FOUNDATION FIELDBUS PRESENTATION
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INSTALLING & COMMISSIONING A FIELDBUS / PROFIBUS PROCESS CONTROL SYSTEM

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1.0 Introduction

Australian Gold Reagents Pty Ltd (AGR) is a Western Australian manufacturer of sodium cyanide, an essential ingredient for the metallurgical extraction of gold.

AGR is the Management Company of the unincorporated joint venture between Wesfarmers CSBP Limited and Coogee Chemicals Pty Ltd.

Wesfarmers CSBP, part of Western Australia's largest public company Wesfarmers Limited, is the major participant in the venture with a 75% shareholding and acts as both plant operator and sales agent.

Coogee Chemicals with a 25% shareholding, is a local manufacturer and distributor of industrial chemicals and a significant tank farm operator.

The AGR facility, which is located at Wesfarmers CSBP's fertiliser and chemicals complex in Kwinana consists of two independent production plants which provide secure, reliable product supply. The first cyanide plant was commissioned in 1988 to service the growing gold mining industry in Western Australia and produces 35,000 tonnes per year.

In 1998 a second, plant was constructed adjacent to the first, increasing production capacity to 50,000 tonnes per year with the potential to further expand to 70,000 tonnes per annum.

The facility, which produces a 30 per cent solution (by weight) of sodium cyanide, was the first sodium cyanide manufacturing plant to be constructed in Australia. It has won a number of engineering excellence awards and is recognised for its innovative design, efficiency and safety. Prior to its commissioning, the demand for sodium cyanide from the local gold mining industry was satisfied by imports of packaged solid product from overseas.

2.0 Project Background

In early 2001 AGR board approval was given to construct the first solids sodium cyanide plant at Kwinana. The solids plant was constructed to maximise utilisation of both liquid plants. The design output of the solids plant, being 20,000 tonnes per year, is primarily for the export market.

Detailed engineering commenced in June 2001. SHEDDEN UDHE in Melbourne carried out the detailed design

Construction started in January 2002. Plant pre commissioning commenced in late June 2002.

3.0 Reasons For Bus Technology

- Existing plant technology using 4-20mA and hard wired I/O for process control and motor control was 15 years old.
- Existing hardware was available to expand but not as a large project option.
- New technology was required for next 20 years.
- Host vendor gave several presentations on the benefits of the Host system and Foundation Fieldbus as well as their ability to interface to Profibus for Motor control.
- Savings on cabling cost.
- Savings on space for control cabinets
- Savings on Engineering and Drafting
- SAvings on Commissioning.
- Opportunity to test new technology for future requirements
- Access benefits of new technology.

4.0 Principal Requirements For New Control System

- Process Control
- Motor Control
- Easily interfaced to existing SCP No.1 & No.2 process plants which both used conventional DCS
- Easily interfaced to vendor packages
- Operator interface was easily adaptable to existing operators and new operators
- Provide for future expansion and enhancements

5.0 Design Philosophy

5.1 Process Control

- The function of the plant was to take feed stock of sodium cyanide solution (30% by weight) and reduce the moisture content in several stages to produce a solid briquette suitable for packaging in 1 tonne boxes. Although the new plant would be a half wet/half dry process and would use batching processes, there was nothing unusual required in terms of process control philosophy.

- The control system consisted of one Operator/Engineering console installed in the main control room, an Operator console located in the field control room out on the plant connected via fibre optic link and a control cabinet containing I/O located in the existing MCC room.

- There was no immediate requirement for any other external connections or networks.

- The control system should interface to existing cyanide plants

- Due to the nature of the process and associated hazards the plant did not require a separate Emergency Shutdown System.

- There were no Hazardous Area requirements.

5.2 Instrumentation

- Where possible all field instruments including control valves were specified as Foundation Fieldbus (FF).

- Where this was not possible 4-20mA with HART protocol were specified.

- Instrument Data Sheets

  Standard ISA Instrument Data Sheets were modified to incorporate the following Fieldbus requirements.

  1. Link Active Scheduler — Yes/No
  2. Polarity Sensitive Termination — Yes/No
  3. Device Description (DD) Revision
  4. Minimum Operating Voltage — VDC
  5. Maximum Quiescent Current Draw — mA

- Analogue (Digital) transmitters were preferred to switches

- Some critical Level applications used two transmitters with deviation alarms

- Control valves were specified as FF positioners.

- Valve couplers were specified for all ON/OFF valves with Limit switches and were located in Instrument Junction Boxes.

