

Client: Centrica Storage Ltd
Project : York Onshore Compression
Service : Feed Gas Compressor

D-R TES Number : 1-3J434
D-R CPC Number : N15E10003A01
Date : 21-Oct-15 **Revision :** 03

Scope of Supply

GENERAL

- One (1) Feed Gas compression Train, Tag Number: C3-201
- Each compression train includes the following components. :
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- One (1) centrifugal compressor model D4R8S.
- One (1) speed-increasing gearbox.
- One (1) Induction type variable speed motor
- One (1) dedicated variable frequency drive system
- One (1) on-skid mounted gas seal panel.
- One (1) on-skid mounted dedicated lube oil system
- One (1) off-skid fin fan cooler for the lube oil system
- One (1) Local Equipment Room – Container Type
- The train components are arranged in the following configuration :
Motor + Gear + D4R8S

APPLICABLE STANDARDS

- The scope offered will be supplied per the following standards and specifications subject to, and as modified by, D-R and sub-suppliers comments & exceptions included in Section 8 of this proposal:
- API-613 - Gears 5th edition.
- API-614 - Oil Systems & Gas Seal Systems 4th edition.
- API-617 - Centrifugal Compressors 7th edition.
- API-661 – Air-cooled Heat Exchanger 7th edition
- API-670 - Monitoring Systems 3rd edition.
- API-671 - Couplings 4th edition.
- API-676 - PD Pumps 2nd edition.
- Project specifications as listed in the "Comments & Exceptions" section.
- D-R engineering standards.
- ANSI B31.3



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COMPRESSOR: ONE (1) DATUM COMPRESSOR MODEL D4R8S

Casing

- Forged radially - split ASTM A350 Grade LF2 steel casing in straight-through configuration. Case maximum allowable working pressure is 1795 psig (2995# Casing + 1795# Heads).

Heads

- ASTM A516 Grade 70 steel heads retained by shear rings.

Connection

- Connection No 1: 8" 900# RJ Top oriented studded flat.
- Connection No 2: 6" 900# RJ Top oriented studded flat.

(Due to the Hydrostatic test being performed on the D-R DATUM compressor casing, the inlet and discharge connections need to have the same rating, which is based on the discharge connection rating. If required, a counter flange can be used to ensure transition between the 8" 600# RJ piping flange and the 8" 900# RJ compressor inlet connection)

Drains

- Two (2) flanged case drains with double block valves, manifold and piped to skid edge.

Internals

- Horizontally-split diaphragms.
- Forged alloy steel shaft. hydraulic-fit, tapered shaft end.
- Total of eight (8) impellers, fabricated construction.

Materials Summary

- Case : ASTM A350 Grade LF2
- Heads : ASTM A516 Grade 70
- Inlet Wall : ASTM A36 Grade 60
- Shear Rings : Grade 4340
- Nozzles : ASTM A352 Grade LCC
- Diaphragms : Stage 1-8 : ASTM A36 Grade D
- Inlet Guides : Stage 1-8 : ASTM A36 Grade 60
- Return Bends : ASME SA516 Grade 70

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Scope of Supply

- Volutes : ASTM A36 Grade 60
- Spacers : ASTM A743 Grade CA-15
- Coupling Seal Sleeves : ASTM A743 Grade CA-15.
- Balance Piston : ASTM A668 Grade 4140
- Shaft : Grade 4340
- Thrust Disc : Grade 4340
- Impellers : Stage 1 : 17-4 PH
 Stage 2-8 : Grade 4330

Gas Seals

- Two (2) John Crane Dry Gas Seal Type 28 XP Tandem with Intermediate Labyrinth and separation seals Type 93FR.

Journal Bearings

- Two (2) DR, Orion, RMT or equal journal bearings. Bearings will be Damper-Tiltpad, leading edge groove, direct-lubed.

Thrust Bearing

- One (1) Kingsbury or equal thrust bearing. Bearing will be self equalizing-tilting pad, leading edge groove, **direct-lubed**.

Special Tools

- One (1) set of special tools per unique compressor body. Detailed list is included on Section 1.6 of the Technical Proposal

Compressor Testing : Mechanical Test

- One (1) mechanical test per compressor rotor. Test will be in accordance with API-617 7th ed. and Dresser-Rand standard 003-360-001. See Section 11.2 for details.
- Mechanical testing for spare rotor will be performed in the contract casing. Test will be conducted using a shop driver and shop auxiliary systems.

Compressor Testing : Performance Test

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- One (1) **performance** test per compressor rotor. Test will be in accordance with API-617 7th ed. and Dresser-Rand standard 003-085-001. See Section 11.1 for details.
- Total Number of identical Rotor tested: 1
- For additional inspections and testing refer to the Inspection & Test Plan in Section 7.1 of this Proposal.

