Glacier Howser Hydro Project
Review of BCTC Interconnection Impact Study
Report number SPA 2007-021M

The report examines the performance of the interconnected system under both heavy winter load and light summer load conditions. However as this generation will only be available during spring freshet only the light summer load condition will be applicable**.**
Power flow and stability analysis results are presented and the impact of fault conditions and planned outage conditions are identified. However, line energization and system shut down contingencies are not investigated under the section dealing with power frequency overvoltages, which is limited to load rejection conditions. This is a limiting case but has not been studied by BCTC !!!

Generation configuration studied differs from that included in the environmental application.
BCTC study-Glacier IPP 3 * 13.5 MW at 0.9 p.f. Environmental report-2*26MW ,1*7MW
Howser IPP 4*12.5 MW at 0.9p.f. Environmental report-3*16 MW, 1*6MW

Network configuration
A junction substation is proposed to interconnect the two generating plants and the line to Invermere. Each line section is considered as a single unit complete with switchgear and protective relaying equipment, whereas all that is required is the ability to isolate the sections at this junction point by installing only disconnect switches and protecting the transmission line as a single unit three terminal network arrangement. This considerably reduces the cost of the transmission system but does not appear to have been considered by AXOR.

BCTC, in compliance with WECC criteria, require microwave communications between Invermere and each generating station, in addition to the proposed fiber optic system, in order to permit transmission of duplicate intertripping signals required for the RAS scheme. No such requirements have been identified in the environmental study. Where will the antenna be located?

The physical point of connection between BCTC and AXOR is defined as the substation at Invermere but from an electrical point of view it must be considered as being at Cranbrook comprising a radial 245 kV transmission line from that station to Glacier and Howser.However the two line sections are entirely different, being designed to different security and performance levels.

The report addresses only the impact of the proposed project on the BCTC system. It does not study the requirements of the AXOR development but simply identifies those facilities required in order to minimize the impact on the existing network. Whenever a negative impact is identified the solution is to trip the interconnection at Invermere, leaving the AXOR network to shut down without identifying any potential problems.

A critical case is that of opening 2L 258 at Cranbrook in the absence of the fault, resulting in an extremely high power frequency over voltage, when a single generating unit is connected at Glacier or Howser. BCTC require a minimum of two generations connected at Glacier or

Howser in order to control this voltage. They do not however address the impact on equipment located within their network particularly the risk of self excitation of the generating units. This will probably be an unacceptable operating mode for AXOR

Multiphase faults on line 2L 258 result in instability of the IPP generation. BCTC propose attempting a high-speed three pole auto-reclose but in view of the over voltage conditions together with the risk of damage to equipment this is not recommended.
Single pole reclose for a single phase fault would be initiated on the line 2L 258, so as to provide the equivalent of a second circuit Invermere-Cranbrook, which would significantly improve the outage performance of this circuit. Provision of similar facilities by AXOR would have a significant impact on availability of their transmission line design, but in view of the design of tower head, single phase faults would rapidly become the multiphase rendering the scheme impractical.

WECC criteria require that a network be capable of withstanding a single contingency, whether planned or unplanned. This requirement is not satisfied by the design of network proposed by AXOR.
A comprehensive RAS scheme is required in the BCTC system in order to secure their network against n-1-1 contingencies. Implementation of the scheme requires duplicate intertripping signaling paths, microwave and fibre optic, but this does not appear to have been catered for by AXOR.
A switching station is proposed to interconnect the transmission lines from Glacier and Howser at 240 kV but this could be considerably simplified to comprise manually operated disconnect switches and a three terminal network concept implemented. This would have a significant benefit from the environmental point of view.
The data utilized by BCTC in the impact assessment study has been assumed using typical data rather than actual. The impact study, together with equivalent case studies for the AXOR system, should be repeated, particularly to recognize the limited period of generation at Glacier and Howser, i.e. freshet, under a light load conditions on the network.
Generation output will be lost for single contingency conditions in both primary and secondary systems within the AXOR generation and transmission system. A significant portion of the system will only be operated for a maximum of five month period, but during this period must be highly reliable. It is apparent that fundamental aspects, e.g. selection of the configuration of generating plant, has not yet been finalized, therefore the scheme should not be committed for detailed engineering onto such decisions have been made and their environmental implications assessed.
Design criteria required for transmission line design frequently requires weather monitoring stations to be established, particularly when crossing the mountainous areas where previous construction has not occurred. This does not appear to have happened in this instance.
The environmental impact of load rejection of the generating Plant as a result of operation RAS schemes within the BCTC system, or it's within the AXOR system should be defined, with particular attention to the hydraulic system and restoration of water flow to the original creeks.

The capital costs of interconnecting the Glacier-Howser system to that of BCTC at Invermere is very significant i.e. $20 million, while the benefit is an interruptible power supply for approximately 5 months of the year. Unique features of the development and its exposure to

natural hazards in both the electrical and hydraulic systems presents a significant risk factor to the availability of power. Failure of a 240kV transformer would result in loss of output for the complete freshet period. Work on the tunnels within the hydraulic system could result in total loss of output for long periods.

A comprehensive risk analysis should be performed in order to evaluate the benefits of the scheme compared to the environmental impact, and provide a basis for decision making.

Significant items

The following items are of significance with respect to design of the electrical system:-

- system analysis utilizing the finalized ratings of generations under startup, synchronizing, load rejection, with or without fault, and the both maximum and minimum generating conditions
- eliminate switchgear currently proposed fully junction substation, and utilize only disconnect switches manually operated
- resolve the requirements for microwave and fiber optic telecommunications
- review the transmission line design based upon the realistic environmental criteria and permit the use of single pole automatic reclosure
- risk of loss of generation for a single contingency anywhere within the development
- time to repair such problems in view of the remote location.

AXOR have not demonstrated that they have the engineering expertise to design the proposed scheme on a coordinated basis i.e. a complete power generation and transmission system rather than a collection of individual components.