CASE STUDY

Abitibi-Consolidated—Iroquois Falls, Ontario, Canada

Paper Mill Pioneers Power Protection Using Optical Fiber Skywire Supported by Digital Relay Protection

Abitibi-Consolidated is working toward the complete automation of its electric power system at its Iroquois Falls, Ontario mill. The system includes SEL protective relays and communications processors as part of a sophisticated upgraded power scheme designed to improve uptime, efficiency, and safety.

Iroquois Falls, ON—Competing in one of industry's most asset-intensive sectors, paper manufacturers must not only achieve efficient productivity but also maintain consistent throughput from their mega-million dollar mills in order to meet market demand.

When a blackout hits a paper mill, the results can be disastrous: paper jams, fire, machinery damage, costly downtime, and sometimes miles of errant paper. One brief power failure can cost tens of thousands of dollars in production delays and repairs.

Abitibi-Consolidated's Iroquois Falls, Ontario mill required an upgrade to more reliable protection for one of its power generation stations, which feeds power directly to the paper mill via two 12 kV transmission lines—without power transformation.

Abitibi-Consolidated is a global leader in newsprint and uncoated groundwood papers, with ownership interests in 27 paper mills in Canada, the U.S., the U.K., and Asia. The Iroquois Falls mill annually produces approximately 246,000 metric tons of newsprint and 46,000 metric tons of "specialty papers," including colored newsprint, construction paper, and nonprinting grades. Don Elliott (P.Eng.), Senior Power System Engineer, chose to install a protective relay from Schweitzer Engineering Laboratories, Inc. (SEL), the SEL-311L Line Current Differential System, using their installed fiber-optic cable from plant to generating station.

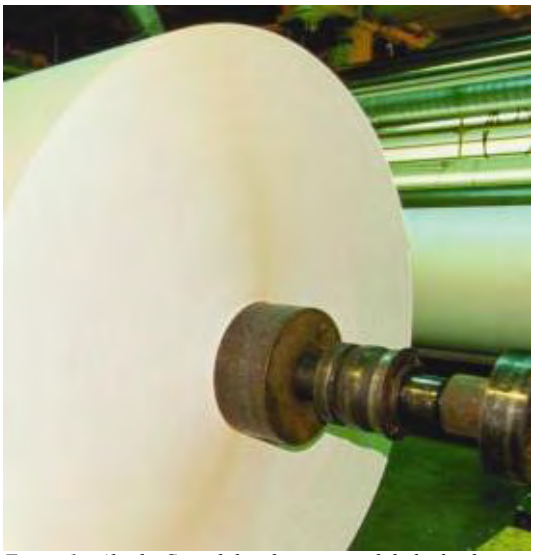

Figure 1—Abitibi-Consolidated is a global leader in newsprint and uncoated groundwood papers. The Iroquois Falls mill produces approximately 246,000 metric tons of newsprint and 46,000 metric tons of specialty papers annually.

"We had a unique situation," explains Elliott. "We had power going from our two transmission lines (five generators) at one end… to the 12 kV bus and our process loads at the other end. Because there were no transformers involved, the mill process was exposed to whatever problems nature gave us, such as transients and faults that occurred on our transmission lines. So, transient survival is paramount."

"Our paper machine rolls along at 1,200 meters per minute through a long winding process," says Elliott. "The slightest little bump or change in some component along the way can cause the paper-making process to be disrupted. There are electrical control systems involving voltage- and frequency-sensitive components that will drop out or stop working if the nominal 60 Hz signal isn't present. Also, there are a lot of motor contactors in our process system, and if they de-energize due to a transient, they'll stay dropped out until there is intervention to bring them back online. So, we really need to clear faults quickly. If we don't, we may have a mild ground fault that may not seem like a big deal, but within 2 or 3 seconds it becomes a 12 kV phase-to-phase fault not far from our bus, which is likely to cause a lot of equipment damage."

In the past, a transmission line fault would cause a trip, and the generation and the paper machines would shut down. "This was a troublesome situation," Elliott says, "because transients endangered all mill processes, including dozens of pumps synchronized with massive rotating equipment."

The power system at the Iroquois Falls mill was vulnerable because its "resistance grounded" 12 kV transmission lines lacked sufficient protection. "If we had a ground fault on a transmission line, the older protection was not sensitive enough to detect the fault. The fault would then remain as an undetected ground fault, and ultimately propagate into a nasty phase-to-phase fault. Generally, then it would knock out the paper machines, which are synchronized with dozens of pumps operating with substantial inertia. If there was an insulation failure with any equipment, the resulting damage could be extensive, and it could include production losses as well as substantial repair costs."

A Fiber-Based Solution

The Iroquois Falls mill replaced its 12 kV copper transmission lines with a double-circuit ACSR (Aluminum Conductor, Steel Reinforced) cable. "When the line was constructed, we included optical ground wire [OPGW] containing 12 single-mode fibers into the circuit," Elliott explains. This enabled the use of fiber communications for protection. Protection of the lines and cables was provided by Schweitzer's SEL-311L Line Current Differential System.

"The SEL-311L was a good choice for line protection and automation," says Elliott. "This relay allows us to use our fiber-optic capabilities to implement efficient line current differential protection. We have to sense ground faults and clear them instantly. Because we've already had a few faults since we have installed the protection, we've noticed that negative-sequence current is developed as expected, but it's nice to review and see the actual results. The negative-sequence differential element does that for us. Using the built-in sequential event report system, we can see if a significant negative-sequence current exists during these previously uncleared ground faults, before they propagate into phase-to-phase faults. They will be detected as a ground fault by the negative-sequence differential element or the other elements and will be cleared very rapidly." The negative-sequence sensing elements in the SEL-311L protection introduce an improved level of fault sensing and high-speed tripping capability not available a few years ago.