GEARBOX : ONE (1) GEARBOX

- One (1) Flender, Renk, Lufkin, Voith BHS or equal speed-increasing gearbox, rated for 3385 kW. Fixed-speed, single-reduction gearbox.
- Shaft end designs are integral flange on the LS shaft and hydraulic shrink fit on the HS shaft.
- Suitable for operation in Zone 2, Group(s) IIB, T3 area classification.
- Painting will be per manufacturers Std (severe environment).
- Testing scope will be per the supplier's standard testing program.
- Gearbox will be mounted on compressor skid.
- The main oil pump is positive displacement type, driven by the gearbox low speed shaft
- For additional details please refer to proposal Section 4.4

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MOTOR : ONE (1) ELECTRIC DRIVER

- One (1) ABB Induction Ex n speed electric motor, rated for 3385 kW at 1485 RPM
- 3300 V, 50 Hz, 3 Phase, 1.0 PF, 1 SF.
- Motor will be mounted on the compressor skid.
- Suitable for operation in Zone 2, Group(s) IIB, T3 area classification.
- Painting will be per manufacturing Std (severe environment).
- Testing scope will be per the supplier's standard testing program.
- For additional details refer to proposal Section 4.3

DRIVE: DRIVE SYSTEM

- One (1) ABB Type variable frequency drive system
- Suitable for installation in the LER.
- Painting will be per the supplier's standard procedures.
- Testing scope will be per the supplier's standard testing program.
- Scope includes a switchgear, transformer.
- For additional details please refer to proposal Section 4.3

LOCAL EQUIPMENT ROOM (CONTAINER)

- Container is offered according DIN/EN ISO standards
- Container is offered for erection in safe zone
- Container protection-class: IP54
- For additional details please refer to proposal Section 4.3

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Scope of Supply

COMPRESSOR SKID PACKAGING

- The package will be designed and supplied per ATEX standards and suitable for Zone 2, Group(s) IIB hazardous area classification.
- Package skid is a torque tube compact onshore type baseplate, fabricated of S355 J2 G3 carbon steel, and includes removable lifting lugs. The baseplate will be common to the driver, gearbox, compressor, seal gas panel and lube oil system. The baseplate includes single lift and four (4) 1.5 inch NPT drain connections with non-sloped deck.
- Package scope includes galvanized steel conduit, 316/L stainless steel flexible conduit, on-skid mounted compressor bundle cradle, laminated shims, 316 stainless steel attaching hardware (for piping, tubing, conduit), carbon steel horizontal jacking screws.
- RF flanges will be used where the ANSI connection ratings are less than or equal to 900#. Flanges will be weld neck with 316/L stainless steel flange bolts.

Service and Material

- Seal gas supply: Piping 316/L stainless steel – Only Insulated piping for the primary seal gas system will be painted
- Intermediate gas supply: Piping 316/L stainless steel
- Separation gas supply : Piping 316/L stainless steel
- Primary vents : Piping 316/L stainless steel
- Secondary vents : Piping 316/L stainless steel
- Seal gas system drains : 316/L stainless steel
- Lube oil supply : 316L Stainless Steel
- Lube oil drains : 316L Stainless Steel
- Lube oil bearing vents : 316L Stainless Steel
- Casing Drains: 316L Stainless Steel
- All piping and tubing within the package will be to DR Standard Offshore Piping Spec. 121718-COCP-Piping&TubingSpecificationRev0.pdf
- All lines within the gas seal panel will be 316 Stainless Steel Tubing with 316 Stainless Steel Tube Fittings

Miscellaneous

- 316 Stainless Steel tubing material for instruments, with non-painted Parker A-Lok Metric (twin ferrule) or equal fittings.
- 316/L Stainless steel junction boxes Ex e mounted at skid edge.

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Scope of Supply

COUPLING: TOTAL OF TWO (2) COUPLINGS

Coupling 1: Driver Side Coupling

- Location: Induction Motor to Gear.
- One (1) Kop-Flex or equal, dry, flexible element, marine style coupling.
- Testing scope will be the supplier's standard.
- One (1) non-sparking aluminum coupling guard with drain connection to lube oil drain header and vent lines.

Coupling 2 : Gear Side Coupling

- Location : Gear to D4R8S.
- One (1) Kop-Flex or equal, dry, flexible element, marine style drive end /reduced moment driven end coupling.
- Coupling hub designed for Hydraulic Shrink Fit on driven end.
- Testing scope will be the supplier's standard.
- One (1) non-sparking aluminum coupling guard with drain connection to lube oil drain header and vent lines.

