in canstor	1,87	
AECL	Whiteshell	Baskets in silos	0,01	

Note that the calculation for Chalk River and Whiteshell is the same as for the All Road mode.

5.2.2.2. DSCTP (number of Outer Packaging)

The calculation for the number of DSCTP is the same as for the IFTC/BM, except for the maintenance ratio of 2% added to the final result (we assume the maintenance to be simpler and shorter than for the IFTC/BM). The basis is 1 DSCTP loaded per day, and 1 DSCTP per railcar.

Total number of Outer Packaging for DSC **17**				
OPG	Pickering	Modules in wet bays	/	4,61
		Modules in DSC	4,61	
	Bruce	Trays in wet bays	/	8,51
		Modules in DSC	8,51	
	Darlington	Modules in wet bays	/	4,12
		Modules in DSC	4,12	
AECL	Douglas Point	Baskets in silos	/	0,00
NBP	Point Lepreau	Baskets in silos	/	
AECL	Chalk River	Baskets in silos	/	
HQ	Gentilly 1	Baskets in silos	/	
AECL	Gentilly 2	Baskets in canstor	/	
AECL	Whiteshell	Baskets in silos	/	

5.2.3. Mostly Water

5.2.3.1. IFTC/BM

The calculation of the IFTC/BM needed for the Mostly Water mode follows the same calculation model that was used for the Mostly Rail mode.

The main difference is that a vessel can contain up to 32 IFTC/BM cask so the calculation refers to this value.
As for the mostly rail mode, the calculation is made on the basis of two IFTC/BM loaded per day.

Total number of IFTC/BM **63**

OPG	Pickering	Modules in wet bays	15,52	15,52
		Modules in DSC	/	
	Bruce	Trays in wet bays	17,33	17,33
		Modules in DSC	/	
	Darlington	Modules in wet bays	15,94	15,94
		Modules in DSC	/	
AECL	Douglas Point	Baskets in silos	1,21	14,11
NBP	Point Lepreau	Baskets in silos	5,85	
AECL	Chalk River	Baskets in silos	0,26	
HQ	Gentilly 1	Baskets in silos	0,26	
AECL	Gentilly 2	Baskets in canstor	6,49	
AECL	Whiteshell	Baskets in silos	0,03	

5.2.3.2. DSCTP (number of Outer Packaging)

The number of Outer Packaging for the DSCs is obtained in the same way as for the IFTC/BM cask, but with the basis of 1 cask loaded per day, and 15 DSCTP per vessel.

Total number of Outer Packaging for DSC **56**

OPG	Pickering	Modules in wet bays	/	14,96
		Modules in DSC	14,96	
	Bruce	Trays in wet bays	/	27,61
		Modules in DSC	27,61	
	Darlington	Modules in wet bays	/	13,36
		Modules in DSC	13,36	
AECL	Douglas Point	Baskets in silos	/	0,00
NBP	Point Lepreau	Baskets in silos	/	
AECL	Chalk River	Baskets in silos	/	
HQ	Gentilly 1	Baskets in silos	/	
AECL	Gentilly 2	Baskets in canstor	/	
AECL	Whiteshell	Baskets in silos	/	

Note that only OPG sites are concerned for DSC Outer Packaging costs sharing as a part of their shipments will be made with DSCs.

5.2.3.3. Waterways transportation constraints

The high number of IFTC/BM and DSC Outer Packaging needed for the Mostly Water mode is linked to the logistics of transportation by waterways and to the times needed to completely load a vessel.

A vessel can transport 32 IFTC/BM but a maximum of two IFTC/BM per day can be loaded in the vessel (refer to the pre-shipments phases and times), so a fully loaded vessel could be ready for departure 16 days after the loading of the first cask.

Even if the assumption is that the first loaded cask will be the first to be unloaded and then to go back to the departure site, the turn around times for one cask is longer than for the other modes.

So, to accomplish the evacuation of the bundles as it is presented in the Excel file “Logistics 40 years – 2035”, a high number of casks is needed.

5.3. Human resources (staff) and management system

To determine accurately all the human resources that are needed to complete the program, the following assumptions were taken:

- ➔ Estimated total hours of working per day: 8 hours (for manual work)
- ➔ Number of working days during a year: 250 days for manual work (**<5>**, Section 6c, Appendix B)
- ➔ Human resources will be determined for each site and for each of the phase presented in **<4>**. They are determined accordingly to the average number of shipments per year during the shipment's period. The detailed calculation was made only for the All Road mode. For Mostly Rail and Mostly water, the total number of resources was derived from All Road results and apportioned accordingly to the number of shipments to be realised.
- ➔ Human resources estimate is made in accordance with the safety and quality assurance requirements (one phase requires at least two persons).
- ➔ All the shipments from the reactor of Whiteshell will be realised within a year.
- ➔ For the shipments from OPG sites and due to a large number of bundles to evacuate, 2 teams of operational workers are needed to carry out the program, during the periods of shipments.

