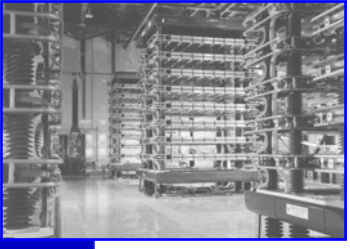


Real time digital simulation for the power industry

RTDS NEWS

Summer 2008

J-POWER's upgraded RTDS Simulator (left) and closed loop test of HVDC controls (right)

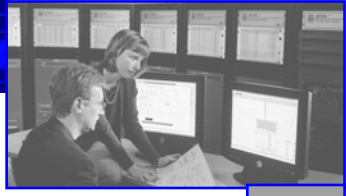
J-POWER (formerly known as the Electric Power Development Co., Ltd. or EPDC) is a wholesale utility company in Japan and is a leading user of the RTDS Simulator in Asia. A recent project using the simulator involved testing the control system for the Hokkaido-Honshu HVDC Link. The link, which is operated by J-POWER, is a bi-polar, +/-250kV, 600MW, DC system with a submarine cable linking Japan's two major islands.

It has been nearly 30 years since the Hokkaido-Honshu HVDC Link was first commissioned so the refurbishment of Pole #1 was undertaken. As part of the refurbishment, the analogue controller was replaced with a state-of-the-art digital system. But before the controls were commissioned, J-POWER tested them using the RTDS Simulator.

J-POWER installed the RTDS Simulator in 1995 as a twelve-rack, TPC-based system and has since carried out an enormous number of power system simulations. The simulator was however getting older and the simulation capability was somewhat restricted. When RTDS Technologies brought out the GPC card, J-POWER decided to upgrade the simulator. The upgrading of the simulator to a 3PC/GPC-based system started from 2003. J-POWER took full advantage of RTDS Technologies' reasonably priced "exchange program" whereby old TPC cards are exchanged for brand new 3PC or GPC cards. Other new cards such as WIF's and IRC's were also received through the exchange program.

Although the number of racks was decreased after the upgrade from twelve to ten, the simulator's total functionality was expanded with respect to simulation capability and versatility of modeling. Through the calculation power of the GPC's, new models, such as small timestep voltage sourced converters (VSC's), were added. With such a powerful simulator, J-POWER formulated the plan to test the new control and protection system for Pole #1 of the Hokkaido-Honshu link. The refurbishment work was awarded to the two major Japanese manufacturers who built the original link, Hitachi and Toshiba. Hitachi was responsible for the control and protection system on the Hokkaido side (Japan's Northern Island) and Toshiba was responsible for the Honshu side (Japan's Main Island). Therefore, it was very important to test if the new control systems operated properly together before their installation on site. The tests avoided wasting time and money on discussions and parameter adjustments that otherwise would have been made across the Japanese strait. Prior to the equipment installation at the converter stations, J-POWER assembled the new control & protection system for both terminals at its R&D center located in the Chigasaki Research Institute. In Chigasaki, the new telecommunication scheme was also set up and connected with the control & protection system to establish test conditions which were as close as possible to the real HVDC system in terms of signal flow and transmission time delays.

RTDS Technologies



Real time digital simulation for the power industry

The RTDS Simulator represented the main circuit including the AC systems, HVDC overhead lines, cables, valves, and other DC equipment. The tests at Chigasaki were run from April until the middle of June 2007 and more than 500 test cases were carried out to verify the HVDC control and protection functions. The tests included system start-up, stop, power flow reversal, steady state current and voltage control, margin angle control, etc. Various kinds of faults were simulated to confirm proper protective action of the HVDC system. In addition to the basic AC and DC overhead line and cable faults, rare cases, such as valve faults, inverter terminal load shedding, line disconnection, fault during start-up, etc., were also tested. Thanks to the easy operation of the RTDS Simulator, fault points were changed very quickly to any location in the system. The new "Listen Mode" feature of RSCAD, which allows an operator to observe and interact with a simulation running in real time on a different PC terminal, was used to monitor system reaction to the disturbances applied during the tests. This feature was found to be very useful. These intensive tests greatly helped to verify the control and protection functions and contributed to improve system reliability. In fact, several control and protection operations were improved before sending the equipment to the stations.

The great success of the closed loop tests conducted on the RTDS Simulator at Chigasaki encouraged J-POWER to proceed with further application of the simulator for the Hokkaido-Honshu HVDC Link refurbishment project. Comprehensive system tests for the new Master Controller (MC), which coordinates between Pole #1 and Pole #2, and the Automatic Frequency Controller (AFC), which controls the frequencies of connected AC networks, were planned for December 2007. These tests were conducted on site using a Portable RTDS Simulator.

Since J-POWER's new ten rack RTDS Simulator is comprised of nine racks installed in fixed cubicles, plus one rack in a portable cubicle, the latter was sent to the Hokkaido side converter station, where the MC control is located. Here the portable unit simulated the AC and DC systems and was connected to the actual MC and AFC controls. The main purpose of the tests was to verify the actual system performance with respect to several different network conditions. In addition to steady state operation, tests were also conducted for sudden frequency changes due to contingencies in the AC network that activate the emergency AFC action. Since it is almost impossible to safely cause this level of system disturbance for testing on the real system, closed loop RTDS Simulator tests were necessary to verify the new AFC control.

The tests were carried out under various conditions and the system performance was improved before the re-commissioning. During the work, J-POWER also developed a more precise simulator model of the Hokkaido-Honshu HVDC Link. The RTDS Simulator helped not only in studying the HVDC operations before re-commissioning of Pole #1, but also in carrying out many simulations relating to commercial operation of the link.

The tests conducted by J-POWER were very successful and Pole #1 was re-commissioned at the end of April 2008.

GTNET – Applications Expanded

IEC 61850 - Use of the GTNET has really taken off. It has been purchased by many customers, but in particular by leading protective relay manufacturers for closed loop testing with IEC 61850. The GSE firmware is used to simulate the station bus (bidirectional GOOSE/GSSE messages for trip, reclose, breaker status, etc) while the SV firmware simulates the process bus for IEC 61850-9-2 sampled values of voltage and current. RTDS Technologies is currently undertaking several enhancements relating to the GTNET's IEC 61850 capabilities and configuration software.

DNP SCADA Interface - Due to customer demand, the DNP firmware option was created to allow the GTNET to act as a DNP slave using the DNP 3.0 protocol. DNP is a SCADA protocol commonly used for network control and monitoring.

The GTNET-DNP can communicate with one DNP master and accommodate the following maximum communication capacity:

- 1024 binary status points (i.e. breaker position) at 1000 Hz scan rate
- 512 binary control points (i.e. breaker commands) at 1000 Hz scan rate
- 500 analogue status points (i.e. output from simulator) at 4 Hz scan rate
- 100 analogue control points (i.e. input to simulator) at 4 Hz scan rate

UPCOMING EVENTS

IEEE/PES General Meeting
Hospitality Suite July 20-24, 2008 in Pittsburgh, USA

Cigré – General Session
Exhibition August 25-29, 2008 in Paris, France

Cigré Canada
Exhibition October 19-21, 2008 in Winnipeg, Canada

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