2017 Plant Simulation Conference
San Diego

Xcel Energy Plant King
And Plant Sherco
Full Scope Simulators
Western Services Corporation has delivered two full scope fossil power plant simulators for Xcel Energy, plant **King and Sherco** in Minnesota.

The Plant King simulator was then upgraded with a new model for the cyclone air dampers.

All process models were created using the 3KEYMASTER environment.
Timeline

• King Plant delivered November 2013
  – The project was declared RFT in November of 2013 and is being used as the training facility for King Plant.
  – In March 2016, the cyclone dampers were upgrade in the plant

• Sherco Unit 1 delivered January 2015
Xcel Energy operates major generating facilities that use a variety of fuel sources including coal, natural gas, nuclear fuel, water (hydro), oil, and refuse; they also have facilities that generate electricity from the wind and sun. In total, their plants are capable of producing more than 17,000 megawatts (MW) of electricity. They generate approximately two-thirds of their supplied power and buy the remainder from other electricity suppliers to meet their customers’ energy needs.

From Xcel’s website http://www.xcelenergy.com/
## 2013 Owned Generating Plants

<table>
<thead>
<tr>
<th>Type</th>
<th>Plants</th>
<th>Units</th>
<th>Summer Net Dependable Capacity in Megawatts (MW)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>13</td>
<td>27</td>
<td>7,597</td>
</tr>
<tr>
<td>Natural gas</td>
<td>27</td>
<td>69</td>
<td>6,758</td>
</tr>
<tr>
<td>Nuclear</td>
<td>2</td>
<td>3</td>
<td>1,594</td>
</tr>
<tr>
<td>Hydro</td>
<td>26</td>
<td>79</td>
<td>377</td>
</tr>
<tr>
<td>Diesel/Oil</td>
<td>2</td>
<td>14</td>
<td>383</td>
</tr>
<tr>
<td>Refuse-derived fuel</td>
<td>3</td>
<td>6</td>
<td>52</td>
</tr>
<tr>
<td>Wind</td>
<td>3</td>
<td>238</td>
<td>42*</td>
</tr>
<tr>
<td>Solar</td>
<td>4</td>
<td>4</td>
<td>0.01</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>77 owned generating plants</td>
<td>440</td>
<td>16,785</td>
</tr>
</tbody>
</table>

*Net generating capacity is 327 MW for Xcel Energy owned wind energy facilities. Summer net dependable capacity is determined to be lower because wind generation is an intermittent resource and is only available when ambient wind conditions exist.

From Xcel's website http://www.xcelenergy.com/
Allen S. King Generating Station

- 511MW single-unit coal-fired generating plant with a cyclone boiler. The unit provides base load electric service, operating 24 hours a day, seven days a week.

- Built in 1968

- The plant’s cyclone boiler burns up to 300 tons of coal an hour – about 2 ½ railroad carloads. A mile long, 600 ton-per-hour-capacity conveyor system several stories high, moves fuel from the coal yard to hoppers in the main building.

- Supplies hot water to neighboring Andersen Windows, a large window manufacturer.
Allen S. King Generating Station

- King plant also was the model for a successful and growing peregrine falcon restoration effort, as the first plant in the nation to place a falcon nest box on its stacks. Several other Xcel Energy plants have joined the effort, along with other generating facilities worldwide.
Xcel King

- Cyclone Burners Example
• The horizontal cyclone furnace is a cylindrical chamber designed to burn crushed, not pulverized, coal.

• Centrifugal action created by coal and air flow through the burner throws the heavier particles of coal into a molten layer of slag, which coats the interior of the cyclone. The lighter coal particles are burnt in suspension.
• The molten layer of slag is ash from the coal after the combustibles have been burned away.
Cyclone Model
• Air quality control system
  – SCR
    • NH3 storage and transport
  – Precipitators
  – SDA
    • Lime System
  – Fabric filter baghouse
    • Baghouse fire simulated
• NH3 transport and storage system
Recycle ash is mixed with ash sluice water and brought in to Mill Slurry supply tanks

FGD Byproduct system modeled as well
Electrical Model

• Full electrical generation and distribution model
• Main control system is virtual Emerson Ovation
• During the simulator project, a new turbine control package in Ovation was developed
• It was tested by Xcel Energy in parallel with testing done during FAT at WSC
• Issues were able to be found and fixes verified on the simulator
• BFPT controlled by Emulated Allen Bradley RSLogix 5000
• Two hard panels screens were developed to allow control
Simulator Room

• An old control room table was used to give a similar feel to the computer layout
• Two computers were dedicated as hard panel interfaces in the same location of the plant hardpanels
Remote Control Instructor Station

- Using a wireless, Windows-based Tablet PC, such as the HP Slate 2 platform, the instructor can roam the classroom and control the simulator load and training session from the Tablet PC
- More advantageous than previous handheld Pocket PC’s, which had limited Instructor Station capabilities
- The Tablet PC Instructor Station platform is similar to that of a Desktop or Laptop, but more portable
- Instructor has access to all simulation displays, P&IDs, etc. from where he/she can initiate simulation events
• Automatically monitors, records and grades critical trainee performance, as defined by the instructor.
SESSION 1
Wednesday, March 18, 2009, 09:55:52

