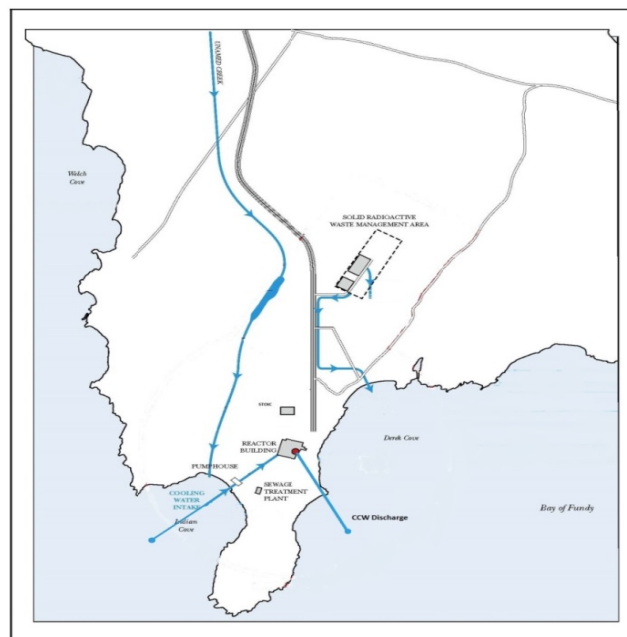


SUMMARY

VALIDATION OF ENTRAINMENT AND IMPINGEMENT PREDICTIONS AT THE POINT LEPREAU NUCLEAR GENERATING STATION

The Point Lepreau Nuclear Generating Station (PLNGS) is one of the first CANDU-6 units to be built, and the design incorporated a number of innovative features, especially with regard to its condenser cooling water (CCW) system. The CCW system is an essential component of the non-nuclear part of the station, taking water from the Bay of Fundy to condense steam as part of the station's steam cycle and providing cooling for various station components, before discharging the seawater back into the Bay.



DESIGN OF CONDENSER COOLING WATER SYSTEM

The design of the CCW was a joint effort between the engineering team and federal environmental experts, and has been recognised as “best available technology” for mitigating effects on the marine environment. The design of the intake structures incorporate several notable features including:

- An offshore submerged intake with multiple ports and a “velocity cap” to minimize entrainment¹ of marine organisms
- A lower “lip” on the velocity cap to prevent benthic organisms from entering the CCW
- Screens in the pump-house to minimize impingement² while ensuring safe and reliable operation.

¹ In this context, entrainment is the capture of small marine organisms into the cooling water flow.

² Impingement is when larger organisms that can swim, get trapped on the screens in the pump house.

The primary objective of the screens is to keep debris out of the pumps to ensure safe operation. The design of the screens and the pump house are at an angle to the CCW flow to reduce the probability of impingement, while still allowing adequate flow to provide necessary cooling.

Schematics for the velocity cap and the pump house / screen arrangement are provided in Figures 1 and 2 below.

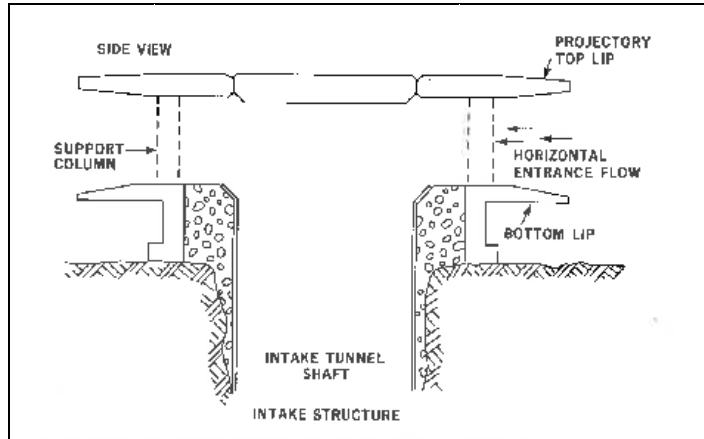


FIGURE 1: POINT LEPREAU VELOCITY CAP (ENVIRONMENT CANADA, 1985)

