Converted turbine, new boilers and stacks: reliable, responsible, ready for growth

MIKE LARSON
University of Illinois at Urbana-Champaign
Director of Utilities Production

MIKE BREWER
Mechanical Engineer
Abbott Power Plant

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Illinois at a Glance

- A leading research university
- One of original Big Ten schools
- Sits on 6,370 acres
- 44,000+ undergrads and grad students
- 11,000+ faculty and staff
Abbott at a Glance

- **Primary** heat and electricity provider
- Constructed **1940**
- Has **always** used CHP
- Serves **19.4 million sq ft** of space, 260 buildings
- **84 MW** electric generation capacity
- **1,235,000 lb/hr** steam production capacity
Abbott and the Environment

For reliability & cost-effectiveness

Progressive: first JBR in North America

Beats proposed EPA emission limits for CO₂ NOₓ Hg
New boilers and stacks

Project criteria

- increased reliability
- lower NOx emissions
- higher efficiency
- additional electric generating capacity
- the ability to run the plant 100% on natural gas
- redundancy for our JBR fan
- more plant flexibility
New boilers and stacks

Moving to higher pressure

New 850 psig gas boilers provide best payback to feed 850 psig and 325 psig turbine generators.
Site preparation – first boiler

New boilers and stacks
## Original one-phase schedule

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statement of work</td>
<td>Spring 2014</td>
</tr>
<tr>
<td>Design startup</td>
<td>January 2015</td>
</tr>
<tr>
<td>Contractors in place</td>
<td>September 2016</td>
</tr>
<tr>
<td>Old boiler shutdown</td>
<td>March 2017</td>
</tr>
<tr>
<td>Boiler delivery</td>
<td>August 2017</td>
</tr>
<tr>
<td>New boiler commissioning – December</td>
<td>December 2017</td>
</tr>
</tbody>
</table>
New boilers and stacks

Dismantling the old
New boilers and stacks

Boiler removal
New boilers and stacks

New boilers arrive
New boilers and stacks

Steel fabrication workaround
New boilers and stacks

Two new stacks in fall 2017
Lessons learned:
Precision modeling crucial
Lessons learned:
BIM 360
Glue tool helped

New boilers and stacks
Lessons learned:
Adopt two-phase design process

Phase 1:
- Process flow diagram
- Detailed lists
- Piping and instrumentation
- Existing plant
- Hazardous materials assessment and remediation plan
- Major equipment general arrangements
- Cost analysis and scope adjustment

Phase 2:
- Updated Phase 1 drawing set
- Demolition and new configuration
- Contract specification only for items not on drawings
- Where possible (not allowed in Illinois), complete as design-build so contractor engaged in planning and design

New boilers and stacks
More lessons learned

- Transfer responsibility for managing/updating model to coordinating contractor at bid award.
- Require contractor competence with 3D model, keeping refreshed with red lines for use by team.
- Complete updating, consolidating of our plant piping standards.
- Increase use of manufacturer model specific parts.
- Require more tailoring of standard details…. 
More lessons learned

- Increase precision in configuration of structural and decking design; improve communications on expectations and capabilities.
- Continue requiring on-site time by the engineering team (mechanical, structural, electrical).
- More precisely define instrument field location in the model and/or drawings, model the route of large conduit.
- Continue daily, weekly on-site, face-to-face meetings of owner, contractor and engineer.
- Continue contractor commitment for site cleanliness.
Converted turbine

Goal: Increased efficiency and reduced costs
Abbott Power Plant load duration curve
Project payback

< 5 years based on $2 per MWh production cost
Moving forward

- **Purchase orders** – Fourth quarter 2016 - early 2017
- **Turbine conversion design completed** – April 2017
- **Turbine connected, piping configured** – September 2017 - December 2017
- **Turbine commissioned** – Early 2018
Converted turbine

Modifications needed

Turbine Modifications

- REMOVE STG 8-10 DIAPHRAGMS & WHEELS
- BLANK DIAPHRAGM AND PACKING
- CONNECTION TO GLAND CONDENSER
- STEAM SEAL CONNECTION
- TWO (2) 10' EXHAUST CONNECTIONS
- MACHINE STEAM FACE & HORIZ JOINT SUPPORT
- NEW STAGE 2-7 DIAPHRAGMS
- NEW STAGE 1 NOZZLE PLATE
- NEW 7 STAGE SOLID ROTOR
Piping connections intricate
Converted turbine

Piping connections tightly secured during installation
<table>
<thead>
<tr>
<th></th>
<th>Original Design</th>
<th>Post Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inlet Pressure</strong></td>
<td>840 psig</td>
<td>840 psig</td>
</tr>
<tr>
<td><strong>Inlet Temperature</strong></td>
<td>750° F</td>
<td>740° F</td>
</tr>
<tr>
<td><strong>Inlet Flow</strong></td>
<td>127,200 lb/hr</td>
<td>168,000 lb/hr</td>
</tr>
<tr>
<td><strong>Extraction Pressure</strong></td>
<td>160 psig</td>
<td>150 psig</td>
</tr>
<tr>
<td><strong>Extraction Flow</strong></td>
<td>0 - 100,000 lb/hr</td>
<td>0 - 28,000 lb/hr</td>
</tr>
<tr>
<td><strong>Exhaust Pressure</strong></td>
<td>not installed</td>
<td>50 psig</td>
</tr>
<tr>
<td><strong>Exhaust Flow</strong></td>
<td>not installed</td>
<td>0 - 140,000 lb/hr</td>
</tr>
<tr>
<td><strong>Condenser Flow</strong></td>
<td>27,000 - 127,000 lb/hr</td>
<td>NA</td>
</tr>
<tr>
<td><strong>Output</strong></td>
<td>12,500 kW</td>
<td>7,750 kW</td>
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Director of Utilities Production
University of Illinois at Urbana-Champaign
217.333.5139
mjlarsol@illinois.edu

MIKE BREWER
Mechanical Engineer
Abbott Power Plant
217.333.7067
mkbrewer@illinois.edu

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Abbott Power Plant thanks our vendors for their participation.