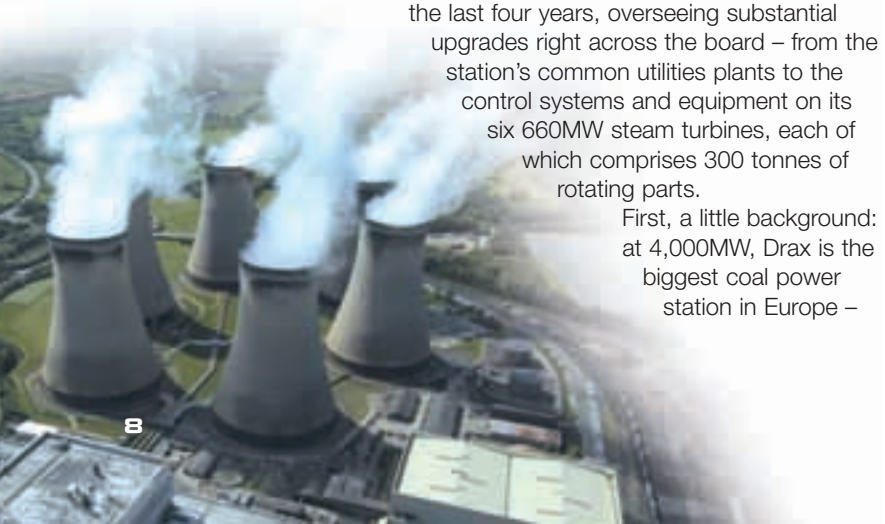
Electric Engineers

Behind the scenes, the UK's largest power plant has been installing and commissioning an array of equipment and systems in its biggest refit yet. Brian Tinham takes a look

It's often said that one of the biggest differences between plants in, say, the chemical or pharmaceutical industries, as opposed to those in power generation, is that the former are developed in a laboratory pilot (where the learning is done) and scaled up for mass production, while the latter are built to produce power from day one, but then evolve constantly over time, as efforts are made to improve efficiency and output.

That's not quite right: the implication is that chemical plants don't change, which, of course, many do – that's what continuous improvement is all about. But the point that this comparison tries to make is around operating ethos. Power plants, particularly the large installations, are in a constant state of flux – partly just to match demand output, partly to keep doing so more profitably and more responsively, and partly to meet increasingly stringent environmental regulations, while also minimising plant stress. And, on top of that come all the plant and system upgrades.

Many will see this as a moot point, so let's look at the huge Drax power station in Yorkshire to get a handle on what's been happening there – and then judge. George Eccleston, senior control and instrument engineer at that plant, is our chief guide, mainly because he has been project manager for the last four years, overseeing substantial upgrades right across the board – from the station's common utilities plants to the control systems and equipment on its six 660MW steam turbines, each of which comprises 300 tonnes of rotating parts.



First, a little background: at 4,000MW, Drax is the biggest coal power station in Europe – more than double the size of any other in the UK and generating around 7% of this country's electrical power. Units one, two and three were commissioned in the mid-1970s, followed by four, five and six a decade later. Flue gas desulphurisation plant was added in the mid-1990s, enabling operator Drax Power to claim its station as the cleanest and most efficient coal-fired plant in the UK.

Drive for renewables

Currently, a biomass preparation plant is being piloted, the objective being to perfect large-scale direct feed into the main boiler furnaces, instead of mixing raw product with coal prior to the pulverising plant. The first biomass stream is due to come online later this year, followed by a second early in 2010, eventually providing for around 12.5% of Drax's power output, and thus cutting its carbon emissions by 2.5 million tonnes. Next, starting in 2010, the plan is to build three additional stand-alone 300MW biomass-fired plants at Immingham, Hull and a third site, yet to be decided, bringing Drax collectively up to nearly 5,000MW from mixed feedstock, with nearly 30% renewables.

Those are the grand developments, but, behind the scenes, changing technology, business and environmental performance requirements have driven substantial additional projects – ranging from turbine upgrades to auxiliary plant improvements, all of which are geared to uprating efficiency and responsiveness, while reducing emissions through, for example, condenser and feed preheating system improvements. And underpinning all of that have been control system upgrades.

Eccleston explains that the control systems on the original three turbine units were refurbished in the 1990s, and that the most recent four-year

George Eccleston, senior control and instrument engineer: taking the giant Drax power station from 1970s technology to the 21st century

project started off with a goal of improving control flexibility, as well as cost-cutting on the remaining newer three units. "Scope of this refit was to replace all of the controls and interfaces for the unit operators. The old system was split into three, with a data processing unit designed to present alarms and graphics to the operator, a modulating control system and a sequence control unit for starting and stopping plant, all running CEGB Cutlass software. On top of that were the safety systems – some hard-wired, others upgraded over the years to 'soft' implementations – but all with hard desk interfaces providing the operator views.

