History of Lepreau 2 since 1974

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Abstract

The 1974 Point Lepreau layout showed four CANDU 6 units with CW intake for the first pair of units. The first CANDU 6 was to be built at Gentilly 2, with Lepreau as a copy of G2 except that the layout was for two units with a common Main Control Room. The Lepreau 1 MCR was relocated resulting in the steam lines passing over the MCR of unit 1 and also near the MCR of the future unit 2.

1984 a Lepreau 2 layout was prepared using the existing CW intake and discharge. This layout was refined in 1986 so that the unit 2 MCR was away from the main steam lines of either units 1 or 2; also that a common external event could not impact both the MCR and Secondary Control Room of unit 2.

In 1991 a layout was prepared of the CANDU 3 as Lepreau unit 2.

1. Introduction to History

The CANDU 6 design history started in about 1973 with the Pre-Project Report prepared by Canatom and AECL, on the proposed construction of a C6 at Gentilly 2, in the Province of Quebec, Canada.

Later in 1973, New Brunswick Power (N.B.Power) engaged Canatom to undertake a study of a possible nuclear and heavy water plant complex at Point Lepreau, and Canatom continued to provide engineering services throughout the design and construction of the Point Lepreau CANDU 6 nuclear power station which went into service in 1983. The early 1974 Point Lepreau layout showed four CANDU 6 units but only the cooling water (CW) system for the first two of units, comprising a direct intake from and discharge back to Duck Cove, and pumphouse for 2 units as shown on Fig.A. However because of concerns about warm water being recycled back into the intake and also fish entrapment, the intake was changed to a 700m undersea long tunnel from Indian Cove on the other side of the Point. Fig.1 and Fig 2 are from Reference 1 published in 1977 which also gives details of the CW inlet and outlet. Fig 2 shows provisions made for a second unit comprising;

- Future CW pump house with forebay served by existing CW inlet tunnel.
- Location only of underground supply a CW tunnel to the future Unit 2 and discharge tunnel. These tunnels could take different routes to suit a future Unit 2.
- The Unit 2 discharge tunnel would connect to the existing vertical construction shaft joining the Unit 1 discharge tunnel to the sea.

2. Point Lepreau 1

2.1 N.B.Power – AECL Agreement for Lepreau 1

In April 1974, N.B. Power and Atomic Energy of Canada Ltd. (AECL) signed an Agreement stating that

- N.B.Power desired to construct the first of a two unit CANDU-PHW generating station having a nominal output of 600 megawatts.
- N.B Power wishes to commence work immediately on the first unit with minimum provision for the second unit.
- That the unit be designed to utilize as much as possible the work performed by AECL on the Gentilly 2 Project.

The first CANDU 6 was built at Gentilly 2 (G2) in the Province of Quebec.
The Lepreau 1 reactor was as a copy of G2 but the 1984 Lepreau layout was for two units with a common Main Control Room as shown on Fig 3.

2.2 Lepreau 1 Service Building Layout

In this July 1974 Service Building layout, the Lepreau 1 Main Control Room (MCR) was relocated near the future Unit 2 so that a combined control room would be created. The Unit 2 MCR would be in the same location as G2, so that eventually some design could be shared. However moving the Unit 1 MCR, resulted in the main steam lines passing over the roof of the MCR; also many cables from the MCR to the Reactor Building (RB) penetrations were considerably extended.

The 1974 layout did not show the following buildings;

- Secondary Control Area (SCA). Originally this was shown in the basement similar to G2, but was moved to the location shown on the Unit 1 part of the layout Fig C 1986, to increase the separation of the Unit 2 SCA from the Unit 1 MCR.

- The High Pressure Emergency Core Cooling. The need for HPECC was not identified until after the RB containment wall had been poured in 1976, so an existing spare penetration on the C axis of RB had to be used. This required an additional 100m length of 16in pipe from the ideal location of the penetration which is on the AB axis where the HPECC valves inside RB are immediately above this ideal location near the HPECC building from which this pipe run starts.

3. Maritime Nuclear

Maritime Nuclear, a group set up in Fredericton in 1983 comprising staff from N.B.Power, AECL and Canatom, prepared a Unit 2 layout with the MCR moved back to the G 2 position. However, because main steam line break (MSLB) was not then a consideration, the layout of Unit 2 was somewhat similar to the original 1974 layout.

