ENERFLEX

AIR LIQUIDE

ESS – ACCP PROJECT
Helium Compressor Station Technical Proposal

Air Liquide Project No.: C1298

Enerflex Ltd

Proposal No. Q3140111-QTE01

ENERFLEX

November 21, 2014

Air Liquide Advanced Technologies
2 Rue De Clémencière
38360 Sassenage
France

Reference: **AIR LIQUIDE PROJECT No: C1298**
ESS ACCP SYSTEM
Enerflex Proposal No. Q3140111 / QTE00

Attn.: **Anne-Sophie Dutrop** ***Category Manager***
Jean-Marc Bernhardt *Technical*
Rawia Ali Said *Technical*
Pierre Roux *Projects*

Dear Ms. Dutrop & Gentlemen,

Please find enclosed our firm bid quotation for the project referenced above. This proposal covers both Technical and Commercial offerings respectively. We appreciate and thank you for your patience throughout this short time frame in preparation of this proposal.

Our team worked diligently to prepare a comprehensive proposal with a primary focus on full and fair value. We understand ALAT has a short time to prepare the final submission to the end user (ESS). As such, we shall remain at your disposal for timely clarifications and further assistance throughout your bid process.

We thank you once again for your kind consideration and confidence in Enerflex to offer a valuable solution.

Very best regards,
Enerflex (UK) Ltd

James Manis
Director of Business Development
Europe / CIS

ENERFLEX

TABLE OF CONTENTS

INTRODUCTION

System Design

Each proposed system has been custom designed to match your specific process requirements. This proposal is based upon systems operating a standard stage compression cycles with a selection focus based on optimization with respect to compression efficiency and power consumption.

LP Helium Compression System

The LP system consists of one skid furnished with two (2) 50% Low Pressure (LP) Howden 321-193 compressors with matching 369kW rated electric motors controlled by individual VFDs from 60-30Hz. A common oil system consists of two (2) 100% full flow oil pumps, a brazed plate oil cooler and dual oil filters.

HP Helium Compression System

The HP system consists of one skid furnished with two (2) 50% High Pressure (HP) Howden 321-132 compressors with matching 988kW electric motors. The oil system consists of two (2) 100% oil pumps, a brazed plate oil cooler and dual oil filters.

Vacuum Compression System

The Vacuum system consists of one skid furnished with two (2) 50% Vacuum Pressure Howden 321-193 compressors with matching 250kW electric motors. Each compressor will be equipped with a VFD controlling the frequency from 50-25Hz. The oil system consists of two (2) 100% oil pumps, a brazed plate oil cooler and dual oil filters.

Oil Removal System

After the HP compression skid, the gas will feed into an oil removal skid to reduce the oil carry over to 10ppbw. There will be three stages of oil coalescing, a carbon bed absorber and a 10 micron dust after-filter downstream of the absorber vessel.

Exchanger / Valve Skid

This skid will incorporate the VP, LP & HP helium aftercoolers as well as all the piping and valves as detailed in the gas management panel section of this proposal.

Component Selections and Code Compliance

In developing the unit design, we have chosen to include several features which we feel will contribute to the efficient and reliable long term operation of the system. In addition, we have also included some conservative component sizing procedures based on our interpretation of your specifications. Some of these significant features are highlighted in the following paragraphs.

As a North American manufacturer and supplier to the European market we are familiar with the harmonised standards and note that not all EN norms meet the harmonised standards as defined by the official EU citing journal. In an average year EFX supplies several systems conforming with the PED, ATEX and European requirements.

NoBo
For Pressure Requirements (PED) we conform by doing a PMA for pressure parts.
That is we carry out a (Particular Material Appraisal) PMA for all pressure parts, however we will use ASTM materials and have a NoBo (Notified Body) review & appraise to PED including all the back up Mill certs (3.1b material certs) and QC data dossiers. The design code chosen will be ASME VIII but in compliance with module G of the PED or the particular module as defined by the PMA.

Stainless steel will not be impact tested, as impact tested stainless steel cannot be purchased from normal stockists either in Europe or North America, however this will also be discussed/agreed with the NoBo.

Local Authorities
PED is about free movement of goods within the EU but not putting into service as this is a customer/end user obligation. Nevertheless on our European projects we would normally meet with the local authorities, where the equipment is to be used, prior to manufacture of any pressure retaining parts, with the end user to discuss and agree the information needed to ensure the local authority is also on board

CE marks
For other CE considerations we will issue either a declaration of incorporation of if necessary a declaration of conformity, depending upon the definition of scope.

This is what we do for all our European work

Compressor - The compressor selection was made after due consideration of the inquiry specifications and the system operating characteristics. Normal pressure piping losses have been factored into the compressor selection process. As a result, the compressor is rated at conditions sufficient to insure the performance required.

Vessels - These items are sized using conservative retention times and velocities for the design flow, plus any storage volume requirements of the system as applicable. All vessels are designed, constructed, and tested per ASME PED module G code requirements.

Exchangers - The shell and tube heat exchangers of this system are designed and constructed according to PED to module G ASME code and TEMA C standards. The materials of design are consistent with the duty performance required and the inquiry specifications.

Other Key Features

Enerflex Standards of Quality

Each unit has many inherent features and components which are not as prominent as key components but nevertheless contribute to the reliability of the package and to the maintenance access of the equipment. Some of these are listed as follows;

- Compressor drive train mounted directly on structural steel base members
- Rexnord spacer coupling
- Refrigeration type hand and check valves or (API type optional)
- Isolation valves for all instruments, root plus block and bleed valves
- Piping per ANSI B31.3 Refinery Piping Code
- Stainless steel Lube oil piping downstream of filters
- Compressor suction & discharge piping is carbon steel
- Stainless steel impulse tubing (304) with stainless steel fittings
- Temperature indicators are 127mm dial, multi-angle with flanged stainless thermowells
- Separate oil charging connection with shutoff valve, check valve, and strainer
- Vertical oil separator with multiple coalescing elements constructed in accordance to PED.
- Reflex lens type armored gauge glass assemblies for all vessels
- Single relief valves sized for blocked discharge or fire case
- PED/EN relief valves on vessels
- Extra rigid steel base for equipment mounting
- Equipment spacing arranged for maintenance access

OUR VISION

THE LEADER AT DELIVERING INNOVATIVE NATURAL GAS COMPRESSION, PROCESSING AND POWER GENERATION SOLUTIONS THROUGHOUT THE WORLD.

OUR VALUES AND GUIDING PRINCIPLES

Integrity... Do the right thing

- Be ethical
- Be trustworthy
- Be respectful
- Be socially responsible

C**ommitment... Deliver on our promises**

- Be a health and safety leader
- Anticipate and meet customer needs
- Establish common goals and deliver results
- Attract, develop and retain the best people

Creativity... Lead with innovation

- Be collaborative
- Value creative thinking
- Embrace change

Success... Achieve sector leading results

- Create and sustain customer loyalty
- Optimize growth and business performance
- Listen and communicate effectively
- Recognize and celebrate achievement

COMMERCIAL

2.1 Pricing

TOTAL PRICE FOR Five (5) SKIDS ..... US$7,350,000

(Deduct for One (1) VP Compressor Skid ..... US$1,780,000)

(Ex-Works Houston TX, Incoterms 2010)

2.2 Shipment

The equipment we have offered can be shipped in 40-46 weeks from date of order or drawing approval, if required. We can work with you to attempt to improve this schedule by beginning major procurement while drawings are being prepared.

Approval drawings can be submitted within 4-6 weeks of receipt of a purchase order.

2.3 Terms Of Payment

Our pricing is based on the following payment schedule. Payment is to be made net 30 days, guaranteed by an irrevocable letter of credit:

- 15% - upon issue of order acknowledgment letter or purchase order confirming the order acknowledgment letter
- 25% - upon submittal of Engineering Approval Drawings
- 25% - upon receipt of compressor for Unit
- 25% - upon receipt of driver for Unit
- 10% - upon notification to Purchaser that the unit is complete

Payment terms can be discussed; however this pricing is based on the use milestone payments to maintain a neutral cash flow during the execution of the project.

Warranty

Enerflex extended warranty is 24 months from commissioning or 36 months from shipping whichever is soonest.

OPTIONS

3.0 Options

Seaworthy Packing - Hoodboxing ..... US$ 87,000

Transport (Incoterms DDP) ..... US$340,000

Transport price budgetary and subject to change. Inc Import Duty. Ex Insurance & VAT.

Spare Parts (As per Specification) ..... US$420,257

Oil flush for all skids ..... US$95,795

Pricing is budgetary and subject to change.

Installation & Commissioning Supervision ..... US$ 42,100

Training for Personnel ..... US$ Per Diem Service Rates

#

DESIGN INFORMATION

4.1 Utility Requirements

Exact power draws to be confirmed upon confirmation of compressor selection and will be included within the firm offering

4.1.1 Electrical:

Below are the rated powers of the electrical requirements. Actual power draws will differ and can be viewed within the compressor performance.

VP Compressor

Electrical Loads:

Two	-	250kW	.....400volts, Compressor motors
Two	-	7.5kW	.....400volts, Pump motors
One	-	3 kW	.....400volts, Oil heaters

LP Compressor Skid

Electrical Loads:

Two	-	369kW	.....6600volts, Compressor motors
Two	-	11kW	.....400volts, Pump motors
One	-	3 kW	.....400volts, Oil heaters

HP Compressor Skid

Electrical Loads:

Two		988kW	.....3300volts, Compressor motor
Two	-	5.5kW	.....400volts, Pump motors
One	-	3 kW	.....400volts, Oil heaters

4.1.2 Cooling Water (CW):

Design Data

Inlet temperature.....	32	ºC
Inlet pressure.....	4 - 9	Bar a
Allowed Pressure Drop....	2	Bar max

The cooling water circuit has been designed to integrate cooling water through a number of heat exchanged locations in order to maximize heat recovery whilst maintaining practical cooler design. Excess water not required for cooling from the low and medium temperature exchangers will be mixed for a second water return line.

Low Temperature Exchangers

Usage:

VP After Cooler	2,850kg/hr
LP After Cooler.....	14,500kg/hr
HP After Cooler	42,079kg/hr
HP Oil Cooler 2	130,215kg/hr

CW Max. inlet temperature	30ºC
CW Outlet temperature....	37ºC

Medium Temperature Exchangers

Usage:

VP Oil Cooler	27,265	kg/hr
LP Oil Cooler.....	48,060	kg/hr

CW Max. inlet temperature	37ºC
CW Outlet temperature....	46ºC

High Temperature Exchanger

Usage:

After Cooler	11,224	kg/hr

CW Max. inlet temperature	46ºC
CW Outlet temperature....	80ºC

Combined water output:

	Produced	Excess	Mixed temp
	kg/hr	kg/hr	C
Water @ 37 ºC	189,614	178,389	40
Water @ 46 ºC	75,326		
Water @ 80 ºC	11,225	11,225	80

Instrument air:

Usage, (per skid)	<10	Nm^3/h
Maximum pressure	9.3	bar g
Minimum pressure	4.5	bar g
Dew point.....	-40	ºC

UNIT DESCRIPTION

ENERFLEX (UK) Limited
Maybrook House, Godstone Road, Caterham, Surrey, United Kingdom, CR3 6RE (Tel:+44 (0)1883 343782) www.enerflex.com

Enerflex proposes to furnish skid mounted packaged compression units designed to provide the duty proposed within the process data sheets provided. Briefly, the proposed packaged system will include the following major components including approximate skid dimensions. Please see P&ID drawings for exact scope of supply.

PACKAGE	L x W x H –millimeters Weight - Kilograms
LP Compression System Equipment Package: System package consists of: • Two (2) Howden Screw Compressors • Two (2) Electric Motors • One(1) Oil Coalescer • Two (2) Oil Pumps • Two (2) Oil Filters • One (1) Plate Oil Cooler • One (1) set of valves and piping One (1) skid for mounting and assembling the above equipment	**9000 x 4700 x 4600** **40,000kgs**
HP Compression System Equipment Package: System package consists of: • Two (2) Howden Screw Compressor • Two (2) Electric Motors • One(1) Oil Coalescer • Two (2) Oil Pumps • Two (2) Oil Filters • One (1) Plate Oil Cooler • One (1) set of valves and piping One (1) skid for mounting and assembling the above equipment	**9000 x 4700 x 4600** **40,000kgs**
VP Compression System Equipment Package: System package consists of: • Two (2) Howden Screw Compressor • Two (2) Electric Motor • One (1) Oil Coalescer • One (1) Secondary Coalescer • Two (2) Oil Pumps • Two (2) Oil Filters • One (1) Plate Oil Cooler • One (1) set of valves and piping One (1) skid for mounting and assembling the above equipment	**9000 x 4700 x 4600** **40,000kgs**

PACKAGE	L x W x H –millimeters Weight - Kilograms
Oil Removal System Equipment Package: Enerflex oil removal system package consists of: • One (1) primary oil coalescer • One (1) secondary oil coalescer • One(1) tertiary oil coalescer • One (1) carbon bed oil adsorber • One (1) dust after-filter • One (1) Nitrogen Heater • One (1) set of valves and piping One (1) skid for mounting and assembling the above equipment	**6500 x 3500 x 4900** **28,000kgs**
Valve & Exchanger Skid: Valve skid consists of: • One (1) SP Full Flow Valve (CV7A) • One (1) SP Small Flow Valve (CV7B) • One (1) LP Full Flow Valve (CV5A) • One (1) LP Small Flow Valve (CV5B) • One (1) MP Full Flow Valve (CV4A) • One (1) MP Small Flow Valve (CV4B) • One (2) HP Gas Return Valve (CV1A-CV1B) • One (1) HP-MP Bypass: Flow Meter • One (1) HP-LP Bypass: Flow Meter • One (1) HP – Buffer: Flow Meter. • One (1) Set of LP, MP, HP, Buffer: Pressure Transmitter • One (1) Set of flow meters at customer interface • One (1) VP Shell and Tube after cooler • One (1) LP Shell and Tube after cooler • One (1) HP Shell and Tube after cooler • One (1) Set of valves and piping One (1) skid for mounting and assembling the above equipment	**3000 x 11000 x 3000** **TBCkgs**

5.1 Compressors

- Common Specifications
  - Type ..... Flooded Rotary Screw
  - Materials of Construction :
    - Casing ..... Cast Iron*
    - Rotors ..... Forged Steel
  - Expected Sound Pressure Level ..... 93 dBa at 1 meter
  - Method of Unloading ..... Speed Variation/Slide valve
  - No of Unloading Steps ..... Infinite
  - Minimum Unloading 15%
  - Shaft Seal ..... Single
  - Journal Bearings ..... Solid Steel - Lined
  - Thrust bearings ..... Angular Contact - Paired
  - Lubrication ..... Forced feed
  - Drive Arrangement ..... Direct coupled
  - MTBF 120months
  - MTBR ..... 1 month
  - Availability 99.8%**
  - Other:
    API 619 design – see standard exceptions
    Valving & Instrumentation as per P&ID
    Non-lubricated, flexible disc type coupling - Non API
    Coupling guard
    Instrumentation & valving
    Flanged Lubrication connections
    Air under water test
    Helium under water test

**Cast steel casing can be offered at considerable extra cost*
*** Based on if the oil system is properly maintained and fed at the correct system conditions*

VP Screw Compressors

- Model 321-193-26
- Number ..... Two (2)
- Operating Speed 3000-1500RPM

❑ **LP Screw Compressors**

- Model 321-193-22
- Number ..... Two (2)
- Operating Speed 3600-1800RPM

❑ **LP Screw Compressors**

- Model 321-132-21
- Number ..... Two (2)
- Operating Speed 3000RPM

Powder draws and capacities can only be guaranteed at full load only. Part load conditions are for information only.

Howden

Howden Select **Howden WLVi 321 - 193 - 26 on Helium at 2980 rpm** Page 1 of 2

Screw Compressor

Preliminary Performance Rating
Subject to Factory Design Clearance

Enerflex11295JA-R3

Job Number - Q3140111 Duty - Helium Date - 11/11/2014

Project - Air Liquid ESS Sweden VLP 50%

Location	Suction
Fluid	**Mole %**
HELIUM	100.00
WATER	0.00
Total	100.00
M.W.	4.0026

Relative Humidity ^	0.00	%
^ Free water must be removed prior to compression		

Atmospheric Press.	1.01353	bar
Cp/Cv	1.667	
Z Comp. Inlet	1.0001	

Input Skid Edge Conditions		
Inlet Press.	0.36	bara
Inlet Temp.	40.0	°C
Outlet Press.	1.20	bara

Input Compressor Flange Conditions		
Inlet Press.	0.33	bara
Inlet Temp.	40.0	°C
Outlet Press.	1.72	bara

Input Lubricant Properties		
Specific Gravity	.828	
Specific Heat	2.142	kJ/(kg.°C)
Lubricant	CP-1516-100	

Performance at Full Load

Flow	225.34	kg/hr	**Flow**	**62.6**	**g/s**	Total Oil Flow	3.08	l/sec
						Bearing Oil Flow	0.66	l/sec
Skid Volume	1261.6	Nm3/hr	Volumetric Eff.	86.0	%	Injection Oil Flow	2.42	l/sec
Comp. Volume	4504.6	Am3/hr	Adiabatic Eff.	53.4	%	Oil Pump	4.85	l/sec
Abs. Power	159.0	kW				Oil Cooler	147.14	kW
Abs. Torque	509.5	Nm				Outlet Temp.	77.0	°C
Oil/Gas dP	2.07	bar				Dew Point	-268.3	°C
Oil Temp.	50.0	°C				Disch. Super-heat	327.5	°C

Performance at Minimum Load

Oil Temp.	50.0	°C				Disch. Temp.	76.5	°C
Oil Cooler	87.88	kW				Total Oil Flow	3.08	l/sec
Injection Oil Flow	2.42	l/sec				Bearing Oil Flow	0.66	l/sec

Referance temperature for Normal flow (Nm3/hr) is 0 °C

Prepared by
Chuck Bauer

DRIVER ---------- Driver power should be at least 10% above full load power. In cases with engine drive, please consult Howden Compressors.