- ON/OFF valve solenoids without limit switches were connected to digital outputs of Fieldbus Digital interface cards located in Instrument Junction Boxes. Solenoids were specified as two (2) watts or less.

- Digital Inputs such as Flow, Pressure and Level switches were multiplexed via 16 channel (8 input & 8 output) Fieldbus interface cards located in Instrument Junction Boxes. (Expand on use of switches).

- The majority of temperature sensors, both RTD and Thermocouple were multiplexed via 8 channel Fieldbus devices located in Instrument Junction Boxes.

- The Instrument Marshalling Panel (IMP) which housed the control system hardware was located in the MCC room. The IMP was a single 900mm wide 650mm deep and 2,200mm high. The cabinet is approximetely less than half full.

- Power for the control system was fed from a 24VDC supply, which was powered by a 240VAC UPS. The power conditioners in the IMP powered Fieldbus devices connected to the segments. Some field devices were powered by 24VDC, while others were powered 240VAC.

- There were a total of nine Instrument Junction Boxes spread over 4 elevations with approximate distances of 140-180 meters to the Instrument Marshalling Panel (IMP) which housed the DCS hardware.

- Spurs from each IJB were approximately 10-60 meters long with two exceptions of 120 and 220 meters. Surprisingly both devices worked without any problems.

5.3 Instrument Take Off Details

- Total Instruments approximately 350
- 140 Fieldbus devices in total comprising:
- 112 Instruments (Pressure, Temperature,Level, Flow and Control Valves)
- 6 Temperature Multiplexer devices(8 Inputs per device)
- 7 Valve Coupler devices(4 D/O + 8D/I per device)
- 13 Digital I/O devices(16 I/O per device)
- 16 Hard wired (4-20mA) transmitters
- 24 Hard wired Digital I/O
- PROFIBUS 58 Drives including 728 digital I/O and 69 Motor Amps
- Modbus : Chiller, Packaging plant and Sodium Cyanide plants 1 & 2
- Total I/O approximately 1300

5.4 Foundation Fieldbus Devices - Supplied By The Following Vendors

- EMERSON
- YOKOGAWA
- SAMSON
- FLOWSERVE
- FISHER
- PEPPERL + FUCHS
- ENDRESS + HAUSER
- MTL
- RELCOM

5.5 P & IDs

Conventional P&IDs were used except for the regular dashed line from instrument symbol to DCS symbol was replaced with '–' and '●' to detail Fieldbus connections.

5.6 Segment Design

- Segments were limited to a maximum of twelve devices including a maximum of three control valves.
- Segment design initially grouped control loops and trip instruments into common segments located together. This then determined the IJB locations. The (IJB) location then picked up the remaining instruments.
- There were a total of eighteen Fieldbus segments with seventeen being used and one spare. The spare could be used as a test segment by maintenance.

- Spare segment capacity was 15-20%
- There were three Profibus segments
- There were three Modbus interfaces

- Analogue transmitters were routed to the nearest IJB.
- An eight pair (8) 1.5mm^2 Individual and Overall screen cable connected each IJB to the Instrument Marshalling Panel. The first three pairs were allocated for segments (including 1 spare). The remaining pairs were allocated for Analogue devices. Each IJB was also connected with 16mm^2 24VDC supply to power digital devices

6.0 Motor Control Profibus

Presented by SIMON ORTON

7.0 Construction & Installation

- The Electrical/Instrument contractor had no prior Fieldbus experience. This was not considered a problem, as there were no E/I contractors with Fieldbus experience anyway.
- All field instruments were specified with factory calibration certificates and could be re-ranged from the Engineering workstation.
- Actual instrument installation wiring from the instrument to the IJB and tubing was no different to a regular installation.
- The main difference was less multi-core cables and more space available on cable ladders.
- All cables were continuity tested.
- Careful scrutiny of screens was carried out as it was thought to be a possible issue during commissioning.

We later found out that there are tools available for cable checking prior to hook up of Fieldbus instruments.

8.0 Factory Acceptance Testing (Fat)

- Initial thoughts for FAT included testing every single Fieldbus device with the HOST system. This was deemed impractical since there were more than 140 Fieldbus devices alone. In addition there were a further 200 devices connected to the Fieldbus devices.

- Factory Acceptance Testing was a big issue. Initially we purchased a software package, which would simulate all the I/O and be used for FAT. We later found out the package could not perform these tasks.

- As part of Factory Acceptance testing one of each type of Fieldbus device was function tested on the HOST system. In retrospect our testing should have been more thorough and may have caused fewer problems during commissioning.

