SECTION 5: ITER CANADA PLAN TO HOST ITER

TECHNICAL SCOPE

5.1 INTRODUCTION

This Section will precisely define the technical scope and details that form the basis of the Iter Canada Plan to Host Iter. The financial aspects of the Plan are defined in Section 9.

Iter Canada and its predecessor organizations has been supporting the overall development of fusion technology and the Iter Joint Central Team technical activities since its inception in 1988 through:

- Personnel secondments to the Garching, Naka and San Diego Joint Central Teams,
- Specialized fusion research & development activities.
- Extensive site specific design and adaptation work for potential Canadian sites, and
  Preparations for Iter licensing.

This Plan is being made at a time when the Iter Final Design Report is being finalized. Iter Canada has recently responded to the Joint Central Team to provided cost estimates on selected complete packages and portions of packages independently of this Plan, although the Iter Canada responses closely link to the scope in this Plan.

Section 5.2 below describes the technical scope of work that is included in the Iter Canada basic financial Plan in Section 9. This Plan is based only on the descriptions of the scope of work as defined in the August 2000 issue of the Procurement Packages. For clarification, specific exclusions to our basic financial Plan are also described below. Iter Canada fully appreciates that the Iter scope could change and/or be transferred between Packages, but assumes that this will be a subject of the Negotiations.

The Iter Parties have previously agreed upon a set of *ITER FEAT Site Requirements and Site Design Assumptions*, and these have been included in the draft Iter Final Design Report . To assist the Iter Parties in their review of this Plan, Section 10 specifically highlights how Iter Canada's Clarington site compares with these criteria.

Iter Canada is also aware that future site specific design work, conducted by either the Joint Central Team/International Team alone or in conjunction with Iter Canada, will also change the Iter designs in order to take full advantage of the Clarington site characteristics. Although this will be subject to future negotiations, Section 5.4 provides the Iter Parties with a number of opportunities that could enhance the Iter project, while also reducing costs. This Section is based on the work that Iter Canada has been conducting over the past number of years in support of the Joint Central Team, and also based on extensive engineering and analysis conducted by Iter Canada in support of its own Canadian site selection process.

In addition to the scope of work included in our base Plan as host for Iter, Canada also has considerable technical capability in "common element" portions of the Iter project. For many years Canada's engineers and scientists have been developing technology in support of fusion, and more specifically in support of the Iter design. A number of our Canadian companies also have expertise and experience in the manufacturing and supply of specialized systems to fusion research installations around the world. Iter Canada believes that the Iter project would be considerably enhanced through the utilization of this Canadian capability. Section 5.4 describes our capabilities in two areas - *tritium processing and remote handling* - and proposes several alternatives for consideration by the Iter Parties with respect to a Canadian participation. Also in Section 5.4.3, Iter Canada proposes additional optional scope for consideration by the Iter Parties, including site construction, installation, commissioning and procurement services during the Construction Phase, that is not part of our base scope of Hosting Iter.

Finally, Section 5.5 describes the scope that Iter Canada has included in its base Plan for the Operating Phase of the Iter project. This Section will only deal with the aspects of the Plan that are part of Iter Canada's contribution to the Iter project, not those activities covered under the Host Services Contract between Iter Canada and the Iter Legal Entity which is covered in Sections 3 and 9.

5.2 THE ITER CANADA "HOST" SCOPE – CONSTRUCTION PHASE

There are two basic components of the Iter Canada Plan "host" scope included in the Construction Phase:

- The physical site with the associated on-site and off-site supporting infrastructure, Section 5.2.1. below, and
- The "non-transportable" scope as defined in the Procurement Packages, Section 5.2.2. below.

This section should be studied in concert with Section 6 – The Project Schedule and Organization. Iter Canada has developed this comprehensive Construction Phase plan through the establishment of an Engineering and Construction Consortium to carry out the Construction Phase work defined within the Iter Canada Plan to Host Iter.

5.2.1. The Clarington Site and On-Site & Off-Site Infrastructure:

This Section describes the technical aspects of the Clarington site, its characteristics, the infrastructure existing, and the infrastructure still to be done. Note that the socio-economic characteristics of the Clarington site are described in Section 8 of this Plan.

During the Engineering Design Activity (EDA) phase, Iter designers developed a generic site arrangement, which was used to provide a framework for system design and cost estimating. The generic design was assumed to be a “greenfield” location without any constraints related to topology, geology, or existing site services. In 1999, this arrangement was revised to reflect the smaller footprint required by the ITER-FEAT design (hereafter referred to as Iter) but retains many of the same relationships between the major buildings, services and systems.

In May 2000, Iter Canada made the significant step of choosing between its two candidate sites, following a comprehensive review process where both sites were rated on the basis of an extensive criteria set which included the Iter site requirements, site adaptation and operating costs, licensing and environmental assessment issues, risk management issues (relating to timely approvals, public acceptance, impact on existing site operations, etc.), Iter staff feedback, and input from both siting communities. The site in Clarington, Ontario was chosen as Canada’s proposed site for the Iter project. The Clarington site meets or exceeds all the Iter compulsory site requirements and site design assumptions [1][1] and this is detailed in Section 10 of this Plan. The Clarington site conditions are more favourable to construction and operation of Iter than the Iter Site Design Assumptions. One example is the much-reduced level of seismicity at the Clarington site.

Iter Canada's site-specific design team has begun to adapt the generic design of the Iter facility to suit the specific characteristics of the proposed Clarington site, as outlined in the following Sections. Iter Canada and its predecessors has been supporting the overall development of fusion technology and the Iter Joint Central Team activities since its inception in 1988, and has been engaged in site specific work for many years[2-5].

5.2.1.1. **The location of the Clarington Site:** The Clarington site is located on the shore of Lake Ontario, approximately 60 km east of Toronto, Ontario (Figures 5-1 and 5-2). The site is bounded by Lake Ontario to the south, the Darlington Nuclear Generating Station on the west, the MacDonald-Cartier Freeway (Highway 401) on the north, and the Blue Circle Cement Plant to the east. The area of the site is approximately 184 ha and is divided into a north and south quadrant by an easement for the Canadian National Railway. The land is currently owned by Ontario Power Generation, but ownership will be transferred to the Iter legal entity when it is appropriate to do so.

[1] Note: References are listed in Attachment 5-A.

Figure 5.1: Location of the Iter facility in Southern Ontario

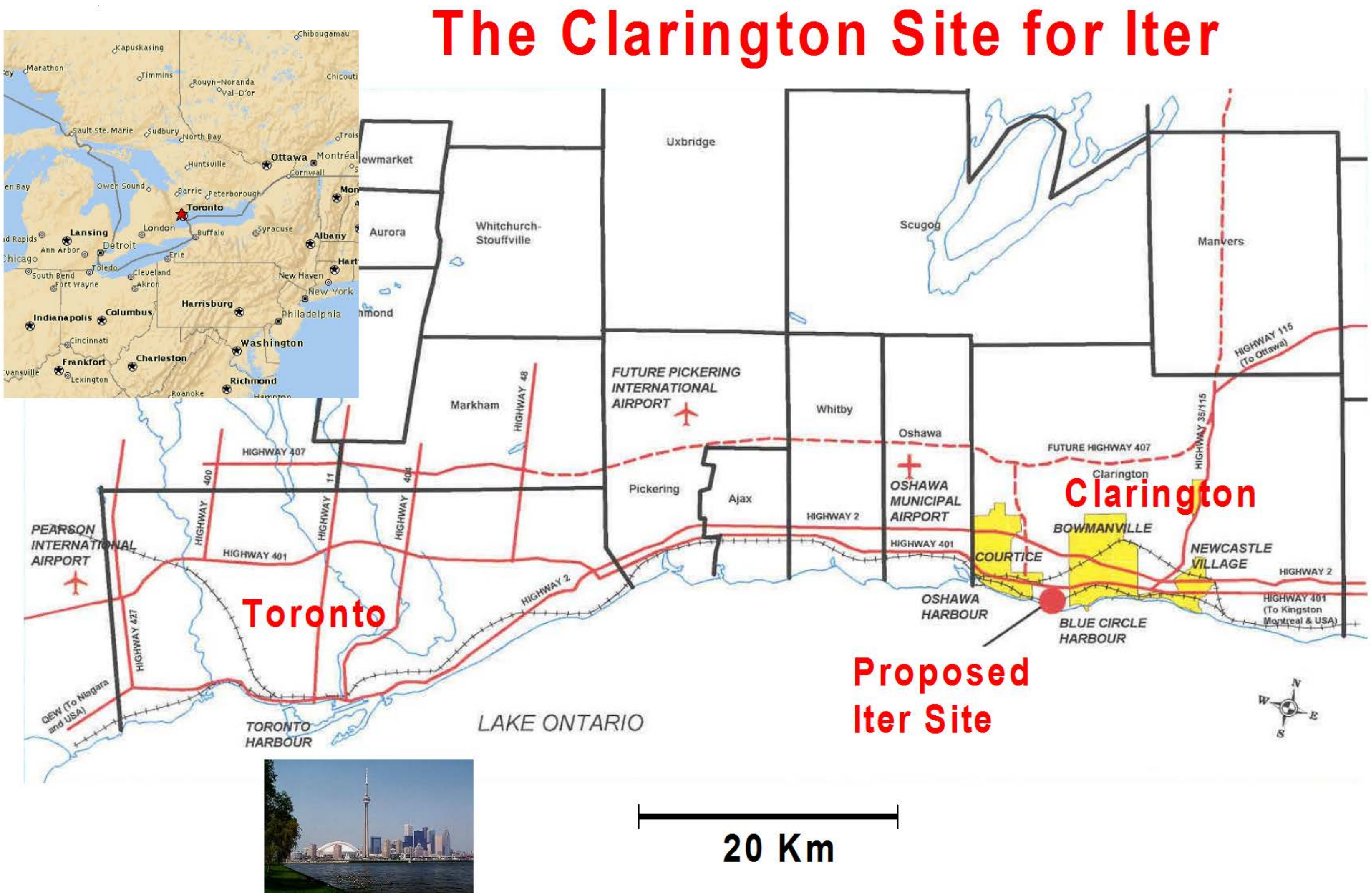


Figure 5.2: Aerial photo of the proposed Iter site between the Blue Circle Cement Plant and the Darlington Generating Station

5.2.1.2. **The Facility Layout and Site Integration:** To provide the greatest operational flexibility for Iter and to minimize the impact of Iter operations on electricity production at the neighbouring Ontario Power Generation site, the area designated for the Iter site allows for an almost total separation between Iter and Ontario Power Generation operations. This also minimizes tie-ins to the existing Ontario Power Generation Station infrastructure where possible. Adaptation of the generic Iter site layout to suit the specific aspects of the Clarington site is shown in Figures 5.3 and 5.4. Figure 5.3 shows the planned locations for the construction camp facilities and laydown of materials and equipment while Figure 5.4 is a 3D visualization of the site layout. Attachment 5-D is a larger drawing giving more detail of the site adaptation (Iter Canada Drawing 008311-01-00L102 Rev. 01).

