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*Presentation for:*

# THE UNIVERSITY OF OKLAHOMA, NORMAN, OK

## Utility Plant No. 4

**Jack Kelly**

# OKLAHOMA UNIVERSITY, CAMPUS UTILITIES

## UNIVERSITY CAMPUS ISSUES

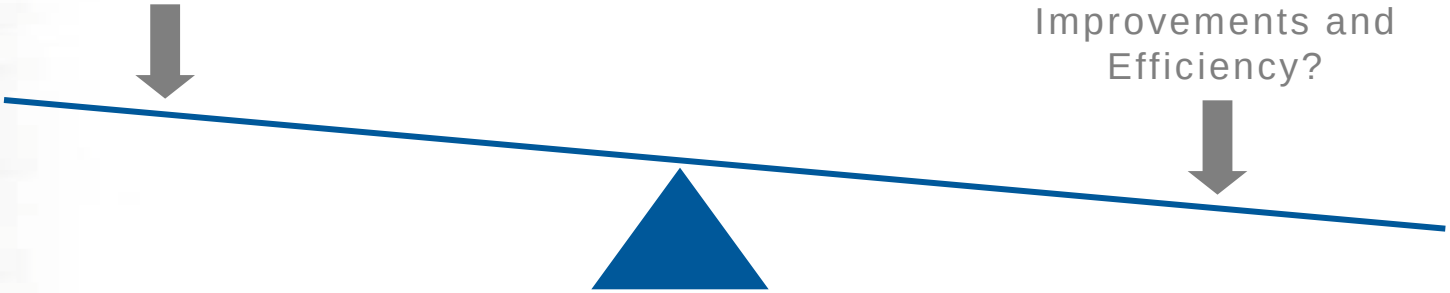
→ Enrollment Growing

→ Utilities Aging

→ Budgets Tight

Continue Addressing Immediate Infrastructure Needs?

Change Course – Invest in Long Term Improvements and Efficiency?



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# PRIOR STUDY

Prior Independent Studies
Recommended Upgrades for:

- Chilled Water
- Steam
- Electrical

2006 – $20 Million Approved for new 6,000-ton Chilled Water Plant

Ready for Detailed Design

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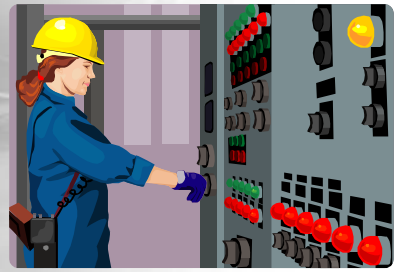
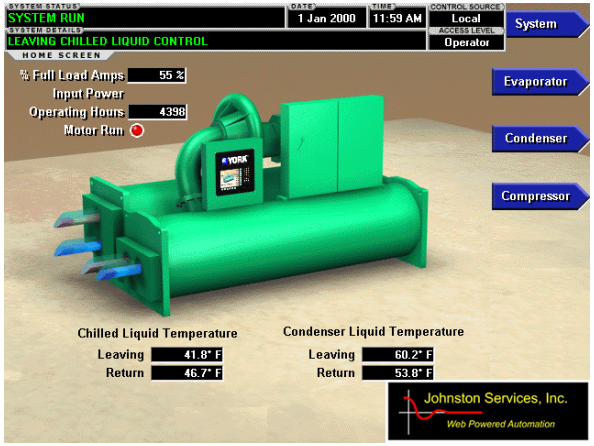
# TAKE A BROADER LOOK

## Suggestion

## Take a Broader Look at its Entire Utility Infrastructure





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# NORMAN, OK CAMPUS UTILITIES

## Steam System:

- Age of Existing Boilers **40 – 62 yrs**. Old.
- Steam System pushed to Capacity Year Round:
  - Steam generation for Electricity
  - Chilled-Water Production
  - Domestic Hot Water
  - Process
- Maintenance & Upgrades Limited Due to Lack of Redundancy

