Hydro Québec Distribution

Hydro-Québec's protection and architecture standard

Switching and Overcurrent Working Group

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Protection standard

- DESIGN PRINCIPLES AND CRITERIA
  - Safety
    - Protection systems are designed to minimize the risks associated with:
      - Explosion of network equipment
      - Abnormal network conditions
      - Exposure of personnel to faults.
    - The safety of workers having to make repairs on or near energized medium-voltage networks is primarily ensured through work methods
  - Power quality and reliability
    - Distribution network protection systems are based on principles aimed at reducing the number of customer interruptions as much as possible.
  - Costs avoided by protection systems
    - Protection systems must not only minimize replacement costs by maintaining the integrity of the network components but also operating costs while avoiding performing repairs as much as possible during temporary faults.

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Protection standard

- RULES
  - Fault elimination
    - The elimination of faults between the maximum value and minimum value of the calculated fault current must be ensured throughout the network by minimizing the energy being released.
    - Excluding High impedance fault
  - Redundancy of protection equipment
    - Excluding fuse
  - Evaluation and coverage of minimum fault current
    - 20 % safety factor
    - 40 ohms as fault impedance still used
  - Tripping thresholds
  - Automatic reclosing on the networks
    - Rules for mixed underground and overhead feeders
  - Location of protection equipment
    - Refer to architecture standard
  - Fault currents during line interconnections (phasing)
  - Alternate protection equipment mode

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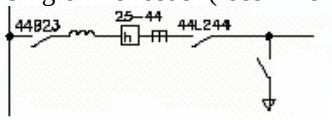
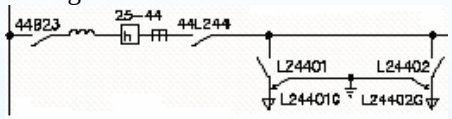
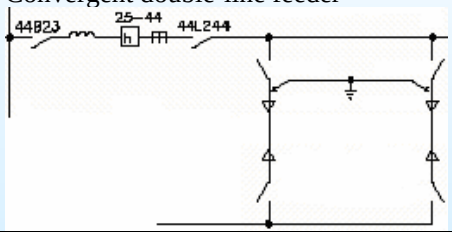
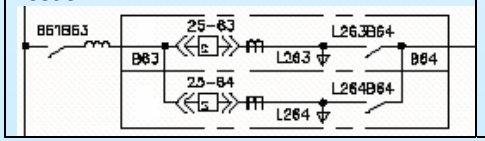
Architecture standard

- Capacity of line feeders
  - Different feeders configuration at the substation

Standard diagrams[1]	Rated capacity (A)	Overload capacity (3 h, 20°C)	Overload capacity (0°C)
Single-line feeder (recommended) 	600	700	770
Divergent double-line feeder 	800	930	1025
Convergent double-line feeder 	800	930	1025
Single-line feeders from a double-line feeder 	800[2]	930[2]	1025

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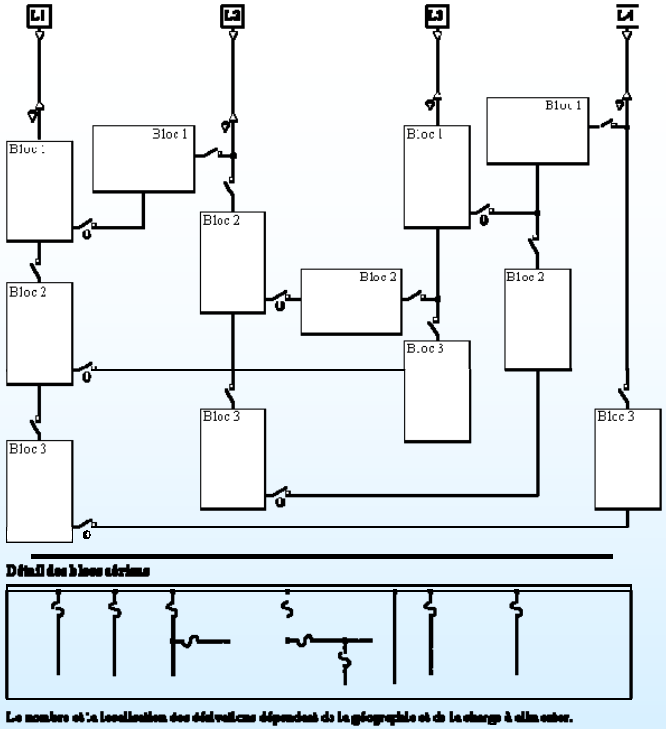
Architecture standard

- TYPES OF STANDARD ARCHITECTURES
  - MUTUAL BACKUP STRUCTURE
    - The cable backup structure is used in the case of underground line feeders The mutual backup structure typically consists of four active lines . Each line comprises three load blocks which are interconnected with the other three lines
  - CABLE BACKUP STRUCTURE
    - The cable backup structure is used for underground line feeders when the load density does not allow enough ties between the lines since a mutual backup structure cannot be justified from an economic standpoint. The cable backup structure is also used for any underground network section that feeds overhead lines, including highway crossings, special underground substations, etc.



