



# Profibus – A successful oil sands application

**Don G.J. Dutton and James Powell, P.Eng.**

As maintainers we want to focus on reliability centered maintenance and zero unscheduled shutdowns. None of us want the 3:00 AM callouts. Although a proven technology, Profibus is a new fieldbus protocol to the Canadian oil sands industry. When SNC-Lavalin recently ran an oil sands technology demonstration project in Alberta, Canada to evaluate an alternate oil sands bitumen extraction process, it tested Profibus PA and DP field instrumentation and electricians as part of the project. In this case, the plant owners, technology licensors of the extraction process, and the engineering team had no prior hands on experience with PROFIBUS and were eager to know the capabilities of Profibus. Profibus PA and DP proved to be reliable and robust. Profibus met the monitoring and control requirements of this project with success.

This demonstration project was fast tracked, approximately a year in the design and construction stage and operated for approximately 4 months, thoroughly evaluating an alternate Oil Sands Bitumen extraction process. Process equipment and unit operations were heavily instrumented and in some key monitoring and control locations, alternate technologies were used to provide comparable results. This was by design, in some cases to accommodate for process swings (for example low velocities), in other cases because the measurement was that important.

## **Field instrumentation and electricians**

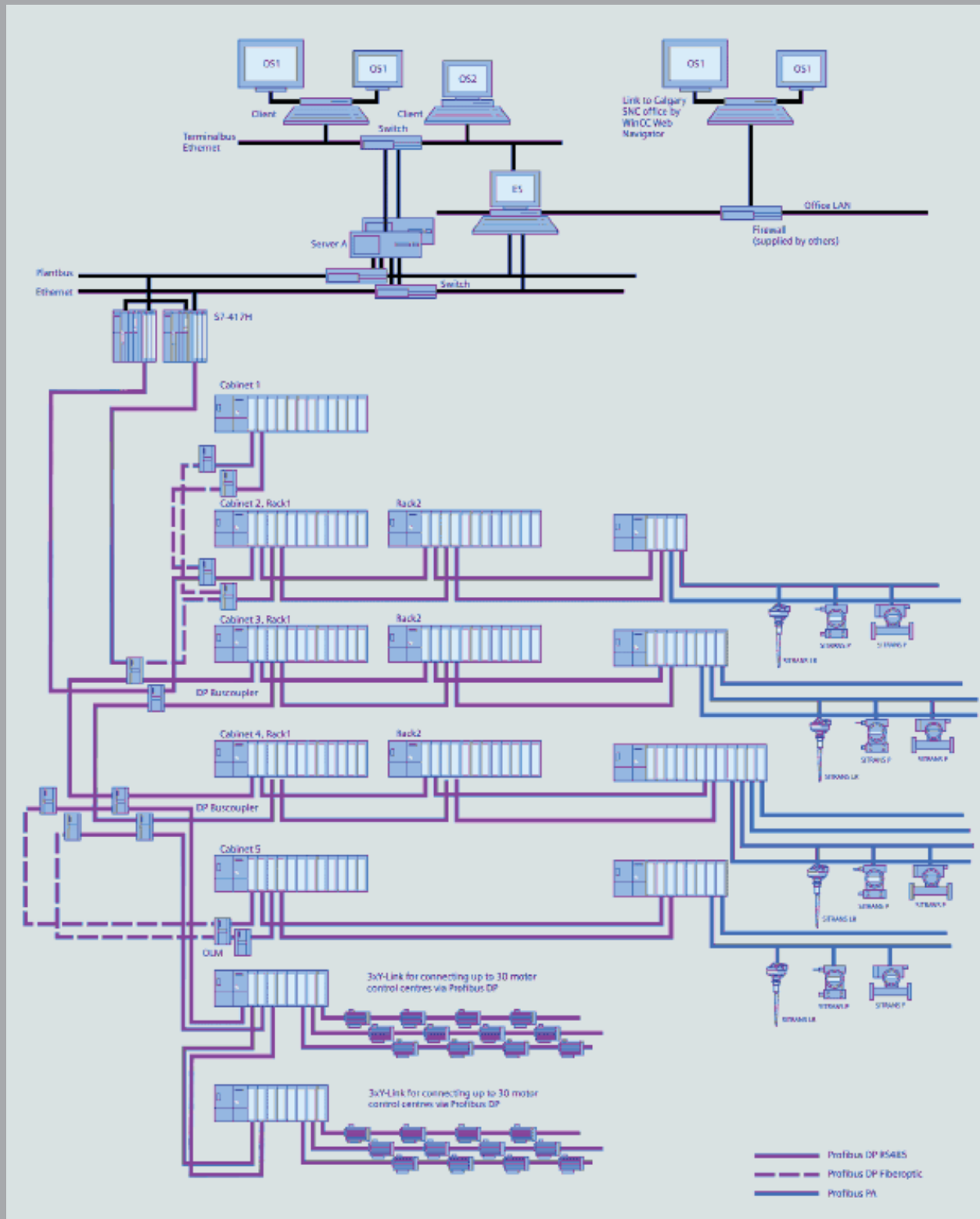
The Profibus PA and DP instrumentation and electricians operated in a process environment with twisted pair and fiber optic cables, a maximum use of Variable Frequency Drives (VFD) with a mix of both networked skid packages, and limited analog and discrete field