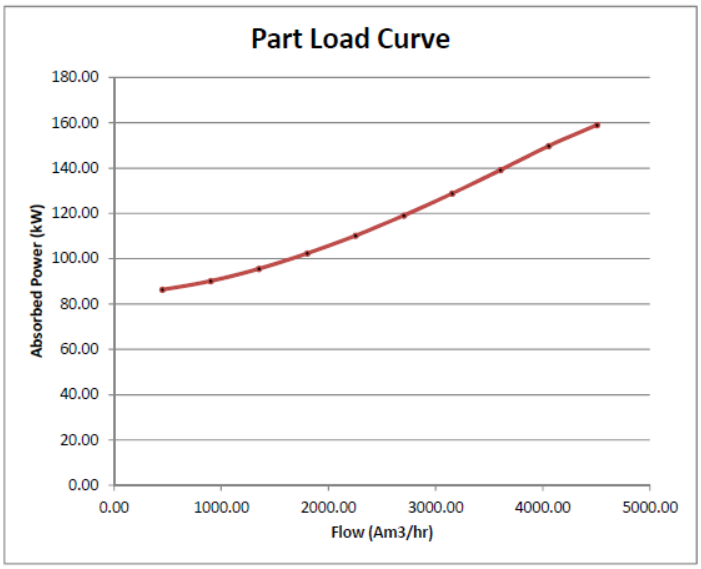
TOLERANCE ------- Full load power and capacity have a tolerance of +/- 10%. Part load powers are not guaranteed.

OIL PUMP SIZING - In cases where oil manifold viscosity is expected to fall below 30cSt, please consult Howden Compressors for oil pump recommendation.

Howden WLVi 321 - 193 - 26 on Helium at 2980 rpm

Enerflex11295JA-R3

Job Number - Q3140111 Duty - Helium Date - 11/11/2014
Project - Air Liquid ESS Sweden VLP 50%



P1 :	0.33	bara
P2 :	1.72	bara

Percentage Load %	Flow (Am3/hr)	Absorbed Power (kW)
100	4504.60	158.99
90	4054.14	149.77
80	3603.68	139.12
70	3153.22	128.78
60	2702.76	119.09
50	2252.30	110.18
40	1801.84	102.39
30	1351.38	95.55
20	900.92	90.15
10	450.46	86.33

PERCENTAGE ------- LOAD — Part load increments shown above are percentage of full load capacity rather than of slide valve position, which may not be in direct proportion to capacity.

MINIMUM LOAD ------- Minimum load is normally 10% of full load, however this amount of turndown will not be achievable in every case.

TOLERANCE ---------- Part load powers are not guaranteed.

Howden Select — **Howden WLVi 321 - 193 - 22 on Helium at 3550 rpm** — Page 1 of 2

Screw Compressor

Preliminary Performance Rating
Subject to Factory Design Clearance

Enerflex11295JA-R3

Job Number - Q3140111 Duty - Helium Date: 11/14/2014

Project - Air Liquid ESS Sweden LP1 50%

Location	**Suction**
Fluid	**Mole %**
HELIUM	100.00
WATER	0.00
Total	100.00
M.W.	4.0026

Relative Humidity ^	0.00	%
^ Free water must be removed prior to compression		

Atmospheric Press.	1.01353	bar
Cp/Cv	1.667	
Z Comp. Inlet	1.0002	

Input Skid Edge Conditions		
Inlet Press.	1.05	bara
Inlet Temp.	40.0	°C
Outlet Press.	4.00	bara

Input Compressor Flange Conditions		
Inlet Press.	1.02	bara
Inlet Temp.	40.0	°C
Outlet Press.	4.28	bara

Input Lubricant Properties		
Specific Gravity	.828	
Specific Heat	2.142	kJ/(kg.°C)
Lubricant	CP-1516-100	

Performance at Full Load								
Flow	866.94	kg/hr	**Flow**	**240.8**	**g/s**	Total Oil Flow	4.21	l/sec
						Bearing Oil Flow	0.95	l/sec
Skid Volume	4852.5	Nm3/hr	Volumetric Eff.	82.0	%	Injection Oil Flow	3.27	l/sec
Comp. Volume	5530.0	Am3/hr	Adiabatic Eff.	54.1	%	Oil Pump	6.03	l/sec
Abs. Power	321.2	kW				Oil Cooler	264.62	kW
Abs. Torque	864.0	Nm				Outlet Temp.	85.4	°C
Oil/Gas dP	2.07	bar				Dew Point	-268.9	°C
Oil Temp.	50.0	°C				Disch. Super-heat	336.5	°C

Performance at Minimum Load								
Oil Temp.	50.0	°C				Disch. Temp.	70.8	°C
Oil Cooler	155.18	kW				Total Oil Flow	4.21	l/sec
Injection Oil Flow	3.27	l/sec				Bearing Oil Flow	0.95	l/sec

Referance temperature for Normal flow (Nm3/hr) is 0 °C

Prepared by
Chuck Bauer

DRIVER ---------- Driver power should be at least 10% above full load power. In cases with engine drive, please consult Howden Compressors.

TOLERANCE ------- Full load power and capacity have a tolerance of +/- 5%. Part load powers are not guaranteed.

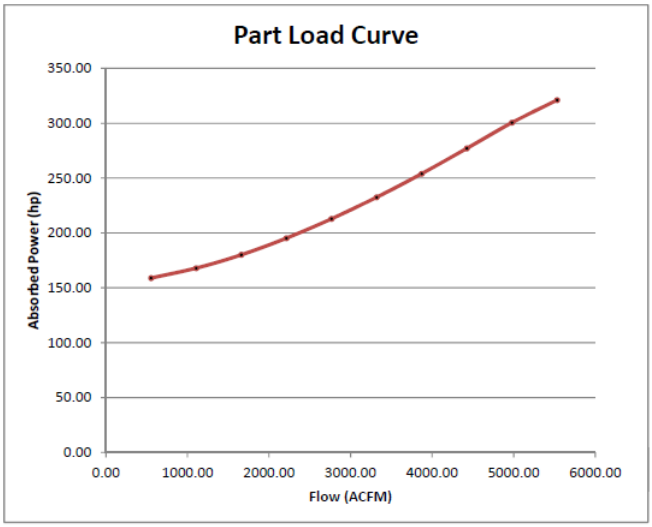
OIL PUMP SIZING - In cases where oil manifold viscosity is expected to fall below 30cSt, please consult Howden Compressors for oil pump recommendation.

Howden Select
Screw Compressor
Version Number: 1.0.4.3

Howden WLVi 321 - 193 - 22 on Helium at 3550 rpm

Enerflex11295JA-R3

Job Number - Q3140111 Duty - Helium Date: 11/14/
Project - Air Liquid ESS Sweden LP1 50%



P1 :	1.02	bara
P2 :	4.28	bara

Percentage Load %	Flow (Am3/hr)	Absorbed Power (kW)
100	5530.00	321.17
90	4977.00	300.62
80	4424.00	277.17
70	3871.00	254.05
60	3318.00	232.53
50	2765.00	212.94
40	2212.00	195.27
30	1659.00	180.18
20	1106.00	167.97
10	553.00	158.98

PERCENTAGE ------- LOAD — Part load increments shown above are percentage of full load capacity rather than of slide valve position, which may not be in direct proportion to capacity.

MINIMUM LOAD ------- Minimum load is normally 10% of full load, however this amount of turndown will not be achievable in every case.

TOLERANCE ---------- Part load powers are not guaranteed.

Howden Select — **Howden WLVS 321 - 132 - 21 on Helium at 2980 rpm** — Page 1 of 2

Screw Compressor

Enerflex11295JA-R1

Preliminary Performance Rating
Subject to Factory Design Clearance

Job Number - Q3140111 Duty - Helium Date - 10/1/2014

Project - Air Liquid ESS Sweden HP1 50%

Location	Suction
Fluid	Mole %
HELIUM	100.00
WATER	0.00
Total	100.00
M.W.	4.0026

Relative Humidity ^	0.00	%
^ Free water must be removed prior to compression		

Atmospheric Press.	1.01353	bar
Cp/Cv	1.667	
Z Comp. Inlet	1.0009	

Input Skid Edge Conditions		
Inlet Press.	4.00	bara
Inlet Temp.	40.0	°C
Outlet Press.	16.00	bara

Input Compressor Flange Conditions		
Inlet Press.	3.93	bara
Inlet Temp.	40.0	°C
Outlet Press.	16.35	bara

Input Lubricant Properties		
Specific Gravity	.828	
Specific Heat	2.142	kJ/(kg.°C)
Lubricant	CP-1516-100	

Performance at Full Load

Flow	1919.33	kg/hr				Total Oil Flow	6.23	l/sec
						Bearing Oil Flow	2.17	l/sec
Skid Volume	10745.9	Nm3/hr	Volumetric Eff.	83.4	%	Injection Oil Flow	4.06	l/sec
Comp. Volume	3178.5	Am3/hr	Adiabatic Eff.	68.1	%	Oil Pump	8.08	l/sec
Abs. Power	859.4	kW				Oil Cooler	687.33	kW
Abs. Torque	2754.2	Nm				Outlet Temp.	102.2	°C
Oil/Gas dP	2.07	bar				Dew Point	-268.9	°C
Oil Temp.	40.0	°C				Disch. Super-heat	353.3	°C

Performance at Minimum Load

Oil Temp.	40.0	°C				Disch. Temp.	96.5	°C
Oil Cooler	421.09	kW				Total Oil Flow	6.23	l/sec
Injection Oil Flow	4.06	l/sec				Bearing Oil Flow	2.17	l/sec

Referance temperature for Normal flow (Nm3/hr) is 0 °C

Prepared by
John Augustine

DRIVER ---------- Driver power should be at least 10% above full load power. In cases with engine drive, please consult Howden Compressors.

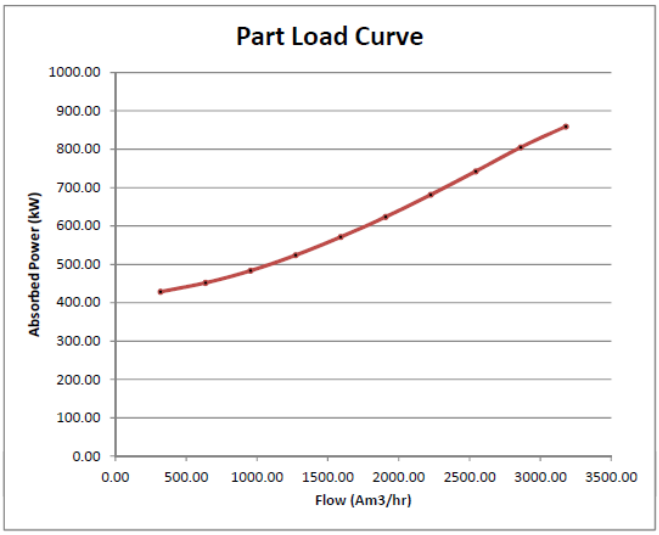
TOLERANCE ------- Full load power and capacity have a tolerance of +/- 5%. Part load powers are not guaranteed.

OIL PUMP SIZING - In cases where oil manifold viscosity is expected to fall below 30cSt, please consult Howden Compressors for oil pump recommendation.

Howden WLVS 321 - 132 - 21 on Helium at 2980 rpm

Enerflex11295JA-R1

Job Number - Q3140111 Duty - Helium Date - 10/1/2014
Project - Air Liquid ESS Sweden HP1 50%



P1 :	3.93	bara
P2 :	16.35	bara

Percentage Load %	Flow (Am3/hr)	Absorbed Power (kW)
100	3178.48	859.41
90	2860.63	805.26
80	2542.78	742.53
70	2224.94	681.51
60	1907.09	623.93
50	1589.24	571.50
40	1271.39	524.24
30	953.54	483.85
20	635.70	452.05
10	317.85	428.84

PERCENTAGE ------- LOAD — Part load increments shown above are percentage of full load capacity rather than of slide valve position, which may not be in direct proportion to capacity.

MINIMUM LOAD ------- Minimum load is normally 10% of full load, however this amount of turndown will not be achievable in every case.

TOLERANCE ---------- Part load powers are not guaranteed.

5.2 Electrical

Technical data sheets to follow

5.2.1 Motors

- ❑ Vacuum Pressure Compressor Motors

• Manufacturer	ABB
• Quantity	2
• Duty	S1
• Rated Power	250kW
• Voltage Characteristics	400v/3ph/50H_z
• Efficiency	96.7%
• Area Classification	Safe Area
• Standard	IEC
• Enclosure	IP55
• Cooling	Air
• Insulation	Class F
• Temperature Rise	Class B
• Bearings	Anti Friction
• I_p/I_n	<7
• Poles	2
• Base Speed	2980 RPM
• Expected Noise levels	78dB(A)

Special Features and Accessories:

Winding temperature detectors (RTD's) – 1 per phase
Heating element, 200-240 V
VSD rating plate
Insulated bearing non-drive end
Routine test report

M3BP 315 LKA 2, 250kW 400V 2-pole Cast Iron Induction Motor

Motor type	Cast iron TEFC
Frame Size	M3BP 315 LKA 2
Duty	S1
Rating (kW)	250
Voltage (V)	400
Number of poles	2
Base Frequency (Hz)	50
Base Speed (r/min)	2980
Maximum Permitted Speed (r/min)	3600
Current, nominal (A)	423
Torque, nominal (Nm)	801
Torque, maximum (FLT x)	2.9
Power factor	0.89
Efficiency (%)	96.7
Mounting	IM1001, Foot mounted, horizontal shaft, feet down
Family	Process performance M3BP High-output design
Terminal Box Position	Top mounted
Enclosure	IP55
Cooling	IC411
Insulation Class	F
Temperature Rise	Class B
Design repetitive insulation test level	1600 V
Paint Finish	ABB Standard Munsell Blue
Bearings	Anti-Friction
Lubrication	Grease
Weight (kg)	1440
Motor Inertia (kgm2)	2.65

Sound pressure level (dB (A)) 78

Accessories Included

- PT-100 2-wire in stator windings, one per phase
- Heating element, 200-240 V
- VSD rating plate
- Insulated bearing non-drive end
- Routine test report

Low Pressure Compressor Motors

- Manufacturer ..... ABB
- Quantity 2
- Duty S1
- Rated Power 369kW
- Voltage Characteristics ..... 6,600v/3ph/50H_z
- Efficiency 95.3%
- Area Classification ..... Safe Area
- Standard ..... IEC
- Enclosure IP55
- Cooling ..... Air
- Insulation ..... Class F
- Temperature Rise ..... Class B
- Bearings ..... Anti Friction
- I_p/I_n ..... <7
- Poles 2
- Base Speed ..... 2980 RPM
- Expected Noise levels ..... <85dB(A)

Special Features and Accessories:

Winding temperature detectors (RTD's) – 2 per phase
Bearing temperature detectors (RTD's) – 1 per bearing
Standard vibration acc. to IEC 60034-14 Grade A
Space heater for stator winding
VSD rating plate
Routine test report

HXR 400LD2, 369kW 6.6kV 2-pole Induction Machine

Technical Specification

Position	**369 kW VSD Motor**
Description	AC Induction Machine
Type	**HXR 400LD2**
Machine Category	Process Performance
Manufacturing location	Helsinki - Finland
Standards	IEC
Potentially Hazardous Atmosphere	No
Max. Ambient Temperature	40° C
Max. Altitude	1,000 m a.s.l.
Supply Type	ACS2000
Load T_L/T_n @ n/n_n; $J(WR^2)$	T_L = 0 p.u., 0 p.u., 0 p.u. @ n = 0%, 50%, 100%; J = 0 kgm2
Output	369 kW
Speed	3,600 rpm
Supply	6,600 V / 3 ph / 60.2 Hz
Temperature Rise Class	B-class
Duty Type	S1
Mounting / Protection / Cooling	IM 1001 / IP 55 / IC 411
Insulation Class	F, vacuum pressure impregnated
Direction of Rotation	Clockwise
Bearings	Standard ball bearings
Bearing Insulation	Insulated NDE only
Terminal Box	Standard air insulated IEC main terminal box
Quality Assurance	ISO 9001 and ISO 14001
Colour	Standard blue Munsell 8B 4.5/3,25

Documentation:

- Auxilairy terminal box drawing (one covering all identical units)
- Main terminal box drawing (one covering all identical units)
- Bearing arrangement drawing (one covering all identical units)
- Rotor drawing for torsional analysis purposes (one covering all identical units)

- Rating plate drawing with data (one covering all identical units)
- Lubrication plated rawing with data (one covering all identical units)
- Machine cross sectional drawing (one covering all identical units)
- Operation and maintenance manual (one covering all identical units)
- Connection diagrams (main and auxiliary circuits), (one covering all identical units)
- Spare parts list (one covering all identical units)
- Order acknowledgement (one covering all identical units)
- Machine perfromance data sheet (one covering all identical units)
- Test procedure (one covering all identical units)
- Machine dimensional drawing (one covering all identical units)
- Documentation in English language
- Only final version of documents in defined language
- Rating and Lubrication plates in English
- Safety instructions and warning labels in English
- Test report

Tests and Certificates:

- Routine test according to ABB standard procedure

Painting and Corrosion Protection:

- Surface treatment C3 - Standard industrial environment

Accessories:

- Design for ACS2000 supply
- Standard vibration acc. to IEC 60034-14 Grade A
- Insulated antifriction bearing construction, NDE only
- Standard air insulated IEC main terminal box
- Blind flange of stainless steel in main terminal box
- RTD's (Pt-100) in stator windings, 6 pcs, 3-wire, unshielded, safe and hazardous areas
- RTD's (Pt-100) in antifriction bearings, 1 pc / bearing, 3-wire, shielded, safe areas
- Space heater for stator winding
- SPM nipple for shock pulse measuring in each antifriction bearing
- Terminal box for RTD accessories
- Terminal box for space heater
- Fabricated aluminium rotor

