

JACOBS



IDEA 27th Annual Campus Energy Conference

CHP FACILITY TRAINING THE UNIVERSITY OF OKLAHOMA



Existing Campus Utilities

Power Generation (1948)

- 4 Superheated Steam Boilers
- 4 Steam Turbine Generators
- 16 MW Power Generation

Chilled Water Plant #1 (1951)

- 5 Chillers
- 5,000 tons Electric Driven
- 6,000 tons Steam Turbine

Chilled Water Plant #2 (1962)

- 3 Chillers
- 5,000 tons Electric Driven



Project of the Year 2012



2013 ACEC— Texas - Gold Medal Engineering Excellence – Energy

2013 ACEC – National Recognition Award - Energy



New Utility Plant #4 (UP – 4)



Solar Taurus 70
Combustion
Turbines
Generators (2)
@ 7.5 MW

Total 15 MW

York 2,500 ton
Chillers (4)
@ 10,000 tons
Future (3)
@ 2,500 tons

Total 17,500
tons

Rentech HRSGs
75klbs/hr (2ea.)
Package Boiler
60klbs/hr

Total 210klbs/hr

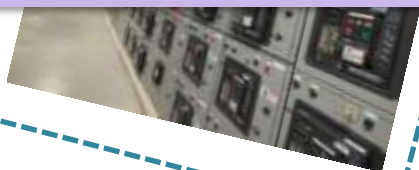


Training Is Required by Specifications

Millions of Dollars Invested



Equipment Training
Vendor Responsibility by Specification





Why Systems Training?

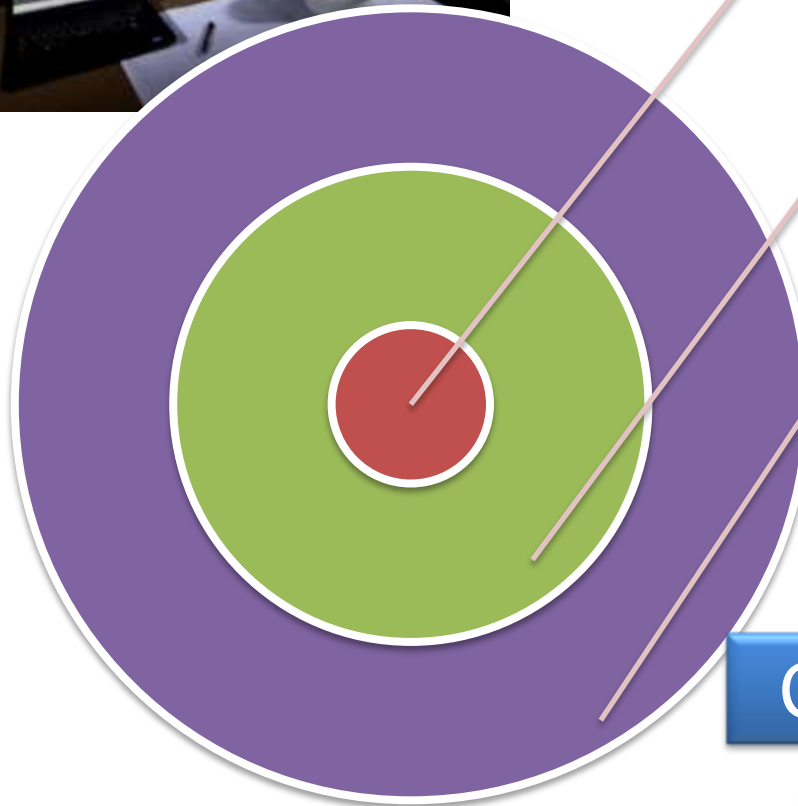


Connecting the Dots





Train Staff - State of the Art Facility



2012 State of the Art
CHP & Chiller Plant

'50s & '60s Steam &
Electric Chillers

1948 Vintage
Power Plant

Capital Investment \$60MM



O&M Staff Training

Two Parts

Vendor Training

Systems Training



Equipment Specs



By Contract



O&M Staff Training

Vendor Training

- Typically found in MasterFormat
 - PART 3.0 – EXECUTION
- Generally for most if not all major equipment
 - Gas Turbine Generators
 - HRSGs
 - Package Boilers
 - Chillers
 - Cooling Towers
 - Switchgear
 - Pumps
 - Gas Compressors
 - RO/Water Treatment
 - Emergency Gen





O&M Staff Training

Typical Example of Requirements Found in Specifications

3.8 TRAINING

Engage a factory-authorized service representative to train Owner's Operations & Maintenance to adjust, operate, and (fill in the blank).