Figure 5.3: The Iter facility layout adapted for the Clarington site (see also Attachment 5-E)

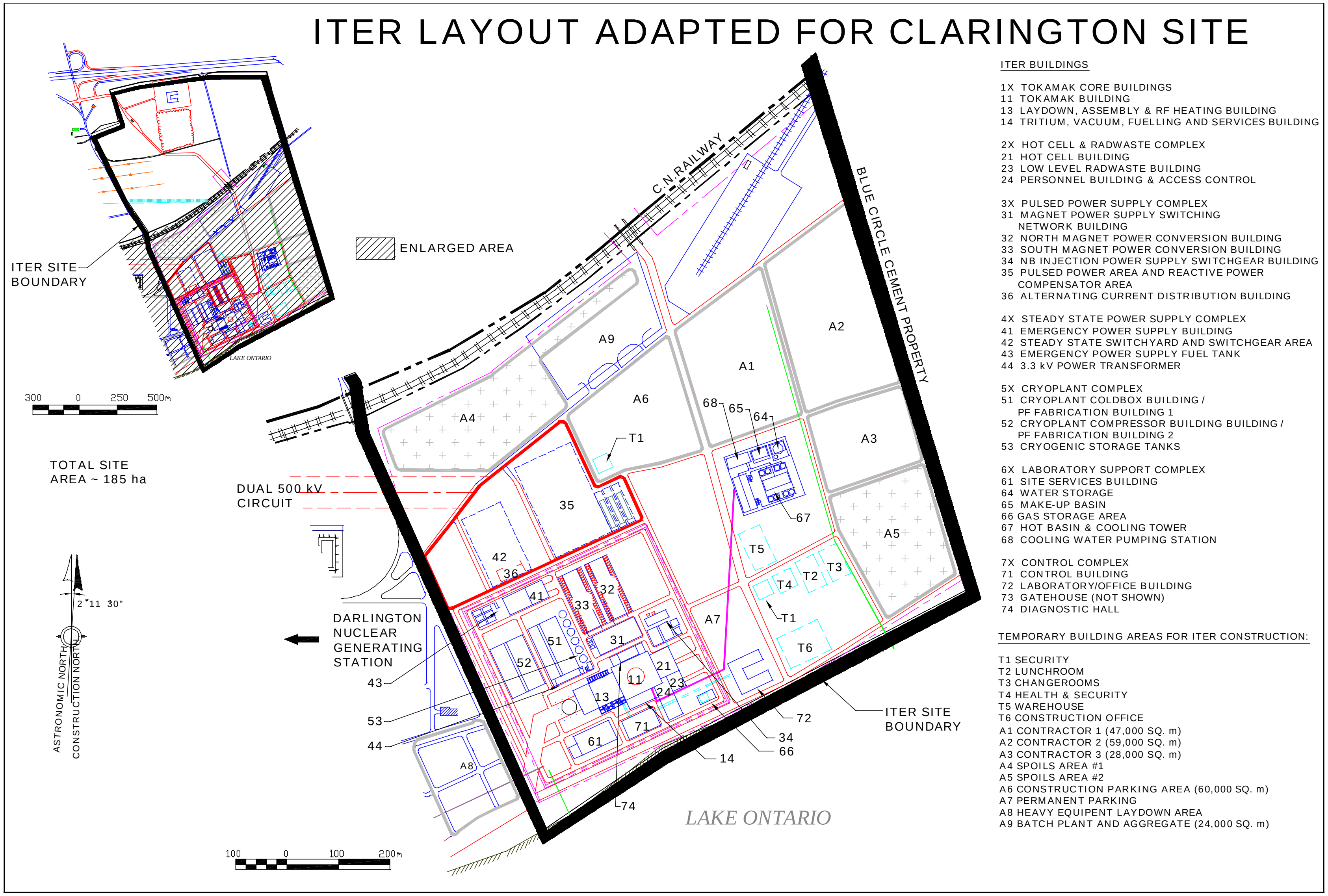
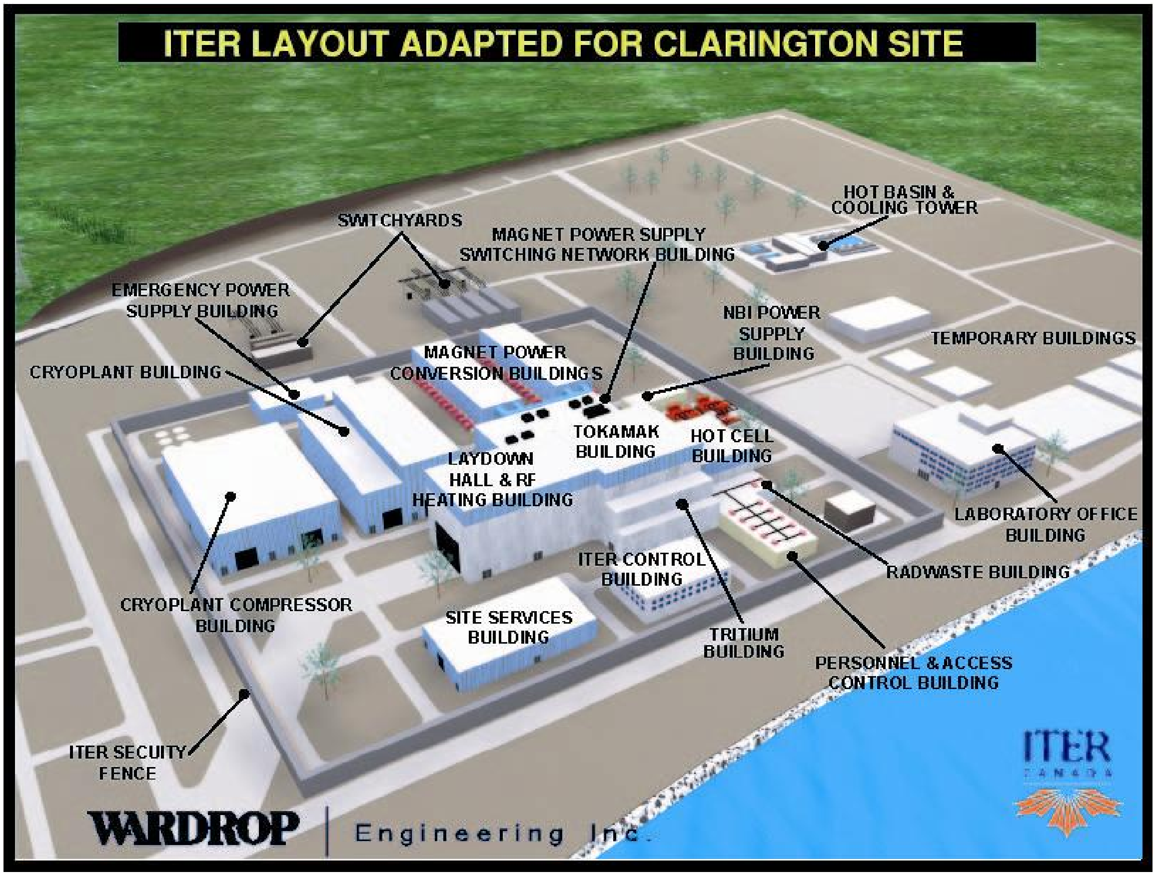


Figure 5.4 Visualization of the Iter Site Layout



The site area usage is detailed in Table 5.1 below.

Table 5.1: Clarington Site Land Use

Use	Area (ha)
High Security Area (inside Double Fence)	15.1
Switchyards	7.1
Cooling towers and basins	2.5
Rail Siding	7.2
Concrete Batch Plant	2.4
Permanent Parking and Lab Office Building	2.0
Construction Parking	6.0
Contractor 1 Laydown	4.7
Contractor 2 Laydown	5.9
Contractor 3 Laydown	2.8
Temporary Buildings & Pipe Warehouse	5.7
Spoils Areas	9.5
Roads and Unassigned	113.1
Total	**184**

The Clarington site is accessible by road transport, railroad, ocean going ships and barge. The highway access is via a multi-lane freeway (Ontario Route 401), which connects to all major highways in the greater Toronto area and North America. Objects greater than 4 m in height or width will require oversize permits, and special precautions will be required for objects taller than 5 m. A railroad passes through the Darlington site, and a dedicated siding area already exists. Objects transported by rail can arrive at the site within about 800 m of the tokamak building.

Very large objects can be shipped directly by water to the site. Lake Ontario is part of the St. Lawrence Seaway and ocean going vessels routinely navigate these waters. A barge slip exists in the forebay area of the Darlington Generating Station and large ship dockage facilities are also available at the neighbouring Blue Circle Cement Plant. These facilities were used extensively during construction of the Darlington station for off-loading of large components. These two dock facilities are highlighted in Figure 5.2. The lakefront location of the Clarington site creates the possibility that the envelope for objects shipped to the site could be increased. It is even conceivable that assembled TF/VV sectors might be completed elsewhere and shipped to the site.

