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FIELDBUS – A BRAVE NEW WORLD

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Revised from an article dated 28/3/00, an edited version appeared in PACE magazine

This paper represents a users perspective on the installation, commissioning and use of Fieldbus technology within a full scale extraction plant.

The plant was built on the GSK Port Fairy Site late in 1988, making it one of the earliest hazardous area plants using Foundation Fieldbus technology anywhere in the world. In addition another fieldbus technology, hazardous area Asi bus, was also used and will be discussed.

Aspects of fieldbus instrumentation to be discussed:

- **Design & Installation considerations**
- **Commissioning experiences**
- **Ongoing maintenance issues**
- **Vendor support**
- **Interoperability of different vendor instrumentation**
- **A look at costing**

Useful tips for the use of fieldbus technology will be given which hopefully should prove useful when considering fieldbus for your next project.

Keywords : Foundation Fieldbus, ASi

1. Introduction

For most of us the chance to explore new technologies in our daily lives is second nature, but when it comes to adopting those technologies in our working lives our conservative nature forces us to examine the practicalities. After all, will it work? The answer to this question has the potential to seriously affect the profitability of your company.

Fieldbus systems are now becoming more popular due to the many tangible benefits that these systems can provide you and your business.

In this article we will be examining some of the things you should be considering when specifying bus systems for your next project. It is based on the experiences gained with our own fieldbus installation and should provide some insight into the practicalities, the difficulties and advantages we have found with our 'real world' application.

2.The Plant

Our new Extraction plant located in Port Fairy, Victoria, is believed to be one of the first hazardous area Intrinsically Safe (I.S. Ex ia) fieldbus installations anywhere in the world using 'Foundation Fieldbus' technology. The plant also utilizes other new bus technologies including hazardous area ASI bus modules for the discrete I/O, again an Australian first.

The Distributed Control System (DCS) used for the plant was a Yokogawa CS-1000 system. Although the plant has nearly 350 hazardous area I/O there is only one standard Rittal control cabinet needed.

In late 2000, the DCS was upgraded to a Yokogawa CS-3000 system, which allowed us greater I/O and processor capacity. Additional software revisions also gave us greater accessibility to Foundation Fieldbus instrument configuration and the ability to interrogate instruments online.

Figures 1 & 2: Yokogawa DCS & ASi master gateways & power supplies, 4 FF I/O cards

3. Foundation Fieldbus Instruments

The plant consists of over 42 IS Foundation Fieldbus instruments. These include a large variety of instruments including:

- Pressure / DP transmitters
- Massflowmeters
- Magflowmeters
- Temperature
- pH
- Control Valves

Interoperability was also proven as instruments from different vendors were also utilised. Vendors included Fisher Rosemount, Valtek, Fisher Controls and Endress & Hauser instrumentation.

Figures 3 & 4: Mass & mag flowmeters (Fisher Rosemount) used in conjunction with Valtek / Somas Control valves.

The instruments were divided into segments of 3 instruments per IS FF barrier. A number of these barriers were then daisy chained to each FF DCS I/O card. All field wiring was directed to a strategically located junction box close to groups of instruments. Individual bus cables were then run to each junction box from the control cabinet located in the safe area MCC area. All instruments were wired in parallel to these cabinets, which contained multiple fieldbus segments.

Multiple variables were used in the control scheme utilising individual instruments. For example, flow, density and temperature readings were used from the one mass flow meter. Also as the FF temperature transmitters supplied could also connect to two field RTD elements, multiple variables were also transmitted over the fieldbus.



Figures 5,6,7: Barriers located in safe area (MTL 4053), Field cabinets, parallel field wiring with IS FF terminators (MTL)

4. Discrete I/O: Asi Bus

Actuated valves (1DO, 2DI), level switches etc were brought into the control system via field mounted hazardous area rated Asi slaves. Asi bus is a bus system specially designed for capturing large amounts of digital I/O and is arranged in a master, slave arrangement.

The slaves are an Ex ia barrier which is encapsulated within an IP68 housing. The housing also contains an Ex e compartment to take the control voltage from the Asi master. These are shown below in figure 8 and were supplied by Pepperl & Fuchs.

Approximately 65 Asi slaves were used in our installation. These were daisy chained together using SWA cable which provides the standard Asi power (30VDC) and control signal. Inputs and outputs were via standard IS cabling. Two different slaves were used providing 2 digital inputs & 2 digital outputs, or 4 digital inputs.