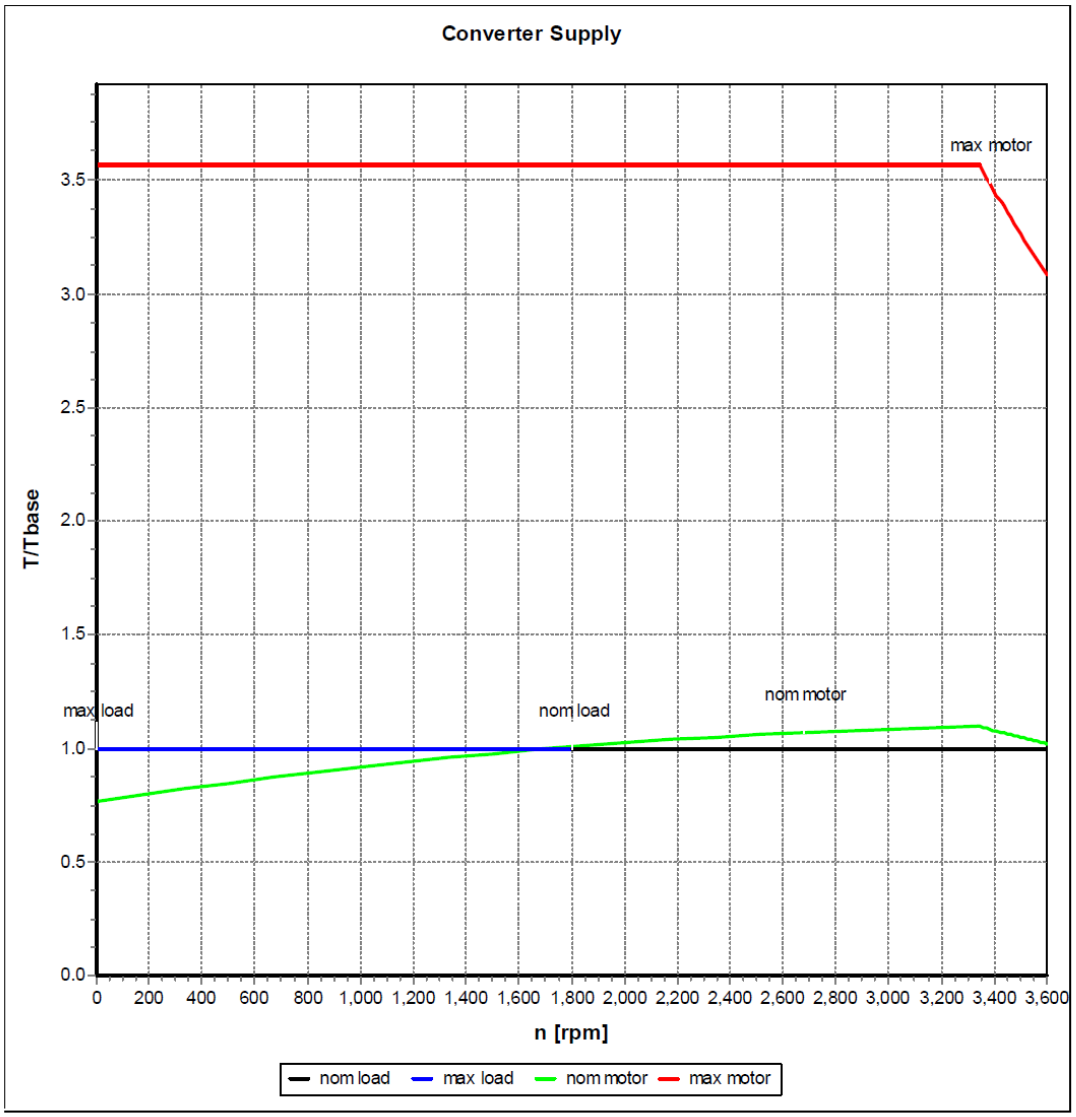
Driven equipment: 030 Compressor

Motor type code		HXR 400LD2		
Motor type		Squirrel cage Motor		
Mounting designation		IM 1001		
Protected by enclosure		IP 55		
Method of cooling		IC 411		
Insulation		Class F		
Standards		IEC		
Ambient temperature, max.		40 °C		
Altitude, max.		1000 m.a.s.l.		
Converter supply		ACS 2000		
Duty type		S1		
Temp. rise		Class B (RES)		
Connection of stator winding		Star		
Rated output	185 -	343 -	369	kW
Voltage	3581 -	6600 -	6600	V
Frequency	30.2 -	56.0 -	60.2	Hz
Speed	1800.3 -	3348.1 -	3599.9	rpm
Current	36 -	37 -	38	A
Power Factor	0.85 -	0.85 -	0.88	
Efficiency	95.5 -	95.2 -	95.1	%
Relat. maximum torque	4.5 -	4.6 -	4.0	
Rated torque	979 -	979 -	979	Nm
Weight of rotor		500 kg		
Total weight of Motor		2640 kg		
Inertia rotor		Approx. 6 kgm²		

All Motor data is subject to tolerances in accordance with IEC.
Efficiency based on typical additional load losses acc. measurements.

Motor Type Code: HXR 400LD2

Rated output	376 kW	Power Factor	0.86
Voltage	6600 V ±5 %	Rated torque	1072 Nm
Frequency	56 Hz	Relat. starting current	10.2
Speed	3347 rpm	Relat. starting torque	1.07
Current	40 A	Relat. maximum torque	4.2



Motor Type Code: HXR 400LD2

Rated output	376 kW	Power Factor	0.86
Voltage	6600 V ±5 %	Rated torque	1072 Nm
Frequency	56 Hz	Relat. starting current	10.2
Speed	3347 rpm	Relat. starting torque	1.07
Current	40 A	Relat. maximum torque	4.2

Equivalent circuit between phase and neutral (equivalent star)

Running			
Stator resistance R_1 (120 °C)	0.61070 Ω	Rotor resistance R_2' (140 °C)	0.43033 Ω
Stator reactance X_1	6.4563 Ω	Rotor reactance X_2'	5.8124 Ω
Magnetizing reactance X_m	235.19 Ω	Iron loss resistance R_{Fe}	9.4 kΩ

High Pressure Compressor Motors

- Manufacturer ..... ABB
- Quantity 2
- Duty S1
- Rated Power 988kW
- Voltage Characteristics ..... 6,600v/3ph/50H_z
- Efficiency 96.0%
- Area Classification ..... Safe Area
- Standard ..... IEC
- Enclosure IP55
- Cooling ..... Air
- Insulation ..... Class F
- Temperature Rise ..... Class B
- Bearings ..... Anti Friction
- I_p/I_n ..... <7
- Poles 2
- Base Speed ..... 2980 RPM
- Expected Noise levels ..... 88dB(A)

Special Features and Accessories:

Winding temperature detectors (RTD's) – 2 per phase
Bearing temperature detectors (RTD's) – 1 per bearing
Standard vibration acc. to IEC 60034-14 Grade A
Space heater for stator winding
VSD rating plate
Routine test report

AMI 400L2A BAH, 988kW 2-pole Modular Induction Machine

Technical Specification

Position	**988 kW DOL Machine**
Description	AC Induction Machine
Type	**AMI 400L2A BAH**
Machine Category	Process Performance
Manufacturing location	Helsinki - Finland
Standards	IEC
Potentially Hazardous Atmosphere	No
Max. Ambient Temperature	40° C
Max. Altitude	1,000 m a.s.l.
Supply Type	Fixed speed
Load T_L/T_n @ n/n_n; $J(WR^2)$	T_L = 0.3 p.u., 0.5 p.u., 0.5 p.u. @ n = 0%, 50%, 100%; J = 3.08 kgm2
Output	988 kW
Speed	2,978 rpm
Supply	6,600 V / 3 ph / 50 Hz
Temperature Rise Class	B-class
Duty Type	S1
Mounting / Protection / Cooling	IM 1001 / IP 55 / IC 611
Insulation Class	F, vacuum pressure impregnated
Direction of Rotation	Clockwise
Bearings	Standard ball bearings
Bearing Insulation	Bearings not insulated
Terminal Box	Standard air insulated IEC main terminal box
Quality Assurance	ISO 9001 and ISO 14001
Colour	Standard blue Munsell 8B 4.5/3,25

Documentation:

- Auxilairy terminal box drawing (one covering all identical units)
- Main terminal box drawing (one covering all identical units)
- Bearing arrangement drawing (one covering all identical units)
- Rotor drawing for torsional analysis purposes (one covering all identical units)

- Rating plate drawing with data (one covering all identical units)
- Lubrication plated rawing with data (one covering all identical units)
- Machine cross sectional drawing (one covering all identical units)
- Operation and maintenance manual (one covering all identical units)
- Connection diagrams (main and auxiliary circuits), (one covering all identical units)
- Spare parts list (one covering all identical units)
- Order acknowledgement (one covering all identical units)
- Machine perfromance data sheet (one covering all identical units)
- Test procedure (one covering all identical units)
- Machine dimensional drawing (one covering all identical units)
- Documentation in English language
- Only final version of documents in defined language
- Rating and Lubrication plates in English
- Safety instructions and warning labels in English
- Test report

Tests and Certificates:

- Routine test according to ABB standard procedure

Painting and Corrosion Protection:

- Surface treatment C3 - Standard industrial environment

Accessories:

- Guaranteed starting current
- Standard vibration acc. to IEC 60034-14 Grade A
- Air-to-air cooler with aluminium tubes
- Hot rolled shaft material (42CrMo4 or similar)
- Bearing insulation for antifriction bearings, none
- Collective lubrication system for antifriction bearings with programmable lubrication cycle
- Standard air insulated IEC main terminal box
- RTD's (Pt-100) in stator windings, 6 pcs, 3-wire, unshielded, safe and hazardous areas
- RTD's (Pt-100) in antifriction bearings, 1 pc / bearing, 3-wire, shielded, safe areas
- Space heater for stator winding, 1 ph
- SPM nipple for shock pulse measuring in each antifriction bearing
- Terminal box for RTD accessories

- Terminal box for space heater
- Fabricated copper rotor
- Warranty 12 months from start-up or 18 months from readiness of delivery, whichever occurs first

Driven Equipment: Compressor

Motor type code		AMI 400L2A BAS		
Motor type		Squirrel cage Motor		
Mounting designation		IM 1001		
Protected by enclosure		IP 55		
Method of cooling		IC 611		
Insulation		Class F		
Standards		IEC		
Ambient temperature, max.		40° C		
Altitude, max.		1000 m.a.s.l.		
Duty type		S1		
Temp. rise		Class B (RES)		
Connection of stator winding		Star		
Rated output		988 kW		
Voltage		6600 V ±5 %		
Frequency		50 Hz		
Speed		2978 rpm		
Current		102 A		
Relat. starting current [1)]		6.2 (6.7)		
Relat. starting torque		0.73		
Relat. maximum torque		2.6		
No load current		28 A		
Rated torque		3167 Nm		
Load characteristics	Load %	Current A	Efficiency %	Power Factor
	100	102	96.0	0.88
	75	79	96.0	0.86
	50	57	95.3	0.80
Sound pressure level: (sinus supply, no load)		85 dB(A), tol. + 3 dB(A), 1 m		
Weight of rotor		770 kg		
Total weight of Motor		3710 kg		
Inertia rotor / load		Approx. 12 kgm² / 3.1 kgm²		

Maximum stalling time	7.9 s (warm)
Starting time	2.6 s (U=100%)
	8.0 s (U=80 %)
Number of consec. starts	3 / 2 (cold/hot)
Maximum number of starts	1000 / year
Warm-up time constant	30 min
Cool-down time constant	180 min

All Motor data is subject to tolerances in accordance with IEC. [1)] Guaranteed values in parenthesis.
Efficiency based on typical additional load losses acc. measurements.

3.2.2 Variable Frequency Drives (VFDs)

- ❑ Vacuum Pressure Compressor Motor VFDs
  - Quantity 2
  - Manufacturer ..... ABB Industrial Drive
  - Drive Design ..... Active Supply Unit, DTC Inverter
  - Voltage Characteristics ..... 400V /3ph/50H_z
  - Protection IP21
  - Frequency variance ..... 50-25H_z
  - Cooling ..... Air
  - Air Flow ..... 3,160 m³/hour
  - Expected Noise Level ..... 75dB(A)
  - Dimensions (w x d x h) ..... 2,130 x 646 x 1,230mm
  - MTBF 437months
  - MTTR 2hrs
  - Availability 99.99%

Special Features and Accessories:

Door Mounted Keypad
3off Pt-100 Relays
230 VAC control voltage

ACS800-37-0260-3, 200kW 400V Low Harmonic Drive

Drive Range	ABB Industrial Drive
Drive Design	Active Supply Unit, DTC Inverter
Type Code	ACS800-37-0260-3
Configuration	ASU, 2 quadrant, non Regenerative
Supply Voltage	380…415 V
Overload Current	110% for 1min, every 5 mins, Imax for 10 secs
Protection	IP21
Output Current, Light Duty (In)	355 A
Output Power, Light Duty (Pn)	200 kW
Maximum Current (Imax)	506 A
Noise Level	75 dB(A)
Heat Loss	9 kW
Air Flow	3160 m^3/hour
Frame size	R8i
Dimensions	
Height	2130 mm
Width	1230 mm
Depth	646 mm
Weight	950 kg
Cable Access	
Incoming	Bottom
Outgoing	Bottom
Cooling Method	Internal fan

EMC Compliance	EN61800-3, C3 (2nd environment distribution)
Auxiliary Supply Voltage	

Accessories Included

- Door Mounted Keypad
- Main switch fuse with aR fuses
- Line contactor
- 230 VAC control voltage
- EMC 2nd Environment
- Common mode filter
- Standard software
- Bottom entry and exit of cables
- Cable lead through entry
- Coated boards
- One set of default language documents
- E-Stop, cat. 0 with opening main contactor breaker Q951
- Cabinet Heater - supply externally derived G300
- Cable conduit entry (US&UK version) H358
- 3off Pt-100 Relays L506

- ❑ Low Pressure Compressor Motor VFDs
  - Quantity 2
  - Manufacturer ..... ABB Industrial Drive
  - Drive Design ..... Active Supply Unit, DTC Inverter
  - Voltage Characteristics ..... 6,600V /3ph/50H_z
  - Protection IP21
  - Frequency variance ..... 60-30H_z
  - Cooling ..... Air
  - Air Flow ..... 8,500 m³/hour
  - Expected Noise Level ..... 75dB(A)
  - Dimensions (w x d x h) ..... 2,205 x 1,178 x 2,518mm
  - MTBF 87months
  - MTTR 4hrs
  - Availability 99.99%

Special Features and Accessories:

Door Mounted Keypad
8off Pt-100 Relays
230 VAC control voltage

ACS2000-066-A01D-T1-010, Active Front End Direct-To-Line (transformerless), 369kW 6.6kV

VSD system configuration

Main VSD system data
General VSD Description

Type code		ACS2000-066-A01D-T1-010
Design		Industrial standard

Main VSD output and driven motor data (motor 1)

Output voltage range	[V]	0 … 6'600
Output frequency range	[Hz]	0 … 60
Type of motor		Asynchronous
Motor shaft power	[kW]	369
Maximum continuous output current	[A]	43
Maximum peak output current	[A]	43 (60s every 300s)
Motor nominal voltage	[V]	6'600
Motor nominal speed	[rpm]	3'600
Motor nominal frequency	[Hz]	60
Speed encoder interface		Manufacturers selection
Control or motor starter for motor cooling fans/pumps		Dry contact for on/off command

Main VSD input and supply network data

Rectifier type		Active Front End (AFE) 6 pulse
Supply type		Direct-to-line (DTL)
Number of input phases		1 x 3
Min supply fault level	[MVA]	200
Max supply fault level	[MVA]	300
Supply network voltage	[V]	6'600

Max cont supply network current	[A]	43
Voltage tolerance[1]	[%]	-10 … +10
Supply frequency	[Hz]	50
Frequency tolerance[1]	[%]	-2 … +2

[1] According IEC 61800, IEC 60146

Converter efficiency	[pu]	0.951

Auxiliary supply network and utility consumption

Auxiliary supply configuration		Single 3-phase
3-phase auxiliary supply voltage		3x 400 V (+/-10%)
Nominal 3-ph auxiliary power	[VA]	3'600
Peak 3-ph auxiliary power	[VA]	45'000
Control supply configuration		Single supply UPS
Control supply voltage		1x 230 Vac (+/-10%)
Control power	[VA]	300
Control power ride-through		100ms control ride-through (safe shut-down)
Space heater for converter		Single phase 230/240Vac supply
Space heater power	[VA]	220

VSD enclosure

Type of enclosure		Corrosion protected, 2mm thick sheet steel, unpainted
Cabinet protection class		IP21
Cabinet color		RAL 7035 (light grey)
Painted surfaces		Whole cabinet painted
Door interlocking		Electromechanical door interlocking system
Dimensions main converter (w x d x h)	[mm]	2'205 x 1'178 x 2'518
Weight main converter	[kg]	2'280
Type of power cable entry (motor-side)		Aluminium plate undrilled

Location of power cable entry (motor-side)		From bottom
Type of power cable entry (line-side)		Aluminium plate undrilled
Location of power cable entry (line-side)		From bottom
Type of cable entry for auxiliary cables		Aluminium plate undrilled
Location of auxiliary cable entry		From bottom
Location of control cable entry		From bottom
Sound pressure level @1m distance	[dB(A)]	< 85
Language of warning labels		English

Cooling data

Site altitude	[masl]	1'000
Min ambient temperature	[°C]	5
Max ambient temperature	[°C]	40
Min off-state temperature	[°C]	5
Cooling method		air forced
Losses into air	[kW]	22
Cooling fans		Single
Cooling air flow	[m3/h]	8'500