This is much too Generic





O&M Staff Training

If its not in the Spec...

3.5 TRAINING

- A. Provide training, at the Owner's facility, for the following personnel so that the Owner can operate, maintain, change system configuration, and repair the complete system:
1. Training for Operators shall be conducted to accommodate a multiple shift schedule.
 2. Separate training sessions will be held for each of the following groups. Engineers have an option of attending any session they want:
 - a. Plant Operators (Minimum of 4 sessions over three weeks).
 - b. Mechanical Maintenance Technicians (Minimum of 2 sessions).
 - c. Electrical/ Instrumentation Maintenance Technicians (Minimum of 2 sessions).
 3. Prior to project closeout and field acceptance testing, provide training plan and schedule including the following information:
 - a. List of classes/courses.
 - b. Description of course.
 - c. Duration of course.
 - d. Sequence of courses.
- B. Provide competent, factory authorized personnel to provide complete training and instruction to O&M personnel.
- C. Provide the name and resume of proposed instructor, instructor must have at least 5 years experience teaching the designated course. Instructor's primary language must be English.
- D. Provide training manual that includes, as a minimum, the following:
1. Course objective.
 2. Course outline.
 3. Theory of operation.
 4. Case studies that demonstrate application, operation, troubleshooting, repair and maintenance of equipment.
 5. Notes that supplement and enhance information provided in the manufacturer's operation and maintenance manuals.
 6. List of references for further independent study.
- E. Overview Training for groups:
1. Course shall cover, as a minimum, the following topics for 15 to 20 persons:
 - a. Describe CTG equipment, interconnections, functions and capabilities.
 - b. Review system terminology, abbreviations and acronyms.
- F. Operator Training:
1. Operator-training course shall be conducted at times that accommodate a multiple shift schedule. A minimum of four, eight-hour, on-site training sessions are required.
 2. The course shall be an in-depth instruction on the CTG and Package equipment.

he shall enable the Owner's operators to be proficient in the topics, as a minimum:
Start-up, Normal Operation and shutdown of equipment.
Response actions to hardware and software failures.
Response to system alarms.
Modifying and locating setpoints.
Review interface to process control system.
Control loop tuning concepts and methods.

Mechanical Maintenance Training:
The course shall be conducted in two separate and identical sessions in order to train half of the workforce at one time.
The course shall be an in-depth instruction on the CTG and Package equipment.
The course shall enable the Owner's operators to be proficient in the topics, as a minimum:
Start-up, Normal Operation and shutdown of equipment.
Response actions to mechanical equipment failures.
Response to System alarms.
Mechanical Maintenance Training:
General design and operational characteristics of the turbine/generator set and supporting auxiliaries.
General maintenance considerations for the turbine/generator set, including inspection plans.
Outage planning and considerations (general) for combustor, hot gas path, major overhauls.
Spares parts planning and considerations.
Specific maintenance considerations for the turbine/generator set including but not limited to:

- Testing methods (visual, NDE):
Description of special tools and their use
Air inlet filtration and cooling systems
Inlet guide vanes
Emission control devices
Lifting considerations (weights, attachment points, etc.)
Disassembly/reassembly required for combustor, hot gas path inspections
Casing removal considerations
Bearing (radial and thrust) disassembly, inspection, and reassembly - Turbine, generator, starting package, gearbox.
Alignment considerations (hot/cold, doweeling, etc.)
Fuel system, including fuel nozzle and combustor disassembly, inspection, and reassembly
Compressor and turbine blade (stationary, rotating) inspection
Compressor, turbine, generator seal disassembly, inspection, reassembly
Starting package and turning gear
Compressor wash systems
Generator cooler removal, inspection, assembly
Filters, other consumable items

3. The course shall enable the Owner's operators to be proficient in the following topics, as a minimum:
 - a. Start-up, Normal Operation and shutdown of equipment.
 - b. Response actions to hardware and software failures.
 - c. Response to system alarms.
 - d. Modifying and locating setpoints.
 - e. Review interface to process control system.
 - f. Control loop tuning concepts and methods.