There are some modifications to the existing Clarington site required to accommodate Iter. These have been studied by Iter Canada and are described in Section 5.2.1.9. below and include:

- addition of dedicated access road
- addition of new bridge over the railway
- modifications to existing roads
- addition of heavy haul roads
- temporary buildings for Iter construction
- addition of permanent roads and parking facilities
- piped utilities
- refurbishment of barge dock and rail siding
- electrical system tie-ins.

5.2.1.3. **Connection to the Electrical Grid:** The Clarington site is adjacent to a major node on the Ontario electric grid, which is one of the largest electric power systems in North America, with an installed generating capacity of over 30,000 MW. The “backbone” of the electric grid is the 500kV transmission system as shown in Attachment 5-B.

Two parallel, single-circuit 500 kV lines taken directly from the Bowmanville 500kV node are proposed to meet the Iter pulsed power needs (ie. magnet power and plasma heating systems) and steady state electrical requirements. This is shown in Attachment 5-C. The multiple circuits and nodes of the 500 kV system and the strategically placed large power generating facilities at these nodes provide a greater flexibility and reliability of power supply to every node in the system.

This choice is based on system study results, as given below, where the frequency and voltage variations due to Iter load swings are within limits imposed by The Independent Market Operator (IMO) that regulates the Ontario power system. The existing 500kV switching station at the site will require expansion. The north and south busbars of the gas insulated switchgear (GIS) of this station could be extended to tie-in with a new GIS with three circuit breakers in a breaker-and-a half configuration. This new GIS would be located in a new building, approximately 30 m east of the existing GIS building. The length of the new overhead transmission lines will be about 660 m. These connections will be made so that either line can be removed from service for maintenance or repairs without causing restrictions to Iter operations.

A preliminary power system simulation study [6] has been conducted to model the response of the Ontario power system to the Iter electrical loads. The pulse power loads to match these power requirement parameters, as defined for the current Iter design, were modeled under various conditions as follows:

- A step active power loading 0 to 500 MW and a step reactive power loadings of 0 to 240 MVAr and 0 to 800 MVAr; and

- A less severe active power loading of 0 to 500 MW in 3s (in steps of 60 MW and 100 MW) and a reactive power loading of 800 MVAr in 3s (in steps of 80 MVAr and 200 MVAr).

The study results are given in Table 5-2 for different grid loading situations. Acceptable frequency and voltage deviations are specified by the IMO as ±30 mHz and ±4% respectively. These preliminary results show that these conditions are met for cases that represent realistic Iter loads with the exception of the light system loading condition, where locally installed reactive power compensators may be required to limit the voltage deviation to 4%.

Table 5-2: Results of the preliminary power system simulation study

Loading Condition	Darlington Nuclear Units in Service	**Frequency Deviation** Δf (mHz)	**Voltage Deviation** Δv (%)	
		Closest Consumers at Richview 230kV	800MVAr	240MVAr
Heavy **(single step, 0-500MW)**	4 of 4	14	3.7	1.6
	2 of 4	14	3.8	1.8
	None	11	4.2	2.2
Light **(single step, 0-500 MW)**	1 of 4	16.5	6.4	4.4
Heavy **(0 to 500MW in 3s in steps of 60MW and 100MW)**	4 units in service	< 5	2.5	1.6

Electrical System Reliability: Data obtained from Hydro One, the Ontario electricity transmission company, confirms that the 500 kV system reliability greatly exceeds the reliability criteria stipulated by Iter. The following facts show the exceptional reliability of the Ontario power network.

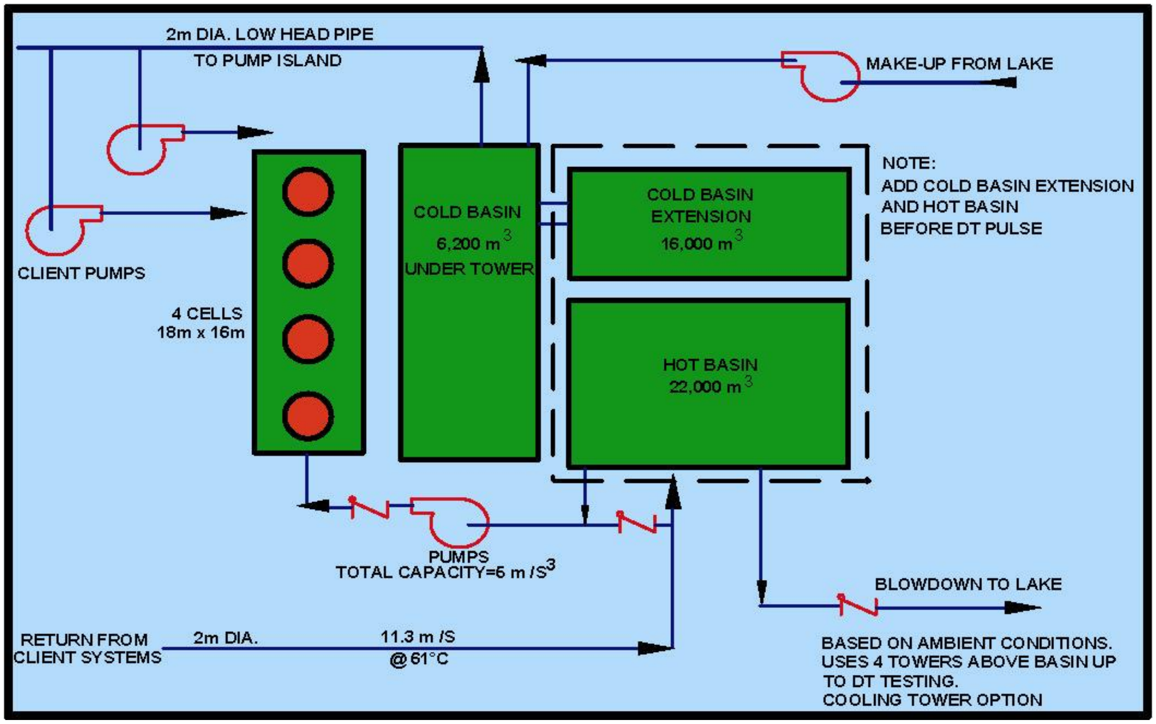
There has been no unscheduled line outage during the past ten years on any one of the four 500kV circuits between Bowmanville 500kV and Cherrywood 500kV.

Cherrywood 500kV, in addition to being interconnected with Cherrywood 230kV via 4 x 750 MVA transformers, has connected to it the two Pickering nuclear generating stations with an installed capacity of 8 x 540 MVA units, for a total of 4320 MVA.

There has been only one (1) unscheduled momentary power outage during the past ten (10) years on one of the four (4) 500kV circuits between Bowmanville 500kV and Lennox 500kV. Note that two (2) of the four (4) circuits between these two stations have been in service only since 1995.

5.2.1.4. **Heat Sink Design:** Preliminary designs have been developed for two heat sink options at the Clarington site – the cooling tower design proposed in the Iter generic design, and a once-through cooling option using some aspects of the existing infrastructure at the site (Figures 5.5 and 5.6) [Reference 22]. The design basis for both options assumes a maximum cooling requirement of 1200 MW for periods of 3600 seconds, however it is recognized that phased construction of the heat sink may be desirable, since this requirement will not occur until sometime after the DT operating phase.

Figure 5.5: Cooling tower option

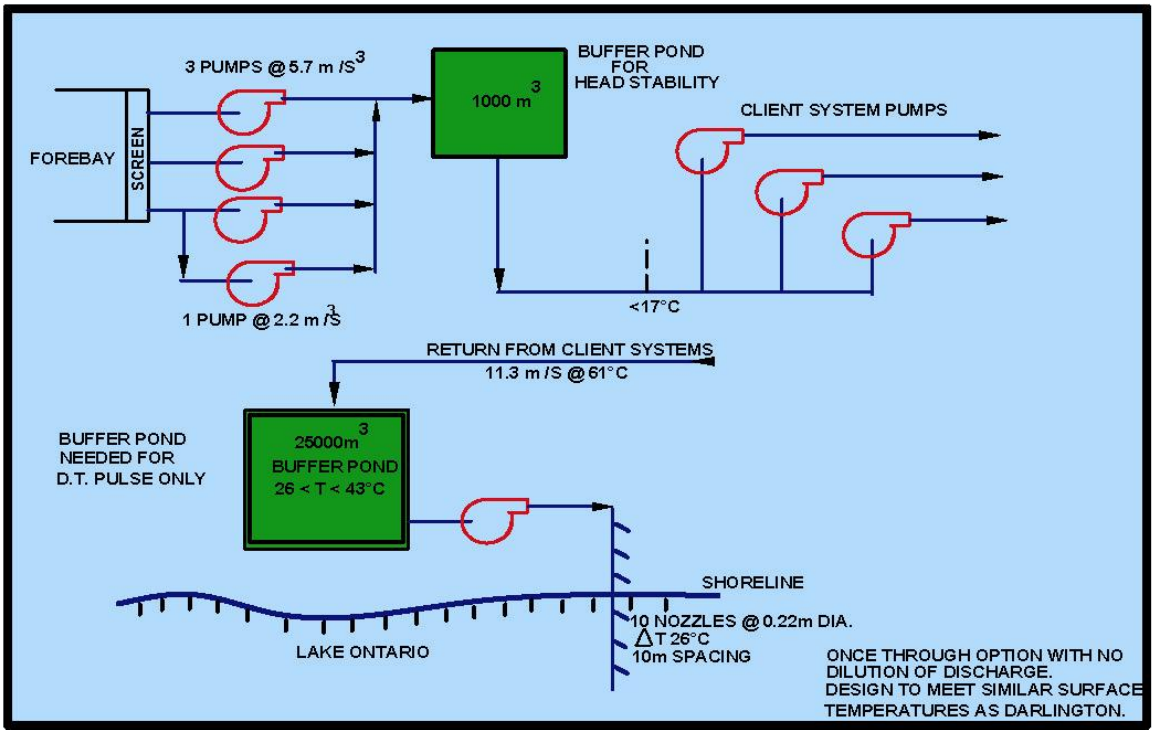


Cooling Towers (Plan to Host Iter chosen alternative):

Preliminary sizing indicates that four mechanical draft cooling towers are adequate to meet Iter's requirements, with a total capacity of 500 MW. The total area required by the towers is estimated to be 18 m x 66 m, including a 5 m deep concrete basin located beneath the towers, with a capacity of 6200 m^3. Cooling water would be gravity fed from the cold basin, through a 2 m diameter pipe to the system pumps and heat exchangers supplied as common elements by non-host Iter Parties (flow rate of 11.3 m^3/s at 34ºC, returning at 61ºC). The design of the system is based on a wet bulb temperature of 25.5ºC during summer conditions.