Configuration

Control interface

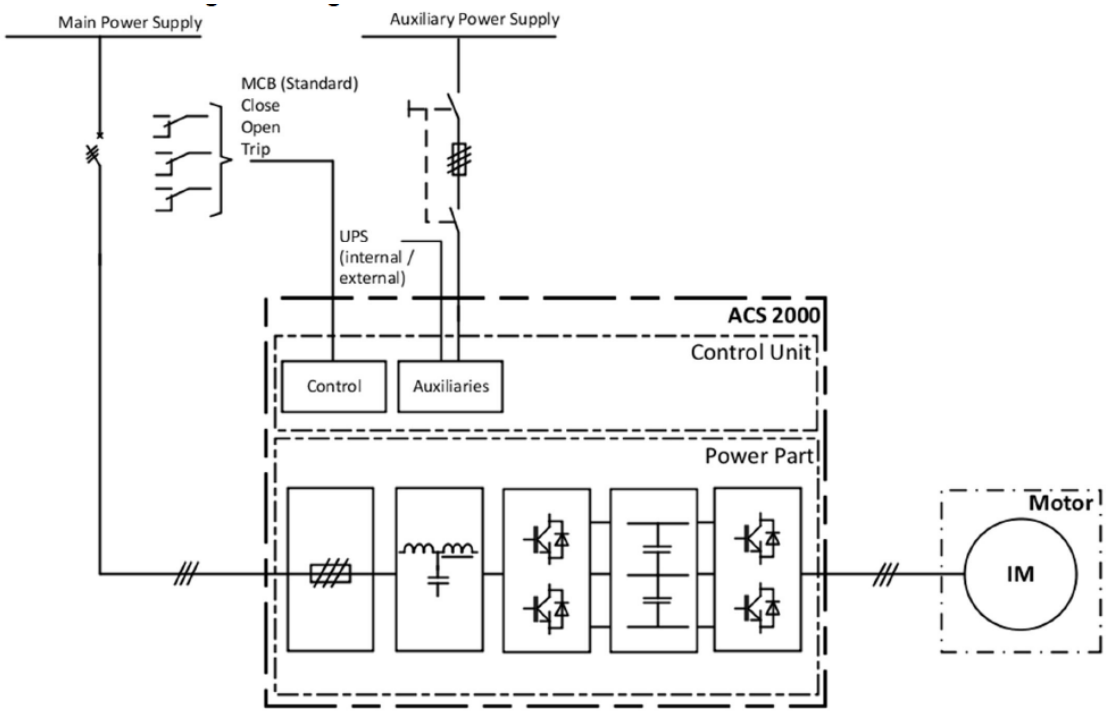
Fieldbus adapter modules	Without

Protection functions

Number of controlled MCBs	Control of 1 MCB
Motor temperature supervision	Motor supervision, 8 PT100 inputs

MCB interposing relays	MCB interposing relay + internal trip loop power supply (24V)
Drive options	
Corrosion protected busbars	Aluminium / corrosion protected
Coated control boards	Yes
Ground ball studs in TEUs	Ball size 25mm
Certifications	
Standards	IEC 61800, IEC 60146
Certification country specific	CE

VSD single line diagram



5.3 Pumps

- ❑ VP Compressor Lube Oil Pump
  - Quantity Furnished ..... Two per Skid (1+1)
  - Item Number ..... P100 A/B
  - Manufacturer ..... Kral
  - Model BG132
  - Type ..... Screw Pump in Flange
  - Body Construction ..... Nodular Cast Iron
  - Operating Speed ..... 1450 RPM
  - Flow ..... 369.6 L/min
  - Rated Power ..... 7.5 kW
  - Drive ..... Direct
  - Driver ..... Electric Motor
  - MTBF ..... 69 month
  - MTTR 10hrs
  - Reliability 99.98%
  - Special Features and Accessories:
    Suction and discharge block valves
    Pressure differential regulating valve
    Discharge check valve
    Suction strainer

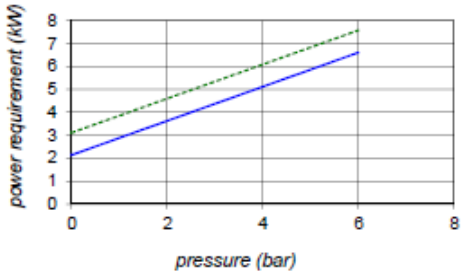
KRAL
Pumpen-Volumeter

110/80Nm → SmCo max. 300°C / 572°F
zuverlässige Betriebsd. / reliable operating data
Hastelloy Spalttopf/containment can
ohne Sanftanlauf (FU) / without soft start (FU)
7.5 kW / BG132 7.5 kW / BG132

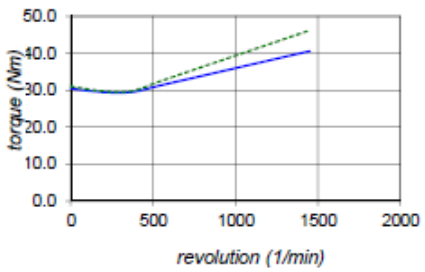
project no.: VLP position no.: Enerflex

Magnetkupplung *magnetcoupling*			Betriebsdaten 1 *operating data 1*	Betriebsdaten 2 *operating data 2*
Fördermedium	*medium*		Schmieröl / Lube Oil	
Baureihe	*series*	*(N-NE-NB-FE-M-K-CK-CL-CG)*	K	K
Pumpengröße	*size*		450	450
Saugdruck	*suction pressure*	*bar*	1.7	1.7
Enddruck	*total pressure*	*bar*	7.7	7.7
Differenzdruck	*difference pressure*	*bar*	6.0	6.0
Viskosität	*viscosity*	*mm²/s*	13	80
Drehzahl	*revolution*	*1/min*	1450	1450
Temperatur	*temperature*	*°C*	68	20
Fördermenge	*capacity*	*l/min*	385.9	413.7
		m³/h	23.2	24.8
Leistungsbedarf	*power requirement*	*kW*	6.16	7.01
min. Saugdruck (abs.)	*min. suction pressure (abs..)*	*mWs / mWC*	22.93	22.48
NPSH erforderlich	*NPSH required*	*mWs / mWC*	2.59	3.04
Luftschallpegel Pumpe	*noise level pump*	*dB (A)*	67.4	67.4
Drehmoment	*torque*	*Nm*	40.6	46.2
Wirkungsgrad gesamt	*efficiency (total)*	*%*	71.0	66.4
Wirkungsgrad volumetrisch	*efficiency (volumetric)*	*%*	86.2	92.4
Axialgeschwindigkeit	*axial velocity*	*m/s*	3.4	3.4
Massenträgheitsmoment	*moment of interia*	*kgm2*	0.00233	0.00233

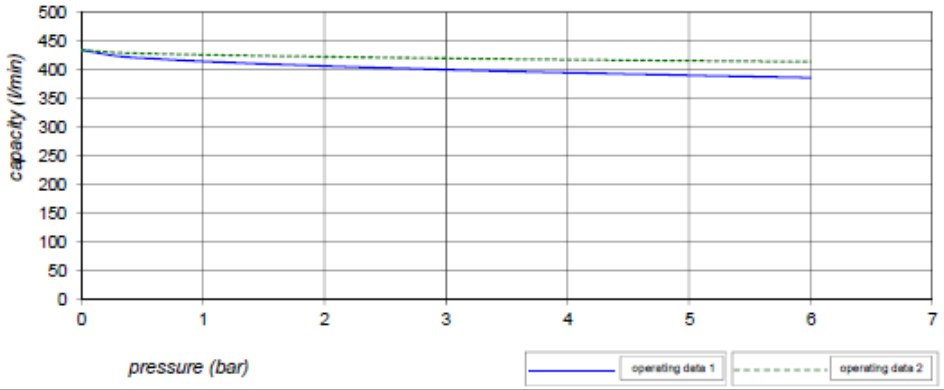
Leistungsbedarf *power required*



Anlaufdrehmoment *starting torque*



Fördermenge *capacity*



Änderungen vorbehalten! (11/2010) *subject to change (11/2010)* Version: 3.9.2COPY RIGHT by KRAL

#N/A

KRAL AG, Bildgasse 40, Industrie Nord, 6890 Lustenau, Austria, Tel.: +43 / 55 77 /
Fax: Verkauf +43 / 55 77 / 8 84 33, Technik +43 / 55 77 / 8 66 44 - 12, Einkauf +43 / 55 77 / 8 66 44 - 10
www.kral.at, E-mail: kral@kral.at, UID: ATU52065437, LG Feldkirch FN 75759 k

18. November 2014

- LP Compressor Lube Oil Pump
  - Quantity Furnished ..... Two per Skid (1 + 1)
  - Item Number ..... P200 A/B
  - Manufacturer ..... Kral
  - Model BG160
  - Type ..... Screw Pump in Flange
  - Body Construction ..... Cast Iron
  - Operating Speed ..... 1450 RPM
  - Flow ..... 508.8 L/min
  - Rated Power ..... 11 kW
  - Drive ..... Direct
  - Driver ..... Electric Motor
  - MTBF ..... 69 month
  - MTTR 10hrs
  - Reliability 99.98%
  - Special Features and Accessories:
    Suction and discharge block valves
    Pressure differential regulating valve
    Discharge check valve
    Suction strainer

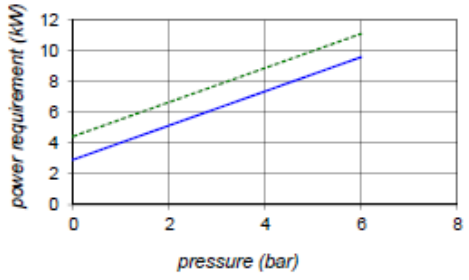
KRAL
Pumpen·Volumeter

110/100Nm → SmCo max. 300°C / 572°F
zuverlässige Betriebsd. / reliable operating data
Hastelloy Spalttopf/containment can
ohne Sanftanlauf (FU) / without soft start (FU)
11 kW / BG160 11 kW / BG160

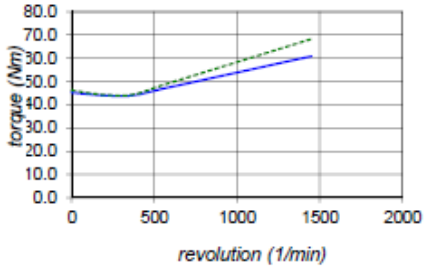
project no.: LP position no.: Enerflex

Magnetkupplung	*magnetcoupling*		Betriebsdaten 1 *operating data 1*	Betriebsdaten 2 *operating data 2*
Fördermedium	*medium*		Schmieröl / Lube Oil	
Baureihe	*series*	*(N-NE-NB-FE-MK-CK-CL-CG)*	K	K
Pumpengröße	*size*		660	660
Saugdruck	*suction pressure*	*bar*	4.3	4.3
Enddruck	*total pressure*	*bar*	10.3	10.3
Differenzdruck	*difference pressure*	*bar*	6.0	6.0
Viskosität	*viscosity*	*mm²/s*	8	80
Drehzahl	*revolution*	*1/min*	1450	1450
Temperatur	*temperature*	*°C*	91	20
Fördermenge	*capacity*	*l/min*	584.9	625.9
		m³/h	35.1	37.6
Leistungsbedarf	*power requirement*	*kW*	9.25	10.37
min. Saugdruck (abs.)	*min. suction pressure (abs..)*	*mWs / mWC*	49.20	48.61
NPSH erforderlich	*NPSH required*	*mWs / mWC*	2.83	3.41
Luftschallpegel Pumpe	*noise level pump*	*dB (A)*	70.2	70.2
Drehmoment	*torque*	*Nm*	60.9	68.3
Wirkungsgrad gesamt	*efficiency (total)*	*%*	69.6	66.2
Wirkungsgrad volumetrisch	*efficiency (volumetric)*	*%*	87.5	93.7
Axialgeschwindigkeit	*axial velocity*	*m/s*	3.9	3.9
Massenträgheitsmoment	*moment of interia*	*kgm2*	0.00618	0.00618

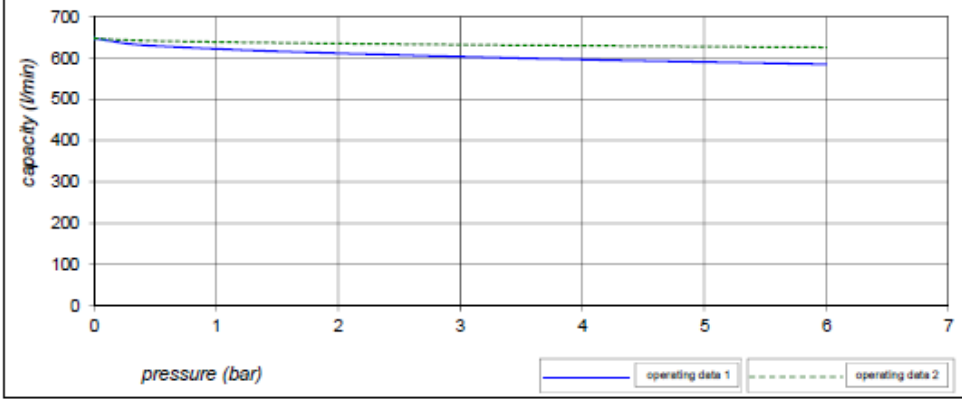
Leistungsbedarf *power required*



Anlaufdrehmoment *starting torque*



Fördermenge *capacity*



Änderungen vorbehalten! (11/2010) *subject to change (11/2010)* Version: 3.9.2©COPY RIGHT by KRAL

#N/A KRAL AG, Bildgasse 40, Industrie Nord, 6890 Lustenau, Austria, Tel.: +43 / 55 77 / 18. November 2014
Fax: Verkauf +43 / 55 77 / 8 84 33, Technik +43 / 55 77 / 8 66 44 - 12, Einkauf +43 / 55 77 / 8 66 44 - 10
www.kral.at, E-mail: kral@kral.at, UID: ATU62065437, LG Feldkirch FN 75759 k

- ❑ HP Compressor Lube Oil Pump
  - Quantity Furnished ..... Two per Skid (1 + 1)
  - Item Number ..... P300 A/B
  - Manufacturer ..... Kral
  - Model BG132
  - Type ..... Screw Pump in Flange
  - Body Construction ..... Cast Iron
  - Operating Speed ..... 1450 RPM
  - Flow ..... 720 L/min
  - Rated Power ..... 5.5 kW
  - Drive ..... Direct
  - Driver ..... Electric Motor
  - MTBF ..... 69 month
  - MTTR 10hrs
  - Reliability 99.98%
  - Special Features and Accessories:
    Suction and discharge block valves
    Pressure differential regulating valve
    Discharge check valve
    Suction strainer

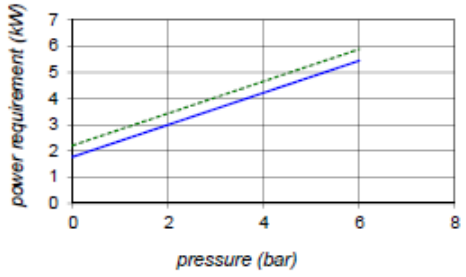
KRAL
Pumpen·Volumeter

75/60Nm → SmCo max. 300°C / 572°F
zuverlässige Betriebsd. / reliable operating data
Hastelloy Spalttopf/containment can
ohne Sanftanlauf (FU) / without soft start (FU)
5.5 kW / BG132 5.5 kW / BG132

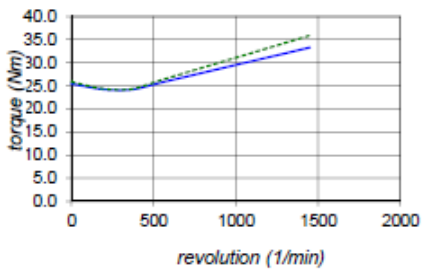
project no.: HP position no.: Enerflex

Magnetkupplung	*magnetcoupling*		Betriebsdaten 1 *operating data 1*	Betriebsdaten 2 *operating data 2*
Fördermedium	*medium*		Schmieröl / Lube Oil	
Baureihe	*series*	*(N-NE-NB-FE-MK-CK-CL-CG)*	CG	CG
Pumpengröße	*size*		370	370
Saugdruck	*suction pressure*	*bar*	16.4	16.4
Enddruck	*total pressure*	*bar*	22.4	22.4
Differenzdruck	*difference pressure*	*bar*	6.0	6.0
Viskosität	*viscosity*	*mm²/s*	33	80
Drehzahl	*revolution*	*1/min*	1450	1450
Temperatur	*temperature*	*°C*	40	20
Fördermenge	*capacity*	*l/min*	342.4	347.5
		m³/h	20.5	20.8
Leistungsbedarf	*power requirement*	*kW*	5.06	5.45
min. Saugdruck (abs.)	*min. suction pressure (abs..)*	*mWs / mWC*	172.96	172.73
NPSH erforderlich	*NPSH required*	*mWs / mWC*	2.41	2.64
Luftschallpegel Pumpe	*noise level pump*	*dB (A)*	65.6	65.6
Drehmoment	*torque*	*Nm*	33.3	35.9
Wirkungsgrad gesamt	*efficiency (total)*	*%*	72.1	67.9
Wirkungsgrad volumetrisch	*efficiency (volumetric)*	*%*	93.1	94.5
Axialgeschwindigkeit	*axial velocity*	*m/s*	2.8	2.8
Massenträgheitsmoment	*moment of interia*	*kgm2*	0.00368	0.00368

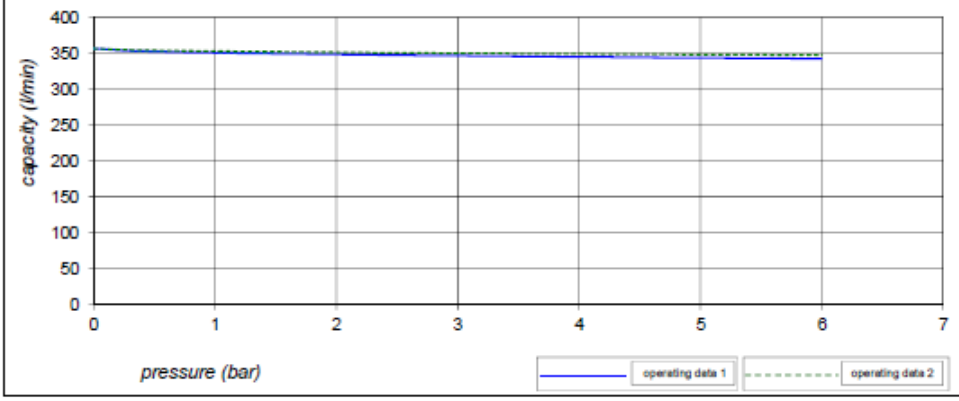
Leistungsbedarf *power required*



Anlaufdrehmoment *starting torque*



Fördermenge *capacity*



Änderungen vorbehalten! (11/2010) *subject to change (11/2010)* Version: 3.9.2©COPY RIGHT by KRAL