Individual bus cables were brought into the control system via Asi master / gateways (see figure 1, green instrumentation). These masters mapped the Asi signal and via MODBUS serially communicated to the DCS system.

Commissioning of the system proved fairly easy as each module was assigned individual addresses via a hand held programmer. Status of the solenoids and limit switches were via the individual LED indicators on the front of the modules. The LED's also have the ability to change colour depending on fault checking diagnostics built into each slave i.e. short circuit or broken lead detection.

Asi slaves (safe area DIN rail mounted, IP20) were also used direct in the MCC cubicles where motor status and starting was also brought back into the DCS system.

Figures 8 & 9: Asi slaves daisy chained together, individual module showing Asi Ex e wiring (right) and IS wiring (left) and individual LED indication.

5. Costing of our fieldbus approach

Although a detail review of the costing was not performed after the completion of the job, it can be stated with a fair degree of confidence that there was no cost difference between the fieldbus option over traditional.

As the plant is fairly compact there were no extremely long runs of cable and hence there was no significant cost savings in this area (although smaller sized cable ladder was all that was needed). However as space was a premium having only one control cabinet was a big bonus in the rather cramped MCC area and the lack of penetrations (which needed to be vapour sealed) from this safe area to the hazardous area did provide savings.

At the time, fieldbus instruments were approximately 5-10% more expensive than traditional instruments, however present pricing from some vendors now have fieldbus instruments either at similar pricing or lower. We also saved some costs by utilising multiple variables from the one instrument.

Generally the field wiring for the Asi system was significantly more than the traditional approach but when looking from a total system point of view the cost savings in the DCS balanced the increased cost of the wiring.

We felt one of the biggest areas of savings was in the commissioning of the system. This was especially so with the Asi fieldbus. The ability to re-range and view diagnostics from the FF fieldbus was a big plus however interfacing proved to be not as smooth as instrument suppliers make it out. Although the problems encountered did not prove to be the rate limiting step during the commissioning there were many sleepless nights, a price paid for pioneering new technology.

To put some qualification on it, these were first generation FF instruments, with many of instruments containing small bugs which made commissioning an interesting experience.

Another advantage we found with the system was that additions made to the plant at later dates, which involved new instruments, could be easily and cheaply installed due to having spare capacity within the fieldbus segment. A factor hard to quantify when examining costs up front.

6. STEPS TO SUCCESS

Most of the recommendations made below are fairly generic however we would like to state that the recommendations are based on observation of our system using the equipment outlined above. They may not apply to other configurations of equipment.

- **Ensure Top management buy in for your fieldbus installation.**

Because fieldbus technology is still relatively new it is essential that upper management understand the potential benefits and pitfalls. Their ownership and buy in is critical for the success of the project.

- **Involve your DCS supplier with the design of your fieldbus system.**

Your DCS supplier must be willing to be a play a critical role in the design process. After all THEY are the experts. Each vendor system is slightly different and the configuration may have to change depending on this factor. Recommendations made by them must be followed because this will enable them to provide the next critical item.

- **Insist on a performance guarantee from your DCS supplier.**

If the DCS supplier is involved from the very earliest moment of design they should not hesitate in providing a guarantee for the performance of the fieldbus. We involved all parties very early on in the process, DCS supplier and instrument suppliers. Helpful suggestions were made by all concerned which was critical to the success of the project.

- **When designing your fieldbus limit the number of instruments per card to less than ten.**

Even though the Foundation recommend up to 16 instruments can be placed on one fieldbus card, we would recommend that the design use less than ten per card. Although this will warrant more I/O cards we feel the tradeoff in extra speed for non-critical communication is warranted. We found using third party software tools during commissioning and troubleshooting can get bogged down, especially if you are trying to examine one instrument in a large group.

- **Maximise the instruments supplied by your DCS supplier**

At this early stage of introduction of fieldbus installations and instruments, try to maximise the instruments supplied by the DCS supplier you have chosen. Although ‘interoperability’ was proven with our installation it did not come without pain. Early on we had a lot of trouble interfacing different vendor instruments to our DCS. Our main problems were software configuration inconsistencies, which were not helped by suppliers having no real expertise in their own products. We suspect that as the popularity of fieldbus products increase this expertise will transferred to local suppliers.

