Control and protection

Creating a control and protection relay for medium voltage distribution feeders

Mohamed Y. Haj-Maharsi, Deia Bayoumi, Thomas G. Sosinski, Doug Voda

To be able to provide a level of safety and productivity that goes beyond the ordinary, a company may often require installations whose specifications go beyond those that are available “off the shelf”. This was the challenge that faced Hydro-Québec in procuring medium voltage feeder-protection units – a challenge that was met through close cooperation between the company and ABB.

As a leader in the fields of power system and apparatus protection, Hydro-Québec is continuing to develop protection applications that place strong emphasis on the safety of its employees. To increase the protection and reliability of its medium voltage feeders, Hydro-Québec has developed specifications for the upgrade of its feeder protection relays using the latest generation of microprocessor controlled protection relays. Compared to standard protection products, this solution permits multiple benefits to be reaped in terms of protection, serviceability and performance. The key lies in a solution using a single enclosure with redundant power supplies and combining primary and back-up protection elements.

Advantages include improvements in product performance, the reliability of electronic device operation, and installed relay life, while reducing retrofit, training, and maintenance costs. Emphasis on application and product design by Hydro-Québec significantly eases the replacement of legacy equipment with new generation protection systems.

It was ABB’s record of providing solutions that integrate multifunction capa-

bilities within a single unit and with versatile communication capabilities and innovative solutions for protection functionality – Engineered for Safety™ – that convinced Hydro-Québec to select ABB as a prime supplier for its medium voltage feeder protection, control, and automation solution.

Hydro-Québec's specifications combined advanced application and analysis requirements with high reliability demands and the need for an easy-to-use interface. Fulfilling this was only possible through significant cooperation and communication between the personnel of the two companies in all phases of product planning, development, material selection, and product validation and manufacturing certification. These interactions broke new ground in development techniques, material selection and the testing process of the final product. The result reflects world-class product function and performance.

Protection beyond the ordinary

Hydro-Québec, the world's largest producer of hydroelectric power, serves Québec, Canada, and areas of the north-eastern United States. Hydro-Québec's distribution division is responsible for maintaining the reliability of distribution network apparatus and the continuous delivery of electric power to its customers.

To strengthen its feeder protection system, Hydro-Québec issued a call for tender in April 2005 to build a protection unit featuring primary and redundant protection systems enclosed in a single case. The relay was needed for retrofitting existing equipment. Design emphasis was on advanced protection, control, system reliability and reduced maintenance. The new relay provides automatic transfer from main to redundant protection as well as a failsafe mechanism for apparatus protection in critical fault situations.

In July 2005, ABB was selected to build the new protection relay. A series of meetings between ABB and Hydro-Québec laid the framework of a valuable collaborative process and led to the creation of a protection relay tailored to Hydro-Québec's needs.

The product name selected by Hydro-Québec was CEPA, "Control Et Protection des Artères" (French for control and protection of distribution feeders).

Hydro-Québec, the world's largest producer of hydroelectric power, serves Québec, Canada, and areas of the north-eastern United States.

The protection unit

CEPA is an advanced microprocessor-based feeder protection system incorporating the latest innovations in protection, control and automation features. Due to its redundant protection functionality, it is the ideal solution for providing highly reliable protection and control of distribution and sub-transmission line applications.

CEPA offers a complete package of protection functionality, including the features listed in Factbox 1. This protection allows the relay to be used in most distribution and sub-transmission applications.

All protection schemes provide parallel fault detection and are autonomous in terms of power supply, measurement and processing of analog signals, A/D converters, binary inputs and outputs, in accordance with specifications and descriptions defined in the standardized technical specifications of Hydro-Québec.

CEPA's user interface encompasses signal lamps, control push buttons, an operator control interface (OCI) on the front featuring dual displays and keypads, dual front panel EIA232 ports for communication with a PC connected locally to the relay, a rear panel EIA232 port and an Ethernet port for network communications Factbox 2.

User interface

Relay settings, metering, events, and control are accessible through the OCI and an external PC-based program, WinECP.

Operator Control Interface (OCI)

The OCI design is temperature compensated, permitting the display to be viewed clearly throughout the entire operating temperature range (–40 ° to +85 °C). The OCI continually displays magnitudes for current and voltage quantities. The OCI displays the number of fast trips allowed, the reclose counter, and the total number of reclosures allowed.

Windows External Communications Program (WinECP)

WinECP provides users with an easy method of communicating with the relay.

A user friendly menudriven application permits users to:

- Show or change settings
- Save settings to a file

CEPA unit

Factbox 1 CEPA protection functionality

CEPA protection functionality features include:
- Phase and ground instantaneous and time overcurrent protection
- Multi-shot reclosing
- Breaker failure check

Factbox 2 CEPA features at a glance

CEPA provides these major features:
- Advanced 32-bit microprocessor technology plus Digital Signal Processor (DSP)
- Enhanced Operator Control Interface (OCI) with dual LCD display, one for primary and one for backup protection
- Isolated Communication ports for superior remote communications
- Front and rear communication ports for simultaneous local and remote access
- Multiple Communication Protocols:
  - DNP 3.0 Level 2+ (Standard)
  - Modbus, Modbus TCP/IP
  - IRIG-B time synchronization; Battery backed-up clock keeps time even during power-down

Standard features include:
- Digital Fault Records (DFR)
- Complete multifunction protection
  - phase/ground overcurrent
  - under/over voltage
  - breaker failure
- Complete metering and control
- WinECP user interface software

- Display various records stored in the CEPA relay (summary fault report and sequence of events)
- Monitor metering values, physical I/O and status points
- Save digital fault record and time sequence data
- Control of the breakers and I/O signals

The new relay provides automatic transfer from main to redundant protection as well as a failsafe mechanism for apparatus protection in critical fault situations.

WinECP can be used off-line to explore the capabilities and functionality of the relay. During off-line operation, the settings and configurations displayed are the factory default values. The relay settings can be edited, saved to a file, and retrieved for downloading to a CEPA unit at later time.

Digital fault recorder

The CEPA relay includes a digital fault recorder to analyze faults and disturbances. Settings of triggering sources and selectable cycles of recorded pre-trigger data are stored in the unit. The data collected is held in nonvolatile memory and can be downloaded to a PC. A separate program is used to display the records for post mortem analysis and system planning.

Working with the customer

In developing the CEPA relay, ABB had to ensure customer requirements were completely fulfilled. Some of Hydro-Québec's requirements constituted standard protection features, whereas others were customized for specific environmental and performance needs. ABB and Hydro-Québec were in constant dialog throughout the specification development, product creation, component selection, system verification and production phases.

While electrical safety standards specified the minimum requirements for application performance, Hydro-Québec had functional expectations that exceeded general standard recommendations. To meet these requirements, ABB defined and tested its product for conditions and stresses beyond typical utility application requirements.
ABB will use the knowledge gained through this process to improve its standard products while continuing to provide engineering applications and expertise to Hydro-Québec for existing and future apparatus and protection products.

Mohamed Y. Haj-Maharsi
ABB Inc USA, Corporate Research
Raleigh, NC, USA
mohamed.maharsi@us.abb.com

Deia Bayoumi
ABB Inc USA, Medium Voltage Products
Allentown, PA, USA
deia.bayoumi@us.abb.com

Thomas G. Sosinski
ABB Inc USA, Medium Voltage Products
Allentown, PA, USA
thomas.g.sosinski@us.abb.com

Doug Voda
ABB Inc USA, Medium Voltage Products
Lake Mary, FL, USA
doug.voda@us.abb.com