#N/A KRAL AG, Bildgasse 40, Industrie Nord, 6890 Lustenau, Austria, Tel.: +43 / 55 77 / Fax: Verkauf +43 / 55 77 / 8 84 33, Technik +43 / 55 77 / 8 66 44 - 12, Einkauf +43 / 55 77 / 8 66 44 - 10 www.kral.at, E-mail: kral@kral.at, UID: ATU62065437, LG Feldkirch FN 75759 k 18. November 2014

5.3 Heat Exchangers

❑ Vacuum Pressure Compressor After Cooler

- Quantity Furnished ..... One
- Type ..... BEM Shell and Tube
- Duty 24kW
- Fluid :
  - Shell Side ..... Helium
  - Tube Side ..... Cooling Water
- Design Pressure:
  - Shell Side ..... 10 barg
  - Tube Side ..... 10 barg
- Materials of Construction :
  - Shell ..... Carbon Steel
  - Tubes and end places ..... 316 Stainless Steel
- Corrosion Allowance (shell only) ..... 0.0625 mm
- Design
- Accessories:
  - Pressure relief valve
  - Instrument Bridle
  - Vent and drain valves
  - CE certified and stamped

Heat Exchanger Specification Sheet

1	To: Joe McEwen				From: Lalitha Balachandran, Delta Tee International, Inc.						
2	Company: Enerflex										
3	Service of Unit: Helium Cooler_VP Skid -metric				Our Reference: 14R2786D						
4	Item No.:				Your Reference: Q3140111						
5	Date: 2014-11-19	Rev No.: 1			Job No.:						
6	Size 219 / 1828.8 mm				Type BEM	Hor	Connected in	1	parallel	1	series
7	Surf/unit(eff.) 9 m2				Shells/unit 1		Surf/shell (eff.)		9		m2
8	**PERFORMANCE OF ONE UNIT**										
9	Fluid allocation				**Shell Side**				**Tube Side**		
10	Fluid name				Helium				Water		
11	Fluid quantity, Total			kg/s	0.1252				0.8577		
12	Vapor (In/Out)			kg/s	0.1252	0.1252			0	0	
13	Liquid			kg/s	0	0			0.8577	0.8577	
14	Noncondensable			kg/s							
15											
16	Temperature (In/Out)			C	77	40			30	36.7	
17	Dew / Bubble point			C							
18	Density (Vap / Liq)			kg/m3	0.37 /	0.4 /			/ 997.34	/ 995.6	
19	Viscosity			mPa*s	0.1522 /	0.1 /			/ 0.7998	/ 0.6957	
20	Molecular wt, Vap				4	4					
21	Molecular wt, NC										
22	Specific heat			kJ/(kg*K)	5.197 /	5.197 /			/ 4.19	/ 4.188	
23	Thermal conductivity			W/(m*K)	0.1472 /	0.1369 /			/ 0.607	/ 0.6157	
24	Latent heat			kJ/kg							
25	Pressure (abs)			bar	2.72	2.60737			9	8.91888	
26	Velocity			m/s	46.22				0.76		
27	Pressure drop, allow./calc.			bar	0.1379	0.11263			0.68948	0.08112	
28	Fouling resistance (min)			m2*K/W	0.00018				0.00018	0.00025	Ao based
29	Heat exchanged	24.1	kW				MTD corrected		19.45	C	
30	Transfer rate, Service	137			Dirty	160.9	Clean		197		W/(m2*K)
31	**CONSTRUCTION OF ONE SHELL**								**Sketch**		
32					**Shell Side**		**Tube Side**				
33	Design/vac/test pressure:		bar		10 / /		10 / /				
34	Design temperature		C		-29 / 93.33		-29 / 65.56				
35	Number passes per shell				1		4				
36	Corrosion allowance		mm		3.18		0				
37	Connections	In	in		1 4 / 150 ANSI		1 1 / 150 ANSI				
38	Size/rating	Out			1 4 / 150 ANSI		1 1 / 150 ANSI				
39	Nominal	Intermediate			/		/				
40	Tube No. 32	OD	19.05	Tks- Avg	1.24	mm	Lengtl 1828.8	mm	Pitch		mm
41	Tube type	Enhanced			Material		SA-249 TP316		Tube pattern		
42	Shell	Carbon Steel	ID	202.72	OD 219.08	mm	Shell cover	-			
43	Channel or bonnet		SS 316				Channel cover	-			
44	Tubesheet-stationary		SS 316				Tubesheet-floating	-			
45	Floating head cover		-				Impingement protection	None			
46	Baffle-cross	Carbon Steel	Type		Cut(%d)		Spacing: c/c				mm
47	Baffle-long	-			Seal type				Inlet		mm
48	Supports-tube				U-bend		Type				
49	Bypass seal				Tube-tubesheet joint		Exp. 2 grv				
50	Expansion joint	-			Type						
51	RhoV2-Inlet nozzle	621			Bundle entrance	396			Bundle exit	370	kg/(m*s2
52	Gaskets - Shell side	-			Tube Side		Compressed Fiber 1/16				
53	Floating head	-									
54	Code requirements	ASME Code Sec VIII Div 1					TEMA class		R - refinery service		
55	Weight/Shell	262.6			Filled with water	317.6			Bundle	86.4	kg
56	Remarks										
57											
58											

❑ Low Pressure Compressor After Cooler

- Quantity Furnished ..... One
- Type ..... Shell and Tube
- Duty 113kW
- Fluid :
  - Shell Side ..... Helium
  - Tube Side ..... Cooling Water
- Design Pressure:
  - Shell Side ..... 10 barg
  - Tube Side ..... 10 barg
- Materials of Construction :
  - Shell ..... Carbon Steel
  - Tubes and end places ..... 316 Stainless Steel
- Corrosion Allowance (CS only) 0.0625mm
- Accessories:
  - Pressure relief valve
  - Instrument Bridle
  - Vent and drain valves
  - CE certified and stamped

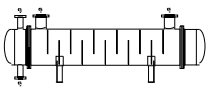
Data Sheet to follow

- High Pressure Compressor After Cooler

  - Quantity Furnished ..... One
  - Type ..... Shell and Tube
  - Duty 344kW
  - Fluid :
    - Shell Side ..... Helium
    - Tube Side ..... Cooling Water
  - Design Pressure:
    - Shell Side ..... 10 barg
    - Tube Side ..... 10 barg
  - Materials of Construction :
    - Shell ..... Carbon Steel
    - Tubes and end places ..... 316 Stainless Steel
  - Corrosion Allowance (CS only) 0.0625mm
  - Accessories:
    - Pressure relief valve
    - Instrument Bridle
    - Vent and drain valves
    - CE certified and stamped

Heat Exchanger Specification Sheet

1	To: Joe McEwen				From: Lalitha Balachandran, Delta Tee International, Inc.						
2	Company: Enerflex										
3	Service of Unit: Helium Cooler_HP Skid-metric				Our Reference: 14R2786F						
4	Item No.:				Your Reference: Q3140111						
5	Date: 2014-11-19	Rev No.: 1			Job No.:						
6	Size 457 / 2438.4 mm				Type BEM	Hor	Connected in	1	parallel	1	series
7	Surf/unit(eff.) 60 m2				Shells/unit 1		Surf/shell (eff.)		60		m2
8	**PERFORMANCE OF ONE UNIT**										
9	Fluid allocation				**Shell Side**				**Tube Side**		
10	Fluid name				Helium				Water		
11	Fluid quantity, Total			kg/s	1.0661				12.2902		
12	Vapor (In/Out)			kg/s	1.0661	1.0661			0	0	
13	Liquid			kg/s	0	0			12.2902	12.2902	
14	Noncondensable			kg/s							
15											
16	Temperature (In/Out)			C	102.2	40			30	36.7	
17	Dew / Bubble point			C							
18	Density (Vap / Liq)			kg/m3	2.22 /	2.65 /			/ 997.43	/ 995.59	
19	Viscosity			mPa*s	0.1969 /	0.1 /			/ 0.7976	/ 0.6959	
20	Molecular wt, Vap				4	4					
21	Molecular wt, NC										
22	Specific heat			kJ/(kg*K)	5.201 /	5.203 /			/ 4.19	/ 4.188	
23	Thermal conductivity			W/(m*K)	0.1541 /	0.1371 /			/ 0.6071	/ 0.6157	
24	Latent heat			kJ/kg							
25	Pressure (abs)			bar	17.35	17.24415			9	8.87263	
26	Velocity			m/s	15.33				1.11		
27	Pressure drop, allow./calc.			bar	0.1379	0.10585			0.68948	0.12738	
28	Fouling resistance (min)			m2*K/W	0.00018				0.00018	0.00025	Ao based
29	Heat exchanged	344.9	kW				MTD corrected		26.45	C	
30	Transfer rate, Service	217.4		Dirty	246.8	Clean	343.4			W/(m2*K)	
31	**CONSTRUCTION OF ONE SHELL**								**Sketch**		
32				**Shell Side**		**Tube Side**					
33	Design/vac/test pressure:		bar	20 / /		10 / /					
34	Design temperature		C	-29 / 121.11		-29 / 65.56					
35	Number passes per shell			1		2					
36	Corrosion allowance		mm	3.18		0					
37	Connections	In	in	1 6 / 300 ANSI		1 3 / 150 ANSI					
38	Size/rating	Out		1 6 / 300 ANSI		1 3 / 150 ANSI					
39	Nominal	Intermediate		/		/					
40	Tube No. 158	OD	19.05	Tks- Avg	1.24	mm	Lengtl 2438.4	mm	Pitch		mm
41	Tube type	Enhanced		Material		SA-249 TP316			Tube pattern		
42	Shell	Carbon Steel	ID	438.15	OD 457.2	mm	Shell cover	-			
43	Channel or bonnet		SS 316				Channel cover	-			
44	Tubesheet-stationary		SS 316				Tubesheet-floating	-			
45	Floating head cover		-				Impingement protection	None			
46	Baffle-cross	Carbon Steel	Type		Cut(%d)		Spacing: c/c				mm
47	Baffle-long	-		Seal type					Inlet		mm
48	Supports-tube			U-bend		Type					
49	Bypass seal			Tube-tubesheet joint		Exp. 2 grv					
50	Expansion joint	-		Type							
51	RhoV2-Inlet nozzle	1471		Bundle entrance	1237		Bundle exit	1039			kg/(m*s2
52	Gaskets - Shell side	-		Tube Side		Compressed Fiber 1/16					
53	Floating head	-									
54	Code requirements	ASME Code Sec VIII Div 1				TEMA class		R - refinery service			
55	Weight/Shell	950.6		Filled with water	1337.4		Bundle	462.6			kg
56	Remarks										
57											
58											



❑ Vacuum Pressure Compressor Oil Cooler

- Quantity Furnished ..... One
- Manufacturer ..... GEA
- Type ..... Brazed Plate
- Duty ..... 295 kW
- Fluid :
  - Shell Side ..... Oil
  - Tube Side ..... Cooling Water
- Design Pressure:
  - Shell Side ..... 10 barg
  - Tube Side ..... 10 barg
- Materials of Construction :
  - Brazing ..... Copper
  - Plates ..... 316 Stainless Steel
- Design
- Accessories:
  - Pressure relief valve
  - Vent and drain valves
  - CE certified and stamped

❑ Low Pressure Compressor Oil Cooler

- Quantity Furnished ..... One
- Manufacturer ..... GEA
- Type ..... Brazed Plate
- Duty ..... 295 kW
- Fluid :
  - Shell Side ..... Oil
  - Tube Side ..... Cooling Water
- Design Pressure:
  - Shell Side ..... 10 barg
  - Tube Side ..... 10 barg
- Materials of Construction :
  - Brazing ..... Copper
  - Plates ..... 316 Stainless Steel
- Design
- Accessories:
  - Pressure relief valve
  - Vent and drain valves
  - CE certified and stamped

- ❑ High Pressure Compressor Oil Cooler 1 – High Temp

  - Quantity Furnished ..... One
  - Manufacturer ..... GEA
  - Type ..... Brazed Plate
  - Duty ..... 444 kW
  - Fluid :
    - Shell Side ..... Oil
    - Tube Side ..... Cooling Water
  - Design Pressure:
    - Shell Side ..... 20 barg
    - Tube Side ..... 20 barg
  - Materials of Construction :
    - Brazing ..... Copper
    - Plates ..... 316 Stainless Steel
  - Design
  - Accessories:
    - Pressure relief valve
    - Vent and drain valves
    - CE certified and stamped

- ❑ High Pressure Compressor Oil Cooler 2 – Low Temp

  - Quantity Furnished ..... One
  - Manufacturer ..... GEA
  - Type ..... Brazed Plate
  - Duty ..... 1015 kW
  - Fluid :
    - Shell Side ..... Oil
    - Tube Side ..... Cooling Water
  - Design Pressure:
    - Shell Side ..... 20 barg
    - Tube Side ..... 20 barg
  - Materials of Construction :
    - Brazing ..... Copper
    - Plates ..... 316 Stainless Steel
  - Design
  - Accessories:
    - Pressure relief valve
    - Vent and drain valves
    - CE certified and stamped

5.4 Vessels

Information and data listed above have been converted from English to Metric or SI units for your convenience. However, actual components will be the manufacturer's standard sizes.

VP Stage Compressor Discharge Coalescer 100-V100

- Quantity Furnished 1
- Item Number 100-V100
- Type ..... Vertical
- Size ..... 609 mm OD * 2159 mm SS
- Materials of Construction:
  - Shell ..... Carbon Steel, SA-516 Gr70 N
  - Heads ..... Carbon Steel, SA-516 Gr70 N
  - Nozzles ..... Carbon Steel, A333 Gr 6
  - Flanges ..... Carbon Steel, LF2
- Corrosion Allowance ..... 1.59 mm
- Design Working Pressure ..... 10 bar g
- Design Working Temperature ..... 0ºC to 121ºC
- Code Requirements ..... ASME Section VIII PED code stamped
- Radiography ..... Spot
- Accessories:
  - Thermostatically controlled heater
  - Instrumentation & Valving as per the P&IDs

VP Stage Secondary Compressor Discharge Coalescer 100-V100

- Quantity Furnished 1
- Item Number 100-V100
- Type ..... Vertical
- Size ..... 762 mm OD * 1016 mm
- Materials of Construction:
  - Shell ..... Carbon Steel, SA-516 Gr70 N
  - Heads ..... Carbon Steel, SA-516 Gr70 N
  - Nozzles ..... Carbon Steel, A333 Gr 6
  - Flanges ..... Carbon Steel, LF2
- Corrosion Allowance ..... 1.59 mm
- Design Working Pressure ..... 10 bar g
- Design Working Temperature ..... 0ºC to 121ºC
- Code Requirements ..... ASME Section VIII PED code stamped
- Accessories:
  - Instrumentation & Valving as per the P&IDs

LP Stage Compressor Discharge Coalescer 100-V200

- ❑ Compressor Discharge Oil Separator and Reservoir
  - Quantity Furnished 1
  - Item Number 100-V200
  - Type ..... Vertical
  - Size ..... 914.4 mm OD * 2159 mm SS
  - Materials of Construction:
    - Shell ..... Carbon Steel, SA-516 Gr70 N
    - Heads ..... Carbon Steel, SA-516 Gr70 N
    - Nozzles ..... Carbon Steel, A333 Gr 6
    - Flanges ..... Carbon Steel, LF2
  - Corrosion Allowance ..... 1.59 mm
  - Design Working Pressure ..... 10 bar g
  - Design Working Temperature ..... 0ºC to 121ºC
  - Code Requirements ..... ASME Section VIII PED code stamped
  - Radiography ..... Spot
  - Accessories:
    Instrumentation & Valving as per the P&IDs

HP Stage Compressor Discharge Coalescer 100-V300

- ❑ Compressor Discharge Oil Separator and Reservoir
  - Quantity Furnished 1
  - Item Number 100-V300
  - Type ..... Vertical
  - Size ..... 1371.6 mm OD * 2286 mm SS
  - Materials of Construction:
    - Shell ..... Carbon Steel, SA-516 Gr70 N
    - Heads ..... Carbon Steel, SA-516 Gr70 N
    - Nozzles ..... Carbon Steel, A333 Gr 6
    - Flanges ..... Carbon Steel, LF2
  - Corrosion Allowance ..... 1.59 mm
  - Design Working Pressure ..... 25 bar g
  - Design Working Temperature ..... 0ºC to 121ºC
  - Code Requirements ..... ASME Section VIII PED code stamped
  - Radiography ..... Spot
  - Accessories:
    Instrumentation & Valving as per the P&IDs

Primary Oil Coalescer OR100
Pure helium oil mist coalescer, with details as follows:

Design

Quantity	1
Tag Number(s)	OR100
Type	Vertical
Size	323 mm OD x 1320.8 mm S/S
Materials of Construction	Low temperature Carbon Steel
Shell	SA-516-70N
Head	SA-516-70N
Flanges	SA-350-LF2-CL1
Corrosion Allowance	1.59 mm
Code Requirements	ASME Section VIII PED CE
Design Pressure	25 bar g
Design Temperature	0 to 121°C
Element Quantity	6
Element Manufacturer	Domnick Hunter Elements
Element Size	266.7 mm OD * 635 mm SS

Features

- 18”-300#RF flanged top access manway with davit
- 6”-300#RF flanged nozzles
- (1) drain connections
- Spiral wound, 304 stainless steel gaskets with graphite filler (style CGI)
- Mounting legs
- Coating per Enerflex standard paint system
- Inspection and testing per code and specification requirements as commented to herein

Secondary Oil Coalescer OR200

Pure helium oil mist coalescer, with details as follows:

