STRATEGIES FOR PROCESS CONTROL & PLANT MANAGEMENT
PROCESS ENGINEERING

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Controls

## Field communications

Published: 14 September 2005 03:22 PM
Article Type: **Controls**
Source: Process Engineering

**The world's largest installation of Foundation Fieldbus has recently gone into commercial operation at China's largest petrochemical complex. Mike Spear reports from Shanghai on this record-breaking project involving ten, centrally controlled, worldscale plants.**

When the Shanghai SECCO Petrochemical Company's new complex went into full commercial operation at the Shanghai Chemical Industry Park on 26 June, it marked the culmination of a remarkable project. Not only is the $2.7billion, 10-plant ethylene cracker complex the largest of its kind in the People's Republic, it was completed — from bare ground reclaimed from the sea, to a fully integrated 2.3million tpa multi-product facility — in just 27 months, three months ahead of a schedule that was already some six months shorter than the norm for similar sized crackers.

The complex was mechanically complete by last December, with the first downstream plants going on stream (using imported feedstock) in February this year. Subsequent start-up of the 900 000tpa ethylene cracker in March took just 10 hours and 45 minutes, a world record for a project on this scale according to SECCO, a joint venture between BP and the Chinese companies Sinopec and Shanghai Petrochemical Corporation (SPC).

From the outset, rather than using an overall project management contractor, SECCO used an integrated team approach to engineering and project management, under which each key plant in the complex had a lead project contractor. With 10 EPC (engineering, procurement, construction) contractors operating on the 2.2km2 site, there was clearly a need for a high degree of co-ordination. The contractors were a mix of international operators — ABB Lummus, Technip, AMEC and CTCI for example — and local Chinese EPCs such as Sinopec Engineering.

'With so many contractors,' says SECCO's styrenics process control manager, Danny McHugh, 'it was realised that partnering with one main automation supplier early on — using a Main Instrument Vendor (MIV) approach — would be critical for the project's success.'

The decision to go with fieldbus was made in 2001 when BP was reviewing technologies and setting goals for the SECCO project. The company viewed Foundation Fieldbus (FF) as 'a leading edge, but mature technology', so proven experience of implementing this field communications technology was a crucial factor in the choice of MIV.

Beating off strong competition from four other control companies for the $45million control and automation contract, Emerson Process Management was appointed MIV in February 2003. With its own established offices, test and staging facilities in the booming Pudong area of Shanghai, Emerson's experience in the region included several other major plants, acting as main automation contractor for a seven-plant complex for BASF in Nanjing, and managing the instrumentation for Bayer Caojing, a project which used more than 300 FF devices and went on line in September 2002.

**Worldscale all round**

SECCO, however, is on a vastly different scale. Across the 10 plants and utilities there are over 48 000 control loops, with about 166 000 I/O tags and around 25 000 points hardwired to the automation system. There are 40 000 instruments and some 13 000 intelligent devices networked in the world's largest Foundation Fieldbus installation. In total there are 2500 FF segments.

Adrian Howell, SECCO's process control manager, says that 'while we knew that a fieldbus approach would save considerable amounts of cabling, a conservative approach was taken to the number of devices connected on each segment. Designs were limited to no more than 12 devices, and the average ended up as five devices per segment, where each segment varies between two to 11 devices.'

Although BP had already used FF on other projects, none of the other partners had any experience of the technology and Emerson's role was seen as crucial to the success or failure of the project. As SECCO's deputy project director, Jack Brinly, explains: 'Our control team in SECCO at the beginning, as a new company, was maybe eight or nine people. We needed help and experience. The complexity of the project and the project execution strategy — with 10 different EPCs — meant that we needed standardisation of equipment and a consistency of engineering across multiple work packages.'

Which is where the MIV approach came into its own. As the main automation supplier, Emerson not only engineered and implemented the control systems — based on its PlantWeb architecture — but also helped manage the multiple international and local suppliers for each of the 10 plants.

