Q. Black Start: Please provide all Hydro documents that establish or describe objectives and standards with respect to black start at the Holyrood Plant.

A. Please see the introduction to Operating Instruction T-022, attached as PR-PUB-NLH-001 Attachment 1, which generally describes the rationale for blackstart at the Holyrood Plant. Although this describes the rationale, Hydro is currently relying on the eight diesel units as opposed to the Holyrood gas turbine or Hardwoods.

See also Hydro's response to CA-NLH-017 in the *Approval of the Installation of Diesel Units at Holyrood for the Purpose of Black Starting the Generating Unit and for the Deferral of Lease Costs* proceeding, attached for ease of reference as PR-PUB-NLH-001 Attachment 2.

newfoundland labrador hydro
a nalcor energy company

SYSTEM OPERATING INSTRUCTION

STATION:	GENERAL	**Inst. No.**	T-022
TITLE:	RESTORATION OF THE AVALON PENINSULA WHEN ISOLATED FROM BAY D'ESPOIR**	**Page** 1	**of** 5

Introduction

The Avalon Peninsula may become separated from Bay d'Espoir and the remainder of the power system during ice, wind or other storm events. When this happens, Holyrood generation will likely trip due to an imbalance between area load and on-line generation. Customers will be without power until Hardwoods Gas Turbine and Holyrood fossil units are placed in-service and load reconnected.

The Hardwoods gas turbine, normally started first following a disruption, can operate into a dead bus system and be loaded in isochronous mode. It can be loaded at a rate of 4 MW per minute per turbine. With both turbines available Hardwoods can be loaded at 8 MW per minute.

Holyrood Units 1 or 2 can also operate into a dead bus system and be loaded in isochronous mode using its Mark V Electro Hydraulic Control System. However, the limitations on the unit's boiler must be respected. Once up to rated speed and connected to the transmission system load can be picked up in 10 MW blocks, allowing 5 minutes to ensure boiler drum level stability before accepting the next block of load. This must be done until the load on the unit reaches 60 MW. At this load level, boiler control is much more stable.

Restoring these units in isolation from Bay d'Espoir requires very close co-ordination between Newfoundland & Labrador Hydro's Energy Control Centre, Newfoundland Power's Control Centre and the Holyrood Thermal Plant.

In order to pick up larger blocks of load and restore customers to service quicker the units should be synchronized together and when possible, with Newfoundland Power's generation on the Southern Shore.

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Guidelines

Hardwoods Gas Turbine

- Start Hardwoods Gas Turbine and place it in isochronous mode. This unit should be synchronized with Newfoundland Power's Southern Shore generation and Holyrood generation where possible. The amount of load to be picked up by these units cannot exceed their response capability. Thus, Newfoundland Power must have load blocks ready to be restored when requested by Energy Control Centre to match the units' capability.

Parallel Operation with Holyrood

- Simultaneous with starting Hardwoods, the Holyrood Thermal Generating Station will be initiating a plant black start. The Holyrood units are black started using local diesel generation to start the Holyrood gas turbine which in turn supplies fans, pumps and other unit auxiliaries.

- Depending on the status of the Holyrood units at the time of the interruption, it may take several hours to bring a unit up to rated speed. Holyrood's Shift Supervisor will advise ECC as to which of Units 1 or 2 will be starting first.

- Once a Holyrood unit is up to rated speed and ready to be connected to the transmission network, Holyrood personnel will notify the Energy Control Centre. ECC personnel will co-ordinate activities on the power system to ensure that a route has been established to supply voltage to synchronize with Hardwoods and Southern Shore generation.

- If a Holyrood unit is synchronized, the incoming unit may be loaded at a rate of 2 MW per minute in load limit control until it reaches 60 MW. To raise the load from zero to 60 MW, Hardwoods will offload to Holyrood. Following the transfer of 2 MW of load to Holyrood, Hardwoods (in isochronous mode) will accept additional Newfoundland Power load. This will continue until the Holyrood unit reaches 60 MW. Once at that load level, Hardwoods should be placed in <u>droop</u> mode and Holyrood placed in <u>speed/load</u> control mode

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Parallel Operation with Holyrood (cont'd.)

- Once the incoming HRD Unit is synchronized, it should be placed in speed/load control mode with operating limits to permit stable boiler operation during unit loading. This will be done until the load on Unit 1 or 2 reaches 60 MW.

- Once the Holyrood unit reaches 60 MW and is in speed/load control and Hardwoods in droop mode, load can be restored more quickly as both units share new loads. The load can be increased by 4 MW/minute per turbine at Hardwoods and in accordance with the attached table for Holyrood. ECC will convey this to Newfoundland Power to prepare them for further load restoration.

- As blocks of load are picked up by the units, ECC will inform Holyrood personnel of the amount of load expected to be picked up. Holyrood personnel will observe the frequency and if necessary increase the load limit to assist in stabilizing the frequency. Holyrood personnel will notify ECC when additional load may be restored. ECC will in turn convey this to Newfoundland Power.

- This process will continue as other Holyrood units are placed in-service and all customers are restored.

Isochronous Operation of Holyrood Unit 1 or 2

- If a transmission route to Holyrood is not available and Holyrood Unit 1 or 2 is available, then one of the units will be operated in isochronous mode to supply isolated loads. Once Unit 1 or 2 is up to rated speed and ready to be connected to the transmission network Holyrood personnel will notify the Energy Control Centre. ECC will direct the closure of one of the unit's breakers to connect to the dead 230 kV transmission network with no load connected.

