SNC·LAVALIN

Building what matters

Enhanced CANDU 6

Technical Summary

Company Profile

SNC-Lavalin's Nuclear team provides leading nuclear technology products and full-service solutions to nuclear utilities around the globe. Our team of 1,200 engineering, procurement, construction and project management experts offer customized operations, maintenance and plant life management services, including waste management and decommissioning. Our experts in nuclear steam plant and balance of plant engineering carry out life extension projects, and design and deliver state-of-the-art CANDU® reactors, which are capable of operating on many types of fuel including natural uranium, mixed oxide (MOX) fuel, recycled uranium (RU) and thorium.

We are the stewards of CANDU technology. The 47 heavy water reactors in operation or under life extension are based on our CANDU design and are an important component of clean air energy programs on four continents. CANDU technology provides safe, reliable, affordable and CO_2-free energy to support the economic viability of businesses and quality of life for consumers in Canada, Romania, Korea, China and Argentina. CANDU reactors have an outstanding performance record, taking four of the top five places on Nuclear Engineering International's 2013 Top Lifetime Performers List.

Continuing a tradition of building nuclear reactors for over 50 years, we make significant contributions to the nuclear energy field. CANDU technology is the basis for Canada's nuclear power program and has been adopted in the nuclear power programs of many countries. The 11 CANDU 6 units, in five countries, have consistently delivered an average lifetime capacity factor of over 87%.

Noteworthy facts about the CANDU reactor fleet

CANDU REACTORS CONSISTENTLY RANK AS TOP PERFORMERS AND HOLD THE WORLD RECORD FOR LONGEST CONTINUOUS OPERATION

CANDU BRAND IS RECOGNIZED AS ONE OF THE TOP 10 MAJOR ENGINEERING ACHIEVEMENTS OF THE PAST CENTURY IN CANADA

CANDU REACTORS CAN BE EASILY ADAPTED FOR FLEXIBLE FUEL CYCLE OPTIONS

EXCELLENT PERFORMANCE OF THE CANDU 6 FLEET WITH AN AVERAGE LIFETIME CAPACITY FACTOR OF OVER 87%

31 CANDU REACTORS IN THE WORLD OPERABLE OR BEING REFURBISHED

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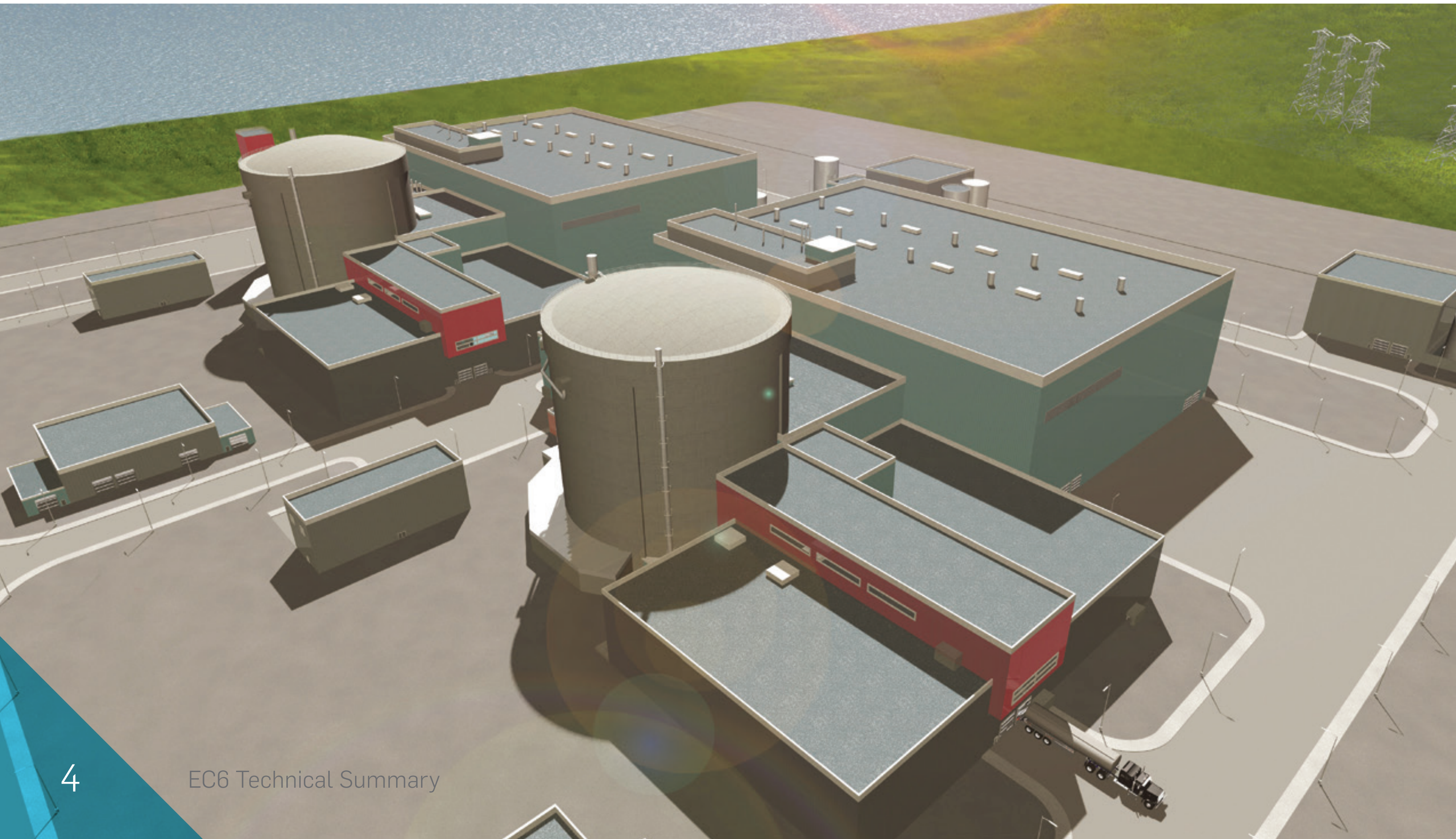
The Enhanced CANDU 6

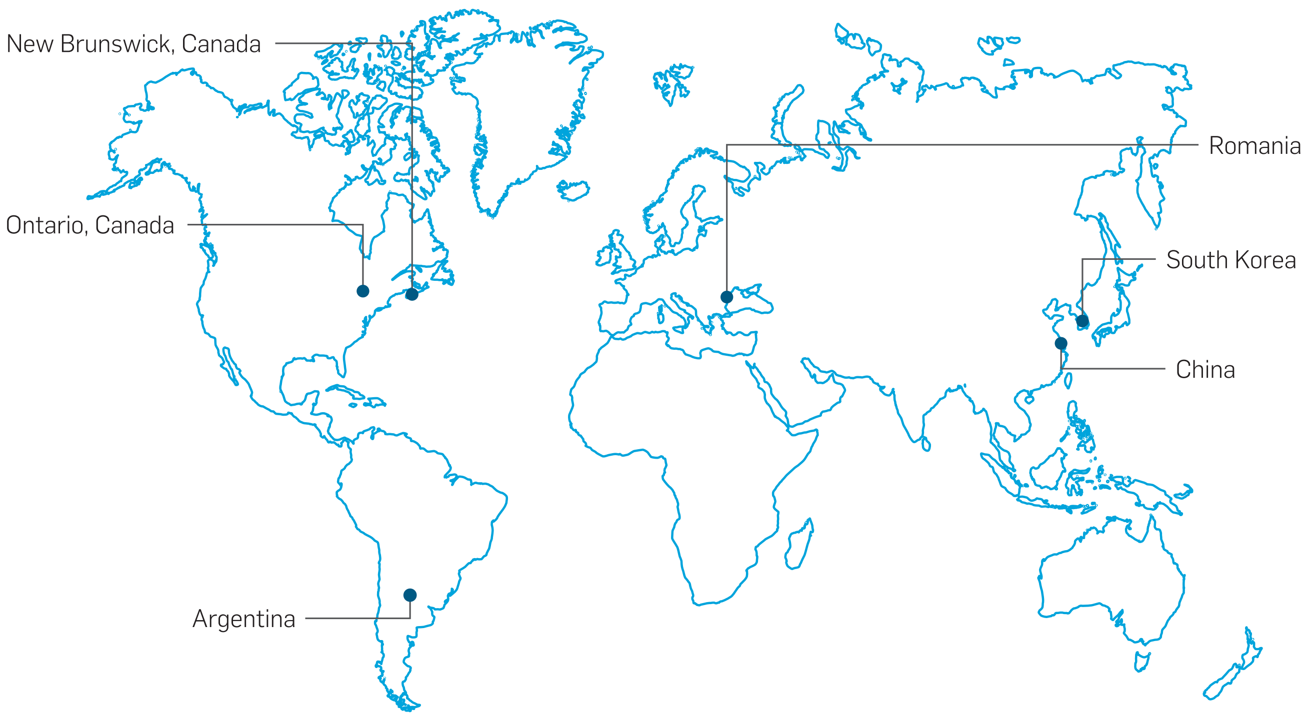
The Enhanced Candu 6® (EC6®) is a Generation III, 700 MWe class heavy-water moderated and cooled pressure tube reactor. Heavy water (D_2O) is a natural form of water that is used as a moderator to slow down the neutrons in the reactor, enabling the use of natural uranium as fuel. This feature is unique to CANDU reactors. The choice of D_2O as the moderator also allows other fuel cycles to be used in CANDU reactors.

The use of natural uranium fuel in our EC6 reactors permits fuel cycle independence and avoids having to deal with complex issues such as reprocessing and enrichment. Technology transfer for localizing fuel manufacture is simple and has been achieved very successfully in a number of countries.

The EC6 reactor design offers:

- Natural uranium fuel with on-line fuelling
- High localization potential
- Suitability for small and medium sized electric grids
- Superior safety performance and economics
- A proven design based on the highly successful CANDU 6 reactors





CANDU Reactors Worldwide
(In operation or undergoing refurbishment for life extension)

The EC6 reactor is the evolution of our proven CANDU 6 design. The nuclear steam plant is based on the Qinshan Phase III CANDU 6 plant in China and is designed to meet industry and public expectations of nuclear power generation to be safe, reliable and environmentally friendly.

The EC6 design has been enhanced by using the experience and feedback gained through the development, design, construction and operation of 10 CANDU 6 units operating in five countries. CANDU 6 reactors are performing well on four continents with over 150 reactor-years of excellent and safe operation.

While retaining the basic features of the CANDU 6 design, the EC6 reactor incorporates innovative features and state-of-the-art technologies that enhance safety, operation and performance.

The latest Computer-Aided Design and Drafting (CADD) software tools and innovative integrated systems, linking material management, documentation, safety analysis and project execution databases, are used to ensure that accurate and complete configuration management can be easily maintained by the plant owner.

The EC6 has a target gross electrical output of between 730 MWe and 745 MWe depending on site conditions and choice of certain equipment. It has a projected annual lifetime capacity factor of over 92%. This is based on the proven reliable performance of the global CANDU 6 fleet that has an average lifetime capacity factor of 87.6%, ranking CANDU as one of the world's top performing nuclear power reactors.

EC6 Evolution

The following key enhancements have been introduced in our EC6 reactor:

- Target design life up to 60 years
- Designed for annual lifetime performance factor of greater than 92%
- Design has incorporated feedback from operating reactors (both CANDU and other designs)
- Incorporates modern turbine design, with higher efficiency and output
- Increased safety and operating margins
- Additional accident resistance and core damage prevention features
- A suite of advanced operational and maintenance information tools (SMART CANDU®)
- Improved plant security and physical protection
- Improved plant operability and maintainability with advanced control room design
- Improved severe accident response
- Upgraded fire protection system
- Improved containment design features that provide for aircraft crash resistance, reduced potential leakages following accidents, and increased testing capability

These design improvements, along with advances in project engineering, manufacturing and construction techniques, result in a reduced capital cost and faster construction schedule, while enhancing the inherent safety features of the CANDU design.