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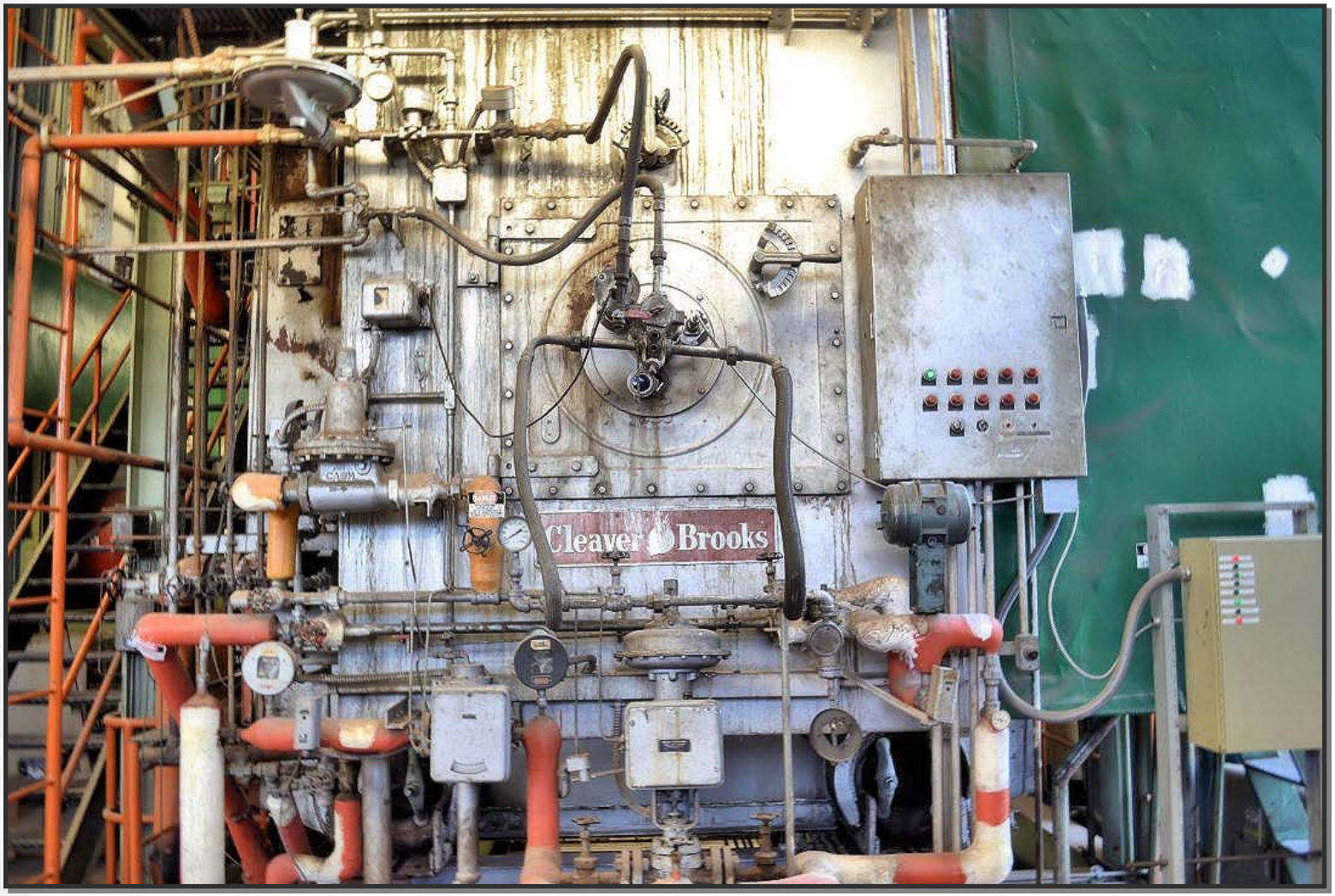
# Existing Watertube Boilers 40 – 62 yrs

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# Valve Repairs in Existing Power Plant

