Anne Boer  
General Manager of TECS  

Presentation of upgrade of a Turbine and Compressor control of an extraction/injection turbine and two stage compressor carried out by KANOO/TECS/WOODWARD  

Ras Tanura, February 26th, 2012  
Jubail, February 28th, 2012  
Abu Dhabi, March 1st, 2012
Reasons for upgrading
Summary of project scope
Challenges
Scope companies
Products used/choice
Old situation
Project handling
Design phase
New system lay out
Field work
Results of retrofit
Reasons for upgrading the turbine/compressor control systems:
• Mechanical problems in the past
  • 2004 drive couple failure
  • 2007 drive couple failure
  • 2007 governor drive worm gear failure
  • 2009 governor drive failure
• OEM could not provide a proper solution for the above failure as they re occurred
• Old Foxboro anti surge controller was obsolete
• Better control of turbine needed, less depending on operator skills
• Increased reliability and availability
CUSTOMER REASONS FOR RETROFIT
Customer definition of project scope
- Upgrade of mechanical governor with state of the art electronic governor
- Removal of governor drive/pedestal and starting device
- Replacement steam injection equipment
- Replacement of obsolete anti-surge protection
- Remote start of the turbine should be possible
- HMI for operators
- Local operator panel for local start of turbine
- DCS communication
- Customer preferred to work with one single vendor doing the whole job

The OEM could not provide the solution the customer was looking for. The contract for the upgrade was awarded to Kanoo/TECS
Challenges:
- First LSTK surge control replacement for TECS
- First Woodward anti surge control done by TECS
- Lack of information regarding the surge line and surge controller
- Limited information regarding the bearing house/governor drive
- Integrated Turbine and Compressor control could not be used
- Shutdown time limited

To limit the risk for each of the parties following approach was taken:
- Woodward support needed for the surge line recovery and anti surge control commissioning
- TECS technically responsible as TECS has the knowledge to support the mechanical and control side of the job
- TECS to prepare a clear scope for the work to be carried out locally
TECS/KANOO/WOODWARD SCOPE

TECS Scope:
- Overall technical responsibility
- TECS to provide concept for mechanical design/lay out and partly supervision of mechanical work
- Design and delivery of Local Panel, control panel, iFix HMI and DCS comm’s
- Configuration/Commissioning of the turbine control
- Hot loop checks

Woodward Scope:
- Surge line recovery
- Commissioning the anti surge control

YBA Kanoo scope:
- Supply of materials ie field cabling, piping etc…
- Mechanical modifications needed
- Mechanical installation/Electrical installation
- Main contractor for the job ie managing the different sub contractors
Choice of Woodward products:
- 505CC-II to control the two anti surge loops of the two staged compressor
- 505E to control the speed and extraction of the turbine
- 2300 control to control the steam injection of the turbine
- CPCII to control the Inlet steam valve, the extraction steam valve and the injection steam valve

Main work to be carried out:
- Design, building and installation of new control cabinet including the 505-CCII, the 505E and the 2300 controls (TECS)
- Design, building and installation of new local panel for local start up (TECS)
- Design and installation of limit switches on trip valves to allow remote control of compressor (TECS/KANOO)
- Design and installation of CPCII skid (TECS/KANOO)
- Retrieving data for anti 505CC-II, 505E and 2300
- HMI design and DCS communications
- FAT
- Mechanical design: concepts done by TECS, detailed drawings by KANOO
After receiving a Purchase Order:

- Internall Kick off meeting regarding pricing, scope, timelines and milestones etc…
- Site visit to retrieve information regarding compressor control, turbine control, mechanical work etc…
- Creation of documents for different departments ie hardware design, HMI design, mechanical work definition, field wiring, FAT etc…
- From documents, conceptual drawings and measurements etc… detailed drawings could be created
- Design work, BOM, Material ordering, cabinet building etc…
- In house testing of new hardware
- FAT
- Customer approval in different stages of the project
- Delivery of goods
- Site installation
- Wire checks
- Power up and signal checks
- Commissioning
- Outstanding issues
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DESIGN PHASE

NEW COVER ASSY.