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Scope of Supply

LUBE OIL CONSOLE

General - System

- Lube oil system to service the compression train.
- Integral within compressor baseplate, special purpose (API 614) lube oil system to supply lube oil to the compressor, gearbox, driver.
- Suitable for operation in a ATEX hazardous area classification Zone 2, Group(s) IIB, T3.
- Sloped non-skid diamond deck plate top decking
- 316L stainless steel supply and drain piping with 316/L stainless steel RF 150# flanges (control valve will be 300#). 316 Stainless Steel tubing and Parker A-Lok fittings.
- Carbon Steel control valve bodies with stainless steel trim. Carbon Steel hand valves with stainless steel trim. Carbon Steel check valve bodies with stainless steel trim.
- Mineral lubricant grade ISO 32.
- Painting will be per D-R severe environment standards (offshore). Refer to Section 11.4 for more details.
- Shop testing will be done at subsupplier's shop and per D-R standard 003-143-001.
- Heat tracing and insulation is not included and is to be supplied by the installation contractor.
- For additional details refer to proposal Section 1.4

Reservoir

- The lube oil reservoir will be of 316L Stainless Steel construction.
- The reservoir will include magnetic type level glass, access manway, purge provision, oil conditioner connections, sampling points, non-skid diamond deckplate top decking.

Pumps

- Two (2) full size iron case positive displacement pumps API 676 as follows: One (1) Shaft driven main, One (1) AC motor (400V) driven auxiliary.
- Auxiliary pump will be top reservoir mounted.

Filters

- Two (2) 10-Micron nominal filters designed per ASME pressure vessel code with code stamp.
- Stainless Steel case.
- Filters will be supplied with a continuous flow transfer valve.

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Coolers

- Coolers will be supplied by Dresser-Rand.
- One (1) Fin Fan type oil cooler
- Air blast cooler with 2 x 100% fans.
- Self-contained temperature control valve.
- See Fin Fan Cooler section 4.5 of our offer for more details.

SEALING GAS SYSTEM

General

- One (1) seal gas panel per compression skid. Panels will be on-skid mounted and suitable for operation in a ATEX hazardous area classification Zone 2, Group(s) IIB.

Gas Seal Panel Details

- Gas Seal Panel will consist of a primary seal gas, intermediate gas, and separation gas systems suitable for operation with the quoted gas seal design.
- Seal gas panel frame will be constructed of **316 Stainless Steel**
- Instrumentation will be supplied with instrument root valves.
- Painting will be per D-R severe environment standards (offshore).
- Heat tracing is not included and is to be supplied by the installation contractor. D-R will indicate requirements on contract issue diagrams.

Primary Sealing System

- Source of seal gas is assumed to be process gas. Source taken from client process piping.
 - The system is designed for auto flow control. Pressure rating of system components is ANSI 900#.
 - One (1) Jordan or equal auto flow control valve with electronic remote mounted controller. Control valve construction is 316 stainless steel body with 316/L stainless steel trim.
 - Supply and vent lines from panel to compressor will be 316 stainless steel piping with RF flanges, ANSI 900# rating. All lines within the gas seal panel will be 316 Stainless Steel Tubing with 316 Stainless Steel Tube Fittings
 - Dual Indufil or equal seal gas supply filters designed per ASME pressure vessel code with code stamp. Filters will have stainless steel filter housing(s), 3-micron absolute coalescing filters, dual 316 stainless steel 3-way transfer ball valves and manual draining.
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Intermediate Sealing System

- Source of intermediate gas is plant nitrogen.
- The system is designed for manual flow control.
- Supply and vent lines from panel to compressor will be 316/L stainless steel piping with RF flanges, ANSI 150# rating. All lines within the gas seal panel will be 316 Stainless Steel Tubing with 316 Stainless Steel Tube Fittings
- One (1) duplex N2 filter common for intermediate and separation gas supply filter. Filter will have 316/L stainless steel filter housing, 1-micron absolute coalescing filters, manual bypass and drain valves.

Separation Sealing System

- Source of separation gas is plant nitrogen.
- The system is designed for automatic flow control
- One (1) Fisher or equal differential-pressure regulator. Control valve construction is 316 stainless steel body with 316/L stainless steel trim. Control valve block & bypass valves will be provided.
- Supply and vent lines from panel to compressor will be 316/L stainless steel piping with 150# ANSI RF flanges. All lines within the gas seal panel will be 316 Stainless Steel Tubing with 316 Stainless Steel Tube Fittings

Vent Systems

- Primary vent system will be supplied with 316/L piping with ANSI 150# RF flanges, two (2) metered orifices, two (2) rupture disks.
- Secondary vent system will be supplied with 316/L piping with ANSI 150# RF flanges.

General Comments

- Double Block and Bleeds Valves and Manifolds will be provided on the 900# piping system only.
- For additional seal gas system scope details, refer to the Seal Gas System P&ID included in our proposal.