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# 2008 STUDY APPROVED

## Recommended Improvements:

- 15 MW of Gas Turbine Power Generation
- 160klbs/hr Steam - Heat Recovery Steam Generators
- 10,000 tons cooling capacity vs. 6,000 tons
- Space for 3 future 2500 ton chillers
- Optimize System hydraulics for both Steam and Chilled-Water Distribution Piping

**Overall Estimated UP-4 Project: $60 million**

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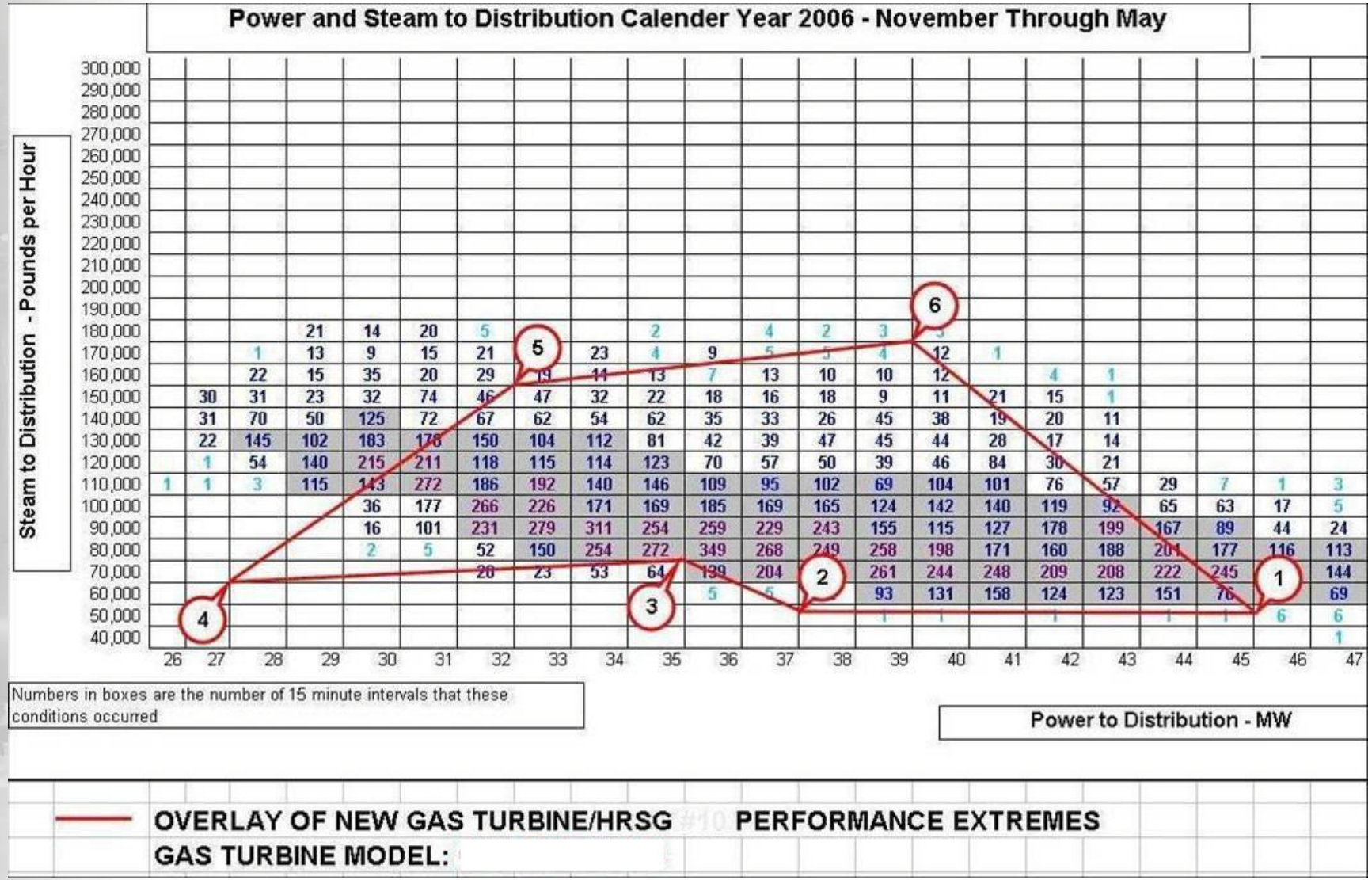
# “RIGHT SIZING”

