Cold Cuts In Deep Water

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Category:
Maintenance and Field Test

Products Used:
NI Developer Suite Professional Control Edition V6.0.2
NI DAQ V6.9.1
PCI-6052E multi-function I/O board

The Challenge: To combine conventional SCADA with high-speed data acquisition and in-line signal processing in a single application interface to control a high-pressure underwater cold cutting system.

The Solution: Use LabVIEW with the LabVIEW DSC Module. The LabVIEW DSC Module is ideally suited to demanding applications that combine conventional supervisory control of PLCs with non-standard I/O, mixed data types, and complex data analysis.

Abstract
This paper describes a Cold Cutting system that uses ultra-high pressure abrasive water jets for sub sea cutting and demolition work down to depths of 500 m. The application combines conventional SCADA supervision of a PLC, with high speed DAQ, high-bandwidth transmission of data over a TCP/IP network, and "near real-time" digital signal processing. In its first commercial trial the system was used to successfully remove abandoned well heads in 80 metres of water in Australia's North West Shelf gas fields.

Introduction
As community sensitivity to maintaining marine environments has increased, there is pressure to return undersea oil and gas production fields to their "pre-production" state once the field is abandoned. The traditional method of severing undersea wellheads involves the use of explosives – a potentially dangerous and obviously environmentally unfriendly technology. Conventional hot cutting techniques are difficult to apply, because the wellhead overhang severely limits external access to the well lining. Cold cutting techniques that use high-pressure abrasive fluids can operate in confined spaces, and in principle could be used to sever the well head from inside the well lining. However conventional cold cutting systems typically operate at pressures of less than 690 bar (10,000 psi), and can not be used for deep-water work.

This paper describes a new high pressure Subsea Cold Cutting System (SCC), developed by Western Australian company Jetcut Offshore Technology, that is capable of developing fluid pressures in excess of 2000 bar and can be used for underwater cutting and demolition work down to depths of 500 m. The monitoring and control system for the SCC was developed by ICON Technologies using LabVIEW and other tools from the NI Developer Suite Professional Control Edition.

Overview of the SCC Operation
The complete SCC comprises:

- A diesel-driven ultra-high pressure pump;
- Two 10,000 l water storage tanks, with reverse osmosis desalinator;
- A storage and handling system for the abrasive slurry;

- A control room/workshop, with generator and air compressor;
- A launching frame, tool carrier, and a suite of tools for inserting and manipulating the slurry stream within the well lining.

The SCC is operated by a three-man crew, and is designed to be readily transportable on a typical small (60 to 70 m) workboat.

Figure 1 shows the major components of the SCC on the workboat. In operation the tool tip is inserted into the well lining below the seabed level, and fed from the surface with high-pressure abrasive slurry. All manipulation of the tool and monitoring of the cut is carried out remotely from the surface vessel. Figure 2 shows a wellhead after removal.

Fig. 1 – The SCC in operation (SCC components in green).

Fig. 2 – A wellhead after removal

The tool tip and slurry pressure are both optimised for the depth and profile of each cut. Operating at higher pressures than are required for an optimum cut greatly increases the cost, complexity, and bulk of the supporting equipment. Well liners are typically a sandwich of concentric steel and concrete layers, with steel crossbars between the layers. The concrete may contain undocumented and heterogeneously distributed "rubble", including significant inclusions of metal scrap. In order to monitor and optimise the progress of the cut through this heterogeneous mix of materials, accelerometers were placed on the tool jig to record variations in the acoustic signature as the cut proceeded.

Not Just a Traditional Control Problem!

Conventional SCADA software does not easily handle the mix of conventional real-time control and waveform acquisition and processing that this application requires. The monitoring and control system had to provide real-time control of all the diesel engine and high-pressure pump hardware, while simultaneously acquiring and processing acoustic signatures at sample rates up to 44 kSamples/s. In addition, all critical operating data, including the acoustic waveforms, had to be archived for off-line analysis and auditing. Finally, for a number of reasons beyond ICON Technologies control, the time available for developing the system was extremely short – around three weeks from concept to offshore deployment.

The real-time control of the diesel engine and high-pressure pump hardware is non-trivial, but is comfortably handled by a conventional PLC – in this case an Allen-Bradley SLC505. Acoustic signatures were acquired using a National Instruments PCI-6025E multi-function I/O card.