The calculation of the needed time for the road transportation phase includes:
- The presence of the drivers during the loading of the cask on the trailer (0.5 day),
- The time needed for the journey to the CES/DGR (depending on the departure site – See appendix A – Table "Distances and Times"),
- The unloading time at the CES/DGR and the loading of an empty IFTC/BM, with the presence of the drivers (0.5 day for unloading and 0.5 day for loading),
- The return journey to the departure site (depending on the departure site – See appendix A – Table "Distances and Times"),
- The unloading time of the empty IFTC/BM from the trailer at the departure site, with the presence of the drivers (0.5 day).

The following tables present the human resources needed for operational purposes (e.g. for the loading and transfer of casks, shipment preparation…). These tables also present the number of drivers needed to achieve the shipping program ("Road Transportation" phase).

The total number of shipments and the average number of shipments/year are issued of calculations presented in the paragraph 4.1.

For a detailed presentation of the calculation of the required resources for the All Road mode, refer to the paragraph 4.3 of this document.

The number of drivers is derived from the table "ALL ROAD – Resources" in Appendix A, which presents the total time for one transport phase from and to each site.
There will be two drivers (1 of these two will be security trained) per transport and no escort for the transport with the IFTC/BM cask.

For the Mostly Rail and Mostly Water modes, the number of personnel is derived from the figures calculated for the All Road Mode and it is linked to the number of shipments and to the road distances between sites and railway terminals.

Note that for the DSCTP transportation, an oversize/overweight convoy escort will be needed. We assume this escort to be composed of 2 cars (1 driver in each car) per transport.
Following this assumption, the number of escort vehicles is directly linked to the number of trucks needed for DSCTP transportation (with the basis of 1 truck and 2 escort vehicles).

All centralised operations (scheduling, forwarding…) will be directed from the CES/DGR, and the resources allocated to these tasks are not included in the following tables (they are part of the management system).

5.3.1. All Road

5.3.1.1. Transportation

The following table presents the number of drivers needed for each site, per period of shipments:

ALL ROAD

Owners	Sites	Type of storage	Periods of shipments	Total	Number of drivers
OPG	Pickering	Modules in wet bays	2035 - 2040	1764	18,82
		Modules in DSC	2043 - 2064	3084	8,97
	Bruce	Trays in wet bays	2035 - 2042	1969	15,75
		Modules in DSC	2041 - 2064	5705	15,21
	Darlington	Modules in wet bays	2039 - 2047	1812	9,85
		Modules in DSC	2047 - 2064	2770	12,89
AECL	Douglas Point	Baskets in silos	2060 - 2064	138	1,77
NBP	Point Lepreau	Baskets in silos	2040 - 2046	665	10,64
AECL	Chalk River	Baskets in silos	2060 - 2064	30	0,38
HQ	Gentilly 1	Baskets in silos	2046 - 2050	29	0,44
AECL	Gentilly 2	Baskets in canstor	2040 - 2050	738	5,10
AECL	Whiteshell	Baskets in silos	2064	3	0,19
* The average is calculated over the period of shipments				18707	

5.3.2.1 Handling

The following table is a summary of the resources needed at each departure site for pre-shipments operations (see Appendix A – sheet “Summary” for more details):

ALL ROAD

Owners	Sites	Type of storage	Periods of shipments	Needed resources/year for loading and pre-shipment operations	Number of team needed at departure site
OPG	Pickering	Modules in wet bays	2035 - 2040	10,58	2
		Modules in DSC	2043 - 2064	4,49	1
	Bruce	Trays in wet bays	2035 - 2042	6,89	2
		Modules in DSC	2041 - 2064	7,61	2
	Darlington	Modules in wet bays	2039 - 2047	7,25	2
		Modules in DSC	2047 - 2064	4,92	2
AECL	Douglas Point	Baskets in silos	2060 - 2064	0,88	1
NBP	Point Lepreau	Baskets in silos	2040 - 2046	3,04	1
AECL	Chalk River	Baskets in silos	2060 - 2064	0,19	1
HQ	Gentilly 1	Baskets in silos	2046 - 2050	0,19	1
AECL	Gentilly 2	Baskets in canstor	2040 - 2050	2,15	1
AECL	Whiteshell	Baskets in silos	2064	0,10	1
* The average is calculated over the period of shipments					

The number of teams (or shifts) is calculated accordingly to the maximum number of casks that have to be sent per day. If this number is over 1 cask/day, we assume that two shifts will be needed to carry out the shipping program.

