Lessons Learned from Commissioning CHP Plants

Herbert Tull, PE | Jacobs Engineering Group Inc.
1. Quality
2. Strategy
3. Sequence
Lesson 1 Quality
Lesson 1 Quality

“Quality is the fitness for use.”

Joseph M. Juran
Lesson 1 Quality

Inspections can identify good or bad

...but inspection alone cannot fix anything.
Lesson 1 Quality

When should you verify quality?
Lesson 1 Quality

QUALITY MUST BE BUILT IN DURING CONSTRUCTION
Lesson 1  Quality

QUALITY

CANNOT BE BOLTED ON AT THE END
Lesson 1 Quality

Was it factory tested?

Yes!

But... Err..... Oops.
Lesson 1 **Quality**

Quality has tasks for *everybody.*

- **Vendors**
  - Submittals & Start-up

- **Contractors**
  - Inspections & Installation

- **AHJ Inspectors**
  - Boiler & Electrical

- **Commissioning**
  - Review, PFC, FPT & Plant
Lesson 1 Quality

Trust but verify.

This vendor provided his startup sheet data.

The boiler efficiency calculated out to 106%
Lesson 2 Strategy
Lesson 2 **Strategy**

Construction

Operation

MAGIC?
Lesson 2 Strategy

SEQUENCE + COMMUNICATION = TEAMWORK
Lesson 3 Sequence
Lesson 3 **Sequence**

Plant systems have dependencies. Build the wall from bottom to top.
Lesson 3 Sequence

Integrated Plant Operations

- Steam Demand
- Electric Demand
- Emissions Control
- HRSG Steam
- HRSG Boilers
- Gas Turbine & Generator
- Feedwater
- Water
- Fuel Delivery

Basic Services

- Electric Power
- Plant Ctrl System
- Compressed Air
Lesson 3 **Sequence**

Integrated Plant Operations

- Steam Demand
- Electric Demand
- Emissions Control
- HRSG Steam
- HRSG Boilers
- Gas Turbine & Generator

Plant Utility Systems

- Feedwater
- Water
- Fuel Delivery
- Electric Power
- Plant Ctrl System
- Compressed Air
Lesson 3 Sequence

Integrated Plant Operations
- Steam Demand
- Electric Demand
- Emissions Control

Production Equipment
- HRSG Steam
- HRSG Boilers
- Gas Turbine & Generator
- Feedwater
- Water
- Fuel Delivery
- Electric Power
- Plant Ctrl System
- Compressed Air
Lesson 3 Sequence

Integrated Plant Operations

- Steam Demand
- Electric Demand
- Emissions Control
- HRSG Steam
- HRSG Boilers
- Gas Turbine & Generator
- Feedwater
- Water
- Fuel Delivery
- Electric Power
- Plant Ctrl System
- Compressed Air

Outside Connection
Lesson 3 Sequence

Integrated Plant Operations

- Steam Demand
- Electric Demand
- Emissions Control
- HRSG Steam
- HRSG Boilers
- Gas Turbine & Generator
- Feedwater
- Water
- Fuel Delivery
- Electric Power
- Plant Ctrl System
- Compressed Air

Total Capacity / Efficiency
Lesson 4 Communication
## Lesson 4  **Communication**

### Daily schedules for morning meetings

<table>
<thead>
<tr>
<th>Date</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/15</td>
<td>Off</td>
<td>1/16 Set up &amp; test chemical injection system NALCO, Polymer &amp; Caustic Pumps</td>
<td>1/17 CTG crank testing FGC Startup (Vendor) Fuel Gas skid start</td>
<td>1/19 First Fire Day (First Fire Postponed)</td>
<td>1/20 CTG First Fire CTG Trip testing</td>
<td>1/21 Catch Up Day</td>
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<tr>
<td></td>
<td>(GE on site)</td>
<td>HRSG Fill Ateanserator line flush Test run Ammonia fans</td>
<td>Set up Glycol system &amp; test run electric heater Installed steam siphons</td>
<td>FGC Startup (Vendor)</td>
<td>FGC Startup (Vendor)</td>
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<td></td>
<td></td>
<td></td>
<td>Set up CBD system Blowdown HRSG modules</td>
<td>Coolung water tuning</td>
<td>Fuel Oil Pump Startup</td>
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<td></td>
<td>Fuel Oil Heater startup as needed:</td>
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<td></td>
<td></td>
<td>Tune HRSG drum level</td>
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<tr>
<td>1/22</td>
<td>1/23 (start 12 hr days)</td>
<td>1/24 Fuel 1 Mapping RO/makepup FPT - remote start</td>
<td>1/25 Fuel 1 Mapping Fuel Oil Drain Tank floats &amp; vent installed as needed:</td>
<td>1/26 Fuel 1 Mapping</td>
<td>1/26 Fuel 1 Mapping</td>
<td>1/28 Catch-up day</td>
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<tr>
<td></td>
<td>Start CTG at 8:00am</td>
<td>Water Sampling FPT as needed: Tune BOP control loops</td>
<td>Tune BOP control loops</td>
<td>Fuel Oil Drain Tank startup?</td>
<td>Feedwater FPT (?) Glycol FPT?</td>
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<td>Electrical Phase Test(10a)</td>
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<td>Synchronize CTG Electrical Testing</td>
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<tr>
<td></td>
<td>Fuel 1 Mapping (gas) as needed: Tune BOP control loops</td>
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Lesson 4 **Communication**

Each day shows the expected tasks.

Schedule vendors on site only when needed.
Summary

Sweet success!

It’s a cold winter morning your CHP plant is online, meeting campus power and steam demands.
Questions?

Easy as \[3.14159\ 226535\ 89793\ 23846\ \ldots\]