Figure 2—The negative-sequence sensing elements in the SEL-311L introduce a new level of fault sensing and high-speed tripping. Standard features include programmable four-shot breaker auto-reclose with synchronism and voltage check logic for optimal system restoration.

With easy-to-apply SEL-311L Relays, users can protect lines and cables by applying three-pole subcycle current differential protection or optional single-pole differential elements for high-speed fault clearing and improved system stability. This relay offers

complete main and backup transmission line protection using line current differential and a combination of four stepped-distance zones of phase and ground-distance elements in communications-assisted schemes with directional overcurrent element backup protection. Users can reduce their protection system costs by using the built-in distance and/or overcurrent backup functions.

"We're also using the SEL-311L as a backup, similar to when we would use an SEL-321 Phase and Ground Distance Relay," Elliott says. "The impedance relaying is enabled, and I'm using four bits that are available as part of the SEL-311L differential scheme as a type of POTT (permissive overreach transfer trip) scheme. So, in the event that the differential scheme doesn't work or a fiber has failed, we've still got good impedance protection, as well as reliable ground and phase protection."

SEL-311L standard features include programmable four-shot breaker auto-reclose with synchronism and voltage check logic for optimal system restoration. "We enabled the synchro-check function so that we could use the relay to supervise an operator-controlled closing of the line breakers at the generating station," explains Elliott. "Right now there's standard dc interlocking that prevents line breaker closing unless several conditions are met. But there are times when we want to overrule that logic (such as when we are black-starting or closing a loop). So, in parallel with the dc logic, we now have a contact out of the SEL-311L that does synchro-check and also live bus, dead-line supervising. That enables the operator to go up to the SEL-311L display, and if it says 'Line breaker close okay,' it means the relay has determined conditions are okay to close the breaker, either via SCADA or the breaker local controls."

Elliott says the relay's voltage check logic function is especially helpful in situations when the mill is separated from the grid. "We have a complicated system with large loads tied to our internal generators. If we get separated from the supplier transmission grid and are completely blacked out, we have the ability to black-start from our generating station. We will energize our transmission system and start building up our internal network from that point. The SEL-311L is the component that will basically supervise the closing of the line breaker and energize the line from the generating station."

Figure 3—The Iroquios Falls mill protection system utilizes GPS-synchronized time and the Ethernet LAN to communicate records, data, and Sequential Events Recorder files from the SEL relays. This exact information is used for reconstruction and analysis of events.

The Iroquois Falls mill also has an SEL-2030 Communications Processor installed, using Ethernet to interrogate the system for records and data from the SEL relays' Sequential Events Recorder (SER), directly from Mr. Elliott's office, rather than having to visit the remote equipment. The relays connect to the SEL-2030, and the SEL-2030 communicates to the Ethernet system LAN. "We also have an "Arbiter 1093B" satellite clock input to the SEL-2030 so that all relay records and all the relay time bases are time-stamped to one millisecond accuracy. When we have an event, we'll reconstruct it and analyze exact

information from all sources, all correctly time-stamped to the same standard GPS-synchronized time." Elliott says.

The current protection scheme at Abitibi-Consolidated's Iroquois Falls mill includes 2 SEL-2PG10 Phase Distance Ground Overcurrent Relays, 5 SEL-321 Phase and Ground Distance Relays, 1 SEL-311C Distance Relay, 4 SEL-311L Line Current Differential Systems, 12 SEL-300G Generator Protection Relays for added primary and backup generator protection, 5 SEL-351A Distribution Protection Systems, 2 SEL-501 Dual Universal Overcurrent Relays, and 2 SEL-547 Distributed Generation Interconnection Relays used for islanding detection. The SEL-2030 can accept IED information on any of its 16 ports, so the relays can be easily accessible to Abitibi's engineering staff for analysis of events and feature enhancement.

Standardized on SEL Protection

Elliott's team has standardized on SEL products for protecting their power system. One of the primary reasons for this is Schweitzer's high level of service. "I have a long and stable relationship with Schweitzer," Elliott says. "They have great product coverage and a very high level of service, including field technical support that has been very valuable to me. During our upgrade project, I was able to get very fast and reliable answers to some technical questions I had about configuration choices. Within half an hour I had an email from an SEL field application engineer who explained precisely what choice made the best sense. And that's simply how good SEL support is. I know we can count on SEL for that level of support every time."

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About Abitibi-Consolidated

Abitibi-Consolidated is a global leader in newsprint and uncoated groundwood papers with ownership interests in 27 paper mills in Canada, the U.S., the U.K., and Asia, plus interest in 22 sawmills, 3 remanufacturing facilities, and 10 recycling centers. Abitibi-Consolidated annually markets approximately 6 million tons of newsprint, and nearly 2 million tons of value-added papers to nearly 100 countries. For more information, contact Don Elliott, Abitibi-Consolidated Inc., 1 Park Street, Iroquois Falls, Ontario, Canada P0K 1E0; phone: (705) 258-3931 x4063; email: don_elliott@abitibi consolidated.com; or visit www.abitibi consolidated.com.

About SEL

Schweitzer Engineering Laboratories, Inc. (SEL) has been making electric power safer, more reliable, and more economical since 1984. This ISO 9001:2000-certified company serves the electric power industry worldwide through the design, manufacture, supply, and support of products and services for power system protection, control, and monitoring. For more information, contact SEL, 2350 NE Hopkins Court, Pullman, WA 99163-5603; phone: (509) 332-1890; fax: (509) 332-7990; email: info@ selinc.com; website: www.selinc.com.

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