Mechanical Maintenance Training:

1. Mechanical maintenance shall be conducted in two separate and identical sessions in order to train half of the workforce at one time.
2. The course shall be an in-depth instruction on the CTG and Package equipment.
3. The course shall enable the Owner's operators to be proficient in the following topics, as a minimum:
 - a. Start-up, Normal Operation and shutdown of equipment.
 - b. Response actions to mechanical equipment failures.
 - c. Response to System alarms.
4. Maintenance Training for CTG- Mechanics
 - a. General design and operational characteristics of the turbine/generator set and supporting auxiliaries.
 - b. General maintenance considerations for the turbine/generator set, including inspection plans.
 - c. Outage planning and considerations (general) for combustor, hot gas path, major overhauls.
 - d. Spares parts planning and considerations.
 - e. Specific maintenance considerations for the turbine/generator set including but not limited to:
 - 1) Testing methods (visual, NDE)
 - 2) Description of special tools and their use
 - 3) Air inlet filtration and cooling systems
 - 4) Inlet guide vanes
 - 5) Emission control devices
 - 6) Lifting considerations (weights, attachment points, etc.)
 - 7) Disassembly/reassembly required for combustor, hot gas path inspections
 - 8) Casing removal considerations
 - 9) Bearing (radial and thrust) disassembly, inspection, and reassembly - Turbine, generator, starting package, gearbox.
 - 10) Alignment considerations (hot/cold, doweeling, etc.)
 - 11) Fuel system, including fuel nozzle and combustor disassembly, inspection, and reassembly
 - 12) Compressor and turbine blade (stationary, rotating) inspection
 - 13) Compressor, turbine, generator seal disassembly, inspection, reassembly
 - 14) Starting package and turning gear
 - 15) Compressor wash systems
 - 16) Generator cooler removal, inspection, assembly
 - 17) Filters, other consumable items

You will not get it.....!!!!



O&M Staff Training

**SPELL IT OUT
BE SPECIFIC**

3.5 TRAINING

- A. Provide training, at the Owner's facility, for the following personnel so that the Owner can operate, maintain, change system configuration, and repair the complete system:
 - 1. Training for Operators shall be conducted to accommodate a multiple shift schedule.
 - 2. Separate training sessions will be held for each of the following groups. Engineers have an option of attending any session they want:
 - a. Plant Operators (Minimum of 4 sessions over three weeks).
 - b. Mechanical Maintenance Technicians (Minimum of 2 sessions).
 - c. Electrical/ Instrumentation Maintenance Technicians (Minimum of 2 sessions).
 - 3. Prior to project closeout and field acceptance testing, provide training plan and schedule including the following information:
 - a. List of classes/courses.
 - b. Description of course.
 - c. Duration of course.
 - d. Sequence of courses.
- B. Provide competent, factory-sanitized personnel to provide complete training and instruction to O&M personnel.
- C. Provide the name and resume of proposed instructor. Instructor must have at least 5 years experience teaching the designated course. Instructor's primary language must be English.
- D. Provide training manual that includes, as a minimum, the following:
 - 1. Course objective.
 - 2. Course outline.
 - 3. Theory of operation.
 - 4. Case studies that demonstrate application, operation, troubleshooting, repair and maintenance of equipment.
 - 5. Notes that supplement and enhance information provided in the manufacturer's operation and maintenance manuals.
 - 6. List of references for further independent study.
- E. Overview Training for groups:
 - Course shall cover, as a minimum, the following topics for 15 to 20 persons:
 - a. Describe CTG equipment, interconnections, functions and capabilities.
 - b. Review system terminology, abbreviations and acronyms.
- F. Operator Training:
 - 1. Operator-training course shall be conducted at times that accommodate a multiple shift schedule. A minimum of four, eight-hour, on-site training sessions are required.
 - 2. The course shall be an in-depth instruction on the CTG and Package equipment.