Following the DT operating phase, additional basin capacity will be required. Lined, earthwork basins for cold and hot coolant streams, sized at 16,000 m^3 and 22,000 m^3 respectively, can be added to meet the full heat sink demand, resulting in a total cycle time of 5 hours.

Figure 5.6: Once through cooling option



Once Through Cooling Option:

The once through cooling option has the advantage of providing lower temperature cooling water (17ºC lower than the cooling tower option) which could reduce the size and cost of the Iter heat exchangers. The disadvantages of this option are that it requires tie-in to the existing nuclear plant systems, a new out flow system into Lake Ontario which might be more difficult to obtain environmental permits, and it could prove to be more costly. Therefore, this option is not the current base offer within this Plan to Host Iter.

To meet the required 11.3 m^3/s coolant flow, three 5.7 m^3/s pumps (one standby) would be required, plus a smaller 2.2 m^3/s pump to meet the dwell period demands. Pending Ontario Power Generation review and approval, coolant water could be drawn from the existing water intake (perhaps the forebay of the nuclear plant). A 2 m diameter discharge line into the lake would have to be separately constructed and would likely extend 0.5 km into the lake, utilizing a spaced nozzle diffuser system at a depth of 8 m. Local mixing at these nozzles reduces the initial intake to discharge temperature rise to 12.3ºC, which meets the environmental permitting requirements that limit the increase of the lake surface temperature to a 2ºC rise.

Following the DT operating phase, an earth berm lagoon with an approximate capacity of 25000 m^3 will be required to buffer the discharge to the lake and achieve a steady state discharge temperature to accommodate the more demanding cooling.

5.2.1.5. **Geotechnical/Seismic Considerations:** The Clarington site is well characterized and documented, comprising data from over 80 boreholes [7-13]. The foundation conditions in the area proposed for Iter consist of a thick layer of dense glacial till overlying bedrock. The bedrock is fairly level, and is found at a depth of about 25 m below grade. The load bearing capacity of the bedrock is very high, probably exceeding 100 tons/m^2. The load bearing capacity of the glacial till is fairly consistent over its vertical range, and is about 40 tons/m^2. In some areas of the site, a layer of sand, silt, and clay interrupts the till, however, it is also quite strong.

Using the existing site data, preliminary excavation estimates can be made for the Iter buildings, assuming the current proposed tokamak building embedment level of approximately 16 m as shown in Figure 5.7 below.

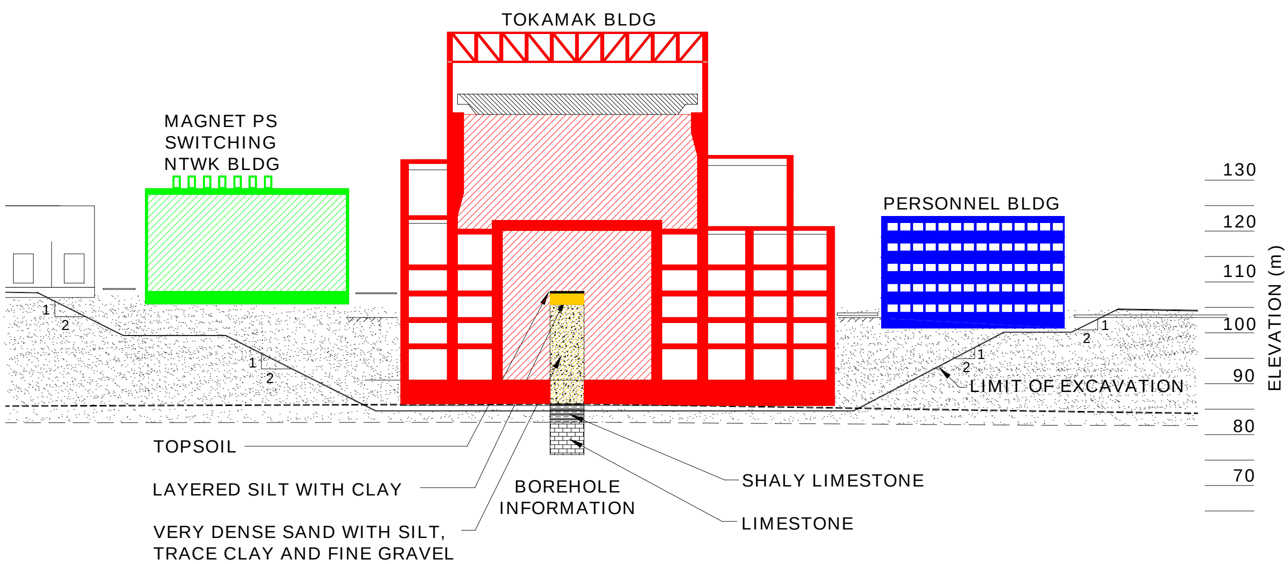


Figure 5.7: Typical subsurface profile showing option for open excavation

Table 5-3 shows these excavation estimates developed for both open and supported excavation. The Clarington site was originally part of an area prepared for the potential future construction of a second nuclear generating station at Darlington and is overall, quite flat. Excavated material, which must be removed for the Iter structures, can readily be disposed of on the site, in two areas already identified for spoils, south of the CNR tracks.

Table 5-3: Preliminary design of the Iter excavation options

Items		Unit	Option 1: Open Excavation	Option 2: Supported Excavation
Excavation	Soil Excavation	m^3	756000	347688
	Rock Excavation	m^3	29000	29000
Dewatering Wells	Pumped Wells	m	710 (total length of 37 wells)	650 (total length of 35 wells)
	Eductor Wells	m	2200 (total length of 88 wells)	1600 (total length of 71 wells)
Granular Backfill		m^3	279000	61000
Slope Protection		m^3	5000	2000
Wall Support Depth		m	-	18
Wall Support Perimeter		m	-	540

Because of the proximity of bedrock to grade at the Clarington site, it may be advantageous to increase the embedment of the tokamak building, so that the upper horizontal port elevation is aligned with grade. Although this would increase the excavation quantities estimated in Table 5-3, the basemat thickness could be reduced by 30% or more, since it can be founded directly on the bedrock layer. This basemat thickness can be further reduced by rock socketing the main support columns into the bedrock and using pad and strip footings to meet the allowable bearing pressure requirements.

The Clarington site has no history of seismic activity, but extensive study was required for the safety analysis of the neigbouring Darlington nuclear plant [14,15]. The local building code for the site is the Ontario Building Code, which refers to the National Building Code of Canada (NBCC) for the definition of seismic zones. The ground motion parameters are statistically derived, based on a probability of exceedance of 10% in 50 years. For Clarington the peak ground acceleration is 0.05 g, which corresponds to the Iter SL-0 level of seimic classification [16].

5.2.1.6. **Site Meteorology:** The meteorology of the Clarington site is also well characterized, as are the environmental conditions required to perform detailed safety analyses [17]. Table 5.4 contrasts the Iter design assumptions with the conditions at Clarington.

Table 5.4: Site metrological conditions (to be confirmed)

Meteorological Parameter	ITER	Clarington
Maximum Wind Speed, km/hr	140	140
Maximum Air Temperature, 24 hr average, degrees C	30	30
Minimum Air Temperature, 24 hr average, degrees C	-15	-22
Maximum Relative Humidity, 24 hr average, percent	95	95
Maximum Relative Humidity, 30 day average, percent	90	90
Elevation above sea level, m	<500	75
Maximum Snow Load, kg/m^2	150	214
Maximum Icing, mm	10	15
Maximum Rainfall, 24 hrs, cm	20	7.6
Maximum Rainfall, 1 hr, cm	5	5
Worst Case Air Pollution (IEC 71-2), Level	3	3

5.2.1.7. This sub-section not used.

5.2.1.8. **Transportation to the Clarington Site:** The Clarington site is easily accessible by highway, railway and water.

By road the site is bounded on the north side by the MacDonald-Cartier Freeway (Ontario Highway 401). Iter Canada will construct a new site access road independent from the Darlington Nuclear Generating Station, approximately 2 km from the Iter high security fence to the highway. There will be one bridge on this road across the railway line. This bridge will be sized for loads of 150 tonnes.

By railway, the main Toronto-Montreal Canadian National Railway line traverses the 184 Ha site in the middle in the east-west direction. Ontario Power Generation, during the construction of the Darlington station, had a rail spur on the east side of the Clarington site. This spur is partially removed, but will be reinstalled by Iter Canada when/if a specific need for rail transport is identified.

By water the site is bounded on the south side by Lake Ontario. Lake Ontario is accessible for 9 months of the year (April – December) from the Atlantic Ocean through the St. Lawrence River to Montreal, and then via the St. Lawrence Seaway to the lake. The St. Lawrence Seaway can accommodate high seas ships up to 220 metre length, 23 metre wide and drawing 8 metre or less. On Lake Ontario and the other Great lakes there are Heavy Deck

Barges of 23 metre width and capacities up to 6000 tonnes. On Lake Ontario there are barges up to 30 metre wide.

