

LISTEN.
THINK.
SOLVE.™

A Turnkey Medium Voltage Drives Solution for a Gas Compression Application

Part I - Solution Development

November 15, 2007

National Helium

Division of DCP Midstream (Formerly Duke Energy)

Natural Gas Decompression, Upgrading and Recompression

Location : Liberal Kansas

Compressors and controls originally installed in 1964

Listening Phase - October 2005 Sales Calls

- DEFS (DCP) Plant Engineer Jim Bloomer contacted RA Distributor, Stanion Electric, to ask about energy savings using variable frequency drives
- RA Area Manager Dan Bodenhamer visited with the Medium Voltage Demo Van to familiarize DEFS with MV Drive Technology
 - DEFS understood that drives can reduce energy costs by eliminating throttling
 - DEFS sought to decrease compressor speed by 10%
 - DEFS estimated 28% energy savings on a 7 figure monthly power bill

Listening Phase - March 2006 Budgetary Proposal

- DEFS (DCP) asked Stanion to re-engage RA sales
 - Sales call to gather drawings, data and photographs
 - Request for budgetary proposal for MV Drives
 - 5 compressor drives
 - Existing synchronous motors
 - ranging from 4500 to 9000 HP
- Budgetary proposal sent March 8th

Project Goals

- Replace or Refurbish Original DOL DC brush type synchronous motors (1962)
- Refurbish and /or re-rate compressors (Dresser Rand)
- Increase system efficiency and improve process control
- Install variable frequency drives
 - To decrease compressor speed by 10%
 - Payback calculated for a 28% energy-savings on a \$1M / month power bill
 - \$1500 power surcharge for each DOL motor star
 - Improve production efficiencies to position plant for increased throughput (new contracts)
 - Eliminate the need to throttle the compressors

Listening Phase - March 2006 Site Visit

- Preliminary meeting to go over project goals
- Plant tour including compressor area, transformer yard, switchgear building
- Metalclad Switchgear
 - Westinghouse type DH Air Magnetic Circuit Breakers
 - 3/60/13,800 Volt main Bus
 - Fed from power station adjacent to the gas plant
- Captive Transformers
 - GE Outdoor Oil filled
 - 13.8 kV Primary, 4160 Vac Secondary
 - Under-ground multi-conductor cable in conduit

Existing Installation - Electrical

- DOL Synchronous Motors
 - 3/60/4000 Vac, 4500-9000 HP, 1200 rpm
 - TEWAC Enclosure
 - Class 1 Group D Div 2 Hazardous location
 - DC brush type field, purged & pressurized
- Rotating Field Exciters
 - Located in switchgear building
 - Maintenance issues with DC brushes

Existing Installation - Mechanical

- Driven equipment consists of centrifugal gas compressors (Dresser Rand)
 - Two operating in tandem take gas of Panhandle Pipeline
 - One operates a process
 - Two operating in tandem recompress gas onto the pipeline
 - Mismatched ratings from 4500 to 9000 HP
- Load sharing by throttle valve
- Flow control by throttle valve
- Classified Hazardous Location
- To be refurbished / rebuilt as part of modernization

Thinking Phase - What are the possible solutions?

- After the plant walk-through we discussed various scenarios to meet the project goals
 - 3 technical scenarios to be performed in conjunction with compressor refurbishment
 - Provide Drives and static exciters for existing synchronous motors, 4000 V
 - Parallel Drives required on largest ratings
 - Single channel drives available on smallest rating
 - Provide Drives & new induction motors @ 4000 V
 - Eliminate need for purged brush-gear (maintenance issue)
 - Required parallel drives & new transformers
 - Provide Drives & new induction motors @ 6300V
 - Single Channel Drives
 - Eliminate need for purged and pressurized brush-gear
- At this time DEFS were working with Dresser Rand to establish parameters of the Compressor Rebuild
- Discussion about providing static exciters lead to request to replace rotating exciters on 6 other synchronous motors

Budgetary Proposal Generation

- The RA Team went for dinner & retired to the Liberal Kansas Holiday Inn
 - Generated budgetary proposals for the 3 scenarios and static exciters
 - Printed copies at Stanion Electrical Wholesale
 - Returned to the plant the next day to present
- Proposals contained:
 - Pricing for Drives & Static Exciters
 - Technical descriptions
 - Weights and dimensions
 - Technical comments

National Helium's Requirements

- Financial justification and appropriation
 - The project had to be deemed feasible and economically sound
 - DEFS justified energy savings and asked RA to estimate installed cost
- Minimize disruption and maintain partial production
 - The plant has continuous commitments to upgrade gas – outages could only be taken on one of each pair of compressors
- Physical layout
 - The existing switchgear room had insufficient space for the equipment
 - RA to furnish modular prefabricated PDC
- Delivery
 - Installation and commissioning can't be done during peak volume season
 - must implement before Oct 06, or must wait until following spring
- Turnkey
 - Project is run from an operating plant with no spare technical resources
 - Only turnkey bids would be accepted