devices. The majority of the field instrumentation used on the project included both Profibus PA and Profibus DP primary sensing elements and final control elements. Siemens Simocode on Profibus DP network provided all motor control and, wherever possible, VFDs controlled all pumps and rotary equipment. We equipped two control valves with Profibus PA positioners, both of which could well have been VFD applications. However, we wanted to set-up and calibrate at least two final control elements (control valves) that featured Profibus positioners. We used a number of gland seal water control valves for slurry pump applications that used conventional 4-20 mA analog control.

We had approximately 200 I/O hard tags and multiple soft tags on the demonstration project, and identified 40 tags as critical, supporting data necessary for a proper evaluation of the process at design tonnages.

## industrial communication

# Trends in Instrumentation



## Control system

We installed a Siemens PCS7 Distributed Control System (DCS) featuring redundant processors (servers) (see figure 1), multiple screen operators console, an engineering console and data archiving software and hardware in a centralized control room. We placed the actual controllers and I/O modules within five field mounted control cabinets; three indoors and two outdoors. The outdoor cabinets featured pre-fabricated multimode fiber optic cables with ST type termination connectors to match those on the Siemens Optical Link Modules (OLM). Configuration of the fiber optic network was virtually transparent. The five remote I/O cabinets formed the Profibus DP network backbone (communications layer) providing standard high-speed operation at an H2 level.

## Field instrumentation – PA and DP fieldbus trunklines/segments

We connected Profibus DP/PA modules housed within the five field mounted controller I/O enclosures to PA and DP fieldbus segments connected in a line-bus topology. The majority of field instrumentation was Profibus PA, which uses a bus powered, 2-wire twisted pair segment technology with an “end of line” feature on each segment. The field level Profibus PA segments operated at the H1 levels of 31.25 kbits per second, and our segment distances were well within the Profibus maximum distance of 1,900 meters per PA segment.

In addition we connected several intelligent field instruments to Profibus DP segments. These externally powered Profibus DP instruments coupled with DP segments operated at much higher communication speeds

than the PA segments. The DP segments were well under the Profibus maximum distance of 1200 meters per DP segment.

Figures 2 and 3 show some examples of our Profibus PA segments. We used various segment loadings to check out the effect on the control loop response time. All the loops, even those segments more heavily loaded, provided fast monitoring and control loop response times that were well under project objective of 300 ms.

## Motor control

The project consisted of 48 motors ranging from 250 HP down to 2 HP. The Motor Control Center (MCC) line up was 480 VAC - 60 Hz 3-phase, featuring intelligent motor starters. All motor control ran via Profibus DP and wherever possible, VFDs controlled all pumps and rotary equipment. The complete electrical switchgear and MCC line-up featured Siemens equipment and electronics. The VFDs were located on MCC panel fronts.

A redundant, line topology, twisted pair cable, AWG 20 connected the MCC and DCS Control System. This cable, running at 500 Kbps, facilitated all permissive logic and start-stop. The 500 Kbps provided fast responsive control that was trouble-free once set up, and faster rates proved unnecessary.

We experienced few difficulties with configuration and set up of the VFDs and the Profibus DP bus using available diagnostics. It went very smooth considering it included 48 motors, with some reversing, and most VFD controlled, on a single pair twisted, stranded, shielded 20 AWG cable.