Key Passive Safety Features

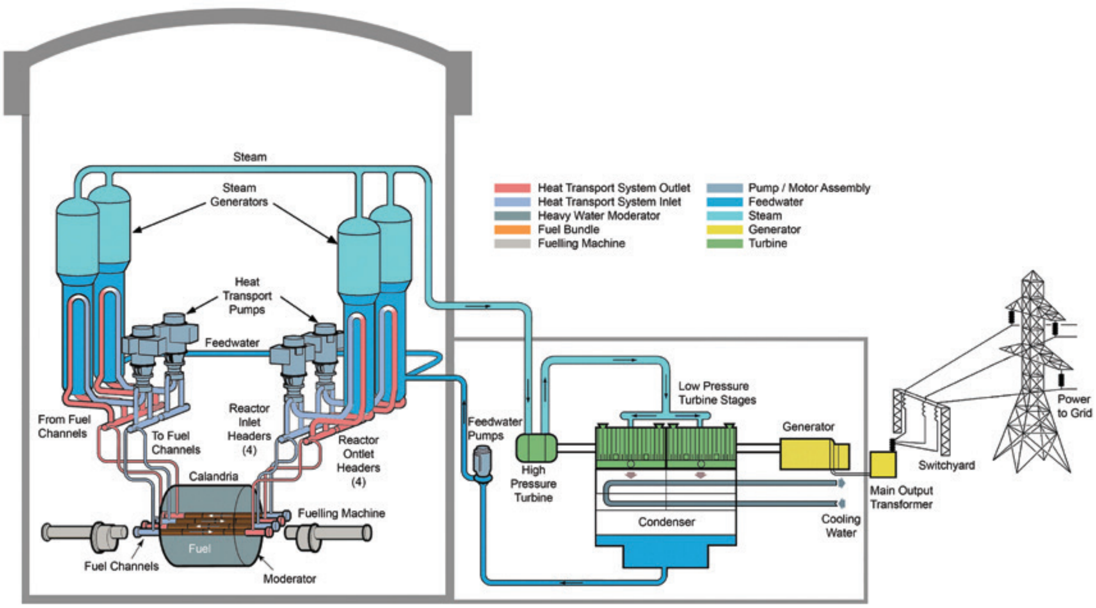
The EC6 reactor design includes a number of passive safety features, some of which are design enhancements over the robust safety systems already existing in CANDU plants.

- Two independent passive shutdown systems, each of which is capable of safely shutting down the reactor
- A cool, low-pressure moderator that, in severe accident situations, serves as a passive heat sink to absorb decay heat generated by the radioactive fuel channels
- A large concrete reactor vault that surrounds the reactor core in the calandria; the vault contains a large volume of light water to further slow down or arrest severe core damage progression by providing a second passive core heat sink
- An elevated water tank located in the upper level of the reactor building that is designed to deliver (gravity fed) passive make-up cooling water to the moderator vessel and the calandria vault to remove heat. This delays the progression of severe accidents and provides additional time for mitigating actions to be taken.
- A passive, robust, seismically qualified reactor building that includes:
  - Thickened pre-stressed concrete structure designed to withstand the impact of aircraft crashes
  - Leak-tight inner steel liner to reduce potential leakages following accidents
  - Passive spray system from the elevated water tank to reduce pressure in the reactor building in the event of a severe accident

Plant Design

The EC6 plant is designed for more efficient operation and increased safety. The plant layout provides improved separation by distance, elevations (different heights) and the use of barriers for safety important structures, systems and components that contribute to protection and safety.

Security and physical protection have been enhanced to meet the latest criteria required in response to potential common mode events, i.e., fires, aircraft crashes and malevolent acts.



Overall Plant Flow Diagram

Plant Layout

The layout for a two-unit plant is designed to achieve the shortest practical construction schedule while supporting shorter maintenance durations with longer intervals between maintenance outages. The buildings are arranged to minimize interferences during construction, with allowance for on-site fabrication of module assemblies. Open-top construction (before placing the roof of the reactor building in place), allows for the flexible sequence of installation of equipment and reduces the overall project schedule risk.

The size of the power block (plant foot print) for a two-unit integrated EC6 plant is 48,000 square metres.

The power block consists of two reactor buildings, two service buildings, two turbine buildings with the associated auxiliary bays, and the heavy water upgrader building. A single-unit plant can be easily adapted from the two-unit layout with no significant changes to the basic design.

Reactor Building

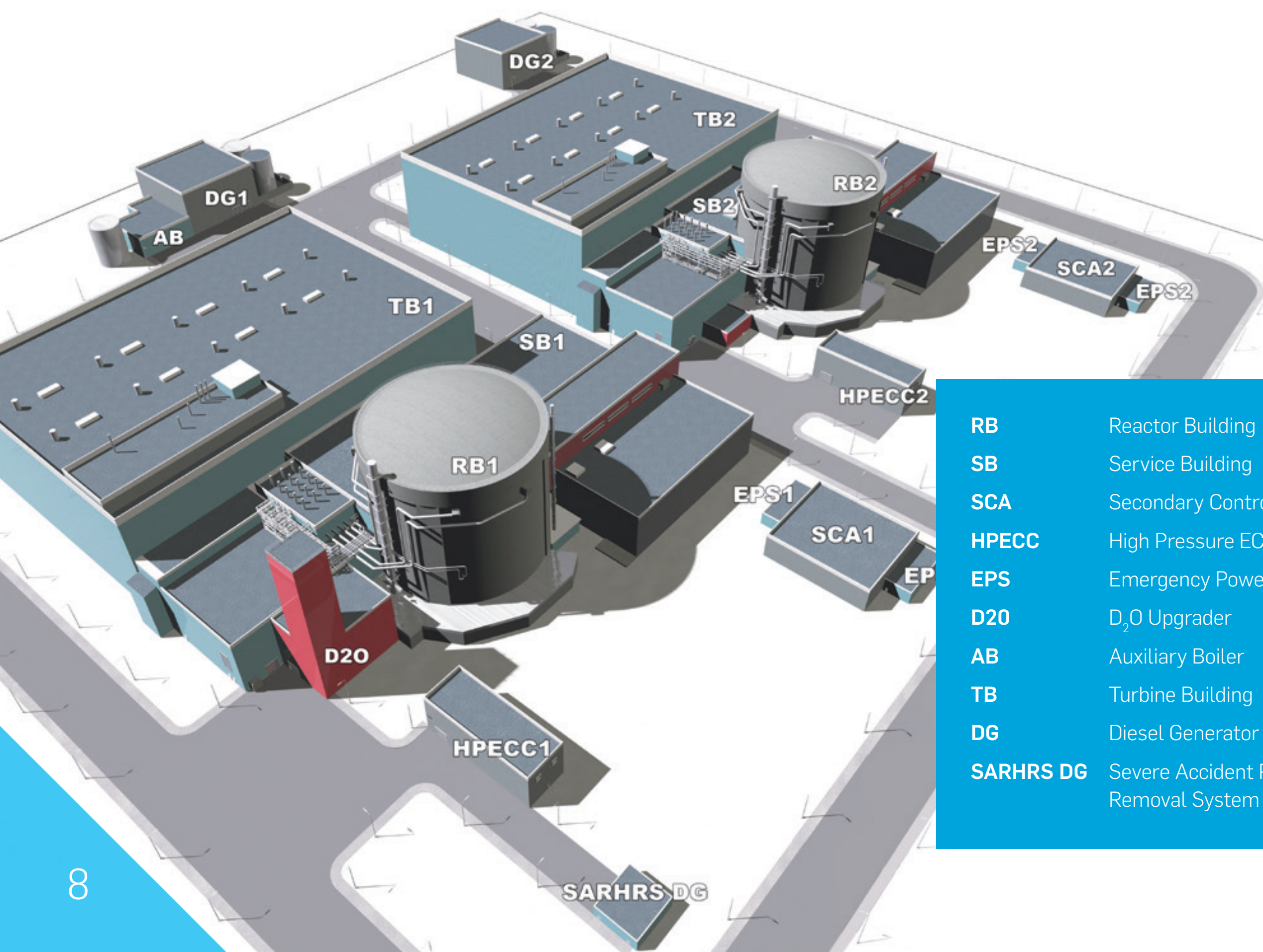
The EC6 reactor building is a pre-stressed, seismically qualified, concrete building and has been strengthened compared to our previous CANDU 6 designs. Pre-stressed concrete is reinforced with cables that are tightened to keep the structure under compression even when the forces it is designed to withstand would normally result in tension. The concrete containment structure has an inner steel liner that significantly reduces leakage rates in the event of an accident.

The entire structure, including concrete internal structures, is supported by a reinforced concrete base slab that ensures a fully enclosed boundary for environmental protection, biological shielding and aircraft crash protection which in turn reduces the level of radiation emitted outside the reactor building, during operation, design basis internal and external events and beyond design basis internal and external events, to values that are insignificant to human health.

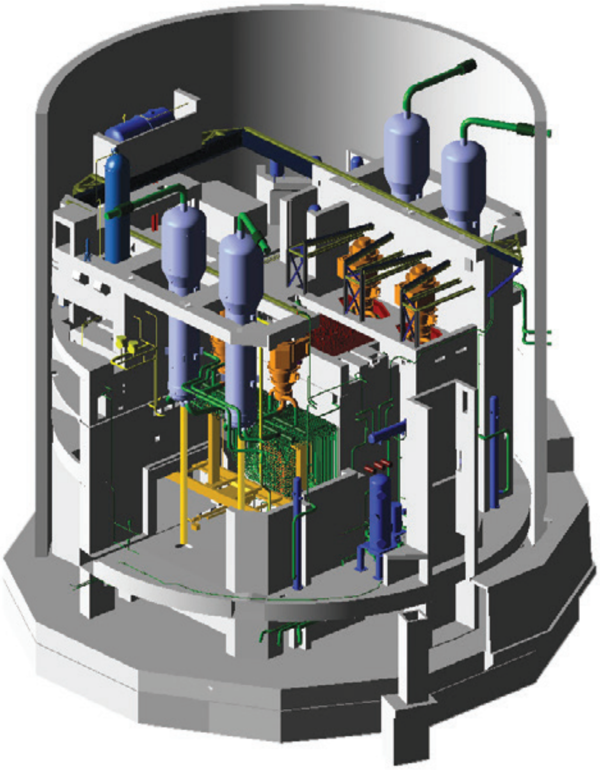
Internal shielding allows personnel access during operation to specific areas for inspection and routine maintenance. These areas are designed to maintain temperatures that are suitable for personnel activities. Airlocks are designed as routine entry/exit doors.

Containment structure perimeter walls are separate from internal structures, eliminating any interdependence and providing flexibility in construction.

Two-Unit Plant Layout of Major Structures



RB	Reactor Building
SB	Service Building
SCA	Secondary Control Area
HPECC	High Pressure ECC Building
EPS	Emergency Power Supply
D20	D_2O Upgrader
AB	Auxiliary Boiler
TB	Turbine Building
DG	Diesel Generator
SARHRS DG	Severe Accident Recovery and Heat Removal System Diesel Generator



Reactor Building

Turbine Building

The EC6 turbine building is located on one side of the service building wherein the service building interfacing wall is tornado missile and aircraft crash resistant. This is an optimum location for access to the main control room; the piping and cable tray run to and from the service building; and the condenser cooling water ducts run to and from the main pumphouse. Access routes are provided between the turbine building and the service building.

The turbine building houses the turbine generator. It also houses the auxiliary systems, the condenser, the condensate and feedwater systems, the building heating plant, and any compressed gas required for the balance of plant. The balance of plant consists of the remaining systems, components and structures that comprise the complete power plant that are not included in the nuclear steam plant.

The heat from the reactor coolant converts the feedwater into steam in the steam generators. The steam from the steam generators drives the turbine, which in turn drives the generator to create electricity.

The condenser cools the steam from the steam generator and converts it back to water (condensate) to be converted into steam again.

Blowout panels in the walls and roof of the turbine building will relieve the internal pressure in the turbine building in the event of a steam line break.

Service Building

The EC6 service building is a multi-level, reinforced concrete structure that is seismically qualified, tornado missile and aircraft crash protected. It accommodates the "umbilicals" that run between the principal structures, the electrical systems and the spent fuel bay and associated fuel-handling facilities. It houses the emergency core cooling pumps and heat exchangers.

The service building also houses the spent fuel bay cooling and purification system pumps and heat exchangers. The spent fuel bay is a water-filled pool for storing spent fuel.

Safety and isolation valves of the main steam lines are housed in a seismically qualified, tornado missile and aircraft crash protected concrete structure that is located on top of the service building.

CANDU 6 Units at Qinshan, China

Nuclear Power Plant Siting

Unit Output

Each unit of our EC6 two-unit integrated plant design has a target gross electrical output of between 730 and 745 MWe depending on site cooling water conditions and the turbine generators' technical characteristics.