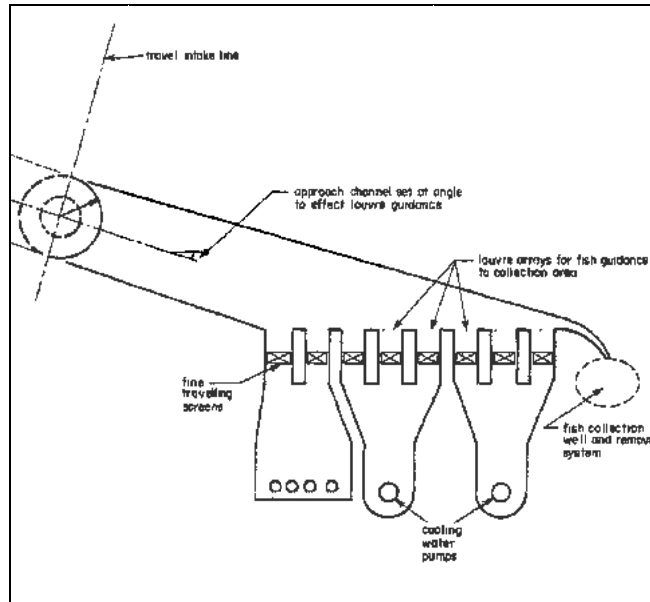


FIGURE 2: FORE BAY – PUMP HOUSE ALIGNMENT

ENTRAINMENT AND IMPINGEMENT ASSESSMENT

The CCW system at Point Lepreau has been the subject of several assessments over the years, in particular in 1977 for the first unit and in 1985 for a potential second unit. Each assessment evaluated the potential effects of entrainment and impingement on fish and marine organisms in the Bay of Fundy, focussing in part but not exclusively, on commercial species. At that time, the most important commercial species were salmon, herring and lobster, and the assessments considered effects of entrainment on both larvae and juveniles, and the effect of impingement on larger juveniles and adult fish.

The assessments of impingement predicted that the majority of adult fish would be excluded from the intake system based on the actual design, as adult fish have the ability to sense attraction flow created by the velocity cap, and can then swim away from the intake. On this basis, the assessments predicted that impingement would not cause a significant effect.

The assessments of entrainment used conservative (worst case) assumptions of flow and mortality in conjunction with field data to predict the number of larvae and juveniles that would be entrained, and then projected these data into the effect on populations and potential commercial landings in the area. Both the 1977 and 1985 assessments predicted that entrainment would not cause a significant effect.

The overall effect of impingement and entrainment was summarized in the 1985 environmental assessment report which stated *"In summary, the effect of impingement and entrainment of juvenile and adult fish would not be measurable on fish stocks in the area, and would not be significant."*

VALIDATION STUDIES

Consistent with environmental standards issued by the Canadian Standards Association, and following changes to the federal *Fisheries Act* in 2012, NB Power contracted ARCADIS to undertake entrainment and impingement monitoring at PLNGS with the objective to:

1. validate, to the extent possible³, the predictions made in the earlier environmental assessments, and
2. generate data to allow a decision to be made whether a *Fisheries Act* authorization is required for PLNGS, and if so, whether or not mitigation or compensation is required.

The first phase involved field work for the impingement study which was carried out in 2014 and the second phase involved field work for the entrainment study which was carried out in 2015. The results of the two studies have been submitted to the CNSC and Fisheries and Oceans Canada (October, 2015 and March, 2016 respectively).

Although the assumptions used in the validation studies are more conservative than in the original environmental assessment⁴, the conclusions of the recent studies are consistent with the earlier assessments:

³ The methodology for estimating losses has changed over the years, which makes direct comparison difficult.

⁴ The original assessments assumed 0.01% survival from eggs to adults, while the validation studies assumed 1% survival

1. As predicted, Atlantic Herring was the most abundant fish impinged. The total mass of herring lost to the population and fishery (approximately 0.7 MT) represents a negligible percentage of commercial landings which were 31,532 MT for New Brunswick in 2014.
2. Only two adult lobster were impinged. Lobster larvae were present, and the estimated mass lost to the population and fishery (approximately 0.5 MT) represents a negligible percentage of the commercial landings of 71,770 MT for New Brunswick in 2014.
3. A number of other species (larvae and juveniles) were identified during the validation studies, however, their abundance was less than herring, and the mass lost is correspondingly small.
4. The validation studies took particular note of threatened or endangered species, however, no species listed as endangered or threatened under the *Species at Risk Act* were found. Larvae of Atlantic Cod and American Plaice, both fished commercially and also listed by the International Union for the Conservation of Nature (IUCN), were found during the entrainment studies. The amount of cod and plaice lost through entrainment (approximately 1 MT and 2 MT respectively) is significantly less than 1% of commercial landings of approximately 2000 MT).

FISHERIES ACT AUTHORIZATION

NB Power has also used the field data and the design information to prepare a self-assessment of the effects of the CCW, using methodologies consistent with current scientific approaches. This self-assessment has been submitted to the CNSC (January 2017), who is the initial contact for potential Fisheries Act Authorizations.

CONCLUSION

The design of the cooling waters system was a cooperative effort involving federal agencies (e.g. Environment Canada) and the engineering design team, and included the objective of minimizing the impact on the marine environment. The final intake design comprising an offshore submerged intake with a velocity cap is still considered to be “state-of-the-art” or “best-available-technology” for minimization of impacts on marine organisms, both in Canada and elsewhere.

The predictions made in each of various environmental assessments were that the effect of operation of the PLNGS on fish and marine organisms would be insignificant. These predictions were made for both one and two unit operation at Point Lepreau.

Studies were carried out by NB Power between 2014 and 2016 to assess actual effects of impingement and entrainment on marine organisms in the Bay of Fundy. The results of the validation studies confirm previous predictions that operation of PLNGS does not cause serious harm to fish populations, or to commercial or recreational or aboriginal fisheries.