

1 Q. Describe Hydro's transmission system planning policy and criterion and process.  
2 Include in the response the numbers and titles of personnel involved with the  
3 transmission planning process.  
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6 A. Hydro's transmission system planning group is responsible for monitoring the  
7 transmission systems to determine when a component's capacity fails to meet the  
8 established planning criteria using load flow, short circuit and stability analyses.  
9 When deficiencies are found, the group prepares and tests alternative solutions to  
10 ensure the transmission system meets the planning criteria into the future. Where  
11 appropriate, a least life cycle cost analysis of technically viable alternatives is  
12 completed and detailed reports prepared with recommendations on preferred  
13 solutions. A summary of the transmission planning criteria is provided in PUB-NLH-  
14 186 Attachment 1.  
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16 Hydro's transmission system planning group consists of four permanent employees:

- 17 • Manager of Transmission Planning and Integration Support;
- 18 • Senior Transmission Planning Engineer;
- 19 • Transmission Planning Engineer (in training); and
- 20 • Design Coordinator Administrator.

21 As well, the group has two HVdc system planning engineers allocated from the  
22 Lower Churchill Project to assist with the planning and integration of the Muskrat  
23 Falls generating station and the HVdc Labrador-Island Link.  
24

25 Each year, the transmission planning group prepares a set of peak and light load  
26 base case load flows for the current year and the subsequent four years utilizing the

current Hydro and Newfoundland Power Infeed load forecasts. These cases form the basis for transmission planning criteria evaluation for capital budget applications as part of Hydro's annual capital budget and five year plan process. Typical outcomes of the base case load flow evaluations include transformer capacity deficiencies, transmission line thermal overload conditions and under/over voltage issues requiring reactive power devices and/or on load tap changer controls.

In addition to supporting Hydro's capital budget and five year plan, the base case load flows provide a starting point for:

- Technical support to Hydro's:
  - System Operations and Energy Control Centre;
  - Transmission and Rural Operations (TRO) staff;
  - Hydro generation staff;
  - Thermal generation staff; and
  - Project Execution and Technical Support Division.
- Technical support to Churchill Falls Operations on the Labrador Interconnected System;
- Integration studies associated with industrial customer requests for interconnection and/or modification of existing facilities; and
- Integration studies associated with new generating facilities such as small scale hydro, wind, and the Lower Churchill Project.

The transmission planning group maintains a short circuit model of the Island and Labrador Interconnected Systems that is updated as the systems are modified (i.e., lines, generators, motors and transformers added or removed). Short circuit cases for minimum, maximum and maximum foreseeable levels are used for relay

settings/coordination, arc flash calculations, ground grid designs and equipment specifications. Requests for short circuit studies are generally on a project specific basis with the number varying from year to year.

The transmission planning group maintains a stability model of the Island and Labrador Interconnected Systems that is updated following modifications to the systems such as new generation, replacements of excitation systems, replacements of governor systems and modifications to under-frequency load shedding schedules. The stability models are utilized to:

- Complete integration studies for new generation additions;
- Complete integration studies for new Industrial Customers as deemed appropriate for the customer;
- Define exciter ceiling voltages and time constants for new or replacement exciters;
- Define governor droop settings for new or replacement governor systems;
- Update critical clearing times following system additions/modifications;
- Assess protection and control philosophies such as out of step relaying on transmission lines and adoption of three pole reclosing; and
- Post event simulation of system disturbances to assist in analysis of the event and identification of potential solutions and/or mitigation strategies.

Requests for stability studies are generally on a project or event specific basis and vary from year to year.

Integration studies typically begin with a preliminary load flow study to assess the impact the proposed addition will have on the interconnected system in steady state with all equipment in service and under N-1 contingencies. Violations in

1 criteria are noted and potential technically viable solutions proposed and tested.

2 Short circuit studies are performed to assess the impact on voltage change due to  
3 shunt capacitor and reactor switching. Stability studies are performed to assess the  
4 impact of:

- 5 • Motor starting for Industrial Customers;
- 6 • Governor and exciter response to short circuits on the system;
- 7 • System stability following system disturbances;
- 8 • Successful application of single pole reclosing on 230 kV transmission lines;
- 9 and
- 10 • System frequency response to disturbances.