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# FEBRUARY 2010

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# JUNE 2011

# TWIN SOLAR TAURUS 70 CTGS

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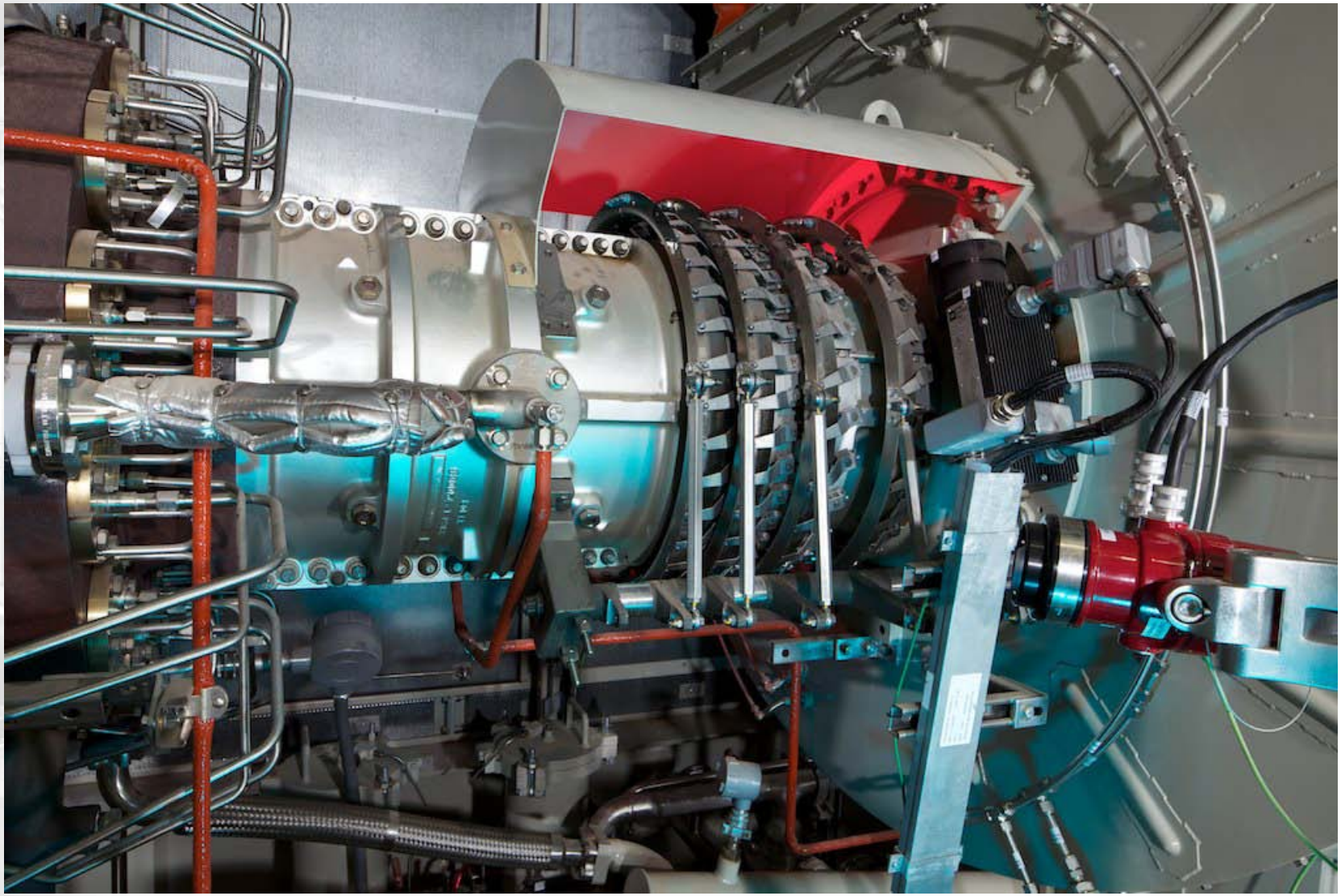
# SOLAR TAURUS 70 COMBUSTION TURBINE



