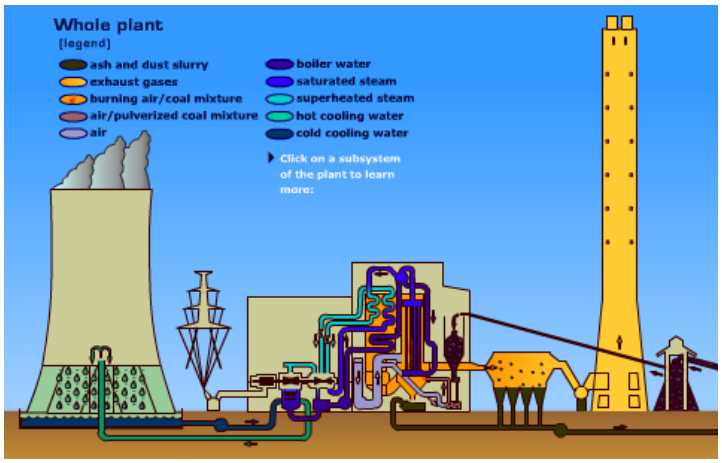
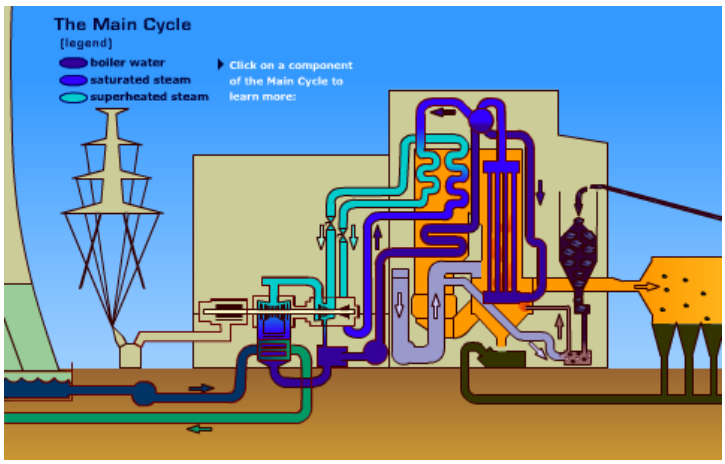
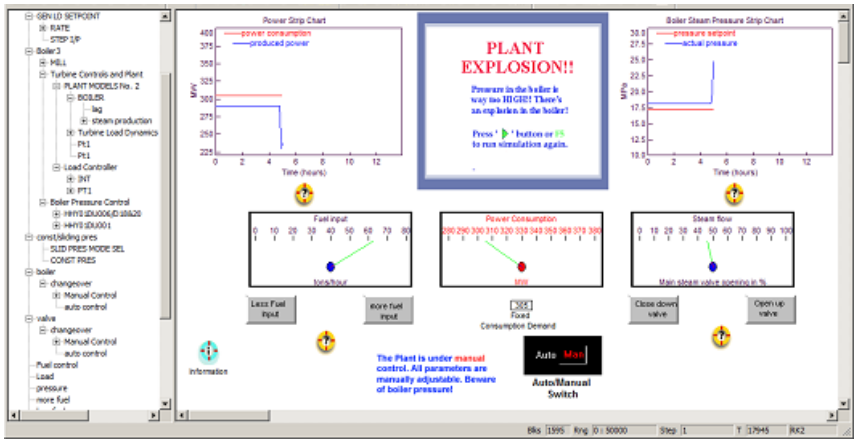
Steam Turbine Power Generation



Virtual Steam Plant webpage from University of Queensland



Steam Boiler Cycle from Virtual Steam Plant



Embed model of Stanwell Steam Boiler Cycle

Click to visit the University of Queensland Interactive Virtual Steam Power Plant tour.

A version of the Stanwell model was used to commission the controllers before going live on the plant. This resulted in a much shorter commissioning time than usual. The Embed model is located <ESSDistributor: I have attached the model and PDF to this email. You will need to put it on your website, then provide the link to it here.>

This model allows the operator to monitor the steam pressure in the boiler throughout the operation. The required safe boiler steam pressure (shown as a red line - denoted as pressure setpoint) is automatically determined by the control system and varies slightly with the power consumption. In order to keep the plant running safely, it is essential that the actual pressure (shown as a blue line) is maintained very close to the pressure setpoint (shown as a red line).

If the actual boiler steam pressure is not kept within the desired limits, warnings will appear suggesting corrective actions. If the pressure deviates significantly from the set point, the plant will go into automatic shutdown and the simulation will stop.

Model Architecture

The steam boiler model is placed in series with the Main Steam Pressure Demand to prevent large pressure errors from occurring between Pressure Demand and Actual Pressure. This allows for a natural progression in steam production while increasing unit load.

Random Electrical Load

If you click the FLUCTUATING DEMAND button, you will get a random walk change of the generator load demand set point for stressful plant operation. Built-in rate limiters control time to desired set point. The rate of increase or decrease is limited by the preset value (usually 7 MW / min).

CC1 (negative rate) and DD1 (positive rate) are the maximum rate of change allowable to Main Steam Pressure Setpoint when starting/ shutting down the plant (constant pressure mode). The reason why CC1 was made variable was to cater to plant disturbances and runbacks (loss of critical areas of plant where unit load maybe reduced from 350 - 175MW).

Fuel flow and pressure are input to Main Steam Demand

Summation of GEN LOAD DEMAND derivative (UEBEU), pressure trim (PROC) and sliding/constant pressure demand derivative (ROB1)to give Main Steam Demand (MS DMD). The "VOR" variable is eventually used to increase the primary air flow demand to the mills, which extracts the stored bed of pulverised coal (on mill table) and carries it into the furnace which adds additional firing to the boiler to assist in stabilising the pressure control (reduce pressure error). Note that many tests were performed to verify model response.

Stanwell model supports two "fixed droop" modes

To sustain a stable and consistent electric supply to the grid, generators at Stanwell rotate at 3000 RPM. When a major generator trips from the circuit, the system impedance changes and load shared across each machine increases. This results in additional torque applied to the generators causing then to spin slower which results in a frequency drop (or "droop"). This drop in frequency is compensated by increasing the steam pressure to apply more torque to the turbines, thereby increasing generator output to match the offset. That is why frequency control is superimposed on the Genload Demand to sustain a stable frequency output to the power grid network. Stanwell operates in two "fixed droop" (fixed frequency window of response) modes of 5% and 10% which is a frequency window of + or - 2.5HZ from 50HZ.