As Brinly says, none of the EPC contractors particularly welcomed the MIV approach — they would have preferred to go through their own bidding processes to appoint automation suppliers for their own parts of the mega project — 'but they got on with it'. Given the tight schedules and the fact that all the plants were being engineered and constructed at the same time, SECCO saw this as the only way to achieve the necessary engineering consistency and co-ordination.

The first stage in the process was to set up a core team drawn from SECCO and Emerson to develop the Functional Design Specification, which defined the set of standards to be adopted for implementation on all the projects. According to McHugh, 'the most important aspect of the project management was consistent systems management, and the FDS was fundamental to this.' Emerson provided separate teams for each of the 10 plants, rather than having a single team moving from one plant to the next, and also appointed a program director and engineering and quality manager to oversee all 10 plants. In all, the company had around 110 personnel involved at any one time, including 68 DCS engineers and 20 field instrument engineers.

Apart from its importance to the goal of a fast start-up, the MIV approach was also critical to SECCO's radical strategy of using a single control room for all 10 plants. Compared by Brinly to NASA's mission control centre at Houston — 'but around 15 times the size' — this impressive nerve centre of the whole complex houses the operator interfaces for all 10 DeltaV distributed control systems controlling and overseeing the main ethylene cracker and the nine downstream derivative plants, 'something that would not have been possible without the FF technology,' according to Howell.

Jack Brinly says the technology enabled economic wiring, space savings and faster commissioning. 'The number of wires was still huge [there are over 70 000 cables throughout the complex], but a fraction of what would have been needed with conventional technology. The fieldbus provides the platform to collect, analyse and share operational and diagnostics information to the 750 operations, engineering and maintenance personnel manning the complex.'

The central control room is connected via fibre optic cabling to 14 outstations adjacent to the plants and containing the system cabinets. These in turn are connected to the field devices mainly over FF and, in some cases, HART or Modbus. The latter protocol was used particularly on the analyser systems, while the safety instrumented systems (SIS) and emergency shutdown systems from Hima and Tyco were conventional 4-20mA.

In terms of hazardous area operations, McHugh says there are not that many intrinsically safe (IS) segments on the fieldbus networks, ‘basically because all the plants have been designed to Exd (explosion-proof) standards rather than IS, which fitted in better with the experiences of the multiple contractors involved.’ He estimates that less than 10% of all instrumentation was of non-Emerson supply (with much of that being on packaged plant with preconfigured instrumentation).

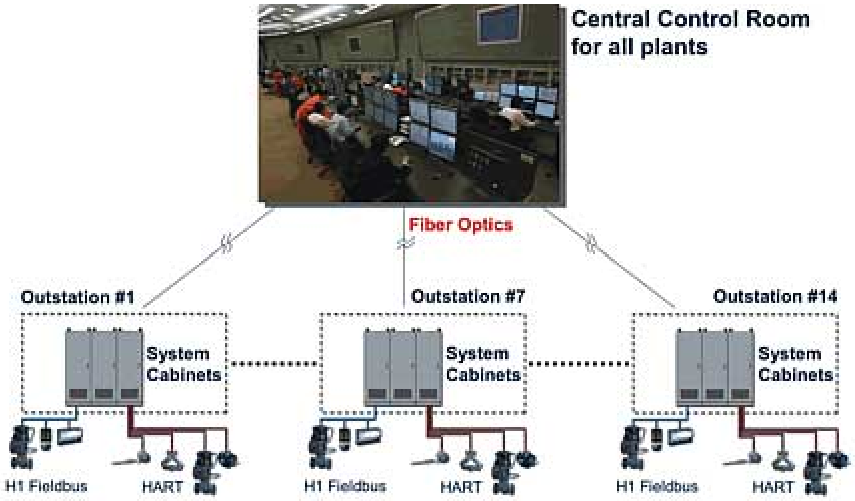
Although the scope of the MIV did not include control valves, many of these are fitted with Fisher digital valve controllers and positioners. Sinopec Engineering’s deputy chief engineer, Huang BuYu, explains that all basic regulatory control on the complex is in the field devices.