Iter Canada's Canadian transportation and shipping suppliers, including ETARCO and MAMMOET Canada, have confirmed they are able to accommodate a piece 20 metre in diameter and with a weight of 750 tonnes (deck crane restriction). For loads heavier than 750 tonnes Ro/Ro (ie. roll-on/roll-off) vessels could be utilized, but width restriction due to lock width would still apply. For the widest pieces anticipated, PF #3 and #4 coils at approximately 25 metre width and 1.5 metre high, a rigid steel structure would be required to carry the coils at a 40^{o} angle without imposing any bending loads on the coils and withstand ocean going forces. There are several options for handling these coils. ETARCO, part of the Van Seumeren/Mammoet Group, specialize in heavy transport and rigging services worldwide and operate the largest fleet of hydraulic platform transporters and super heavy cranes anywhere in the world. They have sufficient equipment in the proposed Iter site area to transport all the heavy components anticipated. They have extensive experience at handling loads exceeding 1500 tonnes from ships, barges, and ro/ro operations.

The Darlington site on the west side of the Clarington site has a barge dock as shown in Figure 5.8. This dock has silted in over the last few years and Iter Canada will dredge the area, if a specific requirement for this dock is identified. The picture shows a 350 tonne 900 MW generator stator for the Darlington Nuclear Generating Station being unloaded from a transfer barge.

On the east side of the site the Blue Circle Cement company has a dock suitable for high seas ships or barges. During construction of the Darlington Nuclear Station this dock was used for transport of heavy components with high seas ships (see Figure 5.9) and barges (see Figure 5.10). The use of the Blue Circle dock with a new heavy transport road, approximately 1.75 km, from the dock to the Iter heavy equipment laydown area and Tokamak hall is the preferred option. Iter Canada will undertake the construction of this 15 metre wide (23 metre clear width) road prior to arrival of the first heavy shipment. There are also nearby port facilities for high seas ships at Oshawa, approximately 20 km, and Port Hope, approximately 30 km, for shipments that can be then transported by road/rail/road to site (see Figure 5.11)

Figure 5.8: Darlington Barge Dock – unloading a 350 tonne generator stator

Figure 5.9: Blue Circle dock with heavy lift ship unloading a 350 tonne generator stator

Figure 5.10: Blue Circle dock with barge unloading a 200 tonne generator rotor

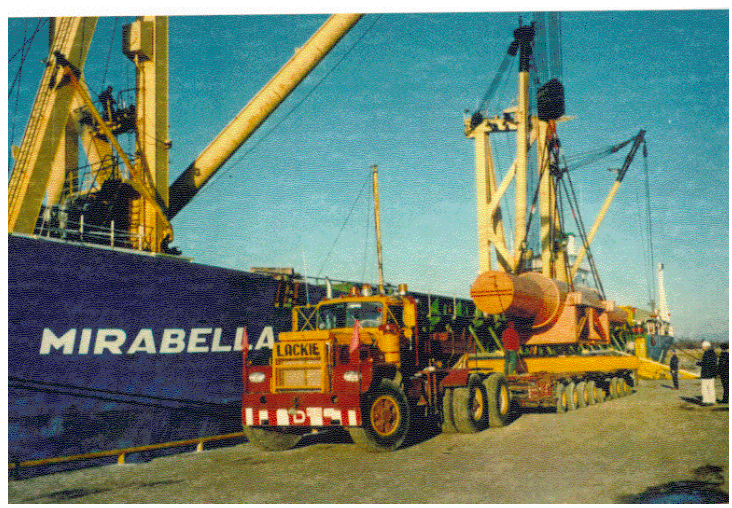


Figure 5.11: Port Hope dock with heavy lift ship unloading a 200 tonne generator rotor onto transfer truck

5.2.1.9. Other Infrastructure and Services at the Clarington Site:

The Clarington site is part of land that was originally developed for the Darlington Nuclear Generating Station. The existing Darlington A station is Canada's most modern CANDU reactor plant, and consists of four 880 MWe nuclear reactors. The site was large enough to permit the construction of four more CANDU units, which would have been designated as Darlington B. Consequently, some of the Clarington site is graded and was used for construction laydown. In order for Iter to be fully functional on the Clarington site, external services must also be connected to the site. Iter Canada proposes to provide all of the necessary site modifications and tie-ins, including the following items:

- **Access road from the MacDonald-Cartier Freeway, approximately 2 km:** This roadway will be sized to handle all Iter related traffic, during construction and operation. This road will connect with Holt Road, which currently serves as a connection between the Darlington site, and Highway 401, also known as the MacDonald-Cartier Freeway which is the major road link across Ontario, stretching from Detroit, Michigan to the province of Quebec. To prevent interferences between Iter and the Darlington generating station, the Iter road will be completely independent. It will enter the site near the intersection of the freeway and Holt Road, and will run about 270 m to the east. There it will widen to accommodate multiple lanes, and an access control checkpoint. It will then turn and run south, to the east edge of the Iter high security area.

- **Modifications to the freeway interchange with Holt Road:** This will accommodate additional traffic, and provide separation of Darlington and Iter traffic. To allow both the daily Iter traffic (estimated at up to 800 autos/1000 persons) and Darlington traffic (estimated at 1600 auto/2400 persons) to use the Holt road interchange, some modifications and improvements will be required. These improvements will include additional lanes, east-bound on and off-ramps, and a traffic control point where the Iter access road intersects with Holt road.

- **New highway bridge over the Canadian National Railway line:** This bridge will allow the Iter traffic to cross the rail line without interference. Some heavy objects are expected to be delivered by road, so this bridge will be sized for single loads on the order of 150 tonnes. Heavier objects are expected to be delivered by rail or barge. A rail siding already exists on the site, although the track will be required to be re-installed.

- **Modifications to widen and strengthen roadways** from the Iter site to the Darlington barge slip, or to the shipping facilities of the Blue Circle Cement company, approximately 1.7 km in either direction will be made by Iter Canada. The lake front location of the Clarington site offers an excellent opportunity for many of the large and heavy objects needed for Iter construction to be shipped directly to the site from their point of manufacture. Loads in the 1000 tonne class will be moved from the docking point to the Iter site over a wide, reinforced roadway. This site modification will facilitate Iter assembly, and offers the ability to expand the shipping envelope.

- **Permanent roadways and parking facilities, outside the Iter security fence:** These modifications will include the roadways and parking needed for construction and operation, as well as intra-site communication and transport.

- **Piped utility connections:** Service water (untreated lake water) will be piped from a new pump structure located on the Darlington generating station forebay. This water will be used for cooling tower makeup, and other service water needs. Potable water will be provided by the municipality of Clarington, using a new local pipeline. Sanitary and industrial drainage will also be tied into the Municipality of Clarington utility infrastructure. Storm drainage will be discharged to the lake, via catchment basins where oil and debris can first be captured.

- **Temporary Buildings:** Iter Canada will also provide the temporary buildings and facilities needed for Iter construction, including temporary office buildings, warehouse, change room building, timekeeping/access control facilities, parking, contractor laydown space, canteen, first aid, construction consumables, and so forth. Most of these facilities will be directly related to the construction of proposed Canadian scope to supply Iter buildings. However, the same facilities will be available to other parties and to support non-Canadian work on site.

5.2.2. **The Iter Canada "Non-Transportable Scope":** This Section describes the "non-transportable" scope included in the Iter Canada Plan. (Note that for this plan, the terms "non-transportable" and "non-common" are used interchangeably.) Non-transportable scope is defined as the scope that only the host can logically provide on a contractual basis directly to the Iter Legal Entity as part of the overall host obligations and listed in the Joint Implementation Agreement. The scope described below in this Section will be the responsibility of Iter Canada as host, subject to the terms and conditions described in the Financial Section 9, and the terms of the Joint Implementation Agreement as described in Section 4.

This portion of the Iter Canada scope is described according to the Procurement Package breakdown of the Iter project, as issued by the Joint Central Team in August 2000. In some cases, Iter Canada's Plan takes responsibility for the total Procurement Package. In other cases, Iter Canada's Plan includes only a portion of a Procurement Package. Partial packages are only proposed where we see there being a logical split to an existing package, between the host and one or more of the other Parties, who will desire to supply only the remaining portion of the specific package, or where the Iter Legal Entity could logically contract directly with third parties for a portion of the package.

6.2 P1 Reinforced Concrete Buildings and Selected Infrastructure:

Iter Canada's Plan includes the full scope of work defined in Procurement Package 6.2 P1 (July 2000 edition), with the provision that the site specific design changes are incorporated into the final design as outlined below and in Table 5.5. As specified in the Procurement Package, this scope is considered as "design and construct" to the functional specifications and drawings supplied.

Modifications to the Procurement Package specifications and the basis of the Iter Canada Plan: Some of the buildings defined in Package 6.2.P1 will be affected by the use of Canadian design standards and practices. The general effects of adapting the Iter building design to the Clarington site may include the following (see also Section 5.3):

Table 5.5: Site specific modifications for the Concrete Buildings

Building No.	Building Name	Planned Clarington Site Specific Modifications Required
11	Tokamak Building	▪ Embed building more deeply, so that grade level 0 is equal to the upper horizontal port access floor level. This allows a reduction in the basemat thickness due to the proximity of the bedrock to the surface. ▪ Eliminate embedded structural steel shapes inside of columns and beams.

		▪ Reposition heat transfer vault to be one bay away from tokamak.
13	Laydown, Assembly and RF Heating Building	▪ Reduced height to match deeper embedment of tokamak building. ▪ Reduced member size, reflecting lower seismic loads.
14	Tritium Building	▪ Revise location of walls and slabs to be consistent with changes in tokamak building and HTS vault. ▪ Eliminate embedded structural steel shapes inside of columns and beams.
21	Hot Cell Building	▪ Embed building to match tokamak building ▪ Eliminate embedded structural steel shapes inside of columns and beams.
23	Radwaste Building	Some functions assigned to the Radwaste Building may be re-assigned to the on-site radwaste disposal facility.
71	Control Building	Iter Canada Plan is based on this building being optionally designed as a steel frame or concrete block structure.

6.2 P2 Steel Frame Buildings:

Iter Canada's base Plan includes the full scope of work defined in Procurement Package 6.2 P2 (July 2000 edition), with the provision that the site specific design changes are incorporated into the final design as outlined below and in Table 5.6. As defined in the Procurement Package this scope is considered as "design and construct" to the functional specifications and drawings supplied.