11  
12 Once technically viable solutions are defined through the load flow and dynamics  
13 simulations, short circuit studies are repeated to assess impact on interrupting  
14 ratings of existing circuit breakers. Cost estimates for technically viable solutions  
15 are requested from Project execution and Technical Services and the least life cycle  
16 cost alternative selected. A detailed report is completed including a preliminary  
17 single line diagram of the winter connection to the system.

## Summary of Newfoundland and Labrador Hydro's Transmission Planning Criteria

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### INTRODUCTION

The following is a summary of Hydro's Transmission Planning Practices:

- Hydro's bulk transmission system<sup>1</sup> is planned to be capable of sustaining the single contingency loss of any transmission element without loss of system stability
- In the event a transmission element is out of service, power flow in all other elements of the power system should be at, or below, normal rating
- The Hydro system is planned to be able to sustain a successful single pole reclose for a line to ground fault based on the premise that all system generation is available
- Transformer additions at all major terminal stations (i.e. two or more transformers per voltage class) and looped systems are planned on the basis of being able to withstand the loss of the largest unit
- For single transformer stations there is a back-up plan in place which utilizes Hydro's and/or Newfoundland Power's mobile equipment to restore service
- For normal operations, the system is planned on the basis that all voltages be maintained between 95% and 105%
- For contingency or emergency situations voltages between 90% and 110% are considered acceptable
- For new terminal stations connected to the bulk system, Hydro's preferred bus arrangement is a breaker-and-one-half scheme. Where there are a limited number of elements, a ring bus arrangement is acceptable.

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<sup>1</sup> Hydro's bulk transmission system on the Island of Newfoundland is generally considered to be the 230 kV transmission system and the underlying 138 kV transmission loops between connection points on the 230 kV system.

## Summary of Newfoundland and Labrador Hydro's Transmission Planning Criteria

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### TRANSMISSION PLANNING CRITERIA POST HVdc CONNECTION

For analysis of the Island Interconnected Transmission System with the HVdc connection to Labrador included, the following criteria are used:

#### Steady State Analysis Criteria

- With a transmission element (line, transformer, synchronous condenser, shunt or series compensation device) is out of service, power flow in all other elements of the power system should be at or below normal rating
- Transformer additions at all major terminal stations (i.e. two or more transformers per voltage class) are planned on the basis of being able to withstand the loss of the largest unit
- For normal operations all voltages be maintained between 95% and 105%
- For contingency or emergency situations all voltages be maintained between 90% and 110%
- Analysis will be conducted with one high inertia synchronous condenser out of service at Soldiers Pond

#### Transient Analysis Criteria

- System response shall be stable and well damped following a disturbance
- System disturbances include:
  - Successful single pole reclosing on line to ground faults
  - Unsuccessful single pole reclosing on line to ground faults
  - Three phase faults except a three phase fault on, or near, the Bay d'Espoir 230 kV bus with tripping of a 230 kV transmission line
  - Loss of the largest generator on line on the Island System with and without fault
  - Line to ground or three phase fault with tripping of a synchronous condenser
  - Fault and tripping of a series compensated 230 kV transmission line with the series compensation device out of service on the in service parallel 230 kV transmission line
  - Temporary pole fault
  - Permanent pole fault
  - Temporary bipole fault
- Post fault recovery voltages on the ac system shall be as follows:
  - Transient under voltages following fault clearing should not drop below 70%
  - The duration of the voltage below 80% following fault clearing should not exceed 20 cycles
- Post fault system frequencies shall not drop below 59 Hz

## Summary of Newfoundland and Labrador Hydro's Transmission Planning Criteria

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- Under frequency load shedding
  - shall not occur for loss of on-island generation with the HVdc link in service
  - shall not occur for permanent loss of HVdc pole
  - shall not occur for a temporary bipole outage
  - shall be controlled for a permanent bipole outage
- There shall be no commutation failures of the HVdc link during post fault recovery.