

1 Q. Please provide Hydro's transmission system, terminal station, substation,
2 subtransmission system and distribution system design criteria. These criteria
3 should include system contingencies and line and equipment normal and allowed
4 emergency loading limitations. Indicate where Hydro's transmission and
5 distribution system is not consistent with these criteria (because the criteria may
6 have changed over the years).

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9 A. Hydro groups its high voltage assets into two broad categories – transmission and
10 distribution based upon nominal voltage rating as follows:

- 11 • Transmission lines are those lines with a nominal operating voltage of 66 kV
12 or greater. Within the province, transmission line voltages include 66 kV, 69
13 kV (Island only), 138 kV, 230 kV and 735 kV (Churchill Falls);
- 14 • Distribution lines are those lines with a nominal three phase operating
15 voltage of 46 kV and below. Within the province, distribution line nominal
16 three phase voltages include: 4.16 kV, 12.5 kV, 13.8 kV (Churchill Falls only),
17 25 kV and 46 kV (western Labrador only). It should be noted that 46 kV is
18 often considered a subtransmission system voltage and functions as such for
19 local distribution in western Labrador, but is covered under distribution
20 criteria;
- 21 • Terminal Stations are those electrical substations which contain a bus having
22 a nominal voltage level equal to or greater than 66 kV; and
- 23 • Distribution Substations are those electrical substations which contain
24 nominal bus voltage levels that do not exceed 46 kV (i.e., 25/12.5 kV).

1 Design criteria for transformers are summarized as follows:

- 2 • CAN/CSA C88-M90 “Power Transformers and Reactors” is used as the
3 reference for MVA ratings of transformers as per clause 7.1 Table 2
4 Preferred MVA Ratings of transformers;
- 5 • For design and planning of the system, the nameplate MVA rating of the
6 transformer is not exceeded. If the transformer is provided with a 0 °C
7 ambient temperature rating on its nameplate, then this rating is used to
8 assess transformer capacity during winter peak load conditions;
- 9 • Hydro’s Energy Control Centre maintains a transformer loading guideline for
10 emergency conditions with acceptable overload levels based upon ambient
11 temperature;
- 12 • Both terminal station and substation transformer capacity is selected such
13 that there is sufficient installed capacity to meet the forecast peak load;
- 14 • Spare transformer capacity considerations include:
 - 15 ○ For isolated diesel systems, the diesel plant step up transformer(s)
16 consists of single-phase units with a spare single-phase unit stored
17 on site for a transformer contingency. As well, for three-phase
18 customers connected to isolated diesel systems, Hydro installed step
19 down transformers in three single-phase transformers and maintains
20 a single phase spare in the community;
 - 21 ○ For single transformer distribution substations, such as 12.5/25 kV,
22 Hydro maintains a number of spare transformers including a multi-
23 ratio unit (i.e., 25-12.5/12.5-4.16 kV) for the larger substations (up to
24 6 MVA);
 - 25 ○ For the 46 kV substations in western Labrador, Hydro is completing a
26 voltage conversion of the town of Labrador City from 4.16 kV to 25
27 kV. The design includes installed spare 46/25 kV transformer

- 1 capacity. The anticipated outcome of the voltage conversion is that
2 there will be 46/12.5-4.16 kV transformer capacity surplus to the
3 Labrador City distribution system, that, pending condition
4 assessment, may be utilized to ensure spare 46/12.5 kV transformer
5 capacity in the town of Wabush distribution system;
- 6 ○ For single transformer terminal stations, such as 66/12.5 kV and
7 138/66 kV, there is a back-up plan in place which utilizes Hydro's
8 and/or Newfoundland Power's mobile equipment to restore service;
 - 9 ○ For major 230 kV terminal stations with two or more transformers
10 per voltage class (i.e., 230/66 kV or 230/138 kV) and for looped
11 systems (i.e., two terminal stations supplying a local geographical
12 area from two in-feed points) the capacity is selected such that the
13 station or loop is able to supply the forecast peak load with the
14 largest transformer out of service. Operation of standby generation
15 such as a diesel plant and/or combustion turbine is considered for
16 the transformer contingency. Exceptions include:
 - 17 ■ At present there is a single 230/66 kV transformer at
18 Buchans Terminal Station. For loss of this transformer there
19 would be customer outage as the Star Lake hydroelectric
20 generator (connected to the 66 kV bus at Buchans) cannot
21 run isolated from the system. Hydro's back up plan for an
22 extended outage to the Buchans transformer is to relocate
23 one of the Massey Drive 230/66 kV transformers to Buchans;
 - 24 ■ There is a single 230/66 kV transformer at Stephenville
25 Terminal Station. For loss of this transformer, customers in
26 the area are supplied through operation of the Stephenville
27 combustion turbine;

- 1 ▪ Ongoing capital work to increase the transformer capacity in
2 the Hardwoods – Oxen Pond Loop through the addition of
3 two 150/200/250 MVA units and relocation of one
4 75/100/125 MVA unit will result in two 230/66 kV, 40/53/66
5 MVA transformers being surplus to the loop. Pending
6 condition assessment of the two transformers, Hydro has the
7 opportunity to install these at the Buchans and Stephenville
8 Terminal Stations to provide a parallel configuration
9 consistent with the other 230 kV stations ;
- 10 ○ Hydro maintains a spare generator step up transformer at its
11 Holyrood Thermal Generating Station; and
- 12 ○ Hydro maintains a spare 13.8/230 kV, 60/80/100 MVA transformer
13 for the hydroelectric generators at Upper Salmon and Bay d’Espoir.