The control and monitoring system for the SCC was developed using LabVIEW and the LabVIEW DSC Module, and is shown schematically in Figure 3. The operator interface is shown in Figure 4. All communications with the SLC505 were handled directly by the LabVIEW DSC Engine, via the standard Allen-Bradley SLC500 Series device driver. Around 120 operating parameters were continuously monitored, with over 30 core parameters logged to the Citadel database for archival storage.

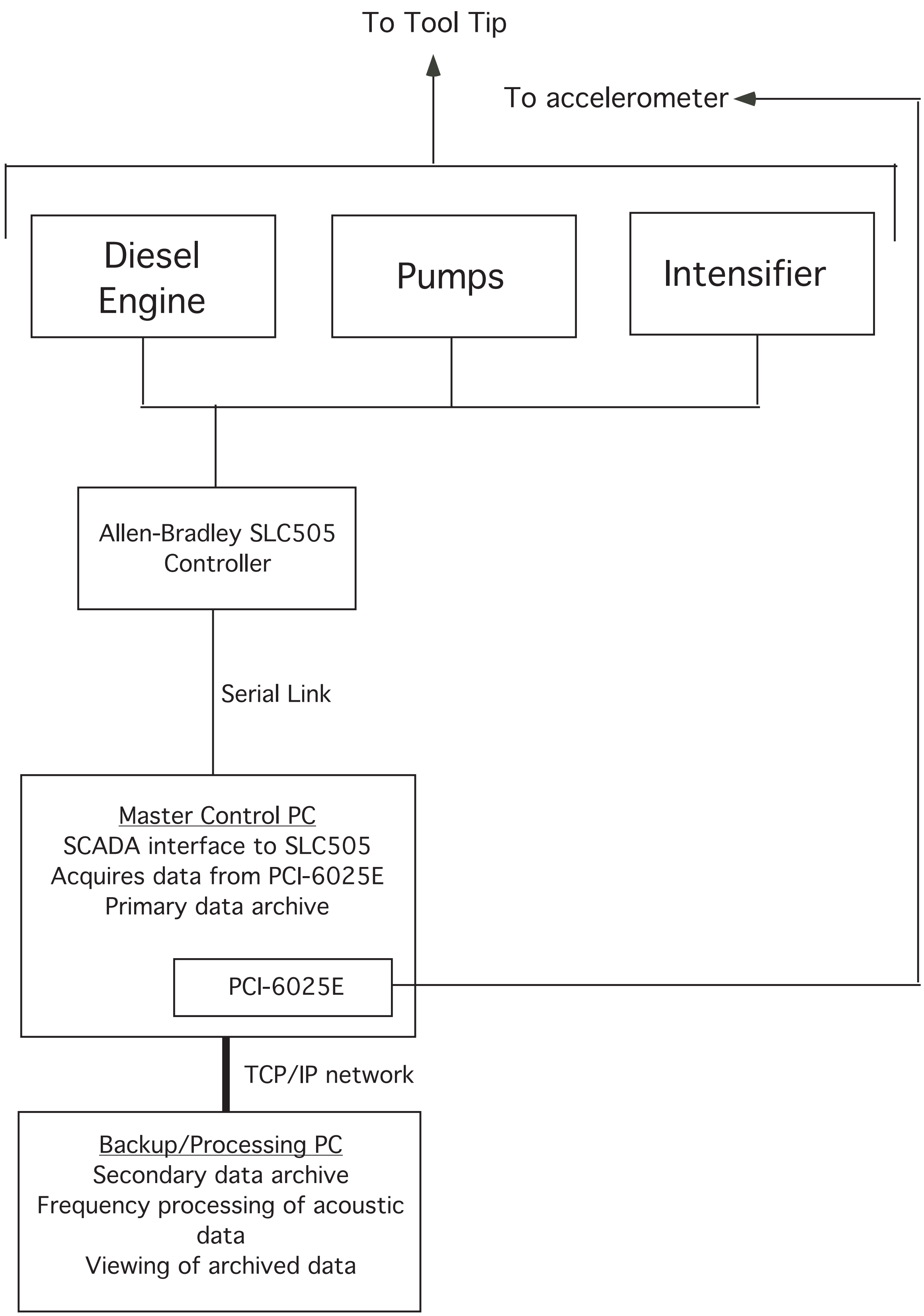

Fig. 3 – A schematic of the SCC showing major hardware units and software function modules.

