

Derby Sewage Treatment Works

extension to sludge digestion facilities

by
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Between 2000 and 2005 Derby STW underwent extensive re-construction. This work included new sludge treatment facilities and a single digester to complement the existing 6 no. digesters elsewhere on the site. In 2004, a feasibility study for refurbishment of the old digesters concluded that the whole life costs for updating and running this, now remote, plant was greater than the cost of adding to the new digester. A project to build 2 no. new digesters and extend/integrate the sludge feed, gas and heating systems was started in 2005 and will be handed over in August 2007 at a cost of approximately £4m. The sludge treatment facilities at Derby STW handle equivalent to 37 tonnes of dry solids per day.



Derby STW: 3D Model View of Digesters 7, 8 & 9, Boiler House & CHP plant

photo courtesy Nomenca Ltd

Contractual arrangements

Derby Digestion Works Order was one of the first major projects let under Severn Trent Water's AMP4 Contract strategy (well defined scope, fixed price and all risks taken by the Contractor). Benchmarking against outturn cost data from previous similar projects; Key Performance Measurement of both designer and contractor; and Contractor gain share incentives gives:

- * confidence that contracts will be completed on programme and to the right quality;
- * confidence that, on average, contracts will come in at or below target price;
- * motivation to the whole delivery team to make this happen (e.g. resisting late changes and unnecessary project additions).

Civil Engineering Works

The design of the new reinforced concrete digesters is based on the one built in AMP3. Each digester has a working volume of 3000m³ with an aspect ratio 1:1. The shallow soils on the site consist of alluvial silts, gravels and weak clays. To overcome this, the two digesters are built on a total of 64 No. 14m long cast in place concrete piles. Ground dewatering was required during construction of the

conical bases. Evidence of low levels of contamination on the site necessitated regular sampling of dewatering returns to a recharge lagoon. Risk management plans were put in place to provide an alternative disposal route in case contamination was found to exceed pre-agreed (with EA) levels; but this was not required. Ground water was also later used for testing these water retaining structures.

CHP & Digester Heating

During AMP3, Severn Trent retrofitted CHP engines at a number of digestion sites. The principal driver was to provide income through generation of 'green energy'. Whilst the engines were plumbed in for heat recovery, this was not always fully achieved.

At Derby the existing system has been rearranged and extended to ensure all available heat is recovered. On the new system, one existing CHP (290kW electrical output) and one new CHP engine (836kW electrical output) have been set up as principal sources of heat onto a primary loop running at 58 - 65°C. A secondary boiler loop runs at 77 - 85°C. 2 no. existing 550kW (heat output) and 1 no. new 900kW (heat output) boilers ignite and add heat into the primary loop through a plate heat exchanger only when heat demand by the digesters exceeds that provided by CHP engines. These engines have



3D Model View (left) of Digester Hot Water System (courtesy of Nomenca Ltd) and view of 'As Built' (right) Digester Hot Water System (courtesy of Severn Trent Water Ltd)

first call on available biogas. The speed and demand of these engines ramp down with the availability of biogas (as measured by the height of the gas bell). The boilers are dual fuel but can only use biogas when the gas bell is over a preset 'high' level.

With this design:-

- * the boiler loop temperature is kept high enough to avoid acid attack from condensing sulphur rich flue gases;
- * heating loop temperatures are low enough to avoid sludge baking in digester heat exchangers;
- * heating loop temperatures are low enough to recover waste heat from CHP engines.

Design team co-location

Responsibility for Mechanical/Electrical design is with the main contractor and carried out by North Midland's in house MEICA resource, *Nomenca*. The co-location of *Nomenca* design team with the Severn Trent delivery team in offices on Derby STW greatly assisted this process. Post contract award, the design was able to evolve with some momentum as the team discussed issues, constraints and solutions on an almost daily basis. In conjunction with this, were meetings with *Nomenca's* process advisors, *Black & Veatch*, together with HAZOPs and design reviews with Operators and Maintainers. The close proximity of design and site teams allowed discussions of 'what if' scenarios. In this way, the design was developed with due consideration of what might occur during construction and phased integration of new elements into a process that had to be kept running.

Virtual 3-D modelling

A complete reconfiguration of the heating system within an existing building, whilst seeking to keep existing plant live was a significant challenge to the team. The use of virtual 3-D modelling was a great help.

For example, it allowed Boiler house layouts to be developed and amended without the need of going back through each elevation and section to check each change. The software used allows 'walk through' inspection of the model. This facility has allowed operators and maintainers, not used to studying engineering drawings, to be brought into the design process and provide useful critique of proposals. Outputs from the model have been used by mechanical sub-contractors to pre-fabricate off site many pipework components - with all the benefits to safety, budget and programme this brings.

Whilst being hugely beneficial, there have been areas of learning. This early model missed off pipe supports and cable tray runs. By adding them later, it detracted from a design where significant consideration was given to buildability, operability and maintainability. Models on subsequent work at Derby (e.g. Inlet Works and Acid Phase Digestion) are including this level of detail.

These latter projects are also seeking to use the animation facilities in the model, to illustrate construction sequences. This will further enhance our ability to manage the installation of new equipment around existing live plant which cannot be removed until the end of the project.

Commissioning

In the last year, Severn Trent has been reinforcing the need to consider commissioning early in the life of a project. The Derby team have benefited from the input of one of Severn Trent's Commissioning Leaders in developing the commissioning strategy into the plan; undertaking 'Hazards in Commissioning' appraisals and drafting plan and contingency flow charts. The rigor of this approach has allowed the Contractor and Client Engineer to collaborate to find the most appropriate approach to each task. In some instances, it has shown up weakness in the control and instrumentation of existing plant, and allowing timely correction before processes were unwittingly put at risk.

The team has now completed dry and wet commissioning and is preparing for process commissioning. First fill of sludge is due in June 2007 and Handover scheduled for August 2007. ■

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View of Digesters 7,8 & 9, Boiler House and CHP Plant courtesy Nomenca Ltd