Fig B is an artists colored sketch in 3D made in 1984, which shows;

- The new pump house for unit 2 CW.
- The top of the vertical construction shaft for to join the CW discharge from Unit 1.
- The HPECC and SCA in the same location as Unit 1. For this and other reasons given under Improved CANDU 6 below, this 1984 layout would not now be considered ideal.

4. Main Steam Lines over the Main Control Room.

4.1 History of MSL routing

The historical reason for routing of the MSLs over the MCR at Lepreau 1was:

(1) In early 1974, G2 was the first CANDU 6 designed. The G2 MCR was located near the main airlock and other support services to facilitate getting permits to work. The majority of cable penetrations in the RB were near the back of the MCR to minimize cable lengths. The secondary control area (SCA) was a later add-on in an awkward location in the Service Building basement.

(2) In late 1974, Lepreau was initially designed as a 2 unit station with the concept of a common MCR inspired by Pickering A. This would save some of the operational staff; at least one shift supervisor over 30 years. The Lepreau Unit 1 MCR was moved to the other end of the Service Building resulting in the MSLs going over roof of the MCR MSL failure was not considered in the original of industrial design of the roof.

4.2. Main Steam Line Break (MSLB)

In 1992, the Atomic Energy Control Board (AECB) became concerned about the effect of a MSLB over the Lepreau MCR so N.B.Power studied the possibility of rerouting the MSLs away from the MCR on the operation Unit 1. It was concluded that it would be possible to reroute the MSLs around the RB at a high level, then around the yard and into the end of the TB route, but with the following implications;

- Considerable cost, including a long shutdown
- Decrease in power output due to the drop in steam pressure caused by the increased length of the MSLs and additional bends.
- Increase in use of site space which would impact the layout of a possible Unit 2.

The AECB accepted the existing Lepreau MSL route provided;

- The MSLs were inspected every shift for signs of a leak. This was justified on the "leak before break" scenario.
- A long term MSL leak detection system was sought.

N.B. Power then investigated various systems and installed a system which continuously detects moisture between the steam line pipe and the insulation. This leak detection system was endorsed by the Canadian Nuclear Safety Commission (CNSC) which replaced the AECB.

5. The 1986 Improved CANDU 6 Layout

5.1 Netherland's Requirements

In 1986 a visit was made to the of Netherlands as part of an AECL initiative to investigate possibility of selling a CANDU 6 there. The Netherlands had some containment requirements which included more protection of the MSLs. This was proposed to be achieved by routing the MSLs down inside the RB to about the elevation of the bottom of a steam generator (SG). It was shown possible for a steam line to take a horizontal route from the top of the SG at about 90 deg from the existing route, then down inside the RB to a new penetration at about 45 ft. above grade which is 67 ft. lower than the existing penetrations which are high up at 112 ft. above grade.

5.2 Application to Lepreau 2 Layout

Fig 4. shows a possible 1986 layout of Lepreau where Unit 2 would be an Improved CANDU 6 prepared as a result of the Netherlands study. The new location of the MSL penetrations steam lines is near the B axis of the RB. Note; the pre-stressing buttress at axis AB may have to be moved a short distance to locate these two MSL penetrations.

This Lepreau 2 layout would have the following functional layout improvements;

(1) MSL Penetration Leak testing. By lowering the penetration to the elevation at the bottom of the SG, the thermal expansion would be about equalized allowing for a solid leak testable penetration.

(2) The MSLs would be protected, because from the RB penetrations, the MSL's in the Service Building would be routed undercover of a reinforced concrete roof containing all the steam valves including the isolating valves. From this valve station, the MSLs could be outside before entering the Turbine Building.

(3) The location of the SCA and HPECC buildings is interchanged, so that the SCA is on the other side of the RB from the 2 MCR. The RB structure would prevent a common external event from impacting both these Unit 2 control areas.

(4) The Unit 2 MCR is away from the main steam lines of either Units 1 or 2, thus this 1986 layout would have avoided later concerns about a MSL break of either Unit 1 or Unit 2 affecting the Unit 2 MCR.

(5) The two MCRs would not be in a common room, but rather have a Resource Center between them. This was somewhat inspired by the 1979 TMI 2 event where the MCR got very crowded and did not have full technical data conveniently available. Also visitors could see the main control panels without entering the MCRs.

(6) Diesel Generator Location. The unit 2 diesel generators nearer the unit 2 loads.