15 **Terminal Station Arrangements**

- 16 • Original 230 kV terminal station layouts within the Island Interconnected
17 System were simple load bus arrangements. Several 230 kV terminal station
18 bus arrangements have been modified to improve overall system reliability.
19 Hydro’s preference is for either ring bus or breaker-and-one-half
20 arrangements as appropriate for the number of elements:
- 21 ○ 230 kV ring buses:
- 22 ▪ Bottom Brook (to be converted to breaker-and-one-half with
23 addition of Maritime Link);
- 24 ▪ Buchans;
- 25 ▪ Bay d’Espoir;
- 26 ▪ Stony Brook;
- 27 ▪ Sunnyside (including 138 kV ring bus); and

- 1 ○ Stephenville combustion turbine;
- 2 ○ Hawke's Bay Diesel Plant;
- 3 ○ St. Anthony Diesel Plant;
- 4 ○ Hinds Lake (single unit radial 138 kV line to Howley);
- 5 ○ Granite Canal (single unit radial line to Upper Salmon); and
- 6 ○ Holyrood (two 230 kV breakers in breaker-and-one-half scheme).
- 7 ● 230/66 kV and 230/138 kV transformers are connected to 230 kV bus via
- 8 motor operated disconnect switches (i.e., no high side circuit breaker) and
- 9 multiple transformers share a common 230 kV bus. Exceptions include:
- 10 ○ Stephenville T3 can be isolated via a 230 kV circuit switcher; and
- 11 ○ Vale (230 kV circuit breakers for T1 and T2).
- 12 ● Motor operated disconnect switches are employed at 138 kV and 230 kV
- 13 voltage levels;
- 14 ● 66/69 kV circuit breakers connected to radial 66/69 kV transmission are
- 15 supplied with manual operated by-pass disconnect switches for circuit
- 16 breaker maintenance (exception is Doyles where Newfoundland Power has
- 17 standby generation at Grand Bay);
- 18 ● Tee-tapping of 66 kV using three manually operated disconnect switches for
- 19 intermediate stations is acceptable depending upon protection and control
- 20 philosophy;
- 21 ● Intermediate 138 kV terminal stations along 138 kV transmission lines
- 22 require line terminations using circuit breakers in looped systems.
- 23 Exceptions utilizing only 138 kV disconnect switches include:
- 24 ○ South Brook (138/25 kV transformer can be isolated with a high side
- 25 circuit switcher);
- 26 ○ Monkstown; and
- 27 ○ Bay L'Argent.

- 1 • For radial 138 kV transmission systems with intermediate 138 kV stations,
2 the source side line termination shall use a motor operated load break
3 switch as a minimum and the load side line termination shall use a circuit
4 breaker. Exceptions utilizing only disconnect switches:
 - 5 ○ Muskrat Falls Tap.
- 6 • For 138 kV radial transmission, 138 kV circuit breakers are supplied with
7 manual operated by-pass switches or circuit switcher for breaker
8 maintenance. Exceptions:
 - 9 ○ Berry Hill (alternate supply from underlying 66 kV);
 - 10 ○ Peters Barren (alternate supply from underlying 66 kV plus Hawke's
11 Bay and St. Anthony diesels); and
 - 12 ○ TL212 stations at Monkstown and Bay L'Argent (alternate supply
13 from TL219 and Newfoundland Power standby generation at
14 Greenhill).
- 15 • Historically, 138 kV buses are load bus arrangements. Exception:
 - 16 ○ Sunnyside 138 kV ring bus.
- 17 • Historically, 66 kV buses are load bus arrangements. Larger load centers
18 consider 66 kV bus tie circuit breakers to split station loads (exception
19 Massey Drive 66 kV bus tie disconnect switches).

21 **Distribution Substation Arrangements**

- 22 • Feeder reclosers, sectionalizers and voltage regulators are equipped with
23 by-pass switches;
- 24 • Distribution buses are arranged as load buses; and
- 25 • Consideration is given to splitting distribution buses with bus tie switches or
26 bus tie circuit breakers when there are multiple transformers (i.e., two or
27 more 46/12.5 kV units) and more than two distribution feeders (e.g., the

1 recent design of the new 46/25 kV substations in Labrador City includes two
2 46/25 kV transformers, a 46 kV bus tie disconnect switch between the two
3 transformers, two 46 kV line terminations using circuit breakers (one on
4 each side of the bus tie disconnect switch), a 25 kV bus tie circuit breaker
5 between the transformers and locating one half of the distribution feeders
6 connected to the substation 25 kV bus on each side of the 25 kV bus tie
7 circuit breaker).

9 Line Ratings

- 10 • Transmission and distribution line ratings are as per Hydro's response to
11 PUB-NLH-177;
- 12 • Hydro does not employ “emergency” load limitations to its transmission and
13 distribution line ratings;
- 14 • In planning its transmission system, transmission line loading shall not:
 - 15 ○ Exceed the rating under normal operation with all lines in service;
 - 16 and
 - 17 ○ Exceed the rating with any one transmission line out of service (N-1)
18 with consideration given that standby generation (i.e., combustion
19 turbine and/or diesel) may be operated within ten minutes to
20 alleviate an overload.
- 21 • In planning its distribution systems, the line loading should not exceed the
22 line rating.