Seal Gas Quality and heater

- Seal gas quality must meet minimum requirements per Dresser-Rand standard 003-350-001.
- A heater for the sealing gas will be supplied, approximate power: 5 kW

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INSTRUMENTATION

General

- All on skid instrumentation will be suitable for installation in a Zone 2, Group(s) IIB, T3 area classification. Instrument housing material will be stainless steel.
- All off skid instrumentation will be suitable for installation in a Zone 2, Group(s) IIB, T3 area classification. Instrument housing material will be stainless steel.
- Seal gas system instrumentation, as well as compressor skid instrumentation, will be mounted on the gas seal panel.
- All Instruments and wiring will be D-R Standard 1000175395_rev01_DRESSER-RAND European Master Wiring Specification RFM_012, section 11.9 of this offer

Notes

- Vibration probes will be supplied with proximitors and will be Bently Nevada or equal series 3300XL or equivalent.
- All probes are mounted and wired to junction boxes located on the compressor skid.
- Skid mounted instrumentation is wired to junction boxes.
- All transmitters will be Rosemount 3051C or equal indicating transmitters. Housing material instrumentation is **stainless steel**.
- All compressor bearing RTD's will be 100 ohm platinum, 2 x one (1) simplex wired to the junction box but one (1) monitored by the UCP.

CONTROLS

- One (1) ship-loose unit control panel suitable for installation in a non-hazardous area classification (LER).
- Control panel will include compressor/driver performance, surge and vibration monitoring.
- Refer to section 1.3 of this proposal for additional details on the proposed control system

ENGINEERING

Rotordynamics

- One (1) compressor unit lateral analysis and report for D4R8S, per API-617 7th ed.
- One (1) lateral analysis additional requirements for D4R8S, per API-617 7th ed. (1-2.6.2.14)
- One (1) transient train torsional analysis and report per API-617 7th ed.



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Manuals

- Six (6) copies of the operating and maintenance manual in electronic format (CD-ROM);
- One (1) copy in hardcopy format.

SURFACE PREPARATION, PACKING, PREPARATION FOR SHIPMENT

- D-R painted equipment will be supplied per D-R severe environment paint standard SPEC-LAB-331.
- Subvendor supplied major components will be painted per the subsupplier's standard procedures and as otherwise indicated in the respective vendor's proposal.

Revision Comments

- DDP Transportation and insurance to Easington terminal (York – UK) included (ALE report mentioned that site gate was only 4 meters wide. It is the responsibility of CSL to widen the gate and ensure the package can be moved within the ground of the Easington site).
- Seal gas heater to be installed in the Gas Seal Panel
- CCC Antisurge controller mounted in UCP.
- D-R Diffuser Array (last stage) for noise attenuation.
- All required interconnecting piping and wiring within the DR Compression package to the end of the skid. Piping between the edge of the skid and the Fin Fan Cooler is not included.
- 120 days of field service (Compressor and Control specialists, excluding CCC) will be free of charge.



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OPTIONAL SCOPE (NOT INCLUDED IN BASE PRICE)

Revision Comments

- Spare parts (start-up, commissioning, 2-year, operating, insurance, and capital spares).
- Dynamic process simulations.
- Lifting kit (spreader bar, shackles and cables).
- Attendance at Customer chaired HAZOP and SIL review meeting (limited to a total of two days for HAZOP meeting and two days for SIL meeting).
- Aflas O-rings for heads and dry gas seals.
- Oil mist eliminator
- Brackets for Stop Push Button for all motors (Push Button to be supplied by others)
- Smart and Hart protocol Latest one protocol 7 with MUX.
- 3 ways valves manifold instead of 2 ways manifolds
- Client specified BS EN 1090-1 and EN 1090-2 European rules, on steel structure for SKID, DR yet confirm compliance to EC marking in accordance.

SCOPE EXCLUSION

- Process coolers, scrubbers, relief valves, separators.
- Cable glands on cables not supplied by D-R.
- Nitrogen generation equipment.
- Design audits.
- High speed rotor balancing
- Coupling alignment tool.
- Mating Flange
- Compressor inlet strainer.
- Train lateral Rotordynamic analysis
- Equipment enclosures.
- Special Tests.
- Process instrumentation.
- Anti-Surge valve
- Anti-Surge valve related instrumentation
- Hot gas bypass valve

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Scope of Supply

- Motor Control Center (MCC)
 - Air run-in equipment.
 - Foundations.
 - Maintenance cranes.
 - First fill lubricants.
 - P&IDs studies.
 - IS calculation loops
 - Positive Material Identification (PMI)
 - Full Compliance with CSL Preferred Vendor List
 - Heat Tracing and Insulation
-
- Training can be proposed as a future option.
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- Any item not mentioned within D-R Scope of Supply.