5.3.2. Mostly Rail

The table hereafter presents a summary of the shipments, the resources needed per year and the number of drivers for the road parts* from railway terminals to the CES/DGR:

MOSTLY RAIL

Owners	Sites	Type of storage	Periods of shipments	Total by road	Total by rail	Needed resources/year	Drivers
OPG	Pickering	Modules in wet bays	2035 - 2040	1764	180	10,58	6,13
		Modules in DSC	2043 - 2064	1552	318	2,26	2,98
	Bruce	Trays in wet bays	2035 - 2042	1969	199	6,89	5,13
		Modules in DSC	2041 - 2064	2864	590	3,82	5,04
	Darlington	Modules in wet bays	2039 - 2047	1812	186	7,25	3,21
		Modules in DSC	2047 - 2064	1386	287	2,46	4,26
AECL	Douglas Point	Baskets in silos	2060 - 2064	138	14	0,88	0,58
NBP	Point Lepreau	Baskets in silos	2040 - 2046	665	67	3,04	1,98
AECL	Chalk River	Baskets in silos	2060 - 2064	30	0	0,19	0,38
HQ	Gentilly 1	Baskets in silos	2046 - 2050	29	3	0,19	0,12
AECL	Gentilly 2	Baskets in canstor	2040 - 2050	738	74	2,15	1,40
AECL	Whiteshell	Baskets in silos	2064	3	0	0,10	0,19
			Total:	12950	1917		
			IFTC/BM only:	7148	722		
			DSCTP only:	5802	1195		

* The number of drivers for the site of Bruce and Point Lepreau also takes into account the first road part (from the departure site to the road/rail transfer terminal).

5.3.3. Mostly Water

The table hereafter presents a summary of the shipments, the resources needed per year and the number of drivers for the road parts from water/road transfer facilities to the CES/DGR (same calculation as for the Mostly Rail mode applies here):

MOSTLY WATER

Owners	Sites	Type of storage	Periods of shipments	Total by road	Total by waterways	Needed resources/year	Drivers
OPG	Pickering	Modules in wet bays	2035 - 2040	1764	58	10,58	6,41
		Modules in DSC	2043 - 2064	1552	112	2,26	2,92
	Bruce	Trays in wet bays	2035 - 2042	1969	65	6,89	5,37
		Modules in DSC	2041 - 2064	2864	213	3,82	4,94
	Darlington	Modules in wet bays	2039 - 2047	1812	60	7,25	3,36
		Modules in DSC	2047 - 2064	1386	106	2,46	4,17
AECL	Douglas Point	Baskets in silos	2060 - 2064	138	4	0,88	0,62
NBP	Point Lepreau	Baskets in silos	2040 - 2046	665	21	3,04	2,15
AECL	Chalk River	Baskets in silos	2060 - 2064	30	0	0,19	0,38
HQ	Gentilly 1	Baskets in silos	2046 - 2050	29	1	0,19	0,13
AECL	Gentilly 2	Baskets in canstor	2040 - 2050	738	23	2,15	1,52
AECL	Whiteshell	Baskets in silos	2064	3	0	0,10	0,19
			Total:	12950	663		
			IFTC/BM only:	7148	232		
			DSCTP only:	5802	431		

5.4. Maintenance

5.4.1. Maintenance of tractors and trailers

5.4.1.1. General

In logistics calculations, we assume that a truck (tractor and trailer) has to be maintained every 40000 km and that a basic maintenance takes 3 days to be completed.

We assume regarding the covered distances per year (between 40000 km and 80000 km, for the All Road mode, and less for the two other modes) that the maintenance on trailers and tractors could be negligible for the calculation of the number of trucks.

The figures concerning equipment are already rounded to the superior unit to give a safe margin for achieving the program without impact.

5.4.1.2. Siting

They should:

- be located next to installations where casks are loaded on the trailer or next to the route of the transportation, in order to minimise transports and lost time
- offer suitable access
- be subject to an environmental impact analysis especially for waste liquid form (when we wash the trailers)

5.4.1.3. Handling

No specific lifting except for frame of transportation cask, weather covers.