## Diagnostics

Diagnostics available at both the control system level and at the field instrument level proved to be detailed and helpful. When something

# Trends in Instrumentation

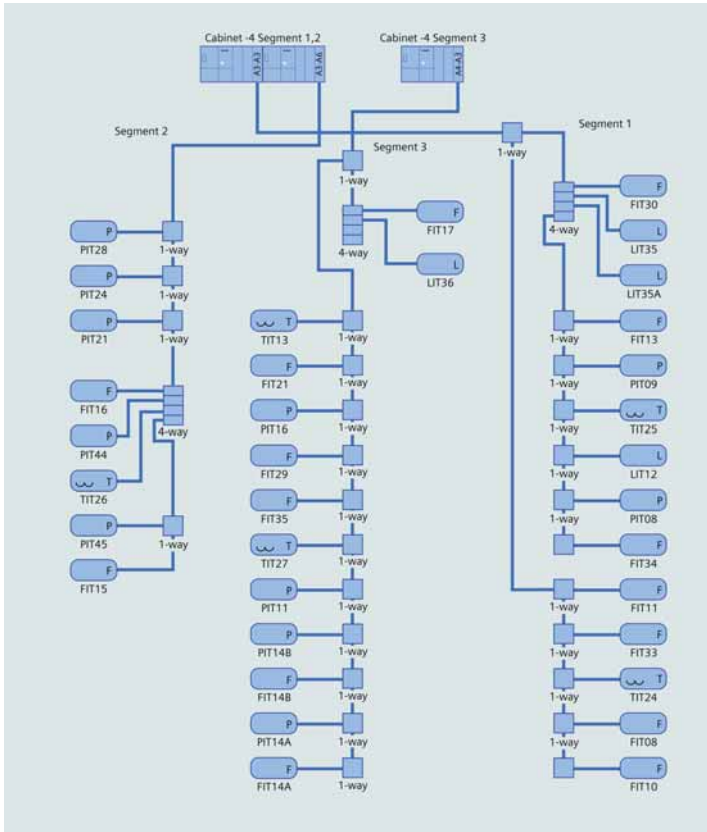


Fig. 2 – Profibus Segment Loading Diagram

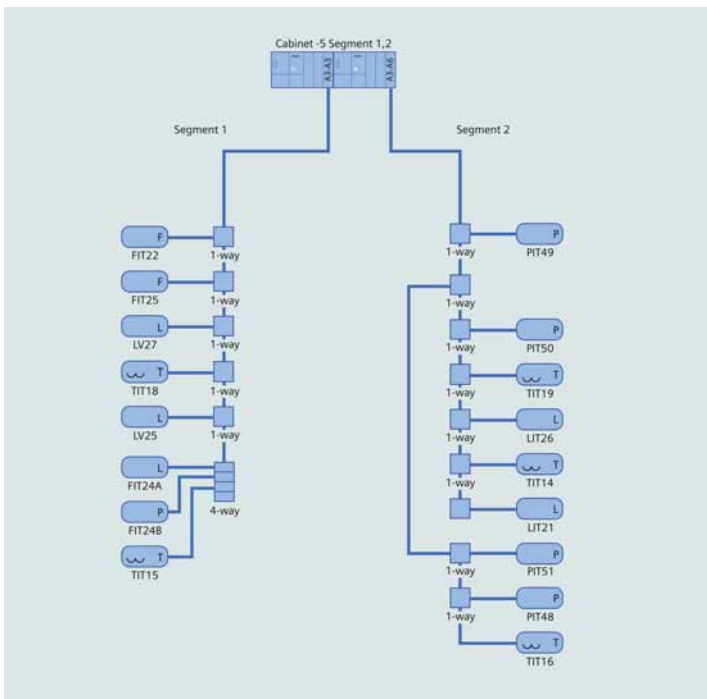


Fig. 3 – Profibus Segment Loading Diagram

went wrong on the bus, a drive, or in an instrument, we knew about it instantly, and were able to troubleshoot it quickly. Profibus PA and DP “data packet size” of 244 bytes per frame enabled detailed analysis of the Process Variable and associated diagnostics. When we needed a more detailed look into what was happening within a segment or a particular field instrument, we simply double clicked on the device, and it launched the configuration software Simatic Process Device Manager. This proved to be a great feature when we added or changed out field instruments on a Profibus segment, as we were able to configure quickly a device over the network – great benefit when it is approaching -30 °C outside.