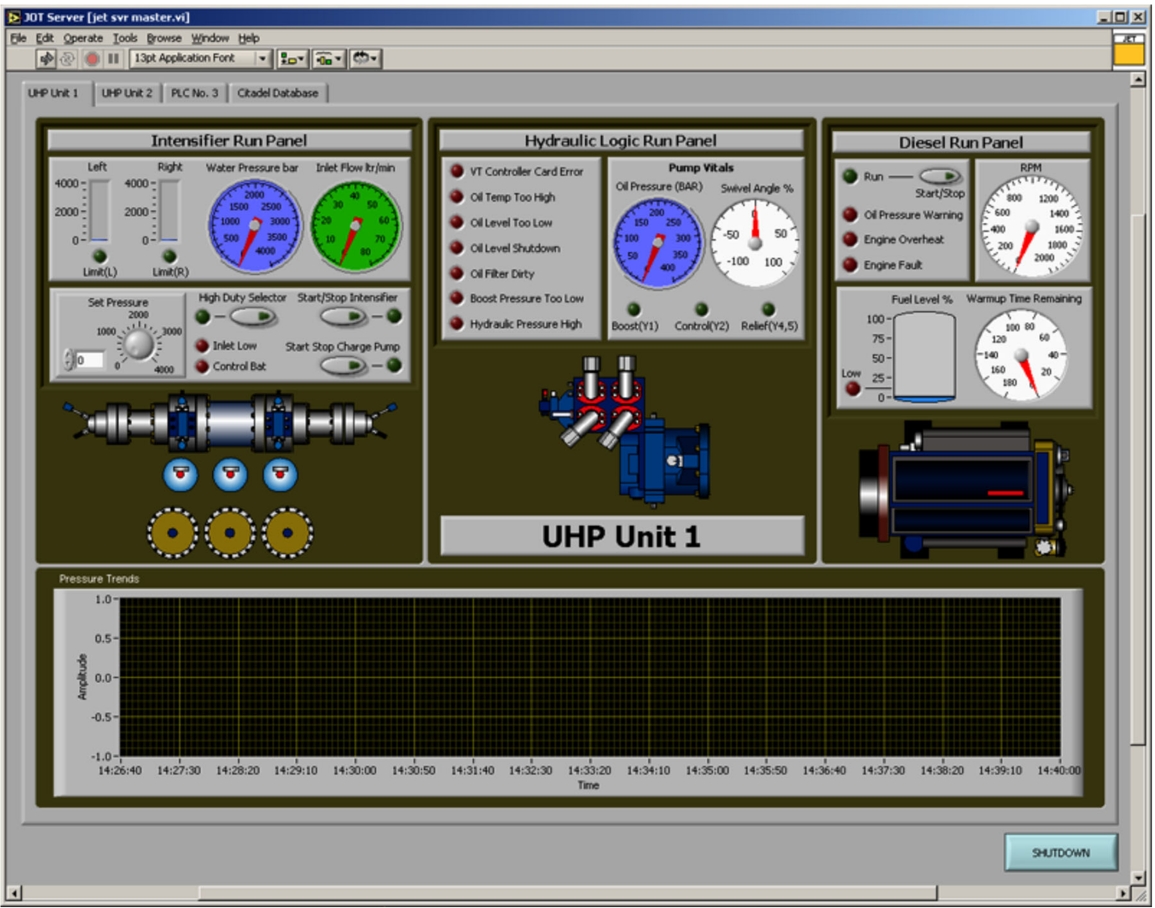

Fig. 4 – A screen image of the SCC operator interface.

Acoustic data were acquired at sample rates up to 44 kSamples/s, and streamed directly to the local disk for archival storage along with all other core parameters. The raw acoustic data was also re-transmitted via TCP/IP to a supplementary network PC for backup archiving and frequency processing. The processed signals provided a "near real time" view of the progress of the cut.

Results

In its first commercial trial the SCC was used by Woodside Energy Ltd to successfully remove wellheads in 80 m of seawater. Woodside concluded that "Jetcut's (new) technology works, and they will be happy to use it in future severance programmes".

The use of LabVIEW and the LabVIEW DSC Module were important factors in the successful and timely deployment of the SCC. Together they offer an application development environment that is unique in its ability to seamlessly blend a conventional configurable SCADA environment with the power and flexibility of a full-function programming language. They are a natural fit with any application that pushes the bounds of conventional SCADA in terms of I/O complexity or bandwidth, programming power, and network or inter-application connectivity.