"All that has now gone, and we have installed unified PLC controls and integrated soft desk systems for everything – all with dual-redundancy, designed to fail-over smoothly and automatically, if there's a problem. Also, the new system connects directly to the site's top-level OSI PI information and optimisation system, which, in turn, now collects plant data from something like 30,000 inputs, covering plant variables and condition monitoring data. That is now the central information system for all engineering disciplines."

PLC controls

Looking at the turbo-generator unit controls, each now comprises 17 hot-standby pairs of Schneider Quantum PLCs, supporting a total of almost 8,000 I/O points and covering everything from motor stop/starts to valve actuators with analogue position feedback – and all remote and linked to the PLCs via dual redundant cable connections. Meanwhile, the PLCs themselves communicate with each other via a self-healing Ethernet fibre optic ring, and the overall system also connects to legacy equipment via Modbus TCP and traditional Modbus links; the entire system uses standard IEC 61131-safety systems compliant software.

Work started on implementing the new control systems in 2005, first on Unit Six, followed in 2006 by Unit Four and then last year by Unit Five – each changeover resulting in just 13 weeks' outage for commissioning and test. Which leaves one year unaccounted for.

"That was when we embarked on the project to modernise the common services plant for all the Drax power station units – which turned out to be a bigger job than we bargained for," laughs Eccleston. He cites: the cooling towers that condense steam for the boiler condensate loops; the boiler feed water treatment plant; new burner equipment, which now runs with various grades of fuel oil for modern coal/petroleum coke firing; polymer plant for silt removal; compressed air systems for everything from pneumatic valve control to dust conveyors, boiler cleaning etc; and the site's huge electrical systems.

"Before the refit, the systems providing monitoring and control for the common services plant ranged from Cutlass alarms down to a collection of legacy stuff, such as pneumatic equipment, Norbit logic and manual systems dating back to the 1970s. So we've now gone for unified generic technology for everything plant-wide. The HMIs [human machine interfaces] and SCADA [supervisory control and data acquisition] systems are now all dual-redundant APMS [advanced plant management systems], developed by Ferranti [now Thales], and the PLCs are all dual-redundant Quantums, with 22 now covering data processing, sequence control, everything."

And it's a similar story with the plant equipment. Much of that has moved from, for example, manual hand valves to electrically-actuated automatic valves, with position feedback, while new 'smart'

10 Pointers

- Unified PLC controls and 'soft' desk systems now manage all Drax monitoring and control, with dual-redundant protection
- Turbo generator unit controls each now have 17 hot-standby pairs of Schneider Quantum PLCs
- Most manual hand valves have been replaced with electrically actuated automatic valves, with digital position feedback
- Single loop controls are all now embedded within the overall PLC systems

field devices have been installed for instrumentation and controls, and single loop controllers have been decommissioned in favour of direct control from the PLCs. In other words, the services plant now runs with the same modern engineering technology as the steam turbine units.

Condition monitoring

Also, at a level below that, Eccleston explains that, to make plant operation and maintenance work more smoothly, the project included moving over to a lot more remote plant status indication – for example, by installing rotation sensors on the screens at the water abstraction point on the river, and remote discharge pressure sensing on all large pumps.

Looking at the boilers, Drax also took the opportunity to reduce NO_x emissions, as part of its commitment to the Large Combustion Plant Directive, by augmenting its already retrofitted low NO_x burners with BOFA (boosted over fire air) technology, where fans inject air into the boilers, so that the coal/air mix burns efficiently at lower temperatures. “We put variable speed drives – Siemens and Danfoss to maintain commonality – on those fans to enable control of the input air, instead of running with outlet discharge dampers. We’ve also replaced fluid coupling on the air flow to the coal grinding machines to improve synchronisation there,” says Eccleston.

Returning now to the turbine units, the refit has also seen installation of new condition monitoring equipment, with the main emphasis on a substantial Rosemount (Emerson) thermocouple management system, with several hundred measurement points across the boilers, turbines and generators. Interestingly, although aimed primarily at improving maintenance management, that system is also used by the plant operators – for example, while bringing boilers back up online. “Something like 20% of the funding went into this aspect, because it’s so important to our efficiency and flexibility,” comments Eccleston.

He also makes the point that, since all plant data is now available in real time from the station’s top-end PI SCADA system, engineering can now see everything it needs, right down to device running hours and associated parameters. “That means we’ve been able to improve the intelligence of our maintenance. Simply knowing that, for example, a set of compressors was running for 10% of the year might hide the fact that it’s stopping and starting thousands of times – which is not what you want. We haven’t moved up to full predictive maintenance yet, but I would say that we’re doing the common sense things really well now, and with good plant data backing us up.”

And there’s another improvement that will ring bells with plant engineers in many industries: since one PLC-based system now handles all plant data, including alarm signals, with time-stamping at source, alarm management and sequence of events analysis are all significantly better. PE