MUTUAL BACKUP STRUCTURE

Architecture standard

- Load Blocks (Medium Voltage)
  - Criteria must be considered when delimiting the load blocks. These include:
    - Characteristics of the load;
    - Network type;
    - Physical constraints;
    - Interconnections between adjacent lines.
  - For an existing line the equipment already in place must be considered.
  - Delimitation of load blocks on an existing line
    - Three-phase reclosing circuit breaker
    - Load break switch
  - Subdivision of lines into load blocks
    - In general, a 25-kV line is made up of three 4 to 6-MVA load blocks (single feeders), while a 12-kV underground line consists of two 2 to 3-MVA load blocks.
    - Adding switchgear must be justified by the gain in avoided CHIs - less than $150/avoided CHI (or $2.5/ avoided CMI).

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- LOCATION OF STRATEGIC SWITCHING POINTS
  - The heads of the load blocks are strategic switching points. The following switchgear is currently available for these points:
    - Three-phase reclosing circuit breaker
    - Three-phase Sectionalizer
    - Load Break switch
  - The interconnections used for a load block backup are also strategic switching points.
    - The Load break switch is currently the only switchgear available for these points.
- Strategic switching points are usually the first feeders equipments to be remote controlled

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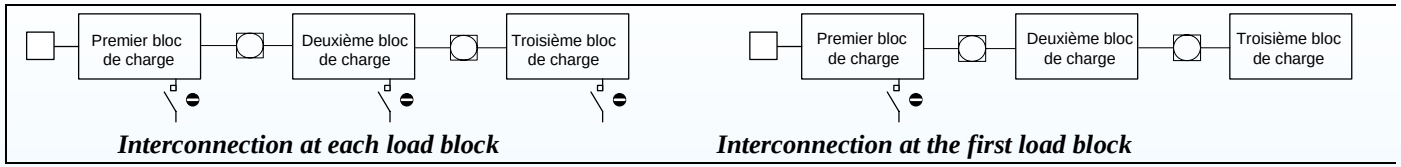
Architecture standard

Line categories

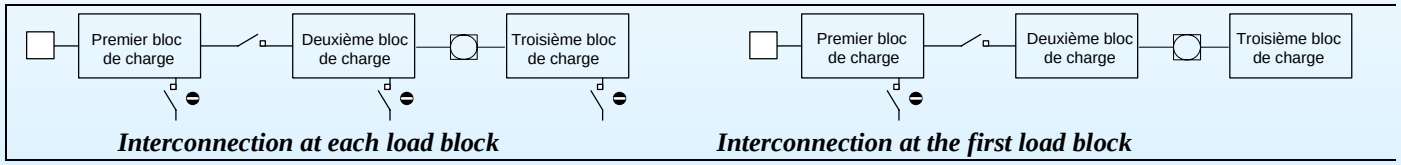
- Lines over 50 km long



Interconnection at each load block — *Interconnection at the first load block*

Note: The load blocks are shown in series, but they can also be found as a tap-off on the line.

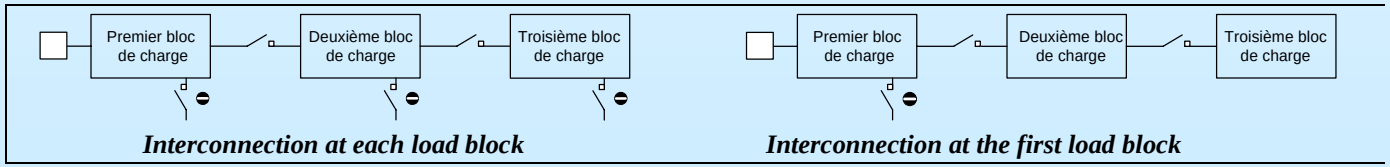
- Lines from 10 to 50 km long



Interconnection at each load block — *Interconnection at the first load block*

Note: The load blocks are shown in series, but they can also be found as a tap-off on the line.

- Lines less than 10 km long



Interconnection at each load block — *Interconnection at the first load block*

Note: The load blocks are shown in series, but they can also be found as a tap-off on the line.

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Architecture standard

Number of protection devices per type of line

Type of lines	Number of devices required
Overhead lines more than 50 km in length	Lines with three load blocks and more must have at least two protection devices on the network. Lines with two load blocks must have at least one protection device on the network.
Overhead lines 10 to 50 km in length	Lines with two load blocks and more must have at least one protection device on the network.
Overhead lines less than 10 km in length	No protection device required.
Underground lines	No protection device required.

Architecture standard

- CONVERTING AN EXISTING NETWORK INTO A MUTUAL BACKUP STRUCTURE
  - Describing the process to move to the Hydro-Québec's standard architecture
    - Economical consideration
    - Technical consideration
    - Special conversions
      - Double radial network
      - Specialized backup network

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Remote Control Program
Overhead System

More than 1000 remote control points installed up to now (3750 targeted for 2013).

Improved appearance control cabinet

Standard control cabinet

Standard design

Conclusion

- Hydro-Québec's is sharing its protection and architecture standards to
  - Help IEEE SOWG writing its *"Application Guide for Placement of Overhead and Underground Switching and Overcurrent Protection Equipment"*
  - Help improve Hydro-Québec's future versions

Note: Hydro-Québec's documents need English revision

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Orientations du réseau

Direction Gestion de l'actif

VP - Réseau de distribution