Modifications to the Procurement Package specifications and the basis of the Iter Canada Plan: The same provisions identified for the reinforced concrete buildings also apply to the supply of steel framed buildings. The general effects of adapting the Iter building design to the Clarington site may include the following effects:

Table 5.6: Site specific modifications for the Steel Framed Buildings

Building No.	Building Name	Planned Clarington Site Specific Modifications Required
24	Personnel and Access Control Building	May be reconfigured to eliminate mezzanine and penthouse used to access upper floors of Tokamak Building, with tokamak building embedded one level more deeply. Shape of building footprint may change, if low level liquid radwaste facility is revised.

31	Magnet Power Supply Switching Network Building	To suit site constraints imposed by the lake shore and the railroad, the aspect of this building will be changed from a square footprint (6 bays by 6 bays) to a rectangular building (9 bays by 4 bays). This should make better use of the site, and shorten the bus bar length.
32	North Magnet Power Conversion Building	Little or no change. If further constraints to the site layout are identified, this building and building 33 could be reduced in length from 120 m to 80 m, and a third identical building added.
33	South Magnet Power Conversion Building	Little or no change. If further constraints to the site layout are identified, this building and building 32 could be reduced in length from 120 m to 80 m, and a third identical building added.
34	NBI Power Supply Building	No change anticipated.
44	3.3 KV Power Supply Building	No change anticipated.
51	Cryoplant Coldbox Building	Canada proposes that all coils will be fabricated off-site. In this case, the cryoplant coldbox building would be configured with a central support wall, and a high bay and a low bay section. The crane for the high bay would be sized for the coldbox installation and maintenance.
52	Cryoplant Compressor Building	The compressor building would be reconfigured as a low bay building with a central support. A light duty bridge crane would be installed in each bay, instead of a singular, heavy lift crane.
61	Site Services Building	No change anticipated.
72	Laboratory Office Building	No change anticipated, for either a lake front location, or for a location near the freeway.

2.2 P1 (AP.P1) Machine Assembly Operations:

Iter Canada's Plan includes the full scope of work defined in Procurement Package 2.2 P1 (AP.P1).

Iter Canada is pleased that it has worked extensively with the Joint Central Team - Naka, under a Task Agreement, to develop the detailed procedures, processes and schedule for the assembly the tokamak.

The complete scope of this Procurement Package covers the on-site transport of the machine components, preparation (pre-assembly) of the components, sub-assembly of the integrated assembly units, and final assembly inside the cryostat. For clarification, the following scope is included in this package:

- The on-site transport and final assembly of the cryostat in the tokamak pit. The cryostat pre-assembly and sub-assembly operations are included in Procurement Package 2.4 P1 (see Section 2.4P1 below). It should be noted that the transportation of manufactured components and materials to the site lay-down areas are not included in the Iter Canada Plan scope of supply.

- The on-site transport and final assembly of the Poloidal and Correction Field Coils. It is assumed the coils are fabricated off-site and shipped to site as complete components. However, Iter Canada has the technical capability and is prepared to assemble the PF and CF coils on site as defined in the Iter Final Design Report, on a contract basis as defined in Section 5.4.

The tooling required for this package is included in Procurement Package 2.2 P2 (AP.P2) Machine Assembly Tools (see below).

The Iter Canada Construction Consortium will be responsible for the installation activities in this package and provide the trades, supervision, field engineering and all support staff and facilities. The Iter Legal Entity is the Design Authority, ie. provides build-to-print information, and provides the Resident Engineering function. The commissioning is also the responsibility of Iter Legal Entity.

The assembly procedure assumes a workforce on two 8 hour shifts per day Monday to Friday, or two 10 hour shifts Monday to Thursday, and an extra 8 hour shift on Saturday for the 5x8 shifting, or on Friday for the 4x10 shifting.

The installation activities includes the following generic operations:

- All the equipment is assumed to be in storage within one of the Clarington site laydown areas.

- The equipment at its on-site storage area is rigged and positioned on a suitable transporter and transferred to the appropriate cleaning facility.
- The component is rigged and removed from its packaging and the external transporter and packaging removed from the cleaning facility. The component is placed on an internal air pallet and temporary cranes and rigging are removed from the cleaning facility.
- The cleaning facility and component are thoroughly cleaned.
- The component is transferred into the building laydown area on the air pallet for pre-assembly inspection.
- The components requiring sub-assembly are transferred to the assembly hall with the building overhead crane.
- The components are transferred to the pit either as an individual component or as a sub-assembly with the building overhead crane and assembled into the tokamak.

The overall assembly procedure within the tokamak pit is divided into the following six main sub-sections:

- **Lower cryostat activities:** includes the assembly procedures for the bottom of the cryostat, the gravity supports, and the lower PF coils.
- **Torodial Field Coil (TFC)/Vacuum Vessel (VV)/Vacuum Vessel Thermal Shield (VVTS) sub-assembly:** includes installation of the (VVTS) workstations, the upending tool, the TFC/VV/VVTS sector sub-assembly, and the completion tool necessary for assembly of the nine sectors.
- **Integrated TFC/VV/VVTS assembly:** covers the sequencing of the nine TFC/VV/VVTS assemblies in the cryostat.
- **Establish Magnetic Axis:** includes the pre-tensioning of the TF magnet and the survey procedures by which the tokamak magnetic datum is geometrically established.
- **Ex-Vessel Activities:** includes the welding of the final VV field joints (Torodial closure), and all of the assembly procedures for the components and systems external to the VV and ports up to the commissioning.
- **In-Vessel Activities:** includes all of the assembly procedures specific to the VV and port internals, up to commissioning.

2.2 P2 (AP.P2) Machine Assembly Tools:

This Procurement Package contains a number of discrete items. Although the package specifies there should be one prime contractor, the Package anticipates the use of sub-contractors for the procurement of some of the tools and services. Hence, Iter Canada’s

Plan includes defined portions of this Procurement Package scope we believe fall under the definition of "non-transportable" scope, due also to their size and also not requiring fabrication by the same supplier as the component for which it is to be used.

This complete Procurement Package contains a number of discrete items grouped into 13 categories:

- 2.2 B.01: Assembly Control Tools
- 2.2 B.02: Assembly Support Tools
- 2.2 B.03: TFC/VV/VVTS Sub-assembly Tools
- 2.2 B.04: TFC/VV/VVTS Assembly Tools
- 2.2 B.05: Cryostat Assembly Tools
- 2.2 B.06: Cryostat Thermal Shield Assembly Tools
- 2.2 B.07: PF Coil Assembly Tools
- 2.2 B.08: Port & Piping Assembly Tools
- 2.2 B.09: Central Solenoid Assembly Tools
- 2.2 B.10: Correction Coil & Feeder Assembly Tools
- 2.2 B.11: In-Vessel Assembly Tools
- 2.2 B.12: Common Handling Tools
- 2.2 B.13: Standard Tools

Iter Canada's Plan scope includes the following specific items, which have also been defined based on the recent discussions with the Joint Central Team during the Task Agreement work:

- **2.2 B.01:** Assembly Control Tools - Complete
- **2.2 B.02:** Assembly Support Tools - Complete
- **2.2 B.05.02.01:** Cryostat purpose built fabrication/transport frames (4 only)
- **2.2 B.07.01.01:** PF Coil purpose built fabrication/transport frames (6 only)
- **2.2 B.12:** Common Handling Tools - Complete
- **2.2 B.13:** Standard Tools - Complete

The scope of this Procurement Package defines only the supply and installation of these items. The operation of these facilities and tools are all covered in other Procurement Packages, the majority being in Procurement Package 2.2P1. The Iter Canada Construction Consortium will be responsible for supply, installation/disassembly where required, and disposal after use of these items.

2.4 P1 Cryostat and Vacuum Vessel Pressure Suppression System (VVPSS):

The Procurement Package specifies that the Cryostat and VVPSS will be supplied on a "build-to-print" basis. Iter Canada's Plan includes a portion of this Procurement Package, consistent with the inclusion of the Machine Assembly Package in the Iter Canada Plan.

The Cryostat scope included in the Iter Canada Plan is:

- Erection of a temporary workshop at the Clarington site.
- Required site fabrication of the Cryostat. It should be noted that this assumes the contractor responsible for supplying the pre-fabricated components takes full advantage of the large shipment size that can be accommodated by the Clarington site and transportation infrastructure (See Section 5.2.1.3.). Iter Canada has also reviewed the assembly of the cryostat in the tokamak pit is detail as part of the Joint Central Team / Iter Canada Task Agreement for the tokamak machine assembly.
- Cleaning of the components at the site.
- Installation of the components in the tokamak pit. (Note that although the Procurement Packages are ambiguous on which one includes the assemble of the cryostat in the pit, the Iter Canada Plan includes this scope of work.)
- On-site testing of the components, including equipment and consumables required for testing.
- **Option:** Iter Canada is prepared to undertake the project management of the full scope of this Procurement Package, including the sourcing of the components, but the cost of the sourced components would be to the account of the Iter Legal Entity.

The supply, fabrication, sub-assembly and installation of the VVPSS is not included in the Iter Canada scope as it can be easily shipped to site in one or a few pieces, and the installation is in the gallery which is outside of the tokamak pit, and therefore outside the scope of Procurement Package 2.2 P1.

2.6 P2 Heat Rejection Systems:

There are several options offered by the Joint Central Team Procurement Package to meet the heat rejection system requirements, and these ultimately will be site specific. This scope is specified to be supplied to a "functional specification".

Considerable work has been conducted by Iter Canada on the heat rejection system appropriate for the Clarington site in support of the Joint Central Team design. For the Clarington site the cooling tower system is the designated site specific approach. Iter Canada's Plan includes the following portions of this Procurement Package:

- Design of the external systems as defined in Annex 2, Tables A2-3 and A2-4 of the Procurement Package.
- Development of equipment procurement packages and procurement of the scope defined above.
- Project management of the above scope.
- The field activities portion of the scope, including the installation of the equipment supplied by other Parties.