MPU (NEW)

GEAR WHEEL (NEW)

STEAM TURBINE CASING

AXIAL BEARING

STEAM TURBINE SHAFT

6030-900-03
DESIGN PHASE

TEC dwg. 6030-906-02
Revision: 02
Title: Oil Piping
Sub-title: tie-ins 01/02/05/06/09
Woodward governor, P/N 1120, and the Amplifier, P/N 1830, will be removed. Instead of this one manual operated valve and two flow control valves will be introduced.
What is required to configure the 505E and 505CC-2

- Steam Turbine Map (for Extraction/Admission)
- Steam Turbine Startup Sequence (Idles, Criticals)
- Compressor Performance Map, Surge line, Surge control line, Boost line
  - Five Head vs. Flow data pairs are used to configure the map into the control
  - Rated Operating Point, Suction Conditions, Gas Mole Weight
- Compressor / Process / Instrument Data Sheets
  - Gas Properties, Process Conditions, Compressor Data, Flow Element Data
- P&ID
  - Compressor Layout, Instrument and Valve Locations
- Other
  - Anti-Surge Valve Size (Cv) (Depending upon configuration)
  - Instrument Calibrations
## CENTERFUGAL COMPRESSOR
### DATA SHEET (API 617-6THM)
#### METRIC UNITS (KG/CM²)

### OPERATING CONDITIONS (Continued) (2.1.9) (2.1.9)

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### DESIGN PHASE

**Operating Conditions (Continued)**

- **Air**: 23.366% (rated: 23.000%
- **Oxygen**: 0.000% (rated: 23.000%)
- **Nitrogen**: 25.016% (rated: 25.016%)
- **Water Vapor**: 0.016% (rated: 0.016%)
- **Carbon Dioxide**: 2.000% (rated: 2.000%)
- **Carbon Monoxide**: 0.000% (rated: 0.000%)
- **Hydrogen**: 2.019% (rated: 2.019%)
- **Methane**: 0.000% (rated: 0.000%)
- **Ethane**: 2.283% (rated: 2.283%)
- **Propylene**: 0.000% (rated: 0.000%)
- **Propylene**: 0.000% (rated: 0.000%)
- **Iodine**: 0.000% (rated: 0.000%)
- **Oxygen**: 0.000% (rated: 0.000%)
- **Propylene**: 0.000% (rated: 0.000%)
- **Pentane**: 0.000% (rated: 0.000%)
- **Hexane Plus**: 0.000% (rated: 0.000%)

**Total**: 100%

**Remarks**:

- **Location**: Indoor, Outdoor, Grade
- **Heater**: Yes, No
- **Uninsulated**: Yes, No
- **Escalation Classification**: 2.1.16, 2.1.16, 2.1.16
- **Winterization Req.**: 2.1.1, 2.1.1, 2.1.1
- **Tropicalization Req.**: 4.4.4, 4.4.4, 4.4.4
- **Elevation**: 1, 1, 1
- **Range of Ambient Temp.**: 1, 1, 1
- **Normal Temp.**: 11, 11, 11
- **Maximum Temp.**: 25, 25, 25
- **Minimum Temp.**: 45, 45, 45
- **Other**: Dust, Fumes, Chemical Plant Atmosphere
- **Usage**: Domestic, Export, Export Boxes Req.
- **Shipment**: 4.4.4, 4.4.4, 4.4.4
- **Horizontal Storage**: Yes, No
- **Vertical Storage**: Yes, No

**Notes**:

- **Noise Specifications (2.1.9)**
- **Applicable to Machine**: Yes, No
- **Exposure Classification**: Yes, No
- **Air Quality Classification**: Yes, No
- **Acoustic Dampening**: Yes, No
- **Vendor Making Unit Responsibility (2.1.7)**
- **Vendor Making Data Sheet**: Yes, No
- **Manufacturers Standards**: Yes, No
- **Finish Coat**: Yes, No
- **Other**: 422-7-799, 422-7-799
- **Ambient Temperature**: 422-7-799
- **Chemical Plant Atmosphere**: Yes, No
- **Domestic**: Yes, No
- **Export**: Yes, No
- **Export Boxes Req.**: Yes, No
- **Outdoor Storage More Than 4 Months**: 4.4.4, 4.4.4, 4.4.4
- **Horizontal Storage**: Yes, No
- **Vertical Storage**: Yes, No

**Remarks**:

- **Aerated Ponds**: Yes, No
- **Aeration System**: Yes, No
- **Aeration Rate**: Yes, No
- **Aeration Efficiency**: Yes, No
FIELD WORK

Remove:
- Governor
- Ratio Amplifier

Install:
- 2x speed sensor
- HP CPC
- LP CPC
- IP CPC
- Extraction PT
- Injection PT
- Local panel
- Junction box
To allow remote start
- Install limit switches
- Modify oil system
FIELD WORK
FIELD WORK

505E, 505CC2, 2300
FIELD WORK
RESULTS OF RETROFIT

Results:
- Elimination of mechanical parts which caused frequent failures in the past
- Speed and extraction done electronically, no more hydraulic/mechanical
- Increased availability
- Less maintenance as several mechanical parts have been removed
- Better control i.e. response times, finer speed control, fine surge control
- Speed changes adjustable i.e. in critical speed bands, hot/cold starts
- Centralized monitoring and control of turbine/compressor
- Easier operation