## GSD files and connecting PA and DP devices

For all Profibus DP devices, you get the device plus a General System Data (GSD) file (a text file). This GSD file contains general information about the device; what it is (Identification Number), its supported baud rates, a summary of functions supported within the protocol, and all cyclic data (data that is exchanged every bus scan with the master). It is extremely important to have the correct GSD file for the instrument as the master uses this file to configure the slave on the bus. Most instrumentation vendors handle this matching device to GSD file very well; in a few cases vendors did not supply the appropriate GSD file and we ran into error messages when we configured the instrument.

With all Profibus PA devices (and some DP devices), you receive the device, the GSD file, and an Electronic Device Descriptor (EDD) file. This EDD file describes all the

configuration information in the device and how to communicate this information to the device. As with GSD files, it is important to make sure that you have the correct EDD for the device. In our case, we had no problems with all our Profibus PA devices.

### Lessons learned

**Design phase:** Derek Bok, an American educator and lawyer and former president of Harvard University, once said, "If you think education is expensive, try ignorance." Nowhere is this more true than in a fieldbus installation. Knowledge is key. At the beginning of this article, we mentioned that our engineering staff had never participated in the detailed engineering associated with a Profibus installation. We were fortunate we had technical support for Profibus readily available, both locally and at the demonstration plant.

**Commissioning phase:** the commissioning phase was short and both the project schedule and Mother Nature imposed challenging deadlines. The Northern Alberta winter was fast approaching, and we knew we could not extend the deadlines without facing long delays due to the winter.

**A short term operating window does not preclude good wiring practices:** We allowed wiring practices that reflected a short term operating phase, and which resulted in a few untimely upsets. Redundant networks do help; however a demonstration or pilot plant facility has to be properly instrumented, and this includes all control system equipment cable and wiring. We had

allowed some of our segment cable to be lashed to support structures and other cables, and we were fortunate not to have had more problems when maintenance was performed on mechanical process equipment.

**We failed to maintain recommended cable separation between the Profibus DP communication cable and voltage cable:** this occurred on the DP segment between the MCC I/O and the DCS controller located in the control room. When we powered up, at close to H2 baud rates, we experienced communication problems. After a few spurious trips of our redundant communication system during commissioning and with reference to network diagnostics, we reduced the DP baud rate down to 500 kbps resulting in trouble-free communications.

**Match GSD file, EDD file and device:** Note that the devices are more than the physical units. There is also a GSD file and in some cases an EDD file, and you will avoid problems if you match these files with the used devices ahead of time.

**Use pre-fabricated cables:** the use of prefabricated fiber-optic cables, complete with connectors that match the control systems vendors mating connectors, and having them constructed and tested at the manufacturing facility made installation simple and fast. We would not have had the same success if we had to perform thermal or mechanical splicing in the field. The installation part came down to simply connecting up the fiber and turning it on.

**Setting up the Profibus PA positioners:** this involved the field calibration of two control valves

equipped with Profibus positioners and was found to be no more difficult than a conventional 4-20mA ADC or Foundation Fieldbus positioner.

### Conclusion

Profibus works – plain and simple. It is a robust and reliable process fieldbus. The design phase on our project went well. On site commissioning and start-up went relatively smoothly moving quickly into the Demonstration Plant operational phase. In the following respects Profibus showed a particular strong performance:

- On heavy loaded segments Profibus PA met the 300 milliseconds update times
- Drives and instruments were on the same bus, with one protocol
- Full diagnostics on all devices that allowed us to track down problems easily

As we move into new oil sands projects, we can now consider Profibus alongside best-in-class industrial fieldbuses and networks, control systems and field instrumentation.

Don G.J. Dutton is Instrumentation and Control Systems Specialist at SNC-Lavalin Inc.  
James Powell, P.Eng. is Product Manager Communications Systems at Siemens Milltronics Process Instruments Inc.

© 2008 Siemens Milltronics Process Instruments Inc.

[www.siemens.com/processautomation](http://www.siemens.com/processautomation)

# Trends in Instrumentation