This scope is considered integral to the overall site preparation and infrastructure scope described in Section 5.2.1.5., and the close relationship to Procurement Package 6.2 P1, and hence, is included in the Iter Canada base Plan.

Exceptions to the Procurement Package specifications: The Iter Canada scope excludes the scope not defined above, which for example excludes the following scope:

- The design, supply and installation of the equipment defined in 2.6 P2 Annex 2, Tables A2-1 and A2-2 (eg. piping, valves, pumps, heat exchangers)

2.6 P1 The Tokamak Cooling Water System:

The installation of this system is included in the Iter Canada Plan, as it is integral to the tokamak building construction.

2.6 P3 The Component Cooling Water Systems and Chilled Water System:

The installation of the Chilled Water System is included in the Iter Canada Plan as it should be installed at an early stage to reject the HVAC load during the vacuum vessel assembly, which is included in the Iter Canada scope.

5.2.3. **Excluded Iter Canada Scope - Clarification of Non-Transportable Procurement Package Scope:** For clarification purposes, the following is specifically excluded from the base Plan of Iter Canada as host for Iter.

5.2.3.1 **11.P3 - Poloidal Field Coil and Correction Coils:** The Iter Canada Plan does not include manufacturing of the poloidal field and correction coils at the Clarington site. As noted in Section 5.2.1.8. the largest coils can be transported to the Clarington site. As this is believed to be the preferred approach for the construction of the Iter machine, Iter Canada has not pursued the option of field manufacture of the PF coils. If required, however, Iter Canada would be pleased to undertake this scope of work, but the costs would be subject to negotiation, and to the account of the Iter Legal Entity – see Section 5.4.4.

5.2.3.2. **Equipment Installation:** Except as defined for Procurement Package 2.2 P1, 2.2 P2 and 2.4 P1, the Iter Canada Plan excludes the installation and commissioning of equipment and plant provided by other Iter Parties. However, Canada has the capability to perform this work, and as proposed in Section 5.4, Iter Canada looks forward to working with the other Iter Parties to provide this scope on a competitive commercial basis, taking advantage of low Canadian costs.

5.2.3.3. **Equipment Shipment:** The Iter Canada Plan excludes the packing and shipping of all equipment and plant provided by other Iter Parties to the Clarington site.

5.2.3.4. **Steady State Power Supply System:** Reference is made to the Single Line Diagram presented in Attachment 5-C;

For Steady State Power Supply, all equipment on the down stream side of the two 500/220kV power transformers ie. all equipment covered in the Procurement Package 41.P8 Annex 2 are excluded.

For the Pulse Power Supply, all equipment on the down stream side of the 500kV switchgear ie. all equipment covered in the Procurement Package 41.P1 Annex 2 are excluded. The list of equipment identified as 41B-1 400kV switchgear would not be required under the Iter Canada Plan since the required 500kV switchgear is included in this proposal. The three main step-down transformers identified as 41B-2 would have to be re-specified as 500/69/33kV instead of 400/69/33kV.

The above is due to fact that this equipment is specified to the exact requirements of Iter power supplies and switching criteria (ref. PP 41.P8 Annex 1 and PP 41.P1 Annex 1). One exception that must be considered for the equipment in question is that they should all be made suitable for operation on 60Hz (the standard north American power system frequency), instead of 50Hz. power system.

Finally, for clarification, since the proposed Iter power supplies are obtained from the 500kV grid in the manner shown in the Attachment 5-C, all 500kV equipment and the 500/220kV transformers would fall within the Iter Canada scope included in Section 5.2.1.3.

5.3 ITER DESIGN IMPROVEMENT OPPORTUNITIES AT CLARINGTON

During the detailed design for the site specific adaptation it is expected that there will be a number of design improvements and opportunities to improve the functionality of systems and reduce the cost of the overall Iter project. As discussed in Section 4.2, this will be a key aspect to the negotiation process to select a site and arrive at a definitive agreement with Iter Canada to host Iter.

These design improvements include the following, several of which have already been identified and highlighted in Section 5.2 above:

- Changing the embedded level of the Tokamak Building,
- Reduced the height of the RF Heating Building,
- Eliminate the embedded structural steel shapes inside columns and beams of selected concrete buildings,
- Change the Control Building to a steel frame or concrete block structure from a concrete structure,
- Reconfigure the Personnel and Access Control Building,
- Reconfigure the Magnet Power Supply Switching Network Building,
- Reconfigure the Cryoplant Building as it will not be required for coil fabrications,
- Reconfigure Cryoplant Compressor Building,
- Relocate the Laboratory Office Building to near the 401 highway,
- Re-specify electrical equipment for the steady state and pulse power supplies to suit North American standards such as ANSI/IEEE, as well as to be compatible with Ontario power system criteria and characteristics,
- Redesign all buildings and structures to accommodate the reduced seismology at the Clarington site.

- Phase in the construction of non-critical buildings to provide a more optimized construction schedule.

The Iter Canada Plan is based on these, and other identified changes being accepted and approved by the Iter Legal Entity during the Construction Phase, assuming they meet the functional requirements of the Iter design.

5.4 ITER CANADA "COMMON ELEMENT" OPTIONS

There are three areas where Iter Canada could make a major positive impact on the overall Iter project with respect to the Common Element scope of work.

- Tritium Plant and Detritiation
- Remote Handling Equipment
- PF and CF coil manufacturing on site
- Equipment Installation/Commissioning and Procurement Services
- Transportation of off-shore supplied equipment to the Clarington site

As is discussed in detail in the Financial Section 9 of this Plan, Iter Canada does not have the financial capability to undertake significant Common Element Procurement Package scope on a "contribution" basis. Iter Canada is, however, prepared to make its capabilities, resources, and technology available to the Iter project on a preferred basis, including within the provisions of the expected Intellectual Property requirements of the Joint Implementation Agreement, in consideration for Iter Canada hosting Iter at Clarington. This approach would not only reduce the cost to the Iter Parties, but it could significantly reduce the technical risk for Iter being a success.

Iter Canada proposes that discussions commence, as part of the overall negotiation process (see Section 4.8) for the following scope of work on a contractual basis between the Iter Legal Entity and Iter Canada Host Inc. Early in the negotiation process Iter Canada proposes that a formal presentation be given to the negotiating team on the Canadian capabilities in these areas, which would lead into detailed discussions on an appropriate scope of work to be considered for Iter Canada.

5.4.1. **Tritium Plant and Detritiation (Procurement Packages 3.2P1 through 3.2P7):** Canada has a unique capability in the processing, removal, storage and management of tritium. This has resulted from decades of work associated with the CANDU nuclear reactor systems and work with fusion research through the Canadian Fusion Fuel Technology Project (CFFTP). A number of Canadian corporations have unique engineering, design, manufacturing and operating capabilities with respect to tritium systems, such as Ontario Power Generation, Acres International, and Kinectrics (formerly Ontario Hydro Technologies). Work has included the design, assembly and test of an isotope separation system for the Princeton Tokamak Fusion Test Reactor when it adopted a full tritium fuel cycle.

The unique technology for these tritium systems relates to the ability to accurately set the process design parameter (flows, distillation parameters, design of columns, etc.). Simulation programs (eg. CFTSIM) developed in Canada over the years are the best available to do this design. Canada also has two other unique technologies for the design of tritium storage beds (uranium, titanium), and leak tight piping and valve systems (for example, bellows sealed valves). Both of these areas of expertise are applied in CANDU plants and detritiation facilities operating in Canada.

Two specific areas where the Iter Parties could consider a role for Iter Canada, is for Iter Canada under contract to the Iter Legal Entity, to undertake the engineering and design for all the tritium packages collectively, and/or the full sub-system supply of only the isotope separation system (Procurement Package 32.P3).

Iter Canada would also be prepared to consider a design/test/build/install/commission contract from the Iter Legal Entity, which would include the activities required to integrate all the scope of supply from all the Iter Parties for their respective scope of supply of any part of the overall tritium systems. This could include aspects of all the defined Procurement Packages for tritium processing:

- 32.P1: Tokamak exhaust processing system
- 32.P2: Storage and delivery, long term storage system
- 32.P3: HTD isotope separation
- 32.P4: Atmospheric detritiation (including hot cell, radwaste building)
- 32.P5: Water detritiation (including tritiated water holding systems)
- 32.P6: Tritium plant analytical system
- 32.P7: Tritium plant automatic control system.

The lead role in Canada would be undertaken by one of the Iter Canada members, under the umbrella of Iter Canada Host Inc. It should be noted that Iter Canada has submitted a Procurement Package estimate for item 32.P3 – HTD isotope separation system.

If this approach is acceptable to the Iter Parties, a second Iter Canada consortium will be established, including possibly Acres International, CanatomNPM and Wardrop Engineering (see Section 2 for details on these companies), and a formal offer will be negotiated for a suitable package of work.

5.4.2. **Remote Handling Equipment (Procurement Packages 2.3P1 through 2.3P6):** Canada has a unique capability and experience in remote handling systems for fusion tokamak installations. This includes the participation of MacDonald Dettwiler Space and Advanced Robotics Ltd. (formerly Spar Aerospace) in the Iter Joint Central Team activities through the provision of visiting home team professionals.

Canada, through MacDonald Dettwiler, has provided the following to the development of fusion technology:

- The Joint European Torus (JET): Articulated boom octant and test facility, remote maintenance system and remote welding systems.

- The Compact Ignition Tokamak (CIT): Design of in-vessel maintenance manipulator, transport system, inspection and viewing system, cutting and welding tools, mock-up and other tools.

- Tokamak Fusion Test Reactor (TFTR): Design of in-vessel maintenance manipulator and maintenance system.

- Next European Torus (NET): Research, design and development of in-vessel vehicle and manipulator, lower plug manipulator, remote cutting and welding bore tools, X-beam in-vessel deployment, and rad-hard multiplexer. This work was utilized for the Iter design.

Attachment 14.1 (MacDonald Dettwiler Space and Advanced Robotics Ltd.) gives considerably more detail on the Canadian capabilities for remote handling systems, relevant to the Iter project. Canada has been in a leadership position on key International Space Station systems, and this is very relevant experience that can be applied to Iter.