Design

Quantity	1
Tag Number(s)	OR200
Type	Vertical
Size	323 mm OD x 1320.8 mm S/S
Materials of Construction	Low temperature Carbon Steel
Shell	SA-516-70N
Head	SA-516-70N
Flanges	SA-350-LF2-CL1
Corrosion Allowance	1.59 mm
Code Requirements	ASME Section VIII PED CE
Design Pressure	25 bar g
Design Temperature	40°C
Element Quantity	6
Element Manufacturer	Domnick Hunter Elements
Element Size	266.7 mm OD * 635 mm SS

Features

- 18”-300#RF flanged top access manway with davit
- 6”-300#RF flanged nozzles
- (1) drain connections
- Spiral wound, 304 stainless steel gaskets with graphite filler (style CGI)
- Mounting legs
- Coating per Enerflex standard paint system
- Inspection and testing per code and specification requirements as commented to herein

Tertiary Oil Coalescer OR300

Pure helium oil mist coalescer, with details as follows:

Design

Quantity	1
Tag Number(s)	OR300
Type	Vertical
Size	323 mm OD x 1320.8 mm S/S
Materials of Construction	Low temperature Carbon Steel
Shell	SA-516-70N
Head	SA-516-70N
Flanges	SA-350-LF2-CL1
Corrosion Allowance	1.59 mm
Code Requirements	ASME Section VIII PED CE
Design Pressure	25 bar g
Design Temperature	40°C
Element Quantity	6
Element Manufacturer	Domnick Hunter Elements
Element Size	266.7 mm OD * 635 mm SS

Features

- 18”-300#RF flanged top access manway with davit
- 6”-300#RF flanged nozzles
- (1) drain connections
- Spiral wound, 304 stainless steel gaskets with graphite filler (style CGI)
- Mounting legs
- Coating per Enerflex standard paint system
- Inspection and testing per code and specification requirements as commented to herein

Oil Adsorber OA100

Pure helium carbon bed oil absorber, with details as follows:

Design

Quantity	1
Tag Number(s)	OA100
Type	Vertical carbon bed oil adsorber
Size	1371 mm OD x 3087.9 mm S/S
Materials of Construction	Low temperature Carbon Steel
Shell	SA-516-70N
Head	SA-516-70N
Flanges	SA-350-LF2-CL1
Corrosion Allowance	1.59 mm
Code Requirements	ASME Section VIII PED CE
Design Pressure	25 bar g
Design Temperature	-20 to 121°C

Features

- (1) 24”-300#RF flanged access manway with davit (on the top of the vessel)
- 6”-300#RF flanged nozzles
- 3160 pounds of Calgon carbon type PCB 4x10 mesh size activated carbon adsorbent
- A 6" layer of 1" diameter D-57 Denstone ceramic balls for top of carbon stabilization
- Johnson Vee wire screen support grid assembly
- Spiral wound, 304 stainless steel gaskets with graphite filler (style CGI)
- Mounting legs
- Coating per Enerflex standard paint system
- Inspection and testing per code and specification requirements as commented to herein

Dust After-Filter DF100

Pure helium dust after filter, with details as follows:

Design

Quantity	1
Tag Number(s)	DF100
Type	Vertical filter
Size	323.85 mm OD x 1320.8S/S
Materials of Construction	316SS
Head	316SS
Flanges	316SS
Corrosion Allowance	1.59 mm
Code Requirements	ASME Section VIII PED CE
Design Pressure	25 bar g
Design Temperature	-20°C to 121°C
Element Quantity	1
Element Manufacturer	Dollinger
Element Size	266.7mmODx152.4IDx635H

Features

- Full diameter, top access manway with davit, 12”-300#RF flange
- 6”-300#RF flanged nozzles
- (1) 1” drain connection
- Spiral wound, 304 stainless steel gaskets with graphite filler (style CGI)
- Stainless steel element mounting internals
- Mounting legs
- 10 micron element
- Coating per Enerflex standard paint system
- Inspection and testing per code and specification requirements as commented to herein
- Documentation per the specifications as commented to herein

3.4 Control Panel and Instrumentation

Each compressor skid will be provided with local start-stop switches to be mounted on each compressor skid. A clearly marked terminal strip is provided for purchaser's field wiring connections. Customer field wiring connections are made in skid mounted junction boxes, IP 55, Stainless steel. The following instruments and devices are part of the control system of this unit. Some are panel mounted, while others are remote mounted in the unit piping:

In addition, a compressor monitoring system can be offered. This would consist of signals used for shut down only and not for control. Control of the system is achieved through the customers DCS.

3.4.1 Preliminary IO list.

This list is not definitive and is subject to further detail and change at engineered phase after purchase order.

	Per Compressor Skid	ORS Skid*	Gas Management
Digital output	15	20	4
Digital input	10	13	4
Analogue output	26	12	7
Analogue input	0	4	0
Motor Control	3	0	

**does not include IO for valves for CV6A/B*

Gas Management Panel

Valve No.1A	:	**HP – Pressure Control**
Inlet Pressure	:	16 bar a
Outlet Pressure	:	16 bar a
Max Inlet Temp	:	105ºC
Flow	:	191.9 kg/h
Valve Type	:	On / Off actuated
Size	:	2” 300#

Valve No.1B	:	**HP – Pressure Control**
Inlet Pressure	:	16 bar a
Outlet Pressure	:	16 bar a
Max Inlet Temp	:	105ºC
Flow	:	191.9 kg/h
Valve Type	:	On / Off actuated)
Size	:	2” 300#

Valve No.2A	:	**HP – Pressure Control**
Inlet Pressure	:	16 bar a
Outlet Pressure	:	4 bar a
Max Inlet Temp	:	95ºC
Flow	:	191.9 kg/h
Valve Type	:	On / Off actuated)
Size	:	2” 300#

Valve No.2B	:	**HP – Pressure Control**
Inlet Pressure	:	16 bar a
Outlet Pressure	:	4 bar a
Max Inlet Temp	:	95ºC
Flow	:	191.9 kg/h
Valve Type	:	On / Off actuated
Size	:	2” 300#

Valve No.3A	:	**HP – Pressure Control**
Inlet Pressure	:	16 bar a
Outlet Pressure	:	1.03 bar a
Max Inlet Temp	:	80ºC
Flow	:	191.9 kg/h
Valve Type	:	On / Off actuated
Size	:	2” 300#

Valve No.3B : **HP – Pressure Control**

Inlet Pressure	:	16 bar a
Outlet Pressure	:	1.03 bar a
Max Inlet Temp	:	80ºC
Flow	:	191.9 kg/h
Valve Type	:	On / Off actuated
Size	:	2” 300#

Valve No.4A : **MP – Pressure Control**

Inlet Pressure	:	16 bar a
Outlet Pressure	:	4 bar a
Max Inlet Temp	:	95ºC
Flow	:	1919 kg/h
Valve Type	:	On / Off actuated
Size	:	6” 300#

Valve No.4B : **MP – Pressure Control**

Inlet Pressure	:	16 bar a
Outlet Pressure	:	4 bar a
Max Inlet Temp	:	95ºC
Flow	:	287.85 kg/h
Valve Type	:	Fine Control
Size	:	2” 300#

Valve No.5A : L**P – Pressure Control**

Inlet Pressure	:	16 bar a
Outlet Pressure	:	1.03 bar a
Max Inlet Temp	:	95ºC
Flow	:	1688 kg/h
Valve Type	:	On / Off actuated
Size	:	6” 300#

Valve No.5B : L**P – Pressure Control**

Inlet Pressure	:	16 bar a
Outlet Pressure	:	1.03 bar a
Max Inlet Temp	:	95ºC
Flow	:	1688 kg/h
Valve Type	:	Fine Control
Size	:	2” 300#

Valve No.6A : NOT REQUIRED

Valve No.6B : NOT REQUIRED

Valve No.7A : **SP – Pressure Control**

Inlet Pressure	:	4 bar a
Outlet Pressure	:	0.36 bar a
Max Inlet Temp	:	80ºC
Flow	:	461.2 kg/h
Valve Type	:	On / Off actuated
Size	:	6” 150#

Valve No.7B : **SP – Pressure Control**

Inlet Pressure	:	4 bar a
Outlet Pressure	:	0.36 bar a
Max Inlet Temp	:	80ºC
Flow	:	69.18 kg/h
Valve Type	:	Fine Control
Size	:	2” 150#

Valve No.CV8 : **To Back Up Compressor**

Inlet Pressure	:	1.03 bar a
Outlet Pressure	:	1.03 bar a
Max Inlet Temp	:	95ºC
Flow	:	n/a
Valve Type	:	On / Off actuated Material
Size	:	2” 150#

5.5 Manually Operated Valves

In general valves would be provided as follows. All valves greater than 1” will be CE marked

- ❑ Manually Operated Valves - Refrigerant /Helium Service
  - For sizes through 1": Refrigerant seal cap type with threaded connections and carbon steel bodies, Henry, Hansen, or equivalent.
  - For sizes 1-1/2" through 8": Refrigerant seal cap type with welded connections and carbon steel bodies, Hansen or equivalent.
- ❑ Manually Operated Valves - Lube Oil Service
  - For sizes 3/4" through 2": Same as refrigerant service.
  - For sizes larger than 2": Same as refrigerant service
- ❑ Manually Operated Valves - Cooling Water Service
  - For sizes 3/4" through 1": Same as ball valves or butterfly as necessary.
  - For sizes larger than 1": butterfly.

5.6 Check Valves

Check valves will be furnished in the quantities, sizes and locations as detailed in the preceding paragraphs and as follows. Standard US pipe sizes are used for these valves.

- ❑ Refrigerant Service
  - For pipe sizes through 1": Check valves will be cast iron body with threaded connections manufactured by Hansen, Refrigerating Specialties or equivalent.
  - For pipe sizes of 1-1/2": Check valves will be cast iron body with flanged connections manufactured by Hansen, Refrigerating Specialties or equivalent.
  - For pipe sizes larger than 1-1/2": Check valves will be carbon steel body with flanged connections manufactured by Refrigerating Specialties or equivalent.
- ❑ Lube Oil Service
  - For pipe sizes through 1": Same as refrigerant service. Or Check valves will be cast iron body with threaded connections manufactured by Refrigerating Specialties or equivalent.
  - For pipe sizes larger than 1": Same as refrigerant service or process. Or Check valves will be cast iron body with flanged connections manufactured by Refrigerating Specialties or equivalent.

5.7 Safety Relief Valves

Safety relief valves are sized in accordance with the provisions of PED 97/23/EC or EN4126. Safety relief valve outlets are piped to two relief headers, one contaminated with oil and one with pure helium, which will terminate in a flanged connection at the edge of the skid.

5.8 Skid Interfaces

Compressor Skids

VP and LP skids have 150# flanges and HP has 300#. Interfaces are per skid.

Description	Service
10",8" or 6" 150# or 300# RF Flange	Gas Inlet
6" 150# or 300# RF Flange	Gas Outlet
8" 150# RF Flange	Cooling Water Inlet
8" 150# RF Flange	Cooling Water Outlet
6" 150# RF Flange	Oil Contaminated Relief Header
6" 150# RF Flange	Oil Free Relief Header
1" 150# RF Flange	Instrument Air Supply
¾" Male Quick Coupling	Oil Charging Compressor One
¾" Male Quick Coupling	Oil Charging Compressor Two
1" 150# or 300# RF Flange	Oil Transfer
¾" 300# RF Flange	Helium Filling
1 ½" 150# RF Flange	Helium Purge / Pumping

Oil Recovery Skid

Description	Service
6" 300# RF Flange	Gas Inlet
6" 300# RF Flange	Gas Outlet
2" 300# RF Flange	Hot GN2 for Drying
8" 150# RF Flange	Oil Return To HP Compressors
¼" OD DBL Ferule	Helium to Analyser
¼" OD DBL Ferule	Helium from Analyser
¾" 300# RF Flange	Helium Filling
1 ½" 150# RF Flange	Helium Purge
2" 300# RF Flange	Hot GN2 Return
6" 150# RF Flange	Oil Contaminated Relief Header
6" 150# RF Flange	Oil Free Relief Header
1" 150# RF Flange	Instrument Air Supply

Exchanger / Valve Skid

Description	Service
6" 150# RF Flange	SP Gas Inlet
6" 150# RF Flange	SP Gas Outlet
6" 150# RF Flange	LP Gas Inlet
6" 150# RF Flange	LP Gas Outlet
6" 150# RF Flange	MP Gas Inlet
6" 150# RF Flange	MP Gas Outlet
6" 300# RF Flange	HP Gas Inlet
6" 300# RF Flange	HP Gas Outlet
2" 150# RF Flange	To Backup Compressor
2" 300# RF Flange	To Warm Helium Storage
2" 300# RF Flange	From Warm Helium Storage

Description	Service
6" 150# RF Flange	Instrument Air Supply
6" 150# RF Flange	SP Aftercooler Inlet
6" 150# RF Flange	SP Aftercooler Outlet
6" 150# RF Flange	LP Aftercooler Inlet
6" 150# RF Flange	LP Aftercooler Outlet
6" 150# RF Flange	HP Aftercooler Inlet
8" 150# RF Flange	Cooling Water Inlet
8" 150# RF Flange	Cooling Water Outlet

5.9 Instruments and Controls

Reliability calculations have not been undertaken on instrumentation but >99% can be assured subject to order.

- ❑ Pressure Instruments
  - Pressure gages will be Wika
  - Pressure transmitters will be Rosemount
    - LCDs provided

- ❑ Temperature Instruments
  - Temperature indicators are bi-metallic dial type, Wika
  - Transmitter, Temperature, Rosemount 100 OHM Platnium RTD
    - LCDs provided

- ❑ Level Instruments
  - Level indicators are reflex type; Jerguson, Daniel, Penberthy or equivalent
  - Level transmitters are DP type, Emerson (Rosemount, Smart type-3051CD-N7)

- ❑ Control Valves
  - Pneumatic control valves are Fisher Rosemount
  - Pneumatic ball valves are Worcester or Jamesbury
  - Pneumatic butterfly valves are Keystone
  - Pneumatic oil temperature regulating valves are Valtec
  - Self-contained type oil pressure regulating valves are Blackmer or Fulflo
  - Solenoid valves will be ASCO

3.10 Structural Steel Base

The structural steel bases will be designed to accommodate and support the equipment described in the preceding paragraphs are included.

Each structural steel base will be fabricated from standard sized US structural shapes. All joints will be continuously welded. Suitable lifting lugs will be provided for rigging and an adequate number of anchor bolt holes will be provided for fastening the skid to a concrete foundation. All full-depth structural members are to be fully supported by the foundation.

3.11 Pipe and Fittings

- ❑ Process Service

The necessary pipe and fittings required for proper interconnection of the above components within the perimeter of the structural steel base is included. Skid interconnecting pipework is not included. All piping and fittings will be standard US nominal pipe sizes.

Construction of piping will be in accordance to PED and incorporated EN codes.

- ❑ Lube Oil Service

Piping downstream of the oil filter will be 304ss pipe with corresponding fittings.

- ❑ Water Service

Water service pipework to heat exchangers is not included unless noted on the P&IDS

- ❑ Impulse Tubing

All control and impulse tubing in process service will be stainless steel with stainless steel compression fittings.

For instrument air service, main tubing runs will be stainless steel with stainless steel compression fittings. For factory assembled control valves or other devices, tubing will be the manufacturer's standard tubing.

5.12 Electrical Wiring Materials

Electrical wiring materials for control wiring within each skid perimeter. The wiring will be suitable for installation in a non-hazardous outdoor location. All wiring will be routed in UL approved rigid metallic conduit. Conduit, fittings and junction boxes will be UL approved and suitable for the electrical classification.

5.13 Assembly

The components and materials described above will be completely shop assembled, piped and wired to form four skid mounted module assemblies.

5.14 Inspection and Testing

The individual components and the completed system will be inspected and tested as follows:

Compressors will be given a manufacturer's standard non-witnessed mechanical run test on air.
The following options have been included on each compressor

- Performance test
- Hydraulic test
- Rotor Balance
- Air Under Water (COFREND II cf EN473 is excluded) standard Howden testing is performed
- Helium Under water

All skid mounted electrical wiring and controls will be checked for proper continuity and function.

All skid mounted pneumatic devices will be checked for proper function. Pneumatic tubing runs will be checked for continuity and leakage.

- The N2 tests will be EFX standard procedures and will be as per ASME, Section V, proceedure available upon request.
- Cleanliness criteria will be to EFX standards commensurate / identical to Helium projects supplied around the world. Verification will be by reference to previously accepted criteria by EFX.
- The assembled skid mounted unit will be pneumatically pressure tested, vacuum tested, dehydrated and charged with dry nitrogen prior to shipment.

Skid helium leak test will be as per ASME Section V.

5.15 Painting

The equipment components and the completed skid mounted assembly will be painted as follows:

❑ Structural Steel

- Surface preparation

  All welding burrs, loose welding spatter and slag will be removed using mechanical hand tool (SSPC SP-2) cleaning procedures.

  A commercial blast cleaning (SSPC SP-6) will be performed on the structural steel assembly.

- Primer

  Primer will be applied immediately after cleaning. One coat of Amerlock 400 High Build Epoxy will be applied.

- Repair

  Repair areas will be mechanically cleaned and primer will be reapplied prior to finish painting.

❑ Equipment Components

Compressors, vessels and exchangers will be prime painted in accordance with their manufacturer's standard procedures.

Prior to finish painting the equipment components will be solvent cleaned (SSPC SP-1) to remove grease, dirt or other foreign material.

❑ Completed Assembly

All piping, fittings and any added structural supports will be mechanically hand tool cleaned. All equipment components will be solvent cleaned as described above.

When all items are primed and thoroughly dry, one finish coat will be applied.

5.16 Shipping Preparation

Preparation of the skid mounted assembly for export shipment by an ocean carrier is offered as an option. Piping will be suitably braced to prevent vibration. Certain small items may be removed to prevent damage during shipment. Small ship-loose items will be tagged for identification, boxed and secured to the skid assembly

All pipe openings will be covered with either blind flanges or wood blocks.

5.17 Spare Parts

A list of spare parts and pricing to follow

5.18 Installation and Comissioning

5.18.1

Enerflex can offer installation assistance for the required period, however Enerflex shall not be held responsible for any deficiencies; which shall rest with the installation contractor.