Adaptation to Site Requirements

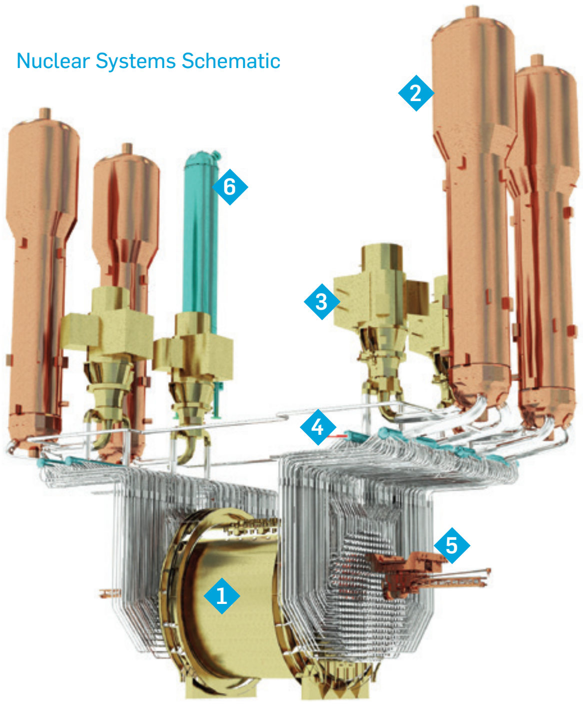
The EC6 reactor can accommodate a wide range of geo-technical characteristics, meteorological conditions and owner requirements through flexible design features such as:

- Cooling water systems for all CANDU reactor cooling requirements can operate at either saltwater or fresh water sites. The plant can also accommodate conventional cooling towers. A range of cooling water temperatures, to suit the plant's environment, can be handled. A generic set of reference conditions has been developed to suit potential sites for the EC6.
- The ability to withstand design basis earthquakes at the plant site. The design basis earthquake is the maximum ground motion of a potentially severe earthquake that has a low probability of being exceeded during the life of the plant. The safety systems are designed to perform the required safety functions during and/or after the seismic event.

Nuclear Systems

The EC6 nuclear systems are located in the reactor building and the service building. These buildings are robust and shielded for added safety and security. Shielding is a protective barrier that reduces or eliminates the transfer of radiation from radioactive materials.

Nuclear Systems Schematic



The nuclear systems are composed of:

> A heat transport system with reactor coolant, four steam generators, four heat transport pumps, four reactor outlet headers, and four reactor inlet headers. This configuration is standard on all CANDU 6 reactors.

> A heavy water moderator system

> A reactor assembly that consists of a calandria installed in a concrete vault

> A fuel handling system that consists of two fuelling machine heads, each mounted on a fuelling machine bridge that is supported by columns, which are located at each end of the reactor

> Two independent shutdown systems, emergency core cooling system, containment system, emergency heat removal system and associated safety support systems

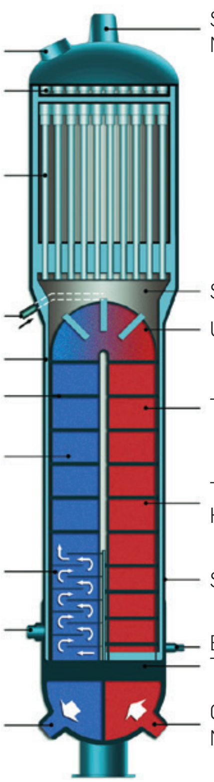
1 Calandria	**4** Header (8)
2 Steam Generator (4)	**5** Fuelling Machine (2)
3 Heat Transport Pump (4)	**6** Pressurizer

Heat Transport System

The EC6 heat transport system circulates pressurized heavy water coolant through the reactor fuel channels to remove heat produced by the nuclear fission chain reaction in the reactor core. The heated coolant is circulated through the steam generators to produce steam that drives the turbine generator system.

Heat Transport System Key Design Parameters	
Reactor Outlet Header Operating Pressure [MPa (g)]	9.89
Reactor Outlet Header Operating Temperature [°C]	310
Reactor Inlet Header Operating Pressure [MPa (g)]	11.05
Reactor Inlet Header Operating Temperature [°C]	265
Maximum Single-Channel Flow (nominal) [kg/s]	28.5

The heat transport system consists of 380 horizontal fuel channels with associated corrosion-resistant feeders, four reactor inlet headers, four reactor outlet headers, four steam generators, four electrically driven heat transport pumps and interconnecting piping and valves arranged in a two-loop, figure-of-eight configuration. The headers, steam generators and pumps are all located above the reactor.



Steam Generator

Steam Generators

The EC6 steam generators are similar to those of our CANDU 6. The tubing is made of Incoloy-800, which is a material proven in CANDU 6 stations. The light water inside the steam generators, at a lower pressure than the hot heavy water reactor coolant, is converted into steam.

Steam wetness, which is the ratio of vapour/liquid concentration in the steam, has been reduced at the steam nozzle using the latest steam separator technology, resulting in improved turbine cycle economics.

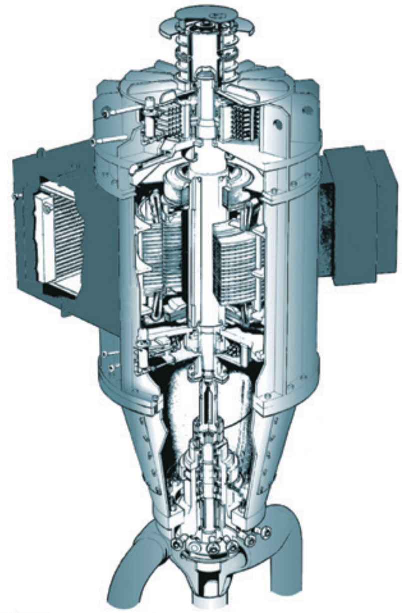
Steam Generator Design Data	
Number	4
Nominal Tube Diameter [mm]	15.9
Steam Temperature (nominal) [°C]	260

Heat Transport Pumps

The EC6 reactor heat transport pumps retain the CANDU 6 mechanical multi-seal design, which allows for their easy replacement. The heat transport pumps circulate reactor coolant through the fuel bundles in the reactor's fuel channels and through the steam generators. Electric motors drive the heat transport pumps.

The cooling of the pump seals lengthens pump service life and the time that the pump will operate under accident conditions.

Heat Transport Pump Data (typical)	
Number	4
Rated Flow [L/s]	2,228
Motor Rating (MW)	6.7



Heat Transport Pump and Motor

Heat Transport Pressure and Inventory Control System

The heat transport pressure and inventory control system of the EC6 reactor consists of a pressurizer, a degasser-condenser, two heavy water feed pumps, feed and bleed valves, and a coolant storage tank.

This system provides:

> Pressure and reactor coolant inventory control to each heat transport system loop

> Overpressure protection

Heavy water in the pressurizer is heated electrically to pressurize the vapour space above the heavy water. This cushions pressure transients without allowing excessively high or low pressures in the heat transport system.

The pressurizer also accommodates the difference in the volume of reactor coolant in the heat transport system that occurs between zero power and full power. This permits reactor power to be rapidly increased or decreased, without placing a severe demand on the reactor coolant feed and bleed components of the system. Otherwise, the pressurizer would have to open and close rapidly in order to compensate for the changing volume of the reactor coolant in the heat transport system.

When the reactor is at power (normal mode), the pressurizer controls the pressure in the reactor outlet headers. Electric heaters add heat to increase pressure, and steam is bled from the pressurizer to the degasser-condenser to reduce the pressure. The feed and bleed circuit adjusts the reactor coolant inventory to maintain the pressurizer level at the setpoint. The purification system provides cool heavy water inventory via sprays, to further reduce temperatures and adjust the reactor coolant inventory before and after maintenance.

Total Heavy Water Inventory (per unit)	
Moderator System [Mg]	274
Heat Transport System [Mg]	196
Total [Mg]	470

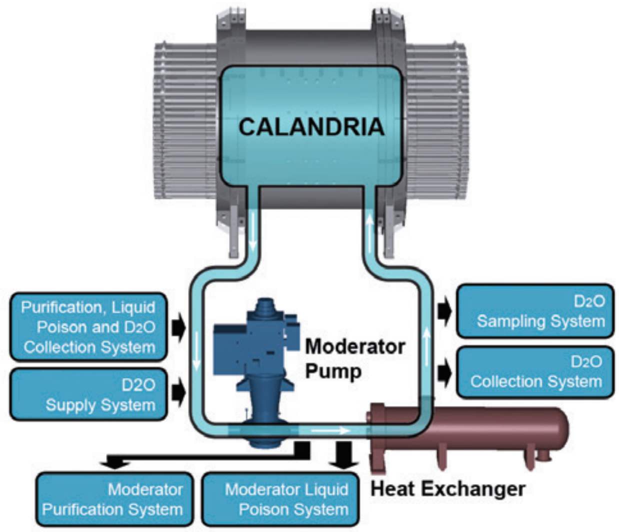
Moderator System

The moderator system of our EC6 reactor is a low-pressure and low-temperature system. It is independent of the heat transport system. The moderator system consists of pumps and heat exchangers that circulate the heavy water moderator through the calandria and remove the heat that is generated during reactor operation. The heavy water acts as both a moderator and reflector for the neutron flux in the reactor core.

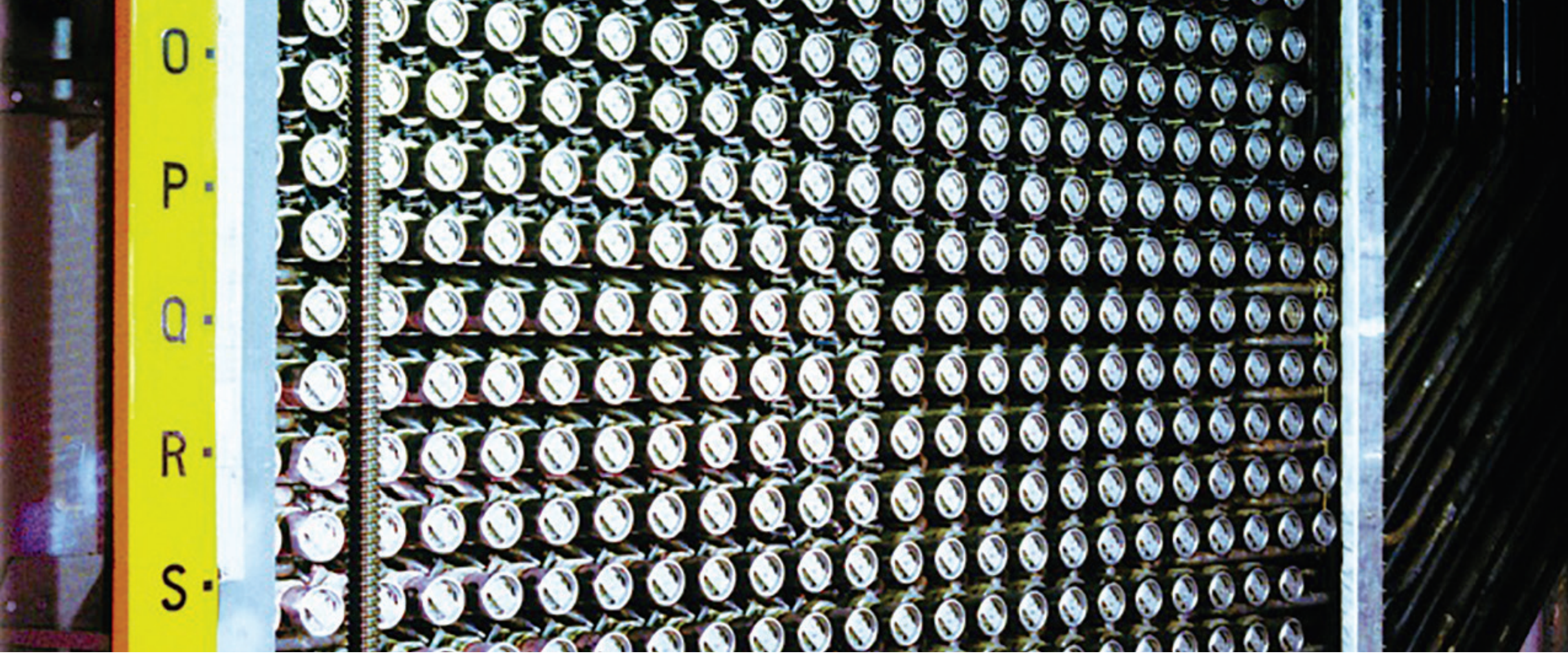
The moderator slows down neutrons emitted from the fission chain reaction to increase the chances of the neutrons hitting another atom and causing further fission reactions. The reflector is the material layer around the reactor core that scatters neutrons and reflects them back into the reactor core to cause further fission chain reactions.