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# CHP FEATURES UTILITY PLANT - 4

Features:

- Two 7.5 MW Combustion Turbine Generators
- Two 80klbs/hr Heat Recovery Steam Generators
- One 60klbs/hr Package Boiler
- Four 2500 Ton Chillers + (3 future)
- Seven cooling tower cells
- 1,300 ft. Utility tunnel

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# SOLAR, TAURUS 70 & RENTECH HRSG

## Cogen Operations with Fired Ductburners:

| | |
|---|---|
| • CTG-1 Taurus 70 | 6,722 kW (Guaranteed) |
| • CTG-2 Taurus 70 | 6,722 kW (Guaranteed) |
| | **13,444 kW** |
| • HRSG -1 Rentech | 80,000 lbs/hr (fired) |
| • HRSG -2 Rentech | 80,000 lbs/hr (fired) |
| | 160,000 lbs/hr |

125 psig @ 356°F

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# Performance Testing

CTG - 1

| Engine Serial Number 0656B | Site Performance Test Results (Natural Gas Operation) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Data Point** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | Avg |
| Barometric Corrected Elevation [Feet] | 1284.2 | 1296.2 | 1308.8 | 1316.4 | 1330.8 | 1330.2 | 1368.7 | 1369.5 | 1345.0 | 1327.7 |
| Air Inlet Temperature [Deg. F) | 55.96 | 57.13 | 58.17 | 58.93 | 59.73 | 59.38 | 60.16 | 59.06 | 57.53 | 58.45 |
| Air Inlet D.P. [inH2o] | -4.21 | -4.20 | -4.19 | -4.19 | -4.27 | -4.19 | -4.18 | -4.10 | -4.19 | -4.19 |
| Exhaust D.P. [inH20] | 3.41 | 3.29 | 3.52 | 3.45 | 3.44 | 3.37 | 3.42 | 3.40 | 3.56 | 3.43 |
| | **Power Analysis [Kw]** | | | | | | | | | |
| Power Guaranteed for Site Conditionds [kw] | 6797 | 6765 | 6737 | 6711 | 6680 | 6694 | 6660 | 6696 | 6744 | 6720 |
| As Measured Site Power [kw} | 7055 | 7023 | 7025 | 6982 | 6954 | 6959 | 6957 | 6967 | 7002 | 6992 |
| Predicted-Test | 258 | 258 | 288 | 271 | 274 | 265 | 297 | 271 | 258 | 271 |
| Percent Delta | 3.79% | 3.82% | 4.27% | 4.04% | 4.10% | 3.96% | 4.46% | 4.05% | 3.83% | **4.04%** |
| | **Heat Rate Analysis [Btu/kW-hr]** | | | | | | | | | |
| Heat Rate Guaranteed for Site Conditions [Btu/kw-hr] | 10656 | 10668 | 10679 | 10690 | 10703 | 10696 | 10708 | 10691 | 10672 | 10685 |
| As Measured Heat Rate [Btu/kw-hr] | 10382 | 10390 | 10408 | 10419 | 10442 | 10442 | 10446 | 10427 | 10421 | 10420 |
| Predicted-Test | -273.7 | -277.7 | -270.5 | -271.4 | -260.5 | -253.7 | -262.3 | -264.0 | -250.7 | -265.0 |
| Percent Delta | -2.57% | -2.60% | -2.53% | -2.54% | -2.43% | -2.37% | -2.45% | -2.47% | -2.35% | **-2.48%** |