- **Plan your cabling runs**

Again this depends on the type of plant you have to run and maintain. However your layout and installation of your FF cabling can have an impact on how easy it is to maintain your system in the future. We decided to use strategically located junction boxes close to groups of FF instruments and install cabling so that each instrument was wired in parallel. This ensured that if an instrument was faulty that it could be disconnected without disturbing other FF instruments.

- **In an I.S. installation, limit the number of instruments per barrier segment to three.**

With an IS installation the barrier is limited to somewhere near 90 mA of power that it can supply out to the field. Depending on the mix of instruments used it is possible to have four or more instruments powered on one barrier. However care must be taken to ensure that startup currents of all the instruments are taken into account when configuring your system. We decided on limiting the number of instruments to a maximum of three on each IS barrier. This gives us the advantage of being able to add instruments very easily in the future.

- **Make sure the instrument supplier can supply fieldbus related software drivers for each instrument.**

At the time of our installation this was an important issue for us as some of the instruments supplied were being used for the first time anywhere in the world. You will now find that most instrument suppliers have dedicated web sites, which will have downloadable software drivers for each instrument. However care should still be taken to check these sites and ensure that the drivers supplied are compatible with the revision of instrument you have purchased.

- **A UPS should be installed for all your fieldbus instrument loops & DCS.**

We decided early on to include a UPS in the design of the control system. The UPS provides some protection in terms of voltage surging and spikes and is generally good engineering practice if you can afford it or if your plant is of a critical nature. A current issue for us is that some instruments do not recover after a power failure and must be reconfigured. The UPS provides some measure of protection against these unforeseen problems.

- **Utilise the benefits of Foundation Fieldbus technology in your design.**

A good example of this was our use of temperature transmitters. Our transmitters are capable of receiving two field RTD elements. Depending on the criticality of the temperatures measured, for many cases we utilitised only one transmitter for two field measurements, which meant a direct saving to the project. This could be the case with your next installation, many instruments now are capable of outputting multiple variables i.e. massflowmeters.

- **Perform a comprehensive FAT & SAT. Test all components of the fieldbus system including cabling.**

By performing comprehensive testing of components, you are ensuring that the installation will be a success when it is time to commission your new plant. Any unforeseen problems can be caught early on and not delay the startup. Make sure ALL components that will actually be used in your new plant are tested. This includes the actual instruments (make sure you will be getting the same revision of instruments), cabling, FF terminators etc. However it may also provide other benefits, for example we tested different types of cabling for our fieldbus. We found that for our installation which was a relatively compact plant we did not have to use expensive fieldbus cabling as recommended by our DCS supplier for FF installations and that standard cable proved adequate which was a big cost saving.

- **Include a commissioning engineer with fieldbus experience from your DCS supplier, and if possible from your instrument supplier.**

We see this as essential for smooth commissioning of your new plant. If expertise is not available onsite or from local suppliers, answers to tricky problems will be delayed, especially if that expertise is located overseas. Ask your DCS and instrument supplier how they will support you when commissioning and insist on having their expert on site during commissioning.

- **Get a pricing schedule in place for fieldbus instrumentation that is valid long after project completion.**

Again this may be not as relevant now as when we installed our plant. However there is still a relatively small number of instrument suppliers at present that can supply IS Foundation Fieldbus instruments. Although project pricing might be good due to the quantities of instruments supplied in a large project, make sure that you have a pricing agreement in place that will guarantee you discounts off list price for future instrument purchase. If your plant is like ours the first thing you usually do is add instruments shortly after new installations.

7. Summary

Hopefully some of the above suggestions will be useful to you when you next decide to try fieldbus technology. Although the benefits of this new technology have not been fully covered in this paper, I feel that this topic has been adequately covered by many others, not least of which the instrument suppliers themselves.

Careful planning and design is essential for any project to succeed, not just when using fieldbus technology. Performance guarantee's and adequate resourcing of FF expertise during commissioning are essential for a successful project. I believe instrument suppliers should freely offer these benefits as they play a key marketing role for the adoption of Fieldbus technology by a generally conservative market.

It is a brave new world out there, as the technology is increasing in popularity the choice and range of equipment is becoming broader, the integration of FF benefits into existing DCS's is becoming stronger and pricing of FF instruments compared to traditional instruments is dropping. All bodes well for the future of this important technology.

8. Acknowledgements

I would like to thank Geoff Allardice of Fisher Rosemount, Steve Bieniak & Paul Everitt of Yokogawa, David Bath of Mdec, and John Gowdie & John Saw of Pepperl & Fuchs, their efforts ensured that our project was a success.