5.18.2 Commissioning And Start Up Assistance

Start-up and commissioning of the unit is not included in our scope of supply. The following work will be necessary as a minimum:

- Final alignment of drivers;
- Final tightening of belts;
- Complete panel check of all tie-in points and recalibration of all instruments;
- Final setting of all controllers;
- Loading of oil and other expendables;
- Final pressure test of system;
- Removal of blocking devices on level controls;
- Purging of system.

Enerflex estimate this will require 1 engineer to work for 2 weeks. However this estimate is not definitive and is subject to extension at per Diem rate. Please find this at under ‘Product Support’ section of this proposal.

5.18 Special Tools

Special tools are not considered to be necessary. The tools expected for the normal installation, pre-commissioning, commissioning, operating and maintenance are not considered to be special, and should be available from a properly equipped maintenance department. It is presumed that major motor or compressor disassembly would be performed by authorized repair and service companies who are properly equipped. The normal on-site tasks which would have to be accomplished include the following :

- Bolting and fastening of flanges, equipment, tubing connectors, etc.: This requires normal hand tools and wrenches.
- Measuring of voltage and current: This requires appropriate voltage and amperage meters.
- Alignment check of compressor-motor coupling: This requires standard micrometer gauges.
- Addition of oil: This requires standard hand or pneumatic driven drum or barrel pumps.

5.19 Items Not Included

Please note that our base proposal does not include the following:

- Freight DDP(to be optioned)
- Export crating (to be optioned)
- Concrete foundation for supporting the equipment
- Field installation; Off-loading, hauling or rigging; labor or materials necessary to install the equipment at the job site - (to be optioned)
- Programming logic or logic schematics for DCS
- Pipe, valves or fittings for cooling water service to heat exchangers - (to be optioned)
- Pipe, valves or fittings for process service outside skid limits – (to be optioned)
- Personal protective insulation on piping over 60°C.
- Pneumatic air supply piping outside the skid perimeter
- Electric motor starters, contactors, breakers, or switchgear -
- Power wiring to skid mounted motors or heaters
- Thermal insulation (recommended for startup at ambient temperatures below 15 ºC)
- Heat tracing
- Interconnecting pipework
- Lubricant
- Chemical Cleaning of pipework/vessels is not performed
- PWHT is not undertaken
- Torsional Analysis

•

Enerflex
ENGINEERING DELIVERABLES LISTING

Number	Description	Size	Format	Included	Date
	GENERAL DOCUMENTS				
	Master Document List	A	Word/Excel	X	4-6 ARO
	Sub-Supplier List with Un-priced purchase orders	A	Word/Excel		4-6 ARO
	Installation and Operating Manuals	A	Word/Excel	X	Shipment+4
	Installation and Operating Manuals	A	CD Rom	X	Shipment+4
	SCHEDULING				
	Project Milestone Bar Chart	A	Project	X	4-6 ARO
	QUALITY CONTROL				
	Project Specific Inspection and Test Plan	A	Word/Excel	X	8-10 ARO
	Test Procedures (Oil flush, vacuum test, etc.)	A	Word/Excel		
	Weld Procedures, Enerflex shop	A	Word/Excel		
	Weld Procedures, Sub-supplier shop	A	Per Vendor		
	Weld Procedure Qualification Record, Enerflex shop	A	Word/Excel		
	Weld Procedure Qualification Record, Sub-supplier	A	Per Vendor		
	Welder Qualification Record, Enerflex shop	A	Word/Excel		
	Welder Qualification Record, Sub-supplier	A	Per Vendor		
	Mill Test Reports	A	As Provided		
	Pressure and Leak Test Reports	A	Word/Excel		Shipment+4
	Certificate of Compliance	A	Word/Excel		Shipment+4
	Third Party Inspection Reports	A	As Provided		Shipment+4
	PROCESS DESIGN				
	Process Flow Diagram	B	Autocad	X	With Bid
	PIPING AND INSTRUMENTATION				
	P & I Diagram	D	Autocad	X	6-8 ARO
	P & I Diagram Notes and Legend	D	Autocad	X	6-8 ARO
	Valve and Instrument Bill of Materials	A	Word/Excel	X	8-10 ARAD
	EQUIPMENT ARRANGEMENT				
	Block Layout	D	Autocad	X	6-8 ARO
	General Arrangement	D	Autocad	X	8-10 ARAD
	Foundation Layout	D	Autocad	X	8-10 ARAD
	Foundation Loading Diagram	D	Autocad		
	Center of Gravity, Shipping and Operating Weights	D	Autocad	X	8-10 ARAD
	ROTATING EQUIPMENT				
	API Data Sheets	A	Word/Excel		
	Allowable Flange Loadings	A	As Provided		
	Lubricants Listing	A	Word/Excel	X	16-18 ARAD
	VESSELS AND EXCHANGERS				
	Pressure Vessel Outline	D	Autocad	X	10-12 ARAD
	Heat Exchanger Outline	D	Autocad	X	14-16 ARAD
	ASME/PED Calculations	A	Word/Excel		
	TEMA Data Sheets	A	Word/Excel		
	Weld Map Drawings	D	As Provided		
	Nameplate Rubbing	A	As Provided		

Enerflex
ENGINEERING DELIVERABLES LISTING

Number	Description	Size	Format	Included	Date
	ELECTRICAL				
	Control Panel Layout	D	Autocad	X	14-16 ARAD
	Single Line Power Wiring Diagram	D	Autocad	X	14-16 ARAD
	Panel Electrical Diagram	D	Autocad	X	14-16 ARAD
	Module Interconnection Wiring Diagram	D	Autocad	X	14-16 ARAD
	Field Wiring Diagram	D	Autocad	X	14-16 ARAD
	STRUCTURAL				
	Structural Steel Base Arrangement	D	Autocad	X	12-14 ARAD
	SHIPPING AND PACKING				
	Packing or Crating Procedure	A	Word/Excel		12-14 ARAD
	Un-packing or Lifting Procedure	A	Word/Excel	X	10-12 ARAD
	SPARE PARTS				
	Commissioning and startup spares	A	Word/Excel	X	At Shipment
	Operating spares	A	Word/Excel	X	At Shipment

COMMENTS & EXCEPTIONS

4.0 Comments and Exceptions

Enerflex's comments and exceptions to the provided specification and API 619 will be provided in the firm bid.

Below please comments to proposed scope of supply.

		Standard			EFX	
		Purchaser	Vendor	AL Comments		Comments
A1	**COMPRESSOR PACKAGES**					
1	Compressors		**S**		**C**	
2	Motors		**S**		**C**	
3	Coupling		**S**		**C**	
4	Gear Box (If Required)		**S**		**N/A**	Not required for operation
5	Compressors suction strainers		**S**	100 µm Filters – Except for suction side, a manual shut-off valves shall be installed upstream and downstream of the filter	**C**	
6	Check valves		**S**	Upstream and Downstream each Compressor	**C**	
7	Isolation Valves		**S**		**C**	
A2	**OIL PACKAGES**					
1	Oil retention vessel		**S**	At the discharge side of each compression stage	**C**	Oil Separator's sump will be used for oil retention
1	Oil Separator		**S**	With demister or coalescers.	**C**	
2	Oil Pumps		**S**		**C**	
3	Oil Filters		**S**	100 µm Filters	**C**	

		Standard			EFX	
		Purchaser	Vendor	AL Comments		Comments
4	Oil Cooler		S		C	
5	He After Cooler		S		C	
6	Oil Pressure and Temperature Control		S		C	
A3	**SEPARATE LUBE OIL**			**For Motor Bearings (if required by manufacturer)**		
1	Oil Circuits (Pumps, Filters, Vessel…)		S	If required.	C	
2	Dual Oil Pumps		S	If required.	C	
A4	**FINAL OIL REMOVAL SYSTEM**					
1	Coalescers		S	3 Stages Minimum.	C	
2	Charcoal Adsorber		S		C	
3	Final Filter		S		C	
4	Isolating Valves		S	For Adsorber and Final Filter	C	
5	Drying System		O	For Adsorber Drying	C	
A5	**PRESSURE CONTROL PANEL**					
1	HP-LP By-Pass		S		C	
2	HP-MP By-Pass		S		C	
3	MP-LP By-Pass		S		C	
4	Load & Unload Valves		S		C	
5	Valves to / from end user		S	As specified.	C	
6	Flow meters		S		C	
7	Pressure transmitters		S		C	

		Standard			EFX	
		Purchaser	Vendor	AL Comments		Comments
8	Temperature transmitters		S		C	
B	GENERAL					
1	Piping within Skid Limit		S	According to Piping Class	C	
2	Counter Flanges		S	Counter Flanges with Gaskets and Bolts	C	
3	Pumping & Filling Circuits		S	All valves required for system conditioning.	C	
4	Required Pressure Relief Valves		S	All PSV shall vent in common manifold	C	
5	Skid Structure and Assembly		S		C	
6	Ladders, Walkways, Platforms		S		C	
7	Personal Protection on Skid		S		C	
8	Painting		S		C	
C1	INSTRUMENTATION					
1	Sensors		S	All: P, PD, T, F and L Sensors required for Operation.	C	
2	Control Valves		S	All: control valves required for Operation.	C	
3	Junction Boxes		S		C	
4	Cable Tray and Wiring		S	Instruments to Junction Boxes.	C	

		Standard			EFX	
		Purchaser	Vendor	AL Comments		Comments
5	Air Instrument		S	Collector and Tubing to each consumer.	E	**Tubing supplied to each consumer and piped to a common header for customer connection. Collector not supplied.**
6	I/O Cards	S				
7	Machine Monitoring System		O		C	
C2	**ELECTRICAL: 240V & 400V**					
1	Junction Boxes		S		C	
2	Cable Tray and Wiring		S	Equipments to Junction Boxes.	C	
C3	**ELECTRICAL: 6.6 kV**					
1	Cable Tray	S		Motors to skid edge.	C	
2	Motors Soft Starter		O	If Ip/In > 7.	C	
3	Motors Starter	S	BD		E	
4	Motors Breaker	S	BD		E	
5	Motors Control Center		NA		C	
6	LP Motors VFD		S		C	
D	**Workshop Tests & Inspection**					
1	Mechanical Tests		S			**See Comments and exceptions to spec.**
2	Components and Skid Leak Tests		S			
3	Electrical Tests		S			**See Comments**

		Standard			EFX	
		Purchaser	Vendor	AL Comments		Comments
4	All Required Inspection		S	Including cleanliness and functional tests	E	and exceptions to spec.
5	In House Oil Flush		O		C	
E	**Packing / Export**					
1	Marking and Certificates of Origin		S		C	
2	Packing		S		C	Compressor hood boxing and crating of supplied loose items
3	Transportation		S		C	EX-Works is offered. Other delivery terms to be optioned
F	**Consumables & Spare Parts**					
1	Spare parts for commissioning		S	Parts to be Identified.	C	
2	Spare parts for two years		O	Parts to be Identified.	C	
3	Capital spares		S		C	
4	Oil: 1st Load	S			C	Subject to confirmation of recommended oil suitability
5	Adsorbant: 1st Load		S			
6	Lubricant: 1st Load		S	Motors	C	If required
G	**Installation**					

		Standard			EFX	
		Purchaser	Vendor	AL Comments		Comments
1	Shims and anchor bolts		O	Pre-embedded soleplates (if any) shall be shipped separately (available on site for civil work activities)	E	
2	Civil Engineering	S	BD		E	
3	Installation Procedure		S		C	
4	Installation	S			C	
5	Installation Supervision		O	**Daily Rate to be included in commercial proposal.**	C	
H	**Commissioning**					
1	Commissioning Procedure		S		C	
2	Commissioning	S			C	
3	Commissioning supervision		S	**Daily Rate to be included in commercial proposal.**	C	
I	**Documentation**					
1	Documentation		S	**As per Requirements.**	C	**Subject to review of requirements**

API Comments & Exceptions

HOWDEN COMPRESSORS LIMITED
OIL INJECTED SCREW COMPRESSORS

The following comments and clarifications review the degree of compliance with the API-619 specification for rotary type positive displacement compressors. The comments are prepared by the compressor manufacturer who is solely responsible for the accuracy and degree of compliance, with respect to the compressor. Enerflex has indicated in the following comments, resolution with respect to the packaging for this offer. Note the comments apply to API 619 4th. edition.

Notes:

The listed **exclusions** to API619 4th Edition cover mandatory clauses for the compressor.

Bullet points (●) are not addressed as these are subject to mutual agreement with Vendor with unit responsibility and purchaser.

In case of conflict this standard shall govern and the packager shall be responsible for interpreting the enquiry and order documents.

Howden Compressors Limited is a sub-vendor (compressor vendor) to the vendor as defined in Para 4.1 of API619 4th edition.

Please refer to **application notes** giving cost and guidance for the packager when applying the mentioned specification. (Separate sheets)

	Exceptions to standard	Resolution
Section 5	**Basic Design**	
5.1.7	The packager with unit responsibility & purchaser shall ensure that the equipment has suitable safeguards to ensure no damage occurs.	See proposal provided by Enerflex
5.1.15	The compressor test shall be on air in the compressor manufacturing facility test stand to factory standard test procedures. The purchaser shall advise the basis of all data used by the compressor sub-vendor to calculate performance.	See proposal provided by Enerflex for design performance of the compressor
5.1.18	Electrical standards may be American, British or International.	See proposal provided by Enerflex
5.1.24	a) Threading on flanges will comply with ASME. Other threading will be metric. c) Studs and nuts are used except for cylinders, covers and some internal components where cap screws are used.	
5.2.3 a & c	Compliance available when specified, other materials may be offered when mutually agreed.	See proposal provided by Enerflex
5.2.11 & 5.2.11.1	Studs are used except for cylinders, covers and some internal components cap screws are used.	
5.2.13	Bolt holes may not be 13mm (0.5 in) larger in diameter than bolt holding down. The spot face diameter on foundation bolt holes may not be three times larger than the hole.	
5.2.14	Available for steel casings. Exclusion when Cast Iron and Nodular Iron Materials are specified.	See proposal provided by Enerflex
5.3.1 & 5.3.2	Some connections smaller than 3/4" are used, where space is limited. Pipe nipples and flanges will not be fitted to these connections due to the size and space limitations. Flanged stub pipe with threaded connections seal welded and shall interconnect / terminate with a welded neck or socket weld flange.	Flanged stub pipes are only available as an optional adder for cast steel case compressors. See optional section, if offered.

Section 5	Exceptions to standard Basic Design	Resolution
5.3.5	Butt welded connections not offered, supports will be fitted where design allows.	Only available as an optional adder for cast steel case compressors. See optional section, if offered.
5.3.10 & 5.3.11	Threaded openings will be tapped BSP parallel, when specified adaptors with ANSI threads are supplied.	
5.5.1.2	If specified we can comply.	Only available as an optional adder. See optional section, if offered
5.5.1.5 & 5.5.1.6	Shaft ends are cylindrical with rectangular keys and keyways to BS4235 Part 1, including keyway fillet and radius.	
5.6.1.8	Standard compressor is single seal. When specified and agreed the dual seal can be offered.	Only available as an optional adder. See optional section, if offered
5.6.2.5	Not applicable to oil flooded compressor.	
5.6.4.1	Restrictive ring fitted as standard. Figure 6 is for guidance and does not prevent alternative designs being adopted.	
5.7.1.2	Investigation of lateral critical speeds and rotor response is carried out by calculations, not by test measurement. Drive train component torsional input information shall be submitted from the packager. It is not carried out within the compressor due to the oil damping effects throughout the compressor and it is impracticable to attempt model analysis within the compressor by adding imbalance.	Only available as an optional adder. See optional section, if offered
5.7.1.3	Vibration analysis of the structural support system would not be carried out	Not offered as experience shows almost no benefit when analysis

Section 5	Exceptions to standard Basic Design	Resolution
	by the compressor manufacturer.	is carried out
5.7.2.4; 5.7.2.5 & 5.7.2.6	Note, The software used for torsional analysis is not suitable for response analysis at specific frequencies, analysis of variable speed drive and engine driven sets. (Normally carried out by the engine supplier)	Not offered as experience shows almost no benefit when analysis is carried out
5.7.3.6	During shop test of the compressor on our shop test stand, compressor casing vibration would be measured using a magnetically attached accelerometer. The shop test stands are used for several different sizes of compressor and therefore are not rigid or representative of site conditions. The following table gives our standard acceptance levels in RMS Velocity mm/s.	