The moderator system fulfills a safety function that is unique to CANDU. It also serves as a backup heat sink for absorbing the heat from the reactor core in the event of loss of fuel cooling, i.e., failure of the heat transport system to mitigate core damage.

An added safety improvement in the EC6 reactor is a connection to the elevated water tank that provides additional passive gravity-fed cooling water inventory to the calandria. This connection extends core cooling and delays severe accident event progression.



Moderator System Flow Diagram
(Only one loop of the moderator system is shown)



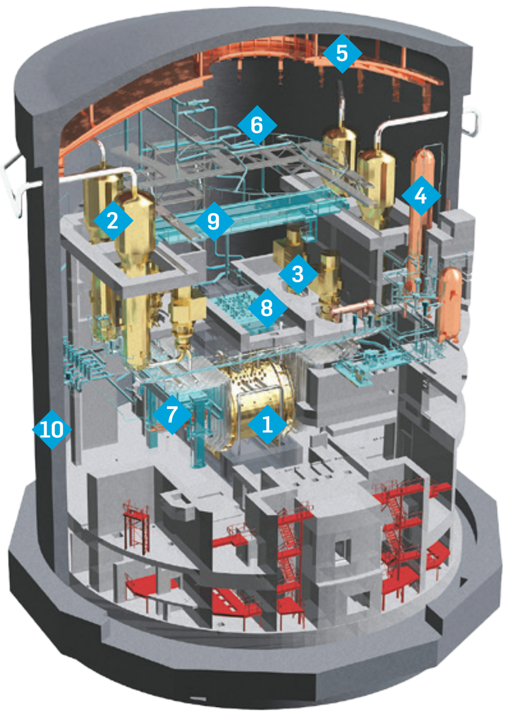
CANDU Reactor Face

Reactor Assembly

The reactor assembly of the EC6 reactor consists of the horizontal, cylindrical, low-pressure calandria and the end-shield assembly. This enclosed assembly contains the heavy water moderator, the 380 fuel channel assemblies and the reactivity mechanisms. The reactor is supported within a concrete, light water-filled calandria vault. Fuel is enclosed in the fuel channels that pass through the calandria and the end-shield assembly. Each fuel channel permits access for re-fuelling while the reactor is on power.

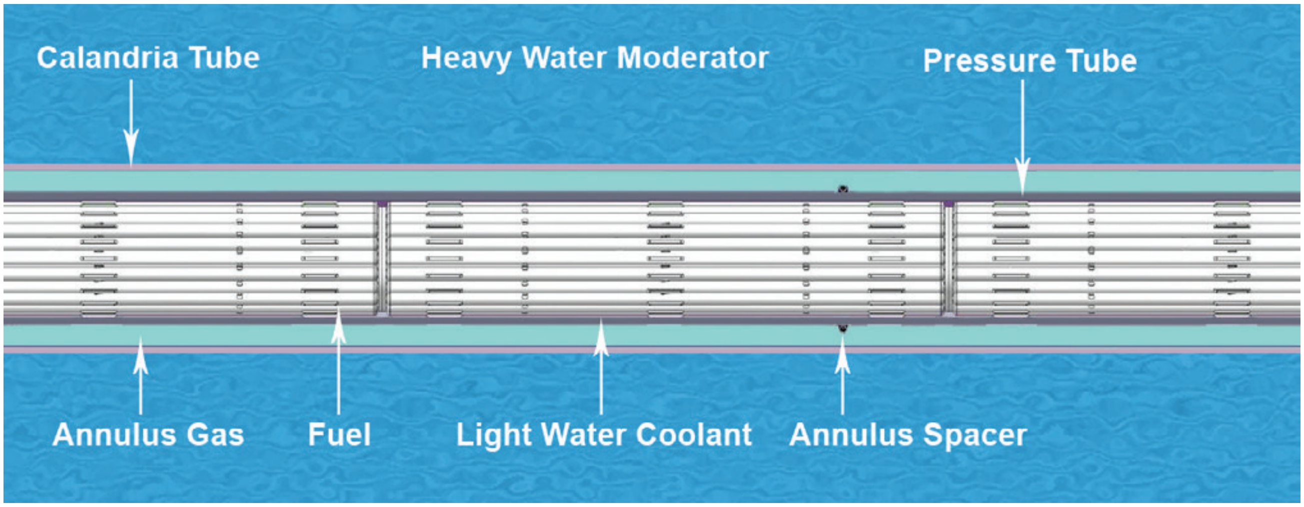
The ability to replace fuel while on power means there is minimal excess reactivity in the core at all times, which is an inherent safety feature. On-power fuelling creates operational flexibility, i.e., it improves outage planning since fixed cycle times are not required, and it allows the prompt removal of defective fuel bundles without shutting down the reactor. The horizontal fuel channels are made of zirconium niobium alloy pressurized tubes with modified 403 SS end-fittings.

Reactor Core Design Data	
Output [MWth]	2,084
Coolant	D_2O
Moderator	D_2O
Fuel Channels	380
Lattice Pitch [mm	286



Reactor Assembly

1. Calandria
2. Steam Generators
3. Heat Transport Pumps
4. Pressurizer
5. Reserve Water Tank
6. Low Flow Spray
7. Fuel Machine
8. Reactivity Mechanism Deck
9. Overheard Equipment Crane
10. Containment



Fuel Channel Assembly

Reactor Control

The liquid zone control units provide the primary control of the EC6 reactor. Each liquid zone control assembly consists of independently adjustable liquid zones that introduce light water in zirconium alloy tubes into the reactor. Light water is a stronger absorber of neutrons than heavy water. Controlling the amount of light water controls the power of the reactor. On-power refuelling and zone-control actions provide reactivity control.

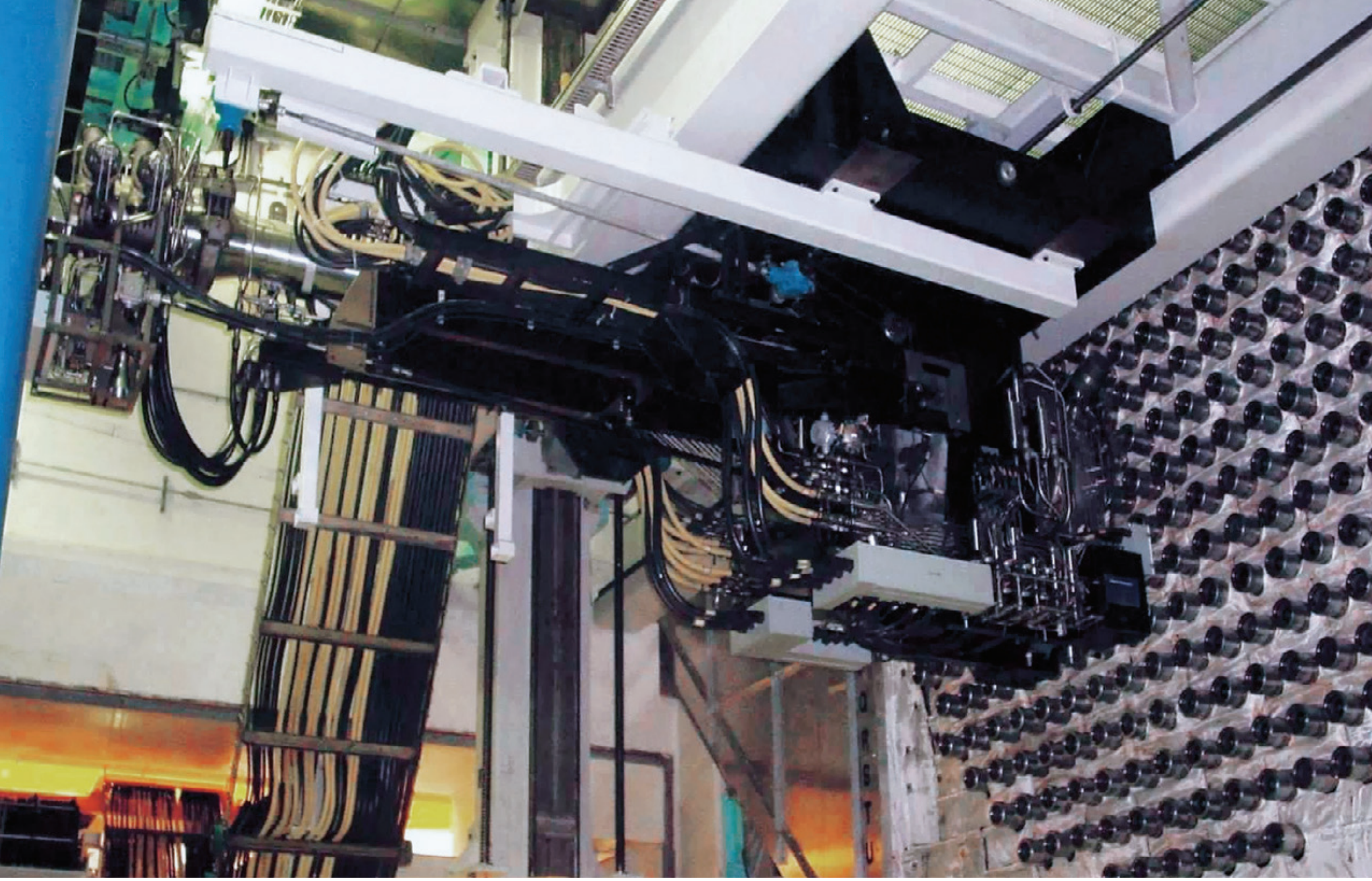
The reactor regulating system also includes control absorber units and adjusters that can be used to absorb neutrons and reduce reactor power if larger power reductions are required.

Fuel Channel Assembly

The fuel channel assemblies of our EC6 reactor consist of zirconium-niobium alloy Zr-2.5wt%Nb pressure tubes, centred in zirconium alloy calandria tubes. The pressure tube is roll-expanded into stainless steel end fittings at each end.

Each pressure tube is thermally insulated from the low-temperature moderator by the annulus gas between the pressure tube and the calandria tube. Tight fitted spacers, positioned along the length of the pressure tube, maintain annular space and prevent contact between the two tubes. Each end fitting holds a liner tube, a fuel support plug and a channel closure. Reactor coolant flows through adjacent fuel channels in opposite directions.

The EC6 reactor is designed for a target life of up to 60 years of reactor operation with provision for life extension at the reactor's mid-life by replacement of fuel channels.