- At this point Newfoundland Power, at the direction of ECC personnel, will start closing feeders to restore customers. Holyrood Unit 1 or 2 can pick up 10 MW blocks with 5 minutes in between block restoration to allow the boiler drum time to stabilize and avoid the possibility of the unit tripping. Newfoundland Power will make ready 10 MW load blocks for this process. The customers supplied will depend on transmission routes available and the priority set by Newfoundland Power.

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Isochronous Operation of Holyrood Unit 1 or 2 (cont'd)

- This process will continue until the unit's load reaches 60 MW. At approximately 20 MW there will be a pause in unit loading due to changeover from full to partial arc steam admission. Holyrood personnel will contact ECC when the changeover is complete. Use the attached table for operation beyond the 60 MW load level.

Cold Load Pickup

Generally, the longer the outage duration for domestic customers the greater the load pickup. It is not unusual to have a cold load pickup that may be 2-4 times the normal distribution feeder peak. It is, therefore, very important that Newfoundland Power accurately indicate the amount of load that will be picked-up when feeders are energized so that underfrequency tripping does not occur. In fact if possible feeders without underfrequency tripping should be used.

Wind Generation

During the initial disturbance which isolates the Avalon Peninsula, the resulting frequency decay will, in all likelihood, cause the wind farms at Fermeuse and St. Lawrence to trip (the latter if the Burin peninsula system remains connected to the Avalon). During the restoration of the Avalon and the corresponding cold load pick-up issues, frequency control could be problematic. The Wind Farms should not be re-connected to the system until the Holyrood plant is in a stable mode of operation and the load is restored. When connected, the output of the wind farm(s) should be limited to the total pick-up capability of the Holyrood plant in the event that the wind generation is suddenly lost or rejected.

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HOLYROOD UNITS
MAXIMUM LOAD PICK-UP
ISOLATED AVALON SYSTEM

Unit Number	Unit Load MW	Load Increase MW	Load Limit MW
1, 2 or 3	0-60	2 MW/min	On load limit
1, 2 or 3 alone	60-100	10	15 MW above speed load
1 & 2	60-100	20	15 MW above speed load/unit
1, 2 & 3	60-100	30	15 MW above speed load/unit
1 or 2 alone	100-140	15	20 MW above speed load/unit
3	100-140	10	15 MW above speed load/unit
1 & 2	100-140	30	20 MW above speed load/unit
1, 2 & 3	100-140	50	Unit 1 & 2, 20 MW above speed load/unit Unit 3, 15 MW above speed load
1 or 2 alone	140-160	10	15 MW above speed load
Hardwoods GT		8	
Hardwoods +1 unit	60-100	20	Holyrood Unit 15 MW above speed load

** Part of the Emergency Response Plan

REVISION HISTORY

Version Number	Date	Description of Change
0	1996-11-27	Original Issue
2	2011-04-27	Changes to Holyrood and Wind Farm Considerations

PREPARED: Kevin Goulding	**APPROVED:**

CA-NLH-017
Holyrood Blackstart Diesel Units Application

Q. In the opinion of Hydro operating staff, can Hardwoods adequately meet black start requirements at Holyrood? Does the Hardwoods black start alternative meet NERC and NPCC standards with respect to black start? Please explain why or why not.

A. Hydro's staff is of the opinion that Hardwoods can meet the blackstart requirements at Holyrood. Blackstart of Holyrood is required so that the Holyrood plant can be used to begin restoration of service to customers in an isolated part of the system when the plant and that area have become isolated from the main system. For emergency planning purposes, this isolated area of the system was considered the broader Avalon Peninsula area and not an isolated area adjacent to the Holyrood plant. In order to supply customers in the Avalon area the Holyrood plant requires a transmission path to the customers. Therefore where the Hardwoods gas turbine plant and Hardwoods Terminal Station are located centrally on the Avalon Peninsula transmission near the load it can provide the initiating point for blackstarting this electrical island. Although an actual blackstart test was not performed, Hydro did simulate a blackstart using its Operator Training Simulator with successful results. Using the results of the simulations, an operating instruction was developed to help guide Hydro's operating staff in carrying out the blackstart procedure. This instruction is provided in NP-NLH-015 Attachment 1.

The available NERC/NPCC information with respect to the blackstart functionality is as follows:

- The North American Electric Reliability Corporation (NERC) defines Blackstart Resource as:

> *A generating unit(s) and its associated set of equipment which has the ability to be started without support from the System or is designed to remain energized without connection to the remainder of the System, with the ability to energize a bus, meeting the Transmission Operator's restoration plan needs for real and reactive power capability, frequency and voltage control, and that has been included in the Transmission Operator's restoration plan.*

NERC Emergency Preparedness and Operations (EOP) standard EOP-005-2 covers system restoration from blackstart resources. In essence, the standard requires that each Transmission Operator have a restoration plan. The plan must include the capabilities of the blackstart resources.

- The Northeastern Power Coordinating Council, Inc. (NPCC) defines Blackstart Capability as:

> *The ability of a generating unit or station to go from a shutdown condition to an operating condition and start delivering power without assistance from the electric system.*

NPCC Directory 8 "System Restoration" provides the basic criteria for entities to plan for and perform power system restoration following a major, or total, blackout. Section 5.1 of the directory provides the restoration plan requirements for NPCC members. Included in these requirements is the need to identify a basic minimum power system (i.e., one or more generators, lines and substations operating in the form of an island) which can be used to initiate the restoration process.

Upon review of the noted NERC and NPCC standards with respect to blackstart of Holyrood to restore the system, there was nothing identified that would prevent the use of the Hardwoods gas turbine (which can be started independent of the system) to energize the 66 and 230 kV buses at Hardwoods, the 230 kV transmission line TL242 to Holyrood and then the 230/66 kV and 66/4.16 kV transformation at Holyrood to start the Holyrood plant to restore service to the Avalon Peninsula.