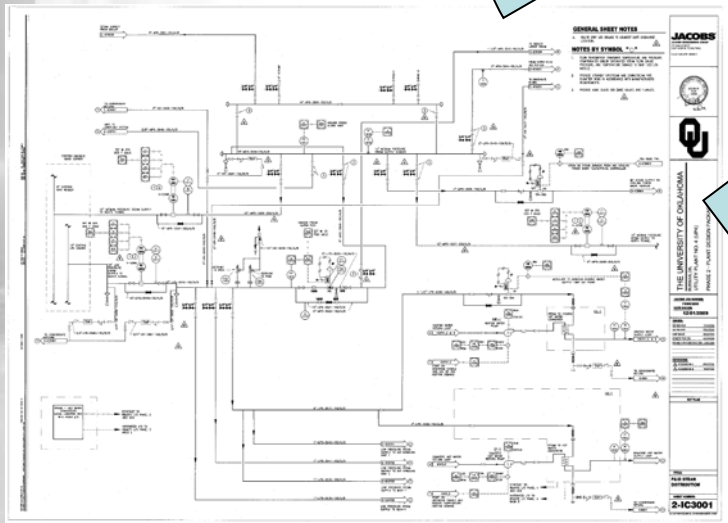
CTG - 2

| Engine Serial Number 0657B | Site Performance Test Results (Natural Gas Operation) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Data Point** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | Avg |
| Barometric Corrected Elevation [Feet] | 1039.6 | 1046.5 | 1054.0 | 1063.4 | 1072.8 | 1088.8 | 1102.3 | 1138.3 | 1158.6 | 1084.9 |
| Air Inlet Temperature [Deg. F) | 53.84 | 53.98 | 55.74 | 56.66 | 57.25 | 57.75 | 58.78 | 59.40 | 60.29 | 57.08 |
| Air Inlet D.P. [inH2o] | -4.17 | -4.27 | -4.27 | -4.27 | -4.26 | -4.23 | -4.25 | -4.23 | -4.19 | -4.24 |
| Exhaust D.P. [inH20] | 5.88 | 6.14 | 6.35 | 6.59 | 6.48 | 6.63 | 6.60 | 6.87 | 7.14 | 6.52 |
| | **Power Analysis [Kw]** | | | | | | | | | |
| Power Guaranteed for Site Conditionds [kw] | 6905 | 6898 | 6852 | 6827 | 6811 | 6795 | 6769 | 6738 | 6706 | 6811 |
| As Measured Site Power [kw} | 7107 | 7117 | 7106 | 7059 | 7030 | 7015 | 6986 | 6968 | 6935 | 7036 |
| Predicted-Test | 202 | 219 | 254 | 232 | 219 | 220 | 217 | 230 | 229 | 225 |
| Percent Delta | 2.93% | 3.17% | 3.71% | 3.39% | 3.21% | 3.24% | 3.20% | 3.41% | 3.41% | **3.30%** |
| | **Heat Rate Analysis Btu/kW-hr]** | | | | | | | | | |
| Heat Rate Guaranteed for Site Conditions [Btu/kw-hr] | 10627 | 10630 | 10649 | 10658 | 10664 | 10669 | 10680 | 10689 | 10701 | 10663 |
| As Measured Heat Rate [Btu/kw-hr] | 10409 | 10425 | 10435 | 10433 | 10450 | 10454 | 10462 | 10468 | 10474 | 10445 |
| Predicted-Test | -218 | -205 | -214 | -225 | -214 | -215 | -218 | -221 | -227 | -218 |
| Percent Delta | -2.05% | -1.93% | -2.01% | -2.11% | -2.01% | -2.02% | -2.04% | -2.07% | -2.12% | **-2.04%** |

# TRAINING

**Insure Success**

**Do the Training**



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# Utility Plant – 4

February - 2012

Questions?

Across from OU's high-profile Memorial Stadium, UP-4 was designed to blend inn with the surrounding campus fabric.