Fuelling Machine

Fuel Handling and Storage System

The fuel handling and storage system of the EC6 reactor consists of:

> New fuel transfer and storage
> Fuel changing
> Spent fuel transfer and storage

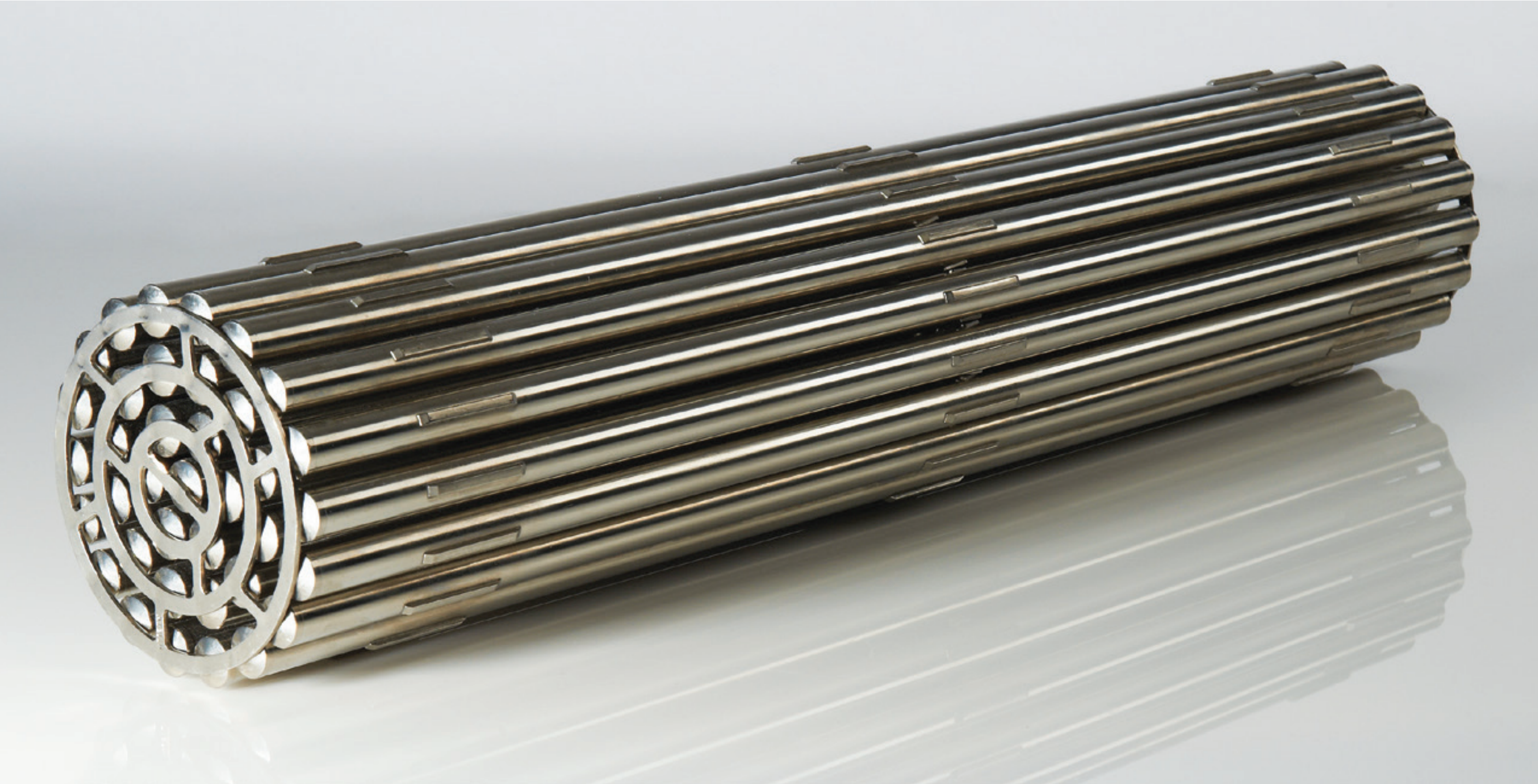
New fuel transfer and storage involves new fuel being received and stored in the new fuel storage room in the service building in sufficient capacity to maintain full-power operation for at least six months. New fuel is transferred to the new fuel loading room in the reactor building as required, where the fuel is loaded into one of two new fuel transfer mechanisms for transfer into one of the fuelling machines via new fuel ports.

Fuel changing includes two remotely controlled fuelling machines, located on opposite sides of the reactor and mounted on bridges that are supported by columns.

Fresh fuel bundles are inserted at the inlet end of the fuel channel by one of the fuelling machines. The other fuelling machine removes irradiated fuel bundles from the outlet end of the same fuel channel.

The spent fuel transfer and storage handles irradiated fuel when it is discharged from the fuelling machine and moved to the underwater spent fuel storage bay. A storage bay man bridge and handling tools permit safe access and manipulation of the irradiated fuel and containers.

From the loading of fuel in the new-fuel mechanism to the discharge of irradiated fuel in the receiving bay, the fuelling process is automated and remotely controlled from the station control room.



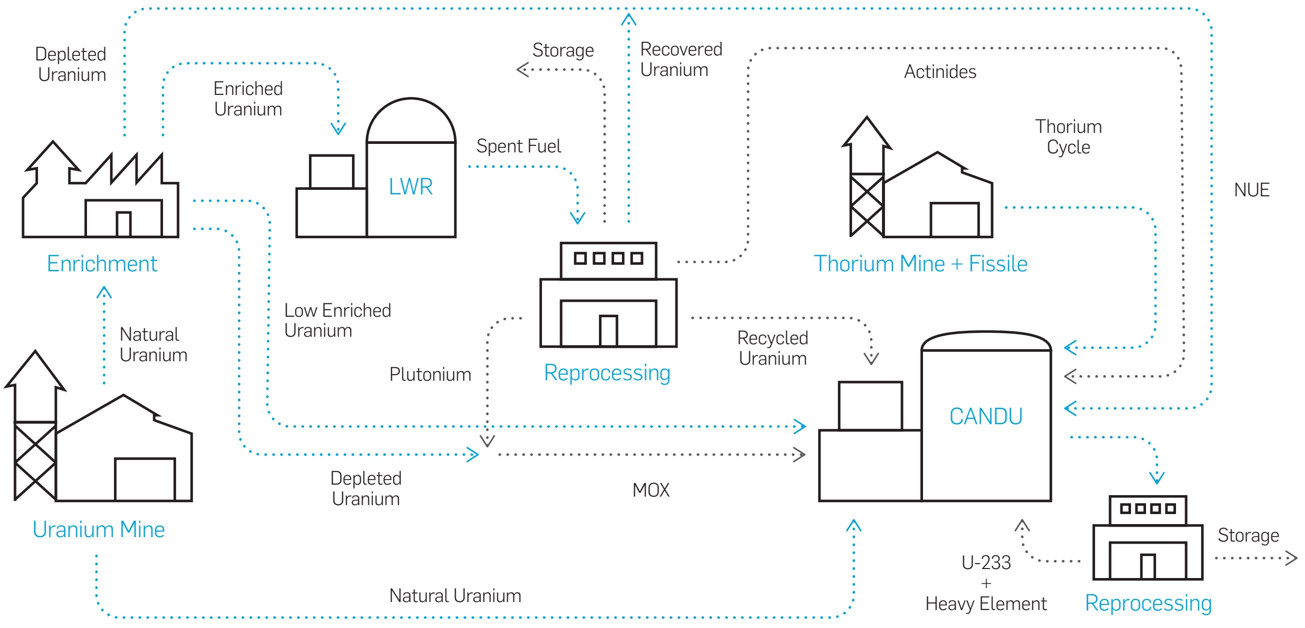
CANDU Fuel Bundle

Fuel

The EC6 reactor uses the proven 37-element natural uranium (NU) fuel bundle design. Each fuel element consists of a column of sintered NU fuel pellets inside a sealed zirconium alloy tube. The ends of a circular array of 37 fuel elements are welded to zirconium alloy support plates to form an integral fuel bundle assembly. Each fuel bundle is approximately 0.5 metres long and 10 centimetres in diameter, and weighs about 24 kilograms. Its compact size and weight facilitates fuel handling. There are no criticality concerns associated with the handling and transportation of NU fuel.

Our CANDU fuel bundle, with its limited number of components, is easy to manufacture. All countries having CANDU reactors manufacture their own fuel. The manufacture of NU fuel also avoids the production of enrichment tails. Excellent uranium utilization and a simple fuel bundle design help to minimize the CANDU fuel cycle unit energy cost, in absolute terms, relative to other reactor types. The efficient use of neutrons in CANDU reactors contributes to its fuel cycle flexibility.

37-Element Natural Uranium Fuel Bundle Design Characteristics	
Fuel	Natural UO_2
Enrichment Level	0.71wt%U-235
Average Fuel Burnup [MWd/te U]	7000
Bundles per Fuel Channel	12
Fuelling Scheme	8-Bundle Shift



Flexible Fuel Cycle Options

Emerging Fuel Cycles

Our CANDU reactor design is flexible and can use a number of alternative nuclear fuels. The EC6 reactor retains the ability to adopt various fuel cycle options, including:

- Natural uranium equivalent fuel is produced by mixing in predetermined proportions of recycled uranium from commercial light water reactor (LWR) nuclear power plants (U-235 content ranging from 0.8 to 1%) with depleted uranium to obtain a blend that is neutronically equivalent to CANDU NU fuel
- Recovered uranium (RU) (~0.9% enriched) fuel from reprocessed LWR fuel can be used in CANDU without re-enrichment, offering access to a potentially economical supply of low enriched uranium fuel at the optimal enrichment level. The enrichment level is dictated primarily by the limit placed on fuel discharge burnup.
- A thorium cycle or CANDU/fast breeder reactor system. Long-term energy security can be assured through either of these. The fast breeder reactor would operate as a "fuel factory" to provide the fissile material to power a number of lower-cost, high-efficiency EC6 reactors. A fast breeder reactor is a reactor that generates more fissile material than it consumes.
- A high burnup mixed oxide (MOX) fuel that could use plutonium from conventional reprocessing or more advanced reprocessing options (such as co-processing). MOX fuel contains plutonium blended with natural uranium, depleted uranium, or recovered uranium from reprocessing plant

Thorium offers a low-uranium-consumption fuel cycle option for the EC6 reactor. It is three to four times more abundant than uranium in the earth's crust and is commercially exploitable. As the world's most neutron-efficient power reactor, the EC6 reactor is uniquely suited for burning thorium. A thorium-fuelled EC6 plant would be attractive to countries with abundant thorium reserves but with little or no uranium, and can assist in addressing their need for energy self-reliance.

Thorium oxide (ThO_2) also has attractive physical and chemical properties: its thermal conductivity and melting temperature is higher than that of UO_2. As a consequence, fuel-operating temperatures will be lower than those of UO_2, and fission-gas release from the fuel is expected to be lower than for UO_2 operating at similar ratings. ThO_2 is chemically very stable, and it does not oxidize, a benefit for normal operation, postulated accidents, and in waste management.

We maintain a thorium fuel cycle program with more than 40 years of history, incorporating reactor physics and core design; fuel design and fabrication; irradiation and demonstration; reprocessing; cycle optimization; and commercial deployment options.

Safety Systems

The reactor safety systems are designed to mitigate the consequences of plant process failures, and to ensure reactor shutdown, removal of decay heat, and prevention of radioactive releases. The safety systems in the EC6 design follow the traditional CANDU practice of providing:

- Independent shutdown systems 1 and 2
- An emergency core cooling system (ECC)
- A containment system
- Emergency heat removal system (EHRS)

The two-shutdown systems, the ECC and the containment boundary system, and the EHRS meet specified reliability targets with which the system design must comply. This is verified by formal reliability analysis. The containment boundary includes the physical structures designed to prevent and control the release of radioactive substances.

Safety support systems are also provided to ensure reliable electrical power, cooling water and instrument air supplies to the safety systems. Standby generators are provided as a backup to the station power for postulated loss of station power events.

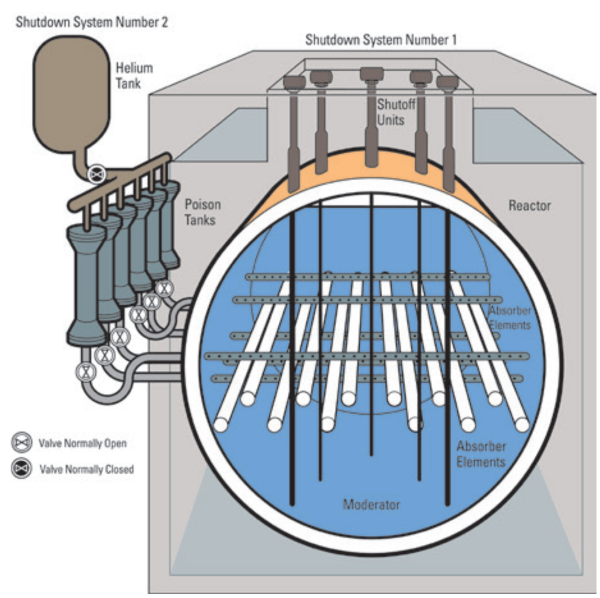
Safety systems and their support services are designed to perform their safety functions with a high degree of reliability. This is achieved through the use of stringent technical specifications, including seismic qualification and environmental qualification for accident conditions.

Shutdown Systems

The EC6 reactor's two passive, fast acting, fully capable, diverse shutdown systems are physically and functionally independent of each other.

Shutdown system 1 consists of mechanical spring-assisted shutoff rods that drop by gravity into the reactor core when a trip signal de-energizes the clutches that hold the shutoff rods out of the reactor core. The design of the shutoff rods is based on the proven CANDU 6 design.

Shutdown system 2 injects a concentrated solution of gadolinium nitrate into the moderator to quickly render the reactor core subcritical, effectively stopping the fission chain reaction. The gadolinium nitrate solution is dispersed uniformly throughout the reactor with pressurized gas, thus maximizing the shutdown effectiveness.