Storage should exist for lifting beams and equipment: frame of transportation cask, weather covers.

5.4.1.4. Workstations

- Maintenance equipment for Trailer: one maintenance area with some mechanical and hydraulic conventional equipment especially for suspension.
- Maintenance equipment for Tractor: one maintenance area with some mechanical and hydraulic conventional equipment especially for suspension.

5.4.1.5. Spare parts

It is necessary to plan with the trailer and tractor owner:

- which spare parts are necessary, in what quantity
- who will procure, own, and store the parts.

5.4.2. Maintenance facilities for rail cars

5.4.2.1. General

Maintenance of rail car equipment is expensive, and a large part of the cost goes to maintenance facilities: careful planning and sizing is essential.
It is expected that maintenance facilities will be used also for repairs and modifications.

In Europe, maintenance of railcars is made on an annual basis, with a 3-days inspection every year and major maintenance (up to 3 weeks) every 4 years.

In the logistics, and due to the fact that railcars figures are rounded to the superior unit, we assume that the maintenance is already taken into account in these figures with a safe margin for not impacting the shipments program.

5.4.2.2. Administrative authorisations and siting

Maintenance facilities will:

- usually be submitted to approval by competent authorities (railway authorities), which takes time,
- generate waste in liquid form.

They should:

- be located next to the route of the rail transportation, or next to a railroad terminal in order to minimise transports and lost time,
- offer suitable access to adequate waste treatment and storage,
- when possible, be an extension of an existing plant, which makes things easier for approvals, access to already available fluids...
- be subject to an environmental impact analysis.

5.4.2.3. Layout

Access to workshop: access may be on rail and road trailers.

5.4.2.4. Handling

Lifting capacity shall be calculated to accommodate the largest rail cars. A safety margin is recommended as designers will always come with heavier designs.

Example (ABRF company in France):

- 2 cranes 15 tons,
- 3 hoists in order to load the main frame of the rail car,
- 3 forklift trucks.

Storage should exist for lifting beams and equipment.

5.4.2.5. Workstations

The number of workstations will be calculated according to the existing and planned fleet, to the maintenance frequency, to the time necessary.

Example (ABRF company in France):

Total area: 115000 m2
Covered area: 13000 m2
Length of rail: 7000 m

The number of railcars they deal with is about 45. Ten persons are in charge of the maintenance of the railcars.

Equipment:

- Washing station for the rail car when they arrive at the plant with a special system to collect and to treat the liquid :
  - Exterior washing: 2000 psi / 70 °C
  - Interior washing: 3500 psi / 70°C
  - Vapour interior washing: 180°C

- Painting area: tunnel with oven (60°C, area : 360 m2)

- Granulating area: tunnel

- Sand blasting equipment

- Special equipment to check the breaks,

- Boilermaking: press, shearing..

- Machining : 1 milling machine, 3 drilling machines, 2 lathes.

5.4.3. Maintenance of casks

5.4.3.1. General

Maintenance of any contaminated and/or irradiated equipment is expensive, and a large part of the cost goes to maintenance facilities: careful planning and sizing is essential.

The main factors are the radiological levels and the mass and size of the cask. High levels of radiation will make a decontamination workshop necessary. Large casks will require much handling space. The lifetime of the cask design shall also be considered, with workshop flexibility in mind for future cask designs.

It is expected that maintenance facilities will be used also for repairs and modifications, as the casks cannot go to a non-nuclear plant. The capabilities and limits, both technical and radiological, of the facilities should be given full consideration.

The maintenance of casks was taken into account with the following basis:

- IFTC/BM:

It is assumed that an IFTC/BM cask has to be checked during 7 days every 15 transports and 15 days every 60 transports.

The calculations take into account that casks have to be maintained 36 days every 60 transports.

To determine the number of casks for the All Road mode, a maintenance ratio was added to the number of trucks, as we know that a transport is composed of 1 truck and 1 cask (see paragraph 5.2.1 for details on this ratio).

Concerning Mostly Water and Mostly Rail, the maintenance is taken into account in the same way (see paragraph 5.2.2.1 for details).

- DSCTP:

For the maintenance of the Outer Packaging used for DSC transportation (concerns only Mostly Rail and Mostly Water), a ratio of 2% was added to the final number of DSC Outer Packaging.

We assumed that not more than 2% of the total number of Outer Packaging could be maintained in the same time.