- It is not good enough to check that a pressure transmitter reads the correct pressure applied to it, or that you can stroke a control valve.

- A complete check of all parameters needs to be carried out.

- FAT without the Fieldbus devices connected is basically a run through the logic without any simulation. This is not adequate preparation prior to bringing the system to site for commissioning.

- Due to practical difficulties with FAT and site construction delays FAT was aborted.

- As a consequence this led to subsequent problems and delays during pre commissioning and commissioning.

9.0 Commissioning

Site Acceptance Testing (SAT) or pre commissioning was really the equivalent of FAT. This is when everything is connected for the first time. Initially pre commissioning of HOST vendor's devices went fine.

- On day one we commissioned thirteen transmitters without a problem. We were a bit excited so we did not rush it.

- Day two we commissioned seventeen.

- Day three we commissioned twenty.

- Day four we commissioned forty.

- Day five we commissioned seventeen, by now we were limited by access and the numbers of devices terminated in the field.

Remember there were 140 Fieldbus devices with an additional 200 devices, which were attached to some of the Fieldbus devices.

In parallel we commissioned motor drives a a rate of 12 per day.

In the second week after feedback from operations we cross checked some transmitter calibrations and found they had not been set up properly in the DCS. This led to a loss of confidence in the system. As a result we then decided to check all Pressure and DP Transmitters from the transmitter through to the DCS by pumping them up (just like the old days). Our original plan was to physically check control loops and trip devices only.

Having worked our way through the Pressure and DP transmitters we then concentrated on third party devices, control valves and temperature transmitters.

As noted above the commissioning of the equipment supplied by the HOST vendor was fairly straight forward.

This was not the case for other vendor devices.

- Commissioning of third party devices was particularly frustrating especially control valves.

- Where it took minutes to commission transmitters, it took days to days to complete commissioning of twentyone control valves from three vendors. This included replacement of four positioners by one vendor. We are still not sure if the problem was in the HOST or the valve positioners.

- It also took several days to commission seven valve couplers from vendor D

- This was due to lack of experience with third party FF devices on the part of the HOST vendor. In addition the third party devices were read/write devices such as control valves and valve couplers. These devices had a lot more information transfer than say a pressure transmitter.

- We had an on going issue with two particular segments and a Temperature Multiplexer supplied by the HOST vendor.

- After two weeks the vendor called in a representative from Singapore.

- The problem was traced to an older revision H1 card having been installed in our system.

- Use of a Relcom FBT-3 tester from MTL assisted in locating the fault.

- Installation of the correct revision card solved the problem but caused frustration and unnecessary time delays.

Approximately one week after power up of the control system on site, the Production guys were hungry to get tanks filled, pumps running, etc, etc.

Pre commission and commissioning ran side by side. Additional problems arose such as

Actual plant commissioning presented many challenges with blockages in the dry section being the principal offender.

After several aborted runs the plant was shutdown for modifications to chutes and to install some additional instruments etc.

This period was also used to evaluate the control configuration.

10.0 Tips For Future Projects

- Prior to selecting a Host vendor you must be satisfied that they really do have the expertise with the HOST system and with Fieldbus equipment.

- Ensure their expertise is local. The person in Melbourne, Sydney, or Singapore is not always much use in the middle of the night or weekends.

- The above applies to all suppliers including Field Instrument and Valve suppliers too.

- Prior to award, the HOST supplier should provide details of experienced personnel who will be assigned to the project. Vendor should have at least two personnel with Fieldbus and HOST experience.

- Vendor should demonstrate inter-operability of HOST system with third party devices including valves. Do this up front if possible. It may identify problems, which can be resolved prior to FAT or site commissioning.

- Clarify how vendor will carry out FAT. For example it is possible to test Modbus and Profibus interfaces but it is not possible to test or simulate Fieldbus devices.

- For me, FAT is a huge issue and I believe we would have encountered less issues on site had we been able to complete it.

- Your contract with your Fieldbus device vendor should state that an experienced vendor representative be on site for commissioning. We were fortunate that several local suppliers were very willing to help but did not necessarily have much experience. The experience was generally interstate or overseas. When vendors can really support the product the customers will readily purchase the product.

- Allocate at least one I/E maintenance person and perhaps one Process operator to participate in the configuration. The experience will be invaluable for both and you will at least have someone on site that can bring a black screen to life.

- In terms of training your own personnel it is difficult to predict what your needs are. Lots of theory is not much use. Hands on experience are hard to get.

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