Shutdown Systems

Emergency Core Cooling System

The ECC system is designed to supply emergency coolant to the reactor in three stages:

- The high-pressure emergency core cooling system is designed to provide initial light water injection to the heat transport system (HTS) from the ECC accumulator tanks pressurized by air/gas pressure
- Following the termination of high-pressure injection, the medium-pressure injection system is designed to supply light water to the HTS from the reserve water tank (RWT) via the ECC pumps
- Following the termination of medium-pressure emergency core cooling injection (upon depletion of the RWT), the long-term automatic ECC injection is provided by collecting the mixture of heavy water and light water from the reactor building basement and re-circulating into the HTS via the ECC pumps and heat exchanger

During normal operation, the ECC system is poised to detect any loss-of-coolant accident (LOCA) that results in a depletion of heat transport system inventory (i.e., reactor coolant) to such an extent that make-up by normal means is not assured.

The system is capable of maintaining or re-establishing sufficient cooling of the fuel and fuel channels for the design basis events, so as to limit the release of fission products from the fuel and maintain fuel channel integrity. After re-establishing fuel cooling, the system is capable of providing sufficient cooling flow to prevent further damage to the fuel.

Containment System

The containment system forms a continuous, pressure-retaining envelope around the reactor core and the heat transport system. The containment structure protects the public and environment from all potential internal events, and is designed to withstand tornadoes, hurricanes, earthquakes and aircraft crashes; and to prevent the release of radioactive material to the environment.

The containment boundary consists of a steel-lined, pre-stressed concrete reactor building structure, access airlocks and a containment isolation system. Local air coolers remove heat from the containment atmosphere and are located to best maintain operating containment pressure and temperature.

A hydrogen control system is designed to prevent the build-up and uncontrolled burning of hydrogen. It consists of passive autocatalytic recombiners (PARs), hydrogen igniters, and a hydrogen monitoring system. In addition, the containment internal structures are arranged to promote natural air mixing inside containment.

The provision of a spray system connected to the elevated reserve water tank will reduce reactor building pressures, if required, in the event of severe accidents.

Emergency Heat Removal System

The EHRS of the EC6 reactor is a seismically qualified safety system that supplies cooling water to the secondary side of the steam generators, the ECC heat exchangers and the HTS via the ECC system piping.

The EHRS design ensures that there is an adequate long-term heat sink available for decay heat removal following a loss of the normal heat removal systems for the reactor unit. The EHRS and its supporting structures, systems and components (SSCs) are designed to operate under the following postulated initiating events considered as DBAs and resulting in the loss of normal heat removal systems:

- Total loss of electrical power (both Class IV and Class III); or
- LOCA followed by site design earthquake after 24 hours; or
- Design basis earthquake

The EHRS is a unitized system. Each unit has two 100% pumps taking suction from a source of on-site fresh water that is in a separate location from the main plant service water system intake.

Balance of Plant

The balance of plant comprises the turbine building, steam turbine generator and auxiliaries, condensate system, condenser and the feedwater heating system with associated auxiliary and electrical equipment. The balance of plant also includes the water treatment facilities, auxiliary steam facilities, condenser cooling water system, and other systems and equipment to provide all conventional services to the plant. The cooling water systems could either employ once-through cooling or a closed loop system utilizing cooling towers, depending on site specification conditions.

Turbine-Generator and Auxiliaries

The turbine-generator system and the condensate and feedwater systems meet the design requirements specified by the nuclear steam plant design to ensure optimum performance and integrity of the nuclear steam plant. These include requirements for materials (i.e., titanium condenser tubes and absence of copper alloys in the feed train), chemistry control, feed train reliability, feedwater inventory and turbine bypass capability.

In the event of loss of off-site power to the plant, EC6 reactors are designed to remain at power for the duration of the event using turbine-generators that are disconnected from the grid. In this mode of operation, power is only supplied to internal auxiliaries as needed for the safe operation of the plant.

Turbine Rotor

Steam and Feedwater Systems

Steam is supplied from the steam generators in the reactor building to the turbine via the steam balance header. The feedwater system draws hot pressurized feedwater from the feedwater train in the turbine building and discharges the feedwater into the preheater section of the steam generators. The feedwater system maintains the required steam generator level by controlling the flow of feedwater.

The condenser steam discharge valves are designed to discharge up to 100% of the steam flow directly to the condenser, bypassing the turbine. This feature provides for operational flexibility in support of load following operation in conjunction with overall reactor control.

The main steam safety valves provide the safety functions of overpressure protection and cooling of the secondary side of the steam generators. The main steam isolation valves can be used to prevent releases in the event of steam generator tube leaks to the secondary side of the steam generator.

Balance of Plant Services

Conventional plant services include water supply, heating, ventilation, air conditioning, chlorination (if required), fire protection, compressed gases and electric power systems.

Service Water Systems

The balance of plant service water systems provide cooling water, demineralized water and domestic water to the nuclear power plant users. The systems consist of the condenser cooling water system, raw service water system, water treatment facility and chlorination systems (if required).

Heating, Ventilation and Cooling Systems

Heating, ventilation, air conditioning, and chilled water (from the chilled water system) are supplied to the nuclear power plant buildings to ensure a suitable environment for personnel and equipment during all seasons.

The building heating plant provides the steam and hot water demands of the entire nuclear power plant HVAC systems. Steam extracted from the turbine is used as the steam source for normal building heating. Dedicated, separate ventilation systems are provided for the main control area and secondary control area.

Fire Protection System

Water supply for the main fire protection system comes from a fresh water source. The main system provides fire protection for the entire station, i.e., nuclear steam plant and balance of plant. A seismically qualified water supply pumphouse and distribution system is also provided.

The fire protection system also includes standpipe and fire hose systems, portable fire extinguishers for fire suppression, and a fire detection and alarm system covering all plant buildings and areas.

Fire-resistant barriers for fire mitigation are provided, where necessary, to isolate and localize fire hazards and to prevent the spread of fire to other equipment and areas.

Instrumentation and Control

Most automated plant control functions are implemented in a modern distributed control system (DCS) using a network of modular, programmable digital controllers that communicate with one another using reliable, high-security data transmission methods. The plant is automated to the level that requires a minimum of operator actions for all phases of station operation.

The control systems are backed up by the safety systems, which include the two independent shutdown systems, the emergency core cooling system, emergency heat removal system, and the containment system. Each of these safety systems operates completely independent of the other and independent of the reactor and process control systems. The two shutdown systems are independent and diverse from each other (including fully separate and diverse voting, actuation and shut-down mechanisms) and each employs triplicated computerized trip channels. The emergency core cooling, emergency heat removal and the containment systems also employ redundant channels and will include at a minimum, computerized testing and, where appropriate, digital safety logic.

The Instrumentation and Control (I&C) design ensures that the random failure of a single component does not result in the loss of an important safety or production function. Important functions use three instrument channels to provide immunity against single instrument faults. Modular redundancy is used to provide transparent failover for components such as DCS controllers, power supplies, and communication modules. Where enhanced cross-link protection is required, the same function is redundantly implemented in multiple independent channels with the outputs from each channel being supplied to separate voting logic.

EC6 Control Centre

The plant control centre makes extensive use of integrated digital technology to enhance the monitoring and supervisory control of functions, systems and equipment necessary for power production, and the monitoring of functions, systems and equipment important to safety.

The main control room features a main operator console, with large video display units (VDUs) for plant overview and annunciation located to the front, and an array of panels, grouped by major system, located to the sides. The operator is normally situated at the main operator console where VDUs provide access to integrated plant information and controls for normal use. From the console, the operator has an optimal view of the large overview displays and the annunciation displays, which together are designed to improve plant state awareness. From here the operator also has access to historical data storage and retrieval facilities to support post event analysis and the monitoring of longer term trends.

An independent set of qualified VDUs, alarms, conventional control and monitoring instrumentation is provided on the control room panels to manage the safety of the reactor and to prevent damage to costly equipment in the event that the VDUs normally used are unavailable.

If for any reason the main control room has to be evacuated, the reactor can be safely shutdown, cooled and maintained in a safe shutdown state from an independent secondary control room.

Latest CANDU 6 Main Control Room

SMART CANDU® Software Suite

The EC6 comes equipped with the SMART CANDU software suite which is an integrated package of software tools and work processes aimed at optimizing CANDU plant performance throughout its operational life cycle. SMART CANDU technologies are designed to use our knowledge base embedded in predictive models, to transform discrete bits of plant data into actionable information used to support operational decisions, maintenance planning and life cycle management.

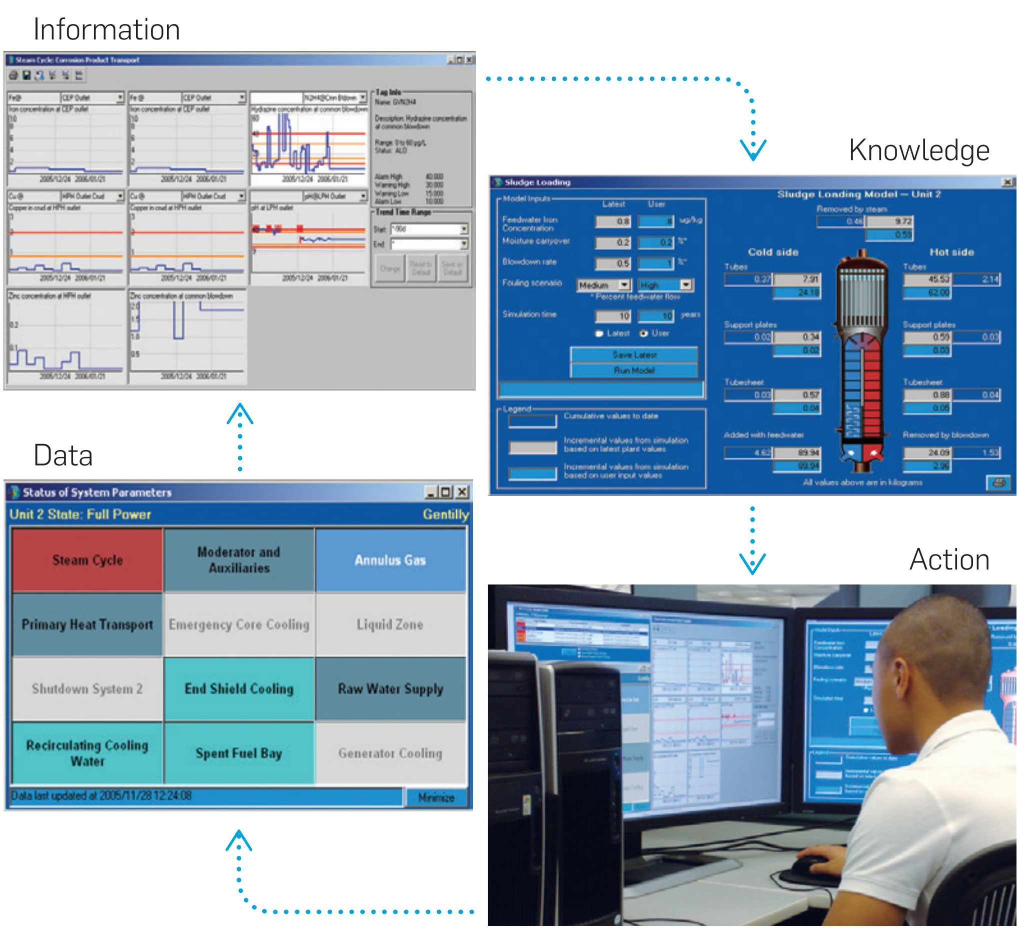
The superior engineering SMART CANDU suite of tools includes:

> CANDU Annunciation Message List System (CAMLS): Intelligent Annunciation Message List System. Assists operators in coping with events such as blackouts

> ChemAND®: Health monitor for plant chemistry. Predicts future performance of components, and determines maintenance requirements and optimal operating conditions

> ThermAND: Health monitor for heat transfer systems and components. Ensures optimal margins and maximum power output.

> MIMC: Maintenance Information Management Control (MIMC) system. Links health monitor to the plant work management system.



SMART CANDU Diagnosis and Action Sequence

Electrical Power System

The plant electrical power system consists of connections to the off-site grid, the main turbine-generator, the associated main output system, the on-site standby diesel generators, the battery power supplies, the uninterruptible power supplies, and the electrical distribution equipment.