As for the tritium systems, Iter Canada requests the Iter Parties to consider a role for Iter Canada, under contract to the Iter Legal Entity, or in partnership with companies from non-host Iter Party countries, to undertake selected areas of the Remote Handling Systems scope of work. The scope of work in this proposal takes into consideration the known experience and interest of the various Iter Parties for participating in the Remote Handling Procurement Packages as part of their contribution to Iter.

Port Maintenance & In-Cask Handling Equipment (portions of Procurement Packages 2.3Pxx): To avoid the release of contaminated particulate into the reactor building, components located on the vacuum vessel ports must be transported in contained casks to the hot cell for maintenance. To this end, Iter Canada could provide under contract, the robotic equipment capable of remotely handling the upper and equatorial port shield plugs with their attachments and the cryopumps. The divertor port tractor/manipulator is not part of this proposed work scope.

The in-cask handling equipment will include a tractor and manipulator system. The manipulator will perform the dexterous handling tasks such as positioning tools, auxiliary cameras, etc. The tractor will be a rail mounted device that can remove or install the shield plug and attached equipment into the transfer cask/operating port. This equipment will be guided and supported on wheels in an enclosed rail able to withstand the overturning moments during transportation and thus minimizing the overall weight of the tractor. Both the manipulator and tractor will be remotely controlled.

The equipment will be designed bearing in mind the radioactive environment when operating at the port and also when in the transfer cask. Components of the in-cask handling equipment will be designed so that they can be readily decontaminated. All items will be chosen so that they will be sufficiently radiation resistant to withstand the environment within the cask for the full duration of the maintenance task. These components will include:

- Motors
- Conductors and insulation
- Lubricants
- Hoses
- Seals
- TV cameras

The handling equipment will be designed with sufficient redundancy that, in the event of a failure, the equipment can continue the task at a reduced performance, or render itself to a state where it can be rescued.

Hot Cell Repair and Maintenance Equipment (Procurement Package 2.3P6): Iter hot cell repair and maintenance equipment consists of the maintenance machines, tools and the remote handling test stand in the hot cell building. Maintenance equipment inside the hot cell is used to maintain radioactive and contaminated tokamak components.

Iter Canada proposes to provide, under contract from the Iter Legal Entity or in partnership with companies from non-host Iter Parties, the items listed in Table 5.7, as a minimum equipment set required for the hot cell. Due to the radiation environment, a dedicated remote control system will be required to operate equipment in the hot cell.

Table 5.7: Minimum Equipment Set for the Hot Cell
• Overhead Travelling Crane • Measuring Equipment (CMM)

- Refurbishment Manipulator
- End effectors & Tools
- Test support equipment
- Viewing System
- Floor mobile transporter
- Fork lift in storage area
- Dust removal system
- Double door docking system
- Pressure and Leak Test Tank
- Rad waste processing equipment (compacting and canning machine)
- NBI ion source cesium cleaning apparatus
- Auxiliary heating maintenance equipment

Further needs for robotic hardware may become evident as Iter is implemented, all of which Iter Canada should be capable of providing.

The repair/maintenance equipment will be used to support the following hot cell areas:

- Dust Cleaning Area
- Common Refurbishment Area
- Common Storage Area
- Rad Waste Processing & Storage Area
- Port Plug Equipment testing Area

The proposed hot cell repair/maintenance will perform the following functions:

- Remove activated and toxic dust
- Disassemble, replace, assemble and inspect/test maintained components
- Compact waste by cutting, compacting and containerizing
- Store discarded parts prior to final disposal
- Prepare samples for material evaluation
- Process hardware within the time constraints of required Iter replacement schedule

Tool and End Effectors (portions of Procurement Packages 2.3Pxx): Tools and end effectors will be used in the routine maintenance of the tokamak. Iter Canada proposes to provide under contract the tools as listed in Table 5.8 for scheduled use in the hot cell building when maintaining divertor and blanket module components.

Table 5.8: Minimum Equipment Set for the Hot Cell

Tool for vacuuming dust
Tool for bolt setting

Tool for pipe cutting
Tool for drilling
Tool for pipe expansion
Tool for pipe welding
Tool for weld inspection

Additionally, during the operation of the machine it is anticipated that occasionally it will be necessary to develop new tools or end-effectors to recover from an unexpected failure of equipment. Although these tools cannot be anticipated at this time, Iter Canada should be capable of meeting these needs as well.

Typical key requirements for tools are:

- Based on conventional tools or tools modified to be handled by the manipulator
- Designed specifically for a special task
- Self aligning
- Integral support
- Torque control
- Automatic feeds
- Cutting tools should be swarf free
- Swage cutters
- Nibblers with vacuum collection
- Welding tools automatic, wire free

Systems Integration: Iter Canada also proposes to provide under contract, systems integration expertise throughout the lifecycle of the Iter project.

Iter is a complex, integrated hardware and software system, with extreme reliability and safety requirements to ensure minimal downtime for maintenance and the safety of the overall operation. As a multinational endeavour, it will be necessary to ensure the integration of hardware and software designed, produced and separately tested by numerous contractors across different continents.

A system of such complexity, designed and built by multiple contractors, will be exposed to high risks of error and misunderstanding unless tight co-ordination of all engineering and fabrication activities at the system level is exercised.

The Systems Engineering Co-ordination and Risk Management function throughout the life of the project must be complemented by a large number of tasks that relate to the overall system analysis (System Reliability and Failure Mode Analysis, Safety Analysis, System Operation Plans, Maintainability, Integrated Logistics Plans, etc.). This assures overall system readiness for operations and successful system certification.

MacDonald Dettwiler Space and Advanced Robotics has a long and successful record of performing similar systems engineering co-ordination tasks on highly complex, safety and reliability critical integrated systems, most recently on Canada's Mobile Servicing System for the International Space Station. Iter Canada is pleased to be able to offer this expertise and capability for Iter.

5.4.3. Equipment **Installation, Commissioning and Procurement Services – Construction Phase:** As described in Section 6, Iter Canada through its Engineering and Construction Consortium, will have a very well established and capable engineering team, a mobilized site labour force, a management and supervisory organization, and a procurement capability on the Clarington site throughout the Construction Phase of the project. While these capabilities will be established for delivering the basic Iter Canada host scope, they are also offered for doing work, under contract, to both the Iter Parties directly and the Iter Legal Entity.

The Engineering and Construction Consortium will establish a separate team to project manage this additional optional work. This work will be offered on a preferred basis with competitive prices, deliveries, performance and quality. Firm price quotes, turnkey projects, or time-and-material contracts will all be considered to meet the needs of the Iter Legal Entity and Iter Parties. (See also Section 6.2.7.3. and Section 9.2.7.)

5.4.4. **Poloidal and Correction Field Coils:** As with more general site work define in 5.4.3. above, Iter Canada is also prepared to undertake the scope of work envisioned in the Iter Final Design Report with respect to site manufacturing of the PF and CF coils on a separate contractual basis.

5.4.5. **Transportation to the Clarington Site Laydown Areas:** The Procurement Packages have been prepared, and the common element scope definition assumes, that the equipment supplied by non-host Iter Parties is provided to the host at the site laydown area, ie. the transportation costs are included in the non-host scope. However, based on the Iter Canada capabilities as described in Section 5.2.1.8. (Transportation to the Clarington site) and Section 3.8 (Risk Management and Insurance) Iter Canada is prepared to undertake this work, under contract, to either the Iter Parties directly and to the Iter Legal Entity. One logical scope division could be that the Iter Canada transportation contract would start at dock-side in the exporting country. This would also allow a broader consolidation of shipments from all the overseas ports of export.

5.5 ITER CANADA OPERATING PHASE SCOPE

Iter Canada recognizes that the Operating Phase details are not nearly as well developed as for the Construction Phase. However, Iter Canada's Plan to Host Iter includes a major contribution, as the host for Iter, to the Operating Phase of the project. Iter Canada's participation during the Operating Phase of Iter will be provided in three major ways:

5.5.1. **Direct Contributions:** Iter Canada will provide up to 20 fusion scientists to the Iter Legal Entity as part of Iter Canada's direct contribution to the scientific development of fusion technology. These scientists would be assigned to the Iter Legal Entity at the start of the Operating Phase of the project, or earlier as appropriate to ensure a continuity of expertise from the design and construction activities to the operating activities. Section 9.2.3. covers the terms and conditions of this Iter Canada contribution. The analysis presented in Section 12.9.2 values this contribution at Cdn $120 million to the Iter Parties.

5.5.2. **The Host Services Contract:** As fully defined in Section 9.2.5, Iter Canada will have a Host Services Contract with the Iter Legal Entity for the provision of a goods and services, including tritium, electricity, professional staff, support staff, capital improvements, maintenance services, and licensing support services. The Iter Canada "contribution" will vary by area of support, but will generally be of the order of 10% of the total Operating Phase costs.

While this direct 10% contribution may not be applied to all items within the Host Services Contract, the net benefit to the Iter Parties will be substantial as defined in Section 9.5.1., estimated at Cdn $720 million of the Operating Phase period.

5.5.3. **Cost Avoidance:** Iter Canada is preparing the groundwork for a greatly reduced cost to the Iter Parties during the Operating Phase of the project in other areas not normally provided by a host to a large scale facility such as Iter. Some of these are described in Section 12.

5.6 ATTACHMENTS

5-A: References

5-B: Ontario Electrical Transmission System

5-C: Proposed Iter Connection to the Electrical Grid

5-D: Iter Layout Adapted for the Clarington Site (Drawing 008311-01-00 L102 Rev. G)

Attachment 5-A
References

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[21] Study Report On Tokamak Building Optimization Of Construction Sequence"(Rev 0), Acres International Limited, August 2000.

[22] Preliminary Report on Heat Rejection (Heat Sink) System, Acres International Limited, October 20

5-B: Proposed Iter Connection to the Electrical Grid

5-C: Iter Layout Adapted for the Clarington Site (Drawing 008311-01-00 L102 Rev. G)