5.4.3.2. Administrative authorisations and siting

Maintenance facilities will:

- usually be submitted to approval by competent authorities, which takes time,
- generate waste in solid, liquid and gaseous forms.

They should:

- be located next to installations where they are used, in order to minimise transports and lost time,
- offer suitable access to, or include, decontamination workshops and adequate waste treatment and storage,
- when possible, be an extension of an existing plant, which makes things easier for approvals, access to already available fluids...
- be subject to an environmental impact analysis.

5.4.3.3. Layout

Access to workshop

Access may be on rail or road trailers. The latter is generally unsuitable because of exhaust gases, oil leaks... Electrically powered lorries should be preferred. Cask storage space preferably covered or indoors should be provided just outside.

5.4.3.4. Handling

Lifting capacity shall be calculated to accommodate the largest casks. A safety margin is recommended, as designers will always come with heavier designs.

Several independent lifting, handling, rolling, hovering devices allow for handling parts of different weight and size. This will preclude waiting for availability of equipment as it is already used for work or maintenance.

Storage should exist for lifting beams and equipment, as they will be possibly contaminated and will stay inside.

5.4.3.5. Workstations

The number of workstations will be calculated according to the existing and planned fleet, to the maintenance frequency, to the time necessary. The number of operators working simultaneously on the same cask is usually limited by elbowroom and occupational safety considerations, such as work-at-height.

It is emphasised that workstations will be occupied by casks that are stopped pending disposition of non-conformances or inspection. As it is generally difficult, impossible or not worthwhile to close and evacuate the cask, it is advisable to have more workstations or stands than strictly necessary.

The best position (vertical, horizontal, rotating...) for the cask will be determined. Stands, stools will raise the cask for good accessibility and working condition. Access platforms, stairs will be preferred to ladders. Platforms will be flexible in order to limit openings between cask and floors.

Hot cells shall be created whenever necessary to separate maintenance outside of the cask and maintenance inside or with the cask open. All components will have to be maintained or repaired, and there must be storage and workstations for all, including internals, baskets, that may require specific shielding.

Ventilation shall be adapted to pollutant concentration, with adequate depression between rooms so that airborne contamination is sucked in. Permanent radiation monitoring equipment shall be installed.

Ample storage will be created for tools and for dismantled parts. Workstations for parts such as shock absorbers, lids and covers, trunnions... shall be installed, with proper clampdown tools to provide safe working conditions.

It may be beneficial to have machining and welding equipment within the shop, as parts will not generally be acceptable in non-nuclear facilities. It will be often preferable to replace components rather than repair, as this will minimise worker exposure, and waste in unwanted form such as airborne or small chips.

Fluids should be distributed in wall mounted / embedded networks as close to the workstation as possible, as flexible pipes and wires must be strictly limited. Inert (such as nitrogen, argon...), detrimental,

flammable gases, any chemicals shall be closely controlled and their use and available quantity shall be limited. Specifically, cask must be ventilated and air quality monitored during any work inside.

5.4.3.6. Personnel

Personnel shall be properly educated in all technical, radiological, safety areas. A worker will normally need six months before being able to work without close supervision.

The capital cost of the maintenance facility is such that it will often be necessary to work in shifts. This will require special attention as any unexpected defect found in a cask may require expert advice that will be available only in office hours.

5.4.3.7. Spare parts

It is necessary to plan:

- which spare parts are necessary, in what quantity,
- who will procure, own, and store the parts.

Appendices

Appendix A

Excel File « D#8 Resources.xls » with the following sheets:

Summary: presents a view of the main results of the study for all modes of transport – 3 pages

All Road – Review of Shipments: view of the number of shipments per site (whole program) – 1 page

All Road – Resources: Number of persons needed per year for each site (packaging preparation and transportation) – 6 pages

All Road – System of Tpt: Equipment (Tractors, trailers and casks) needed to achieve the program – 8 pages

Mostly Rail – Review of Shipments: Number of shipments per site and per means of transport – 2 pages

Mostly Rail – System of Tpt: Number of trains, trucks road links, IFTC/BM and DSC Outer Packaging – 8 pages

Mostly Water – Review of Shipments: number of shipments per site and per means of transport – 2 pages

Mostly Water – System of Tpt: Number of vessels, trucks for road links, IFTC/BM and DSCTP Outer Packaging – 8 pages

Distances and Times: presents the distances between sites and the CES/DGR and the transportation times calculated – 1 page

Appendix B

OPG Excel File « Fuel Age 2001.xls »:
The sheet “Logistics 40 yr – 2035” was used as a basis for the calculation of shipments.