Compressor Rotor Size mm	Horizontal and Vertical	AXIAL	
		Antifriction Thrust Bearings	Tilting Pad Thrust Bearings
163	5.5	7.5	
204	6.0	8.0	-
228	-	-	-
255	7.0	9.0	7.0
321	7.0	9.0	7.0
365	7.0	9.0	7.0
510	7.0	-	7.0

5.7.3.7; 8 & 9	Deviation, Non-contacting radial vibration probes are excluded.	
5.8.1.1	WRV Howden Oil Injected Compressors the radial bearings are Hydrodynamic no option is offered. The largest compressor, 510 rotor size has tilting pad	

Section	Exceptions to standard Basic Design	Resolution
5	hydrodynamic thrust bearings, no option is offered.	
5.8.1.3	Coupling type must eliminate applied thrust load to the compressor.	
5.8.1.5	Embedded temp elements available in larger compressors.	Only available as an optional adder. See optional section, if offered.
5.8.2.1.b	Bearings are retained on the shaft using HCL design standards.	
5.8.3.2.4	Tilting pad thrust bearings are available on 255 diameter rotor and above.	Only available as an optional adder. See optional section, if offered
5.9.3	The oil inlet temperature maximum allowable is 70 Deg C with Standard bearing design. The oil outlet temperature can exceed 80 Deg C, in these cases.	
5.9.5	Deflectors are not required.	
5.10.1.1	The compressors pressurised oil system shall not be used for external gearbox or main driver bearings.	
5.11.1.2	Refer to our proposal for material offered.	
5.11.1.4	To be mutually agreed and negotiated with the purchaser.	See proposal provided by Enerflex
5.11.1.10	Materials complying with NACE MR01 75 are available on request.	
5.11.3.1	Where forging is requested Material shall be to Howden Compressors API619, Annex F is informative. Refer to proposal for material offered.	See proposal provided by Enerflex
5.11.4.2	Howden standard procedure will be used and submitted for review.	Only available as an optional adder for cast steel case compressors. See optional section, if offered.
5.11.4.5	When fitted, Stub pipes shall be screwed	Only available as an optional

	Exceptions to standard	Resolution
Section 5	**Basic Design**	
	and seal welded to casing full Penetration welds are not offered nor do we offer radiography for these Connections as it would be impractical. Seal welds on nipples for stub pipes will not be heat-treated.	adder for cast steel case compressors. See optional section, if offered.
5.12	Standard nameplate not fully compliant.	
5.13	ISO9001: 2000; ANSI /ASQ Q9001: 2000 Quality management systems, assessed by UL. Will apply.	See proposal provided by Enerflex
Section 6	Accessories	
6.2.5	Deviation, The compressor would be tested on our shop test Stand, using a test coupling hub and spacer. Calculations are not offered.	
6.10	Special tools are only required for a major overhaul or repair and are not required for routine maintenance (seal replacement) therefore not included in quotation. Itemized cost and can be furnished on request.	
Section 7	***Inspection, testing and preparation for shipment***	
7.1.4	It shall be the joint responsibility of the purchaser / vendor/sub-vendor to agree the type and level of NDT required.	
7.2.1.1	Key documents shall be held for a maximum10 Years period.	
7.2.1.2	Pressure retaining parts such as the casing shall be tested with primer coat to prevent corrosion.	
7.2.2.1 & 7.2.2.1.2	Refer to comment 7.1.4. Note HCL shall limit the acceptance standards to level 2 maximum.	
7.2.2.2	Due to the complex nature of the compressor steel casing it is not considered Practical to carry out 100% radiography of the casing	Only available as an optional adder for cast steel case compressors. See optional section, if offered.

	Exceptions to standard	Resolution
Section 5	**Basic Design**	
	therefore a design review will define critical areas and number of shots to carry out the test. The acceptance level is not greater than quality level 2.	
7.2.2.2.1	If the purchaser specifies radiographic testing it shall be in accordance with ASTM E446 on the outer shell and flanges. Acceptance levels for defect categories A,B,C are level 2 per ASTM E186, with the remaining categories having no permissible faults- i.e. faults such as hot tears, chills, chaplets etc must be repaired at the foundry.	Only available as an optional adder for cast steel case compressors. See optional section, if offered.
7.2.2.3.1 & 7.2.2.3.2	If purchaser specifies ultrasonic inspection a detailed procedure must be agreed with Howden Compressors Ltd prior to work proceeding. For critical areas such as the outer shell, the acceptance criteria shall be quality level 2 and quality level 3 for the remainder (see ASTM A609 Table 2).). On rotor forgings it would be carried out to BS EN10228-3.	Only available as an optional adder for cast steel case compressors. See optional section, if offered.
7.2.2.4	Castings to be subject to MPI in accordance with ASTM E709 on the Outer shell and at major fillets. Acceptance levels are type 1, degree 2 per ASTM E125.	Only available as an optional adder for cast steel case compressors. See optional section, if offered.
7.3.2.1	Howden acceptance procedure shall apply un witness hydro test is included.	
7.3.3.1	**Mechanical running test (Pre test)**	
7.3.3.1.2	Oil pressures, viscosities and temperatures comply with HCL operating values. Bearing oil flows are measured.	
7.3.3.1.3	Test stand oil filtration is 30 microns.	
7.3.3.1.7	The compressor would be tested on our shop test stand using a "test" coupling hub and spacer. Contract hub cannot be utilised.	
7.3.3.1.8	Deviation, Howden standard vibration	

Section	Exceptions to standard Basic Design	Resolution
5 & 9 &10& 11	equipment shall be used integration of vibration meter measured using a magnetically attached recording vibration velocity in mm/sec RMS values. The shop test stand is used for several sizes of compressor and therefore is not rigid or representative of site conditions. Seismic test values are not specified.	
7.3.3.2.1	**Mechanical running test (Test run)** Mechanical running test is included as part of four hour test. The mechanical run over speed test for electric motor drive contracts will be conducted at 102.5% of contract speed for 5 minutes or as test bed facilities permit.	Only available as an optional adder. See optional section, if offered
7.3.3.2.2	Not applicable since compressor is operating at fixed speed.	
7.3.3.2.3	HCL test is limited to a maximum 10% above contract speed or as allowed by the test facilities for a period of 5 Minutes.	
7.3.3.2.4	Variable speed drive is not in our scope test facilities allow 4 hour test at contract speed.	
7.3.3.3.1	HCL standard method of recording vibration applies.	
7.3.3.3.2	Vibration measurements are in rms values at contract speed the spectrum analysis recorded at DE and NDE.	
7.3.3.4.4 & 5	Oil injected compressor assemblies including shaft seal shall be tested in an “Air under Water” test.	
7.3.4	Optional tests are subject to agreement between HCL and Client.	Only available as an optional adder. See optional section, if offered
7.4.3	Howden standard procedure is offered, Optional procedures are subject to agreement between HCL and Client	Only available as an optional adder. See optional section, if offered

API 614

Reference Document	Deviation Purpose	Reason
API 614 edition Project specification	Clarification To Note that API 614 is not fully applicable to an oil system pressurized by the compressed gas, These are covered by systems utilizing API 619 oil injected screw compressors	The oil system is an oil system pressurized by the compressed gas, it is an oil system that requires specialist design requirements and experience in order to ensure that the compressors can operate safely and effectively under all process conditions and oil management priorities. This system has been submitted in P&ID format for review pre order with the offer
Chapter 1	Clarification	N/A to an oil system pressurized by the compressed gas,
Chapter 2	Clarification	N/A to an oil system pressurized by the compressed gas,
Chapter 3		
1.2.16	Clarification	N/A to an oil system pressurized by the compressed gas,
1.3	Clarification	The compressor & oil system are integral & pressurized for this application
1.4.4.3	Clarification	N/A to an oil system pressurized by the compressed gas,
1.5.1	Clarification	Manufacturers standard API clarifications shall be utilized for pressurized system pumps
1.6.1	Exception	Duplex oil cooler excluded by client requirements
1.6.1.1	Clarification	TEMA R offered not TEMA C
1.6.5.2	Clarification	Single thermostatic valve offered as per reviewed P&ID and system only has one cooler.
1.7.3.6	Exception	Purpose designed filters shall be used which have in excess of 5 years proven experience with this size of compression module.
1.9	Clarification	N/A
4	Exception	Operational test is not possible due to system not being pressurized with an oil system pressurized by the compressed gas, Voltage frequency differences, temperature and viscosity differences render such a test Null & void. TES will flush system at workshop to standard procedures and cleanliness prior to dispatch to site
5	Clarification	Documentation shall be as defined on the agreed VDRL
API 614 Fourth edition 1999	Clarification	Project specific specifications for piping, instrumentation, electrics and painting take precedence over API 614 standard specifications. Where items that require to be specified by the client

		and these items have not been specified these items have not been included Where items that require to be specified by the client and these items have been specified these have been included.
Chapter 1	Clarification	N/A to an oil system pressurized by the compressed gas,
Chapter2	Clarification	N/A to an oil system pressurized by the compressed gas,
Chapter 3		
1.1.1	Exception	Design time for the oil system is a minimum of 1 minute
1.2.2	Clarification	Oil is designed for pressurized gas application with Helium as the gas
1.4.3.2	Clarification	N/A to an oil system pressurized by the compressed gas,
1.4.6.2	Exception	Design time for the oil system is a minimum of 2 minute
1.4.11	Exception	Specified material are ASTM 304L for normal applications, see proposal for details.
1.5.13	Exception	Single suction line is provided from the oil separator for pressurized applications
1.7.4.4	Exception	Purpose designed filters shall be used which have in excess of 5 years proven experience with this size of compression module.
1.9	Clarification	N/A to an oil system pressurized by the compressed gas,
4.3.3	Exception	Operational test is not possible due to system not being pressurized with refrigerant propane Voltage frequency differences, temperature and viscosity differences render such a test Null & void. EFX will flush system at workshop to standard procedures and cleanliness prior to dispatch to site
Flow Schematics	Clarification	Project specific flow schematics P&ID's have been provided by EFX for this an oil system pressurized by the compressed gas, application and as such define the minimum scope necessary to safely operate this plant. This supersedes and replaces API 614 Standards.

PRODUCT SUPPORT

INTERNATIONAL
FIELD SERVICE DAILY RATE

SERVICE TECHNICIAN……..……..…$2,550.00/DAY.USD
This rate is based on a standard day rate. This rate applies to each day from date of departure to date of return to home base.

1. Hours in excess of ten (10) hours Monday – Friday will be charged at:…….…..…….$320.00/HR.USD

2. Hours in excess of ten (10) hours daily during Weekends and Holidays work will be charged at:……..…...$420.00/HR.USD

3. Travel and lodging expenses will be invoiced at cost plus 15% from time of departure of home base until return.

4. Air travel (business class or equivalent) Invoiced at cost plus 15%

5. Billable travel hours begin upon departure from home base and continue until arrival at the jobsite. If required to overnight the billable hours stop upon arrival at overnight accommodations and resume with departure the next morning. The same format is used for calculating travel hours for the return leg.

6. High Risk Working Environment
   In the event the work site is located in an area that has been designated by the United States Department of State as a high risk area, the Technician Rates shall be adjusted up by 15%

7. Incidental expenses will be invoiced at cost plus 15% or prevailing daily per diem rate. Incidental expenses will include, but not be limited to the following:
   - Lodging (to be of IATA 3-star or equivalent)
   - All transportation costs for technician's luggage, tools, etc. and will include any excess baggage charges.
   - All visas, passports, permits and associated travel taxes.
   - Currency exchange premiums.
   - Laundry and dry cleaning.
   - Communications costs, including all telephone costs.
   - Tips gratuities where expected.
   - Vaccinations, medicals, etc.
   - Any extra insurance costs for international and/or overseas work will be invoiced at the current rate applicable. In the event that medical services are required, charges will be invoiced at cost plus 15%
   - Offshore work or man-camp accommodations minimum billing - twelve (12) hours per day, Seven (7) days per week.

   - **Terms of payment** – Suitable approved line of credit on a USA based Purchase Order or a deposit sufficient to cover the estimated duration of work will be required prior to dispatch of any Enerflex personnel on overseas assignments. All costs will be reconciled upon return of representative. Remaining balance if any will be returned.

Commissioning will be invoiced at the rates in effect at the time work is performed

Valid Through Dec 31, 2014

ENERFLEX

INSPECTION AND TEST PLAN (ITP)

Form Revision: 2	Form Number: SUS-QAC-FRM-003	Form Revised: 14-Jun-2013

PROJECT NUMBER:		DATE RELEASED:	
PROJECT ENGINEER:		PROJECT ITP REVISION NUMBER:	
CUSTOMER:		MODIFIED BY:	
REQUIRED NOTICE:		APPROVED BY:	

Level of Inspection

H = HOLD POINT (do not pass without inspection/approval	**R = DOCUMENT REVIEW** (do not hold work)
W = WITNESS POINT (notification required, proceed after notification)	**A = DOCUMENT APPROVAL** (approve prior to start of work or release)
I = RANDOM INSPECTION/SURVEILLANCE (randon inspection during fabrication/assembly, do not hold work)	

Item	Activity Description	Enerflex / Customer Document No.	National Standard / Specification	Type of Cert.	Inspection			Remarks
					Vendor	Enerflex	Customer	
1.00	**MATERIALS AND EQUIPMENT**							
1.10	Receiving	Enerflex P.O.	N/A	N/A	I, R	R		
1.20	Inspection	Enerflex P.O.	As Applicable	N/A	I	I		
1.30	Vendor/Subcontractor Inspection	Vend/Sub ITP	As Applicable	ITP	I	R		
2.00	**STRUCTURAL (Subcontract)**							
2.10	Material certification	Enerflex Drawings	ASTM / ASME	MTR	R	R		
2.20	WPS / PQR	Fabricator WPS/PQR	AWS D1.1	N/A	A	R, A		
2.30	Fit-up	Enerflex Drawings	AWS D1.1	N/A	I	I		
2.40	Welding	Enerflex Drawings	AWS D1.1	N/A	I	I		
2.50	NDE	Enerflex Drawings	Vendor Procedures	NDE Record	H	R		
2.60	Surface prep., coating and/or galvanizing	PD-001	SSPC (Surf. Prep.)	Paint Report	H	I		
3.00	**PRESSURE VESSELS (Subcontract)**							
3.10	Material certification	IFC/IFF Drawings	ASTM / ASME	MTR	R	R		
3.20	WPS / PQR	Fabricator WPS/PQR	ASME Sec. IX	Traveler	A	R, A		
3.30	Head fit-up & nozzle layout	IFC/IFF Drawings	ASME Sec. VIII	Traveler	I	I		
3.40	Fabrication and installation of internals	IFC/IFF Drawings	ASME Sec. VIII	Traveler	I	I		
3.50	Internal cleaning	Subcontr. Procedure	N/A - Enerflex Stds.	Traveler	I	I		
3.60	Closing head fit-up	IFC/IFF Drawings	ASME Sec. VIII	Traveler	H	I		
3.70	Welding	IFC/IFF Drawings	ASME Sec. VIII	Traveler	I	I		
3.80	NDE	IFC/IFF Drawings	ASME Sec.V	NDE Record	H	R		
3.90	Hydrostatic Test	Subcontr. Procedure	ASME Sec. VIII	U-1, Chart	H	I		
3.100	Surface preparation and coating	Subcontr. Procedure	SSPC (Surf. Prep.)	Paint Record	H	I		
3.110	Code document preparation	SUS-QAC-STD-002	ASME Sec. VIII	U-1	R	R		
4.00	**PIPING FABRICATION**							
4.10	Material certification	Enerflex IFF Drawings	ASTM / ASME	MTR		R		
4.20	WPS / PQR	EFX WPS/PQR per Dwg	ASME Sec. IX	N/A		N/A		
4.30	Material preparation	Enerflex IFF Drawings	ASME B Series, as appl.	N/A		I		
4.40	Spool fit-up and dimensional check	Enerflex IFF Drawings	N/A	N/A		I		
4.50	Welding and final dimensional check	Enerflex IFF Drawings	N/A	N/A		I		
4.60	NDE	Enerflex IFF Drawings	ASME Sec.V	NDE Record		W		
4.70	Hydrostatic Test	SUS-QAC-PRO-002	ASME B Series, as appl.	Hydro Record		W		
5.00	**MECHANICAL ASSEMBLY**							
5.10	Mount and align rotating equipment	Enerflex Drawings	Manufacturer Specs.	Report		I		
5.20	Mount pressure vessels and exchangers	Enerflex Drawings	EFX Specification	Traveler		I		
5.30	Install piping spools and valves	Enerflex Drawings	N/A	Traveler		I		
5.40	Fabricate and install small bore piping	Enerflex Drawings	N/A	Traveler		I		
5.50	Install instrumentation	Enerflex Drawings	N/A	Traveler		I		
5.60	Install instrument tubing and supports	Enerflex Drawings	N/A	Traveler		I		
5.70	Mechanical P&ID check	Enerflex Drawings	N/A	Traveler		I		
6.00	**I & E ASSEMBLY**							
6.10	Mount control panels and junction boxes	Enerflex Drawings	N/A	Traveler		I		
6.20	Install conduit or cable tray	Enerflex Drawings	NEC, as applicable	Traveler		I		
6.30	Pull cable/wire and terminate	Enerflex Drawings	NEC, as applicable	Traveler		I		
6.40	Install tubing	Enerflex Drawings	N/A	Traveler		I		
6.50	P&ID Walkdown	Enerflex Drawings	N/A	Traveler		H		

ENERFLEX	INSPECTION AND TEST PLAN (ITP)		
	Form Revision: 2	Form Number: SUS-QAC-FRM-003	Form Revised: 14-Jun-2013

PROJECT NUMBER:		DATE RELEASED:	
PROJECT ENGINEER:		PROJECT ITP REVISION NUMBER:	
CUSTOMER:		MODIFIED BY:	
REQUIRED NOTICE:		APPROVED BY:	

Level of Inspection	
H = HOLD POINT (do not pass without inspection/approval	**R = DOCUMENT REVIEW** (do not hold work)
W = WITNESS POINT (notification required, proceed after notification)	**A = DOCUMENT APPROVAL** (approve prior to start of work or release)
I = RANDOM INSPECTION/SURVEILLANCE (randon inspection during fabrication/assembly, do not hold work)	

Item	Activity Description	Enerflex / Customer Document No.	National Standard / Specification	Type of Cert.	Inspection			Remarks
					Vendor	Enerflex	Customer	
7.00	**PACKAGE TESTING**							
7.10	Pneumatic testing	SUS-QAC-PRO-003	ASME B Series, as appl.	Test Record		H		
7.20	Lube Oil Flush	SUS-QAC-PRO-022	N/A	Test Record		H		
7.30	Mechanical Test Run	SUS-QAC-PRO-025	N/A	Test Record		H		
7.40	Controls and functional testing	SUS-QAC-PRO-005	EFX Controls Narrative	Test Record		H		
8.00	**SURFACE PREPARATION AND COATING**							
8.10	Final surface preparation and coating	SUS-QAC-PRO-001	SSPC (Surf. Prep.)	Paint Report		I		
9.00	**FINAL INSPECTION**							
9.10	As Built Drawings (Vessel, GA, P&ID, Elec.)	Enerflex Drawings	N/A			R		
9.20	Final inspection and release	Enerflex Drawings	Contract Requiements	Assembly Traveler		H		
9.30	Final Assembly Traveler Complete	N/A	N/A			H		
10.00	**PREPARATION FOR SHIPMENT**							
10.10	Final preparation and shipment	PD-030	N/A	Checklist		R		
11.00	**SPECIAL NOTES**							
11.01								
11.02								
11.03								
11.04								
11.05								
11.06								
11.07								
11.08								
11.09								
11.10								