New Build Highly Active Evaporator Dynamic Process and Control Simulator

Project Overview

DBD is working together with a major project construction organisation to provide the differentiating expertise in the area of nuclear plant commissioning and pre-operational strategy for a key nuclear waste treatment plant design, build and commissioning project. DBD has been charged with the management of all commissioning and pre-operational aspects of this multi million pound project.

With our clients DBD is delivering the design, build, commissioning and operator training associated with a major new highly active facility at Sellafield. As part of our support, DBD highlighted a key requirement for a Dynamic Process and Control (DPC) Simulation of the Evaporator processes and feeds as being essential to the successful outcome of the project.

DBD is leading a team, possessing specialist simulation expertise, to develop and implement a model that simulates the full core and ancillary plant. The simulation enables the process design to be checked and validated, to provide a vital plant commissioning baseline and operator training tool.

Scope of Work

- Dynamic Process Simulation for process design and control system verification
- Gas process modelling of evaporator off gas at vacuum conditions via two stage steam ejector condensers
- Modelling of two phase flow multi-component in pipework carrying steam, air and steam condensate with change of phase
- Built, run and verified in stages to give client early feedback of results
- Early capture of design and operational issues prior to plant construction phase
- Long term aim to interface with actual control system to support commissioning and operations phases

DBD Deliverables

DBD's deliverables were to deliver a dynamic process and control simulator.

The Results

DBD delivered a dynamic process and control simulator to our client, a major construction company. The simulator models a new Highly Active Evaporator at Sellafield, UK. The model was based on design documentation as the plant was still being constructed. The purpose of the model was to verify that the control system definition and philosophy will correctly and efficiently control the plant during its cyclic and batch sequential operation.

The simulator models the process and control system. It also has fully navigable 'control room' screens of the complete process plant, including auxiliary equipment and services (See Figure 1). This allows the designers to operate the plant before it is built or commissioned, allowing offline

This document is the property of DBD Ltd Registered Office: Chadwick House, Birchwood Park, Warrington, Cheshire WA3 6AE Registered in England and Wales: No 03118924. VAT No. 836 6153 18
This is a CONTROLLED Document

controller tuning, corrections to the control system and verification of the design. It has brought the design to life and in many cases the operation of the plant has not conformed to the designer's vision. This feedback means that the control system can be tuned or corrected to ensure that a round of design iteration is removed from the expensive commissioning stage.

An example is of a main vessel level control that is designed to control a feed flowrate. The model showed that the process volumetric holdup caused sufficient time lag in the feedback control loop, resulting in setpoint overshoot and triggering of alarms/trips as well as unstable operation during startup.

The model was built in phases, with the core of the process being modelled first. This demonstrates how DBD applied their process knowledge to decide which parts of the plant, process and control, are of most benefit to the client at the current stage of the project lifecycle.

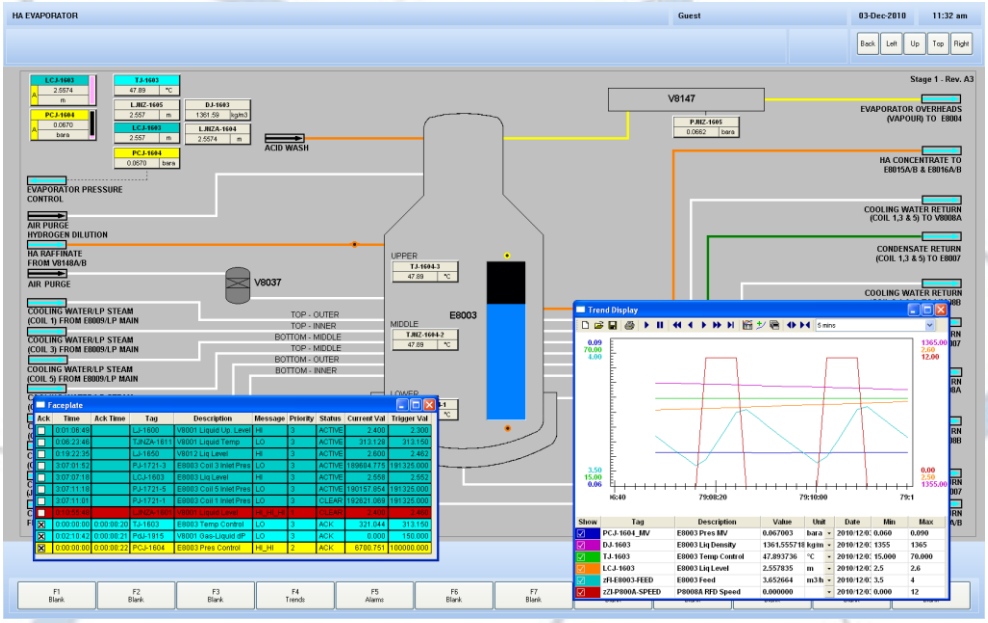

Figure 1 – Example Screen from the Simulator

The simulator has completed a full Factory Acceptance Test (FAT) and the model output has been compared to the expectations of the client's design and operational team.

On the whole, the simulator provided the client with the confidence that the process design was fit-for-purpose. However, the simulator found many discrepancies (some hazardous) and suggested some enhancements to the control system definition. These have now been corrected at the design stage.

The model paid for itself many times over by discovering a significant discrepancy in the process design that may otherwise have been found during commissioning. This discrepancy would have meant the plant throughput not being achieved and therefore the functional specification requirements not being met. It has been conservatively predicted that a delay of 2-3 months to

This document is the property of DBD Ltd Registered Office: Chadwick House, Birchwood Park, Warrington, Cheshire WA3 6AE Registered in England and Wales: No 03118924. VAT No. 836 6153 18
This is a CONTROLLED Document

commissioning testing would have resulted (at a cost of £6m to £9m). Due to DBD's efforts it was found in design stage so remedial action could be taken at low cost.

The simulator platform was partly chosen due to the ability to support the plant operations after the design stage is completed. The simulation looks like a control room DCS (e.g. with trends, alarms etc) and so plant operators were immediately comfortable with the visual side. The plant operator was keen to use the simulator for operator training, taking advantage of the fault injection system and scenario handling capability. The simulator can, in the future, be used to test plant modifications prior to implementation on plant.

The simulator was built with a 'generic' control room interface but when the actual plant control system is delivered and approved, the simulator will be merged so that it can provide offline operator training and control system testing with a high degree of realism.

Client Benefits

- Identification of discrepancies during the design stage, enabling remedial action to be taken at a low cost and preventing delays to the commissioning schedule
- A saving to the overall project budget of between £6M to £9M through the identification of a key design issue that was able to be redesigned prior to the commencement of manufacture of the main evaporator
- Longer-term benefits to control system testing and plant operator training

This document is the property of DBD Ltd Registered Office: Chadwick House, Birchwood Park, Warrington, Cheshire WA3 6AE Registered in England and Wales: No 03118924. VAT No. 836 6153 18
This is a CONTROLLED Document