‘In the event of a controller fault or disengagement,’ he says, ‘field instruments will continue to execute and operate the process at set point.’

Again, this is something that would not have happened without FF. ‘The choice was made to locate PID algorithms at the point of final control — in the valve controller,’ says Stanley Ee, Emerson’s program director. ‘This "Control in the Field (CIF)" helps give the improved reliability of a truly distributed control system. It also significantly reduces the [need for] communication between the automation system and the field devices, further adding to increased reliability.’

Only single-loop control was implemented in the valves, however. All complicated control, such as cascade and multi-element strategies, is done in the DeltaV systems. Control function blocks could be performed in any of the field devices or in the automation system, since ‘it is an easy drag-and-drop software choice’, explains Howell. ‘This easy configuration will save time as we modify our ever-changing plant.’

Another feature of the overall control system that will gradually come into its own with the passage of time is Emerson’s asset management system, an integral part of the PlantWeb architecture. AMS ValveLink, for example, is being used to obtain valve signatures as the complex settles down to full operation. These will enable SECCO to monitor valve status and take action to optimise performance and avoid abnormal situations.



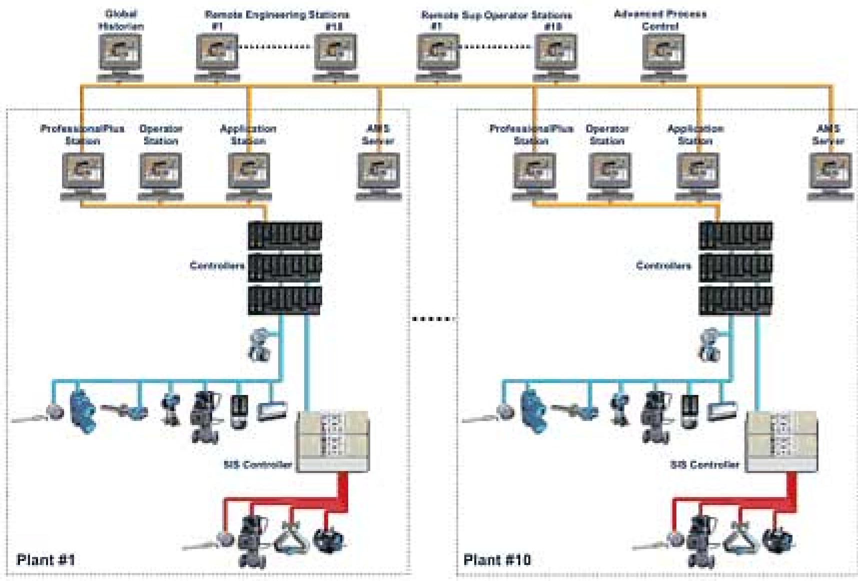

With the first shutdown of the cracker not scheduled until 2009, and the other plants on a two-year schedule, asset management will play a vital role in keeping the complex at peak performance. 'The predictive diagnostics of PlantWeb and AMS Suite will help optimise our maintenance plan,' adds Howell, 'enabling personnel to focus directly on the problems, which will greatly improve efficiency and minimize downtime. Knowing what the problems are beforehand, the staff can schedule maintenance and obtain the needed parts. Where there are no problems, the maintenance schedule can incorporate delays accordingly. This is a clear advantage over traditional plants that may tear down and rebuild equipment every two years, whether or not it is needed.'

According to Danny McHugh, implementing Foundation Fieldbus on such a scale was seen as something of a risk at the start, but 'BP had already used it and it was thought that not to use FF would make the plants obsolete much earlier than would otherwise be the case.' And a mere four years on from that decision, Stuart Mountfield, SECCO's control systems project engineering manager, can now say: 'We have proven that Foundation Fieldbus works, and works on a large scale. I don't see any reason for any project anywhere in the world not to use this technology. It works and it's robust.' A satisfied customer indeed.