O&M Staff Training

Linking the Two Together

Vendor Training

- Chillers
- Cooling Towers
- Combustion Turbines
- HRSGs
- RO/Water Treatment
- Switchgear



Systems Training

- Chilled Water System
- Condenser Water System
- Power Generation Systems
- Steam System
- Makeup Water
- Electrical Systems



Course Development

ADDIE Model

Analysis

Design

Deve

Imple

Evalu

Type of Training per 1 hour	Low Hours	High Hours
	Per hour of Instruction	Per Hour of Instruction
Stand-up training (classroom)	43	185
Self-instructional print	40	93
Instructor-led, Web-based training delivery (using software such as Centra, Adobe Connect, or WebEx-two-way live audio with PowerPoint)	49	89
E-learning Developed <u>without</u> a Template		
Text-only; limited interactivity; no animations		152
Moderate interactivity; limited animations		186
High interactivity; multiple animations		243
E-learning Developed within a Template		

Type of Training per 1 hour	Low Hours Per hour of Instruction	High Hours Per Hour of Instruction
Stand-up training (classroom)	43	185
Self-instructional print	40	93
E-learning Developed <u>without</u> a Template		
Text-only; limited interactivity; no animations	93	152
Moderate interactivity; limited animations	122	186
High interactivity; multiple animations	154	243



O&M Staff Training

Components

CHP & Cogen - Highly Technical Subject Matter

Specifications

Vendor Submittals

Drawings

P&IDs

Machinery Arrangement

Sequence of Ops

Screen Shots

Commissioning & Startup Data

TAB Report

As Builts

Change Orders

Performance Data

O&M Manuals

Lock Out/Tag Out

Safety Procedures

Startup/Shutdown



O&M Staff Training

Training Tools

PowerPoint (Since early 2000)

Simulators

Video

Self Paced Training

Technical Manuals





O&M Staff Training

Many Stakeholders

- Owner/Client
- AE Firm/MEP/Owner's Engineer
- Equipment Vendors/Suppliers
- CMR
- EPC/EPCM
- SME
- Sub Contractors
- I&C
- O&M





Integration of Training w/Vendor Training

Training Session 1 - Plant Operators	
April 18th - April 21, 2011	
TIME	
	Monday - April 18, 2011
7:00AM to 9:00AM	Jack Kelly - Condenser Water System
9:00AM to 12:00PM	Brandon Baldwin - Tower Engineering - Cooling Towers
12:00PM to 1:00PM	Lunch Break
1:00PM to 4:00PM	Jack Kelly - Condenser Water System Tracing (plant/classroom)
	Tuesday - April 19, 2011
7:00AM to 12:00PM	Jack Kelly - Chilled Water Piping & Valves (Plant & Classroom)
12:00PM to 1:00PM	Lunch Break
1:00PM to 4:00PM	Keith Averitt - Paco Pumps - Chilled Water & Condenser Water Pumps
	Wednesday - April 20, 2011
7:00AM to 10:00AM	John Chaplin - Siemens - Electrical System 4160 Volt
10:00AM to 12:00PM	John Chaplin - Siemens - Electrical System 480 Volt
12:00PM to 1:00PM	Lunch Break
1:00PM to 4:00PM	Chris Richards - Yaskawa Electric America - VFD's
	Thursday - April 21, 2011
7:00AM to 9:00AM	Jack Kelly - Acid System, Chlorine, and Anti-Scalant Systems
9:00AM to 12:00PM	Steve Titus, ChemTreat - Cooling Tower Treatment & Water Chemistry
12:00PM to 1:00PM	Lunch Break
1:00PM to 4:00PM	Steve Titus/Jack Kelly - Plant Water Treatment Systems
	Note: 30 minute break in morning sessions
	30 minute break in afternoon sessions