The electrical power distribution systems are separated into Group 1 and Group 2 in accordance with the two group separation philosophy. Group 1 system is divided into four classes of power based on availability:

> Class I is delivered from batteries
> Class II from uninterruptible power supplies
> Class III from standby diesel generators
> Class IV from the main generator or grid

The emergency power supply (EPS) system is a Group 2 system. Seismically qualified emergency standby generators are provided for backup power to safety loads that are required. Seismically qualified UPS and batteries are provided for backup power to some of the safety loads identified during station blackout (SBO) events and beyond design basis accident.

Nuclear Safety

Nuclear safety requires that the radioactive products from the nuclear fission process be contained, both within the plant systems for the protection of the plant workforce, and inside the plant structure for the protection of the public.

This is achieved at all times by the following:

> Providing multiple fission product barriers

> Providing multiple levels of defence to protect the fission product barriers when challenged

> Protection of these physical barriers in each level of defence by the safety functions, including:

- Control of reactivity
- Removal of heat from the core
- Confinement of radioactive material
- Monitoring of safety critical parameters to guide operator actions

The reliability of the safety functions is achieved by the structures, systems and components (SSCs) with a high degree of reliability by applying the following principles:

> The use of high-quality components and installations

> Maximizing the use of inherent safety features of the EC6 reactor

> Providing enhanced features to mitigate and reduce consequences of design basis events and severe accidents

Defence-in-Depth and Inherent Safety Features

Our EC6 design incorporates four major physical barriers to the release of radioactive materials from the reactor core to the environment, including:

> The fuel matrix. The bulk of the fission products generated are contained within the fuel sheath
> The fuel sheath
> The heat transport system (HTS). Even if fission products are released from the fuel, they are contained within the HTS. The HTS is designed to withstand the pressures and temperatures resulting from the accident conditions.
> Containment. In the event of an accident, automatic containment isolation will occur, ensuring that any subsequent release to the environment does not occur

Consistent with the overall safety concept of defence-in-depth, the design of the EC6 plant aims to prevent, as far as practicable, challenges to the integrity of physical barriers, failure of a barrier when challenged, and failure of a barrier as a consequence of the failure of another barrier.

During normal operation, the level of defence built in the design ensures that the plant operates safely and reliably. This is achieved by incorporating substantial design margins, adopting high-quality standards and by advanced reliable control systems to accommodate plant transients and arrest the progression of the transients once they start. Following the design basis event, the EC6 safety systems and equipment automatically start to shutdown the reactor and maintain it in a safe shutdown condition indefinitely.

The design of the safety systems that perform the safety functions follows the design principles of separation, diversity and reliability. High degrees of redundancy within systems are provided to ensure the safety functions can be carried out assuming a single failure with the systems. Protection against external events and internal hazards (e.g., seismic events, tornadoes, floods and fire) is also provided, ensuring independence of systems or components performing safety and highly reliable and effective mitigation of postulated events, including severe accidents.

The EC6 design maintains the following traditional CANDU inherent safety characteristics with additional enhancements:

> The low-pressure and low-temperature heavy water moderator slows down neutrons, resulting in a fission process that is more than an order of magnitude slower than that of light water reactors. Reactor control and shutdown are inherently easier to perform.
> Refuelling during on-power operation reduces the excess reactivity level needed for reactor control. Reactor characteristics are constant and no additional measures, such as the addition of boron to the reactor coolant (and its radioactive removal), are required.
> Natural circulation capability in the reactor cooling system can cope with temperature transients (changes) due to loss of forced flow
> Reactivity control devices cannot be ejected by high pressure because they are in the low-pressure moderator and do not penetrate the EC6 reactor coolant pressure boundary
> Moderator back-up heat sink maintains core coolability for loss-of-coolant accidents even when combined with the unavailability of emergency core cooling
> Reserve water tank (RWT) makeup to steam generators by gravity for station blackout (SBO)
> Calandria vault plus shield cooling system or severe accident recovery and heat removal system (SARHRS) which could be used to arrest severe core damage progression within the calandria vessel
> RWT makeup to calandria or calandria vault to delay the severe core damage progression
> Passive capability of the containment itself, which ensures the containment integrity is maintained while an offsite emergency response plan is implemented following the onset of severe core damage

Severe Accidents

In CANDU reactors, fuel resides in fuel channels, which are surrounded by the cool and low-pressure moderator inside the calandria vessel, and the cool and low-pressure shield cooling water inside the reactor vault surrounds the calandria vessel. A severe accident for CANDU reactors could only occur when the core cooling by the moderator system is unavailable.

The CANDU design principle is to prevent severe accident events and to mitigate them when they occur, minimizing their consequences. The severe core damage is prevented by:

- Reactivity control
- HTS pressure control
- Core cooling and the HTS inventory control
- Containment heat removal

If severe core damage occurs, the mitigating features are provided to ensure it will not lead to the failure of the calandria vessel and the containment. This is achieved by:

- A large reactor vault water inventory surrounding the calandria vessel
- Using the shield cooling system to remove heat from the outside surface of the submerged calandria vessel to the ultimate heat sink via the shield cooling system heat exchangers or severe accident recovery and heat removal system (SARHRS)

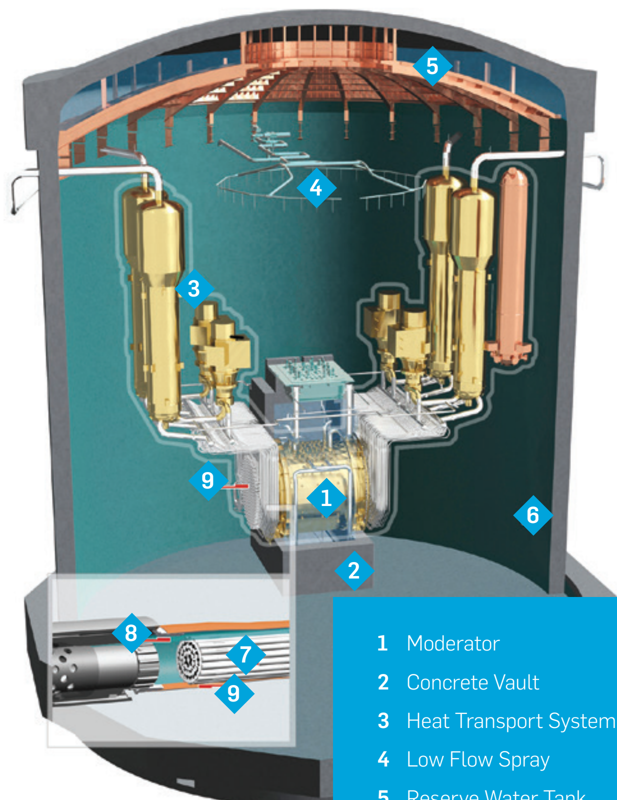
Defence-in-depth features are provided in the EC6 design for the extremely unlikely event of calandria vessel failure to maintain the containment integrity for a sufficient period of time to implement off-site emergency response procedure.

Severe Accident Recovery and Heat Removal System

The SARHRS in our EC6 is provided to prevent and/or mitigate severe accident progression that may lead to significant core degradation and challenge the containment integrity following a beyond design basis accident. This system is designed and constructed to deliver cooling water to the reserve water tank, calandria vessel, calandria vault and the containment low-flow spray system following a beyond design basis accident.

This system includes gravity-driven, passive water supply lines and a pump-driven recovery circuit. The reserve water tank provides gravity-driven water in the short term while the SARHRS fresh water source is used in the interim prior to recovery and re-circulation from the reactor building sump.

Barriers for Prevention of Releases



1 Moderator
2 Concrete Vault
3 Heat Transport System
4 Low Flow Spray
5 Reserve Water Tank
6 Containment
7 Fuel Bundle
8 Pressure Tube
9 Calandria Tube

CANDU Project Delivery

Through feedback from previous construction projects, we have been able to optimize key project elements. The EC6 plant construction schedule, from first containment concrete to in-service, is 57 months. The overall schedule, from contract to in-service, is project dependent but can be as short as 69 months. The second unit can be in service six months later. Deployment of the EC6 reactor requires the coordination and timely delivery of key project elements including licensing programs; environmental assessments; design engineering; procurement, construction; and commissioning start-up programs.

Design Engineering

Preliminary design and development programs of the EC6 plant are executed in parallel with the environmental assessment and licensing programs to ensure continuous improvement and plant configuration are maintained. The final design program ensures that plant reliability, and equipment and component maintainability and constructability requirements are maximized.

Licensing

Our EC6 reactor builds on the successful CANDU track record of accommodating the requirements of offshore jurisdictions in various host countries while retaining the standard nuclear platform. CANDU 6 has been licensed in Europe, Asia and North and South America. The EC6 reactor incorporates improvements to meet the latest regulatory requirements.

Licensing programs are executed and coordinated with the engineering design programs and environmental assessment and are structured to support regulatory process requirements.

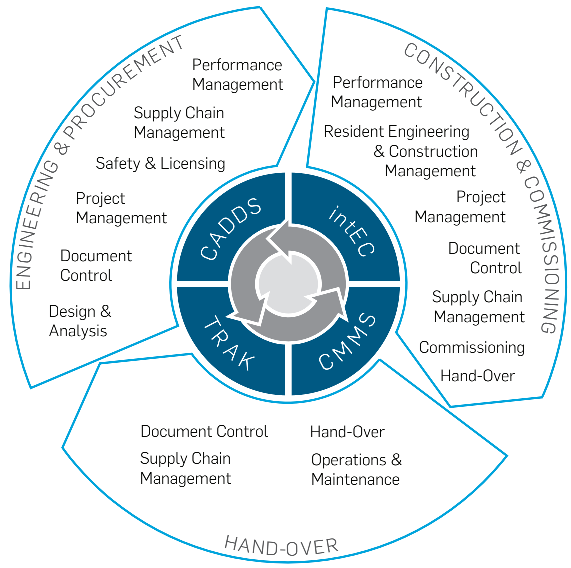
Configuration Management

The EC6 reactor makes use of the latest computer technology for managing the complete plant configuration from design to construction, and turnover to the plant owner/operator. State-of-the-art electronic drafting tools are integrated with material management, wiring and device design, and other technology applications.

Project Management

The EC6 reactor project management structure provides fully integrated project management solutions. Performance management programs are executed from project concept, through a project readiness mode, to project closeout.

The project management framework consists of three key elements: total project execution planning; a critical decision framework to control each phase of the project lifecycle; and a comprehensive risk management program.



Design Engineering and Project Tools

Procurement

Standardized procurement and supply processes are implemented to support time, cost, and performance benefits to the project, such as efficiency through variety control (i.e., standardization) and economy in manufacturing and servicing.

Construction Programs

Constructability programs are implemented to ensure project simplification by:

> Maximizing concurrent construction to increase construction productivity

> Minimizing construction rework to decrease equipment costs

> Minimizing unscheduled activities to reduce capital costs and construction risk

Construction Strategy

The main features of EC6 reactor construction are:

> Open-top construction method using a very-heavy-lift crane

> Concurrent construction

> Modularization and prefabrication

> Use of advanced technologies to minimize interferences

This construction strategy has contributed to the successful completion of CANDU 6 units around the world, delivered on budget and on/or ahead of schedule.

CANDU 6 Project Performance Record Since 1996

In-Service	Plant	Status
1996	Cernavoda Unit 1 – Romania	On Budget* On Schedule
1997	Wolsong Unit 2 – South Korea	On Budget On Schedule
1998	Wolsong Unit 3 – South Korea	On Budget On Schedule
1999	Wolsong Unit 4 – South Korea	On Budget On Schedule
2002	Qinshan, Phase III Unit 1 – China	Under Budget 6 weeks ahead of schedule
2003	Qinshan, Phase III Unit 2 – China	Under Budget 4 months ahead of schedule
2007	Cernavoda Unit 2 – Romania	In service Oct. 5, 2007**

*Per 1991 completion contract
**Work on Cernavoda 2 was suspended in 1989 and resumed in 2003

Operations and Maintenance

Plant Performance

The target operating capacity factor for the EC6 reactor is 92% or more over the operating life of 60 years. This expectation is based on the proven track record of CANDU 6 plants, as illustrated below.

Features to Enhance Operating Performance

Incorporation of feedback from utilities operating reactors (both CANDU and other designs) is an integral part of the design process. Various new features and maintenance improvement opportunities have been incorporated to enhance operating performance throughout the station life.