**A template for successful project management**

'When you look at the complexity of building 10 units at one time, and asking all of them to start up in a short timeframe with minimum disruption, it's pretty amazing', says Jack Brinly, SECCO's deputy project director. 'At the beginning BP felt there was no possibility of finishing before June 2005, but the last process unit was commissioned and put on line in March — three months earlier than planned.' By any standards, the SECCO project was an impressive feat of engineering. Not only was the 10-plant complex completed and commissioned ahead of schedule, but the project recorded no major accidents and zero fatalities during construction — which included more than 50million manhours of labour from a workforce that peaked at a total of 12 500.

With ten different contractors involved, SECCO's own integrated project management team worked with an Emerson team to develop the all important functional design specifications (FDS) over five months. This was the crucial document — all 1000 pages, 14 sections and 14 appendices of it — that was required to have all the contractors singing from the same hymn sheet. Once written, the FDS was presented to the control managers of all plants for review and fine tuning. For example, a simulation was created of one heater of the ethylene cracker, which enabled further refining of the specifications with all the various graphics and control models. The simulation was also fine-tuned for one of the polyethylene processes to enable better understanding of the process when writing the sequences template.




The engineering manager of the core FDS team eventually became the master editor of the design specifications — every new module anywhere in the plant needed to be created by him, to keep the ten-plant complex consistent. He also became the ‘master trainer’, which is seen as the key to the successful start-ups by Emerson’s program director, Stanley Ee.

The scope of the FDS was all embracing. From the overall system architecture drawings and description, through Foundation Fieldbus segment design, to system cabinet and wiring design, and on to operator interfacing and then the asset management system, every element of the control systems for the overall complex was precisely specified in a way that brooked no argument (well, perhaps some, but mostly lost) from the disparate contractors and suppliers.

A feature of Emerson’s role as Main Instrument Vendor was the degree to which the company used indigenous resources as far as possible. With its own established 4000m2 centre in nearby Pudong, Emerson was able to maximise local engineering involvement and use its local facilities for assembly and wiring, staging, integration, and customer acceptance testing.

**Mega scale - and more to come**

SECCO came fully on stream not long after the BASF-YPC joint venture complex at Nanjing. The latter is slightly smaller — its nine plants, based around a 600 000tpa ethylene cracker, output some 1.7million tpa of products compared with SECCO’s 2.3million tpa — but the scale of both gives an indication of the current state of the booming Chinese economy. And to these can be added a third megascale complex in the country, the Shell j-v at Huizhou with an 800 000tpa cracker.

However, demand in China is such that even if another SECCO-sized were to be built every four or five years, the country would still need to continue importing petrochemicals. With a virtual replica of SECCO already slated for an adjacent site on the Shanghai Chemical Industry Park (SCIP), that situation might change, of course, in which case the world’s petrochemical producers will find themselves competing with not just worldscale operations, but world class ones at that.

In detail, SECCO currently comprises ten separate plants (there are plans in place that would allow the addition of two more plants if necessary) and their required utilities such as power and wastewater treatment facilities. Each of the ten is among the largest of its kind in the world. The main 900 000tpa ethylene cracker generates feedstock for the other plants, which respectively produce 600 000tpa of polyethylene, 250 000tpa polypropylene, 500 000tpa styrene, 300 000tpa polystyrene, 260 000tpa acrylonitrile, 200 000tpa of aromatics, and 90 000tpa of butadiene.

Another plant in the complex producing MMA (methyl methacrylate) is owned by Lucite, but operated under contract by SECCO.

Apart from the SECCO complex, the 29.4km2 Park is already home to, among others, a BASF PTHF (polytetrahydrofuran) plant, a BASF/Huntsman MDI/TDI project, several integrated plants operated by Bayer, and a Degussa polyester project that started construction last September. According to SCIP's director for technology, Li Guo Hua, the goal is to build a world class chemical park to rival those at Houston, Antwerp and Jurang (Singapore).