(7) Truck Access. There is better access for trucks turning into the service building.

5.3 Reduction in Quantities of Commodities

There would be a reduction in the quantities of the following commodities:

(1) Length of Main Steam and Feedwater lines. The length of the MS and FW lines is reduced as can be seen by comparing the MSL routing of Unit1 and Unit 2 on the Fig. 4 plan view. There is also a reduction in the number of pipe bends which can only be seen on a section of the plant layout shown in Figure 2 of Reference [2]. This results in improved thermal efficiency due to less pressure drop.

(2) Length of cabling. The MCR is nearer the cabling penetrations into the RB like G2. This substantially reduces the length of cabling, cabling cost, congestion and long term cable maintenance difficulties.

(3) High Pressure Emergency Core Cooling. The HPECC was moved to the Figure 4 position in order to minimize the site footprint and provide clearance from the road passing the settling lagoon. In this location the 16” dia, nuclear grade HPECC pipe length would be reduced by 85m by having the RB penetration moved 110 deg. from axis C to the ideal location at axis AB which is just below the HPECC valves inside RB and near the HPECC building. However a detailed site layout may show sufficient space to locate the HPECC on the “B” axis resulting in considerable reduction in HPECC pipe length.

6. The CANDU 3

The C3 concept was started in about 1985 with the objective of having a CANDU design which would be of minimal cost, short construction schedule and easy to retube.
In 1990 a layout of multi-unit 450 MWe CANDU 3's on an ideal river or lakeside was prepared. Reference [3]. A single unit C3 layout for Lepreau 2 is shown on Fig 5

In the C3, the turbine generator axis is in-line with the center point of the reactor building. This TG orientation has become popular because missiles from TG break up will not fly in the direction of the MCR. However there are many nuclear plants where the TG axis is parallel with the Service Building and MCR, so that electrical end of the TG is near the service loads and, on multi-units, there is a common turbine hall so that the turbine building cranes can be used on all units (like Pickering).

On in-line layouts like the C3, the distance from the RB center line to the side or end of the TB where the main transformers are located, is greater than on parallel layouts like the C6, so it was checked that the conceptual C3 layout would fit in the space available at Lepreau. In the proposed layout of C3 as Lepreau 2 the distance from the Unit 2 turbine building from the Unit 1 CW inlet tunnel, seemed just reasonable for civil construction.

In December 1991, AECL made a preliminary proposal to NB Power that a CANDU 3 be constructed as unit 2 at Lepreau. This included a study of the common services that could be used including the following where the numbers ( ) refer to items on the above layout;

- The common CW intake to the pump house intake.
- Extension to the CW pump house (13).
- CW intake tunnel (15) and discharge tunnel (16) to the existing discharge.
- The existing EWS pond, requiring additional Group 2 unit pumps for Unit 2 in a new building (14).
- Extension to the existing Admin building (12)
- The existing water treatment plant, but requiring additional demineralized water storage tanks.

7 Conclusion

The author is unaware of any subsequently proposed Lepreau 2 layouts, so perhaps some of these more than 20 year old new ideas will be relevant to the next Lepreau layout.

8 Figures

8.1 Figures printed with the paper.

Fig. 1 Point Lepreau area map showing cooling water intake and discharge tunnels - from Ref [1]

Fig. 2 Plan showing provision made for second unit – from Ref [1]

Fig. 3 July 1974 Service Building layout for 2 units at Lepreau.

Fig. 4 1986 Improved CANDU 6 concept for Lepreau 2 – from Ref [2]

Fig. 5 CANDU 3 Point Lepreau 2 Plant Layout – from Ref [3]

8.2 Figures to be presented at talk only.

Fig. A Initial 1974 concept showing space for 4 units at Point Lepreau

Fig. B 1984 Maritime Nuclear Layout of Lepreau 1 and 2; Artists 3D colored sketch.

9. References

[1] Craik N.G., and Parfitt A.W., of Canatom, "Site-specific design features" *Nuclear Engineering International*, June 1977;
including several other articles on Point Lepreau

[3] Craik N.G. of AEC/Canatom, "Improved CANDU 6 Designablility." *Canadian Nuclear Society*,
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[2] Craik N.G. of Canatom, and Chisholm R.G. of AECL.
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Proceedings of 12 Annual Conference 1991,

Final edit by Neil Craik 2007 March 20