O&M Training - Classroom & Field

PUTTING IT ALL TOGETHER



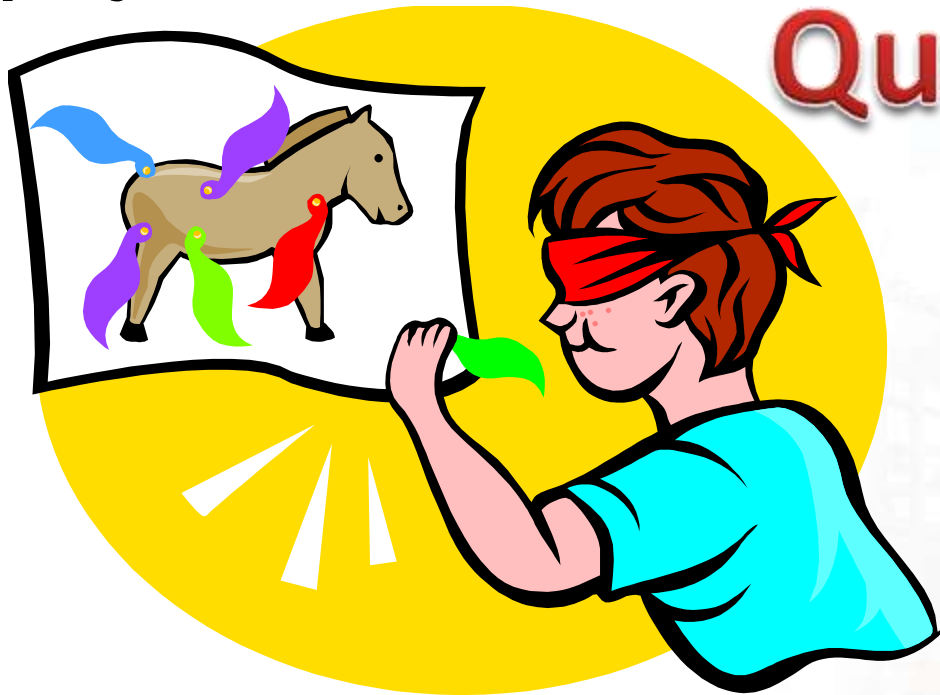


O&M Staff Training - Elements

- Write training requirements into Specs
- Begin early in design process
- Coordinate with Cx
- Be realistic in estimating project scope
- Account for Vendor Participation (no shows)
- Accommodation of clients multiple shifts
- Educate client on level of effort required
- Deliver what the client expects

Training Approach

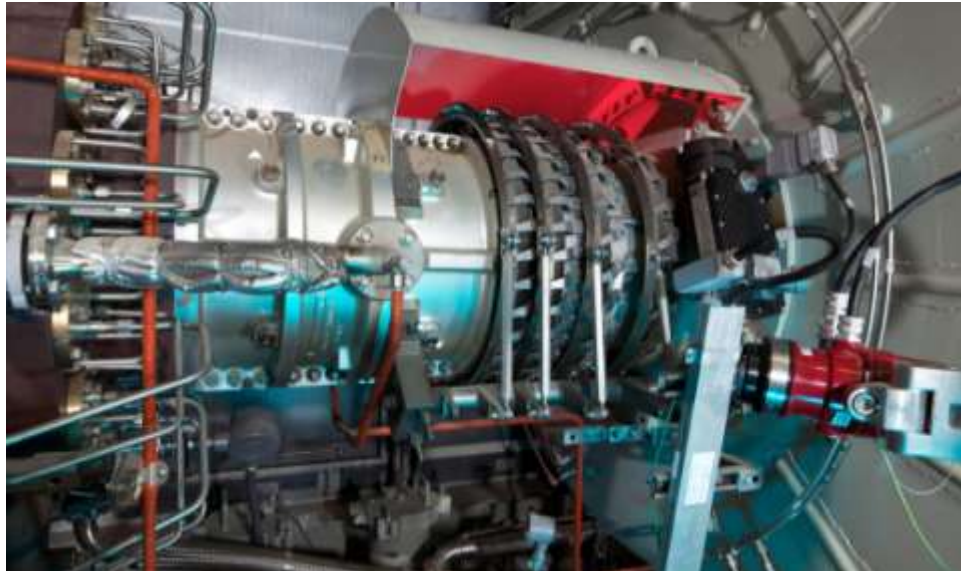
- Don't leave training to end of project...!!



Questions..?

Pin the Tail on the Donkey Approach
Not the way to go...!!!

CHP FACILITY TRAINING THE UNIVERSITY OF OKLAHOMA



Name: Jack Kelly

Title: Project Manager

Phone: 817-347-7636

Email: jack.kelly@jacobs.com