Thinking Phase - April 2006 Site Visits

- A larger RA contingent returned to site to work out a turnkey solution
 - RA Sales Engineer
 - RA Allen Bradley MV Drives Division
 - Subcontractor Philip Doyle Manufacturing
 - (Power Distribution Centers, HVAC)
 - Phone support from transformer subcontractors
 - RA Allen Bradley Motors Division
 - RA Installation Services
 - Local electrical contractors

Thinking Phase - Detail 3 Technical Scenarios

- Hands on working sessions with DEFS personnel to optimize the three technical scenarios
- Re-use of existing metal-clad switchgear
- Replacement of Transformers
 - Relocation
 - new concrete foundations
 - oil containment dam
 - cable and conduit layout
- Elimination of five rotating exciters (scenario 2&3)
 - As a result of switch to Induction from Synchronous
- Mounting space for 6 additional static exciters (for other DOL compressor motors)

Thinking Phase - Detail 3 Technical Scenarios

- Rating and selection of MV VFD
 - Efficiency, losses, heat rejection, power factor, harmonics
 - Liquid to Liquid vs. Liquid to Air Heat Exchanger
 - Weights & dimensions
 - Control Features including load sharing PLC
- On board design and review of control house layouts
 - Physical space requirements adjacent to switchgear room
 - Relocation of an obsolete steam generator
 - Control Power feeds from switchgear room
 - HVAC sizing and layout (settled on dual redundant pad mount)
 - Site access for offloading and erection
 - Foundations (slab on grade)
 - Liquid to air heat exchanger foundations, layout, piping & wiring
 - Personnel Doors
 - Equipment Doors and clear access

Thinking Phase - Detail 3 Technical Scenarios

- Power cabling and control wire routing
 - Underground Conduit vs. Overhead supported
 - Road Crossing (Overhead)
 - Access from Switchgear Room to Transformer
 - Access from Transformer to Control House
 - Hazloc considerations, lead sealing
 - Stress cone / termination kits / NEC
- Motor Data
 - Nameplates
 - Request by DEFS to standardize on 6000 HP
 - Dimensional
- Motor foundation & adapter base
- Handling of coupling halves
- RA Installation Services made a second visit later in April with prospective contractors

Site Visit Outcome - May 10, 2006 Proposal

- Based on the findings of the site visit RA put forward a priced proposal for a jointly developed project solution that DEFS could use for project justification purposes
 - Re-use existing 13.8 kV metal clad switchgear
 - Provide qty (5) new 13.8 kV / 6600 Vac Outdoor Oil Filled Transformers
 - Provide qty (5) 6000 HP, 3/60/6300 Vac PF7000L Liquid Cooled Drives
 - Provide qty (3) modular prefabricated control house sections
 - Provide qty (2) pad mounted industrial grade HVAC units
 - Provide qty (5) liquid to air heat exchangers
 - Provide qty (5) 6000 HP, 3/60/6300 Vac 1200 Rpm SCIM, TEWAC
 - Provide load sharing PLC and PLC program
 - Provide labor & material to install and connect equipment
 - Provide labor & material to commission equipment
- DEFS (DCP) then sought and obtained authorization to conduct a formal competitive bid for appropriation purposes

Competitive Tendering Process - June 15, 2006

- DEFS issued a formal RFP was issued
 - Binding proposals from RA and 2 competitors
 - Turnkey proposals only
 - Environmental, Health & Safety Qualifications
 - Financial Qualifications
 - Sample Contract Language
 - 3 Technical Scenarios
 - Base Bid – VFDS for existing 4000 Vac Synchronous Motors
 - Alternate A – VFDS and new 4000 Vac Induction Motors
 - Alternate B – VFDS and new 6300 Vac Induction Motors
 - Including Design, Manufacturing, Procurement, Testing, Shipment, Offloading, Installation, Erection, and Commissioning

Meetings in Tulsa - July 25, 2006

- Site visit to Kimberly Clark Mill at Jenks, Oklahoma
 - A similar drive installed on a critical application
 - Discussions with maintenance staff
- Pre-award meeting at DEFS head office
 - Project has been deemed feasible and would be submitted for executive approval
 - RA introduced Project Manager Bob Ellis
 - RA introduced Contracts & Negotiations Manager Andrea Villanyi
 - RA nominated an executive sponsor
 - Answers provided to bid review questions
 - Minor scope changes
 - Preliminary discussions on T&Cs negotiations

Solving Phase - Project Structure & Order Handling