Major enhancements of our EC6 reactor:

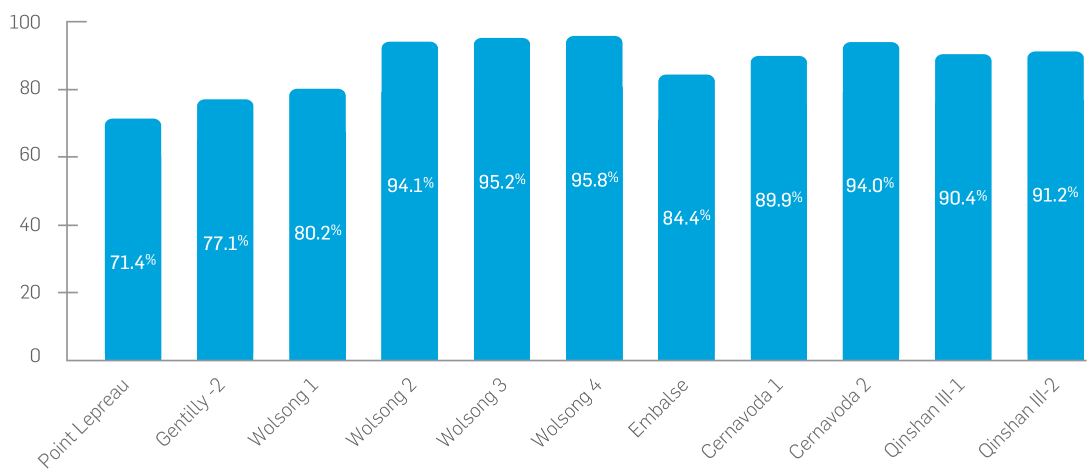
> Use of improved material and plant chemistry specifications based on operating experience from CANDU plants, e.g., life-limiting components such as heat transport system feeders and headers have been enhanced with higher chromium content to limit the effect of feeder corrosion

> Implementation of advanced computer control and interaction systems for monitoring, display, diagnostics and annunciation

> Utilization of integrated SMART CANDU suite for monitoring plant chemistry of systems and components, and providing predictive maintenance capability

> Ensuring capability for return to full power on restoration of the electrical grid. The EC6 reactor has the capability to continue operating and delivering house load without connection to the grid, therefore enabling a rapid return to full power upon reconnection.

CANDU 6 Lifetime Capacity Factors 2011*



* Source: CANDU Owners Group Inc., "CANDU Station Performance Graphs January–December 2011", February 07, 2012.

Features that Facilitate Maintenance

The number and duration of maintenance outages impact plant capacity factors. The traditional annual outage duration has been improved to an average of one month every 36 months in our EC6 design. To achieve this, the following enhancements have been incorporated:

> A maintenance-based design strategy. This program incorporates lessons learned and ensures maintainability of systems and components. It defines an improved maintenance program based on SMART CANDU technology to identify and take mitigating actions, if required, to ensure plant conditions are diagnosed and maintained within their design performance limits.

> Improved plant maintenance with provisions for electrical, water and air supplies that are built in for on-power and normal shutdown maintenance

> Shielding in radiologically controlled areas is provided to minimize worker exposure and occupational dose

> Improved equipment selection and system design based on probabilistic safety evaluations and specific outage intervals

Radioactive Waste Management

The waste management systems of the EC6 reactor will minimize the radiological exposure to operating staff and to the public. Radiological exposure for workers from the plant is monitored and controlled to ensure that the exposure is within the limits recommended by the International Commission on Radiological Protection. The systems for the plant have been proven over many years at other CANDU sites and provide for the collection, transfer and storage of all radioactive gases, liquids and solids, including spent fuel and wastes generated within the plant.

Wastes are handled as follows:

- Gaseous radioactive wastes (gases, vapours or airborne particulates) are monitored and filtered. The off-gas management system treats radioactive noble gases. Tritium releases are collected by a vapour recovery system and stored on-site.
- Liquid radioactive wastes are stored in concrete tanks that are located in the service building. Any liquid, including spills that require removal of radioactivity are treated using cartridge filters and ion exchange resins.
- Solid radioactive waste can be classified in five main groups: spent fuel; spent ion-exchange resins; spent filter cartridges; compactable solids; and non-compactable solids. Each type of waste is processed and moved using specially designed transporting devices if necessary. After processing, the wastes are collected and prepared for on-site storage by the utility or for transport to an offsite storage location.

In addition, the plant owner/operator maintains an environmental monitoring program to verify the adequacy and proper operation of the radiological effluent monitoring systems that monitor and control release of effluents at the release point.

MACSTOR-200 Module at Cernavoda, Romania

Modular Air-Cooled Storage (MACSTOR®)

Our spent fuel dry storage technology evolved from the concrete canister system, which was successfully deployed at the Point Lepreau, Canada and Wolsong 1, South Korea CANDU 6 plants. These concrete canisters hold up to 540 spent CANDU fuel bundles in nine baskets, each holding 60 spent fuel bundles for a concrete canister capacity of approximately 10 MgU. Subsequently, the MACSTOR-200 storage module was developed to store 12,000 bundles in 200 baskets and is currently used to store spent fuel at Gentilly-2 and Cernavoda.

To address larger fuel throughputs of multi-unit CANDU stations, the MACSTOR-200 module capacity has been doubled, further reducing space requirements and lowering capital costs. This advanced MACSTOR module design has been jointly developed with Korea Hydro and Nuclear Power (KHNP). The selected configuration has four rows of storage cylinders instead of two and provides a capacity of 24,000 bundles stored in 400 baskets. The module is termed MACSTOR/KN-400 and increases storage density by a factor of approximately three. Compared to the MACSTOR-200 module, the Advanced MACSTOR module requires about 30% less space.

Technology Transfer and Localization

Our technology transfer and localization program is the most effective in the nuclear industry, capable of achieving the highest level of local content in the shortest time. In South Korea, for example, CANDU technology achieved up to 75% local content by the fourth unit. Such accelerated results are possible due to our innovative design, as well as extensive experience in project management and technology transfer.

With a customer-focused approach, this program ensures great success in achieving self-sufficiency and self-reliance. The resulting partnerships provide the customer with the "know-why" and "know-how" to effectively serve domestic needs and achieve as much self-sufficiency as possible.

Further fine-tuning has been done in this area for the EC6 program through a variety of measures, including equipment standardization and optimization.

Program Details

A successful technology transfer and localization program is largely dependent upon technical information as well as personnel development and partnership with our customers. Our experience has shown that success in a technology transfer program and subsequent localization involves the recognition of and preparation for the following factors:

- People: The availability of trained personnel to interpret the documentation and implement the technology
- Training: A necessary ingredient as not all of the technology resides in document form – much of it can only be transferred through personal communication
- Practice: The technology transfer and localization program runs concurrently to a nuclear build project, allowing customers to practice their skills as they learn. Such an approach prevents knowledge dissipation and relearning.
- Technology Flexibility: Adjustments and modifications of manufacturing techniques, equipment and skills is often essential
- Environmental and Cultural Differences: Recognition of socio-economic-technological differences is an important consideration in any international endeavour
- Potential Conflict Resolution: Recognition of project priorities must occur between all parties in order to prevent possible conflicts, maintain project schedules and minimize overall costs
- Coordination: As there are often several recipients of technology transfer, coordination is required in order to:
  - Ensure that the necessary infrastructure is in place to provide adequately trained personnel
  - Determine priorities for the areas of technology to be transferred and to ensure sufficient allocation of funds and human resources
  - Determine the most suitable recipients who will receive and eventually develop the technology
  - Monitor and coordinate the actual technology transfer process

Summary

Evolution

By capitalizing on the proven features of our CANDU technology, the EC6 reactor has been designed to be cost-competitive with all other forms of energy, including other nuclear reactor designs, while achieving high safety and performance goals consistent with customer expectations. The size of the EC6 makes it unique as a product for utilities whose requirements are for an economic, medium-sized reactor with a proven performance record.

Proven CANDU features include:

> Heavy water moderator and horizontal fuel channel design
> Series of parallel fuel channels — rather than a single pressure vessel — allowing simpler manufacturing and reduced costs
> Two independent, passive, fast-acting safety shutdown systems and a unique inherent emergency-cooling capability
> On-power fuelling for flexible outage planning and minimal excess reactivity burden
> Multiple heat removal systems to prevent and mitigate severe accidents
> Very high degree localization
> Five decades of excellent operating and safety performance

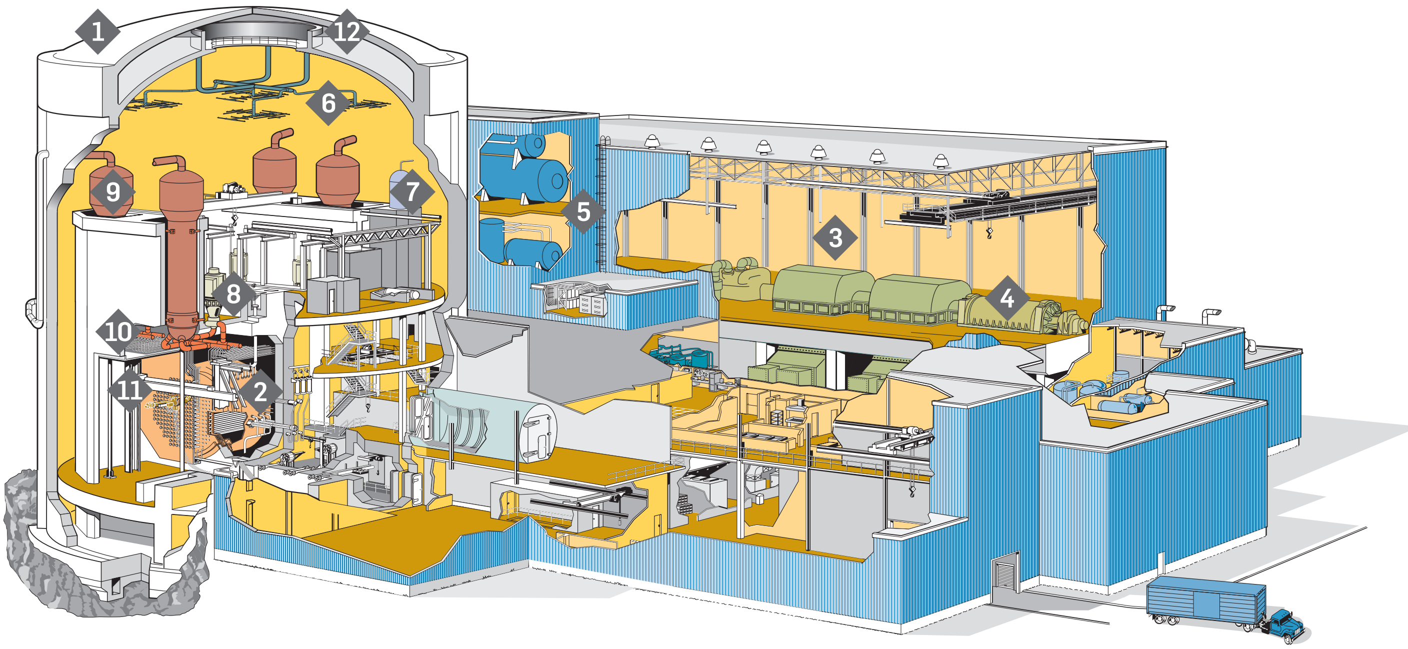
EC6 Improvements

The key improvements incorporated in the EC6 reactor design include the following:

> Enhanced safety design, including the addition of a reserve water system for passive accident mitigation
> Upgrades to the emergency heat removal system for safety qualified active and passive accident mitigation
> In addition to the robust preventative design provisions to prevent severe accidents from occurring, complementary design features are provided to halt the progress and mitigate the consequences of severe accidents using the severe accident recovery and heat removal system for containment heat removal
> Optimized chromium content in feeders to reduce corrosion and enhance life
> Steel liner and thicker containment
> Improved overall design for maintainability and operability
> Competitive economics
> Enhanced safety
> Improved operability and maintainability
> Construction schedule of 57 months achieved by use of advanced construction methods
> Total project schedule as short as 69 months
> Evolutionary, efficient design using proven technologies based on over 150 reactor years of successful operation by the CANDU 6 reactor

The EC6 reactor will meet customer expectations for safe, reliable, and economically competitive power production. It benefits from our wealth of experience, technical excellence, and innovations in engineering.

EC6 Nuclear Power Plant Diagram



1	Reactor Building	**7**	Pressurizer
2	Calandria	**8**	Heat Transport Pumps
3	Turbine Building	**9**	Steam Generators
4	Turbine Generator	**10**	Heat Transport System
5	Service Building	**11**	Fuelling Machine
6	Spray System	**12**	Reserve Water Tank

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