Instructor Name: Charlie G Smith
Student Name: James
Team members: Sergei Thomas
Scenario Name:
TPR Names: 12

Comment: Test Case 12 for Training

TPR: 12
TPR duration: 637:29:27

1) MW:
   h3TM1C21.PV : Range: 400 500
      Min= 461.867; Max= 462.079; Max duration= 0; Number outside= 0

2) STM FLW:
   h3BM1P04.PV : Range: 3000 3200
      Min= 3122.4; Max= 3123.27; Max duration= 0; Number outside= 0

3) FW FLW:
   h3FW1P02.PV : Range: 2900 3100
      Min= 2978.97; Max= 2984.72; Max duration= 0; Number outside= 0

Integrated score = 100.00
Ovation Updates

• After delivery of the simulator on site, plant personal successfully updated logic to latest plant changes

• Able to now use as testbed for logic changes before being performed on the plant
• Plant King installed a new damper system for the Cyclone furnaces
• Changed number
  – 1/3, 2/3 old
  – 1/3, 1/3, 1/3 new
• This upgrade was done to lower NOx usage
Damper Upgrade 2016
Damper Upgrade 2016
• Prior to being installed on the plant, new Ovation control logic was installed into the simulator and tested
• This allowed the operators to training on new damper rotations for slag
• The developer of the Ovation control logic was the one doing the install into the simulator
  – Issues found can be directly fixed
• A quick trial of the new 1/3,1/3,1/3 “triasing” damper system showed ammonia usage dropped 40%  
• However, slagging problems during the upgrade prevented long term operation of “triasing” systems.  
  – Other procedures were changed as well and the investigation continues
Xcel Energy Plant Sherco Unit 1 was delivered on-site in January 2015. Unit 1 is a full scope simulator for a 730MW coal fired boiler with AQCS scrubbers attached.

In addition to operator training, the simulator will be used as a testbed for a new Metso maxDNA plant control system before being installed onto the main plant. The goal is to resolve issues with the new control system to reduce costs and avoid delays.

The Unit 1 simulator was installed successfully on site and is being used to verify logic before the plant upgrade.
Sherburne County (Sherco) Generating Station

- 2,222MW three-unit plant
  - Unit 1 – 680MW
  - Unit 2 – 682MW
  - Unit 3 – 860MW

Sherco is the largest in terms of square feet, steam production, power generation capability and coal consumption. Sherco’s boilers are more than 200 feet tall – taller than the dome of the Minnesota State Capitol building. Each boiler weighs about 8 million pounds and contains about 200 miles of steel tubing.

From Xcel’s website http://www.xcelenergy.com/
Units 1 and 2 have wet scrubbers, which use an alkaline spray to capture sulfur dioxide and ash.
Metso DNA control system was used as the main control system for Sherco Generating Station.

DNA is an automation and information platform for process control. It combines all controls for process, machine, quality, supervisory, drive, as well as optimizations, and mechanical condition monitoring into a single platform.
• Based in KS
• Contracted by Xcel Energy to help assist testing, scheduling and organization
• Delivered unit 1 simulator on site beginning of January 2015

• SAT testing was conducted in February 2015
Outage

- Major focus for Unit 1 Simulator was a new plant control scheme during outage

- Simulator was used as verification of controls before being put onto the real unit
• Metso control system was contained in four full sized cabinets

• Each containing 3-7 racked mounted computers, routers, and power supplies

• Cooling was done by several fans
• Virtual Metso DNA control system provided by Metso

• Emulated Ovation Boiler & Mill Control

• Emulated local Turbine protection and controls
Boiler & Mill Control
Boiler

- Dual path furnace, with separate fireball and tilt control
• Twelve scrubbers modeled
Lower Scrubbers
• Complete model with main and emergency generators modeled
• Extensive benchboard controls in Sherco Units 1 and 2
• Dual glasstops were used to simulate the full range of controls
Discrepancy Report

- WSC web system of keeping track of Discrepancy Reports (DRs) was used as the main tool to track DCS changes

- Metso and Xcel Energy was able to use WSC’s DR system to record, test, and verify all needed issues with HMIs and Control logic was resolved before outage

- Over 100 DRs were created for DCS, due to the high fidelity of testing capable with a full scope simulator
• The use of Western Service's tools and simulation solutions let Xcel Energy complete two full scope simulators.

• The Plant King simulator is being actively used for plant personal training and DCS tests.

• Cyclone damper updates were tested in the simulator first.

• The Plant Sherco simulator is being used to verify the DCS upgrade before it is deployed to the plant.
Western Services Corporation
7196 Crestwood Blvd, Suite 300
Frederick, MD 21703
www.ws-corp.com

Joel Dixon
301-644-2500, ext. 2649
dixonj@ws-corp.com