

Scope of Supply - Equipment Description:

Site and Utility Design Basis

Items in red italics have not been defined by Purchaser and are estimated until clarified.

Understood Place of Installation: Lakeview, Oregon, USA

Installation: Outdoor location; weather protection and heat tracing may be required at site by others.

Elevation: 4760 fASL (~1451 mASL) max. elevation design, site barometric pressure is 12.4 psia

Design Op. Ambient Temp. -31.1 → 42.2 deg C (start-up permissive and operation is subject to system pre-heat per IOM).

-20 → 40 deg C is the design basis for the startup condition of the Equipment

Equipment should not be allowed to operate unless and until the materials are at the minimum operating temperature (-20 deg.C minimum; refer Control Logic). This must be achieved by heating of the equipment via process, oil, and other heating as required with applicable heat sources included by Howden or by the customer. The heating and minimum start temperature permissives must be controlled by the instrumentation included in the fan scope including but not limited to bearing, oil, fan RTDs or switches. In any case where the site ambient temperature is <-20 deg.C, the equipment is only allowed to be exposed when in transport, storage, or idle provided the equipment is properly handled.

Heat tracing if required is to be at site by others.

Electrical Area Class 1 Div 2 Group B,C,D (NEC)

Electric Power availability: 3ph./60Hz/4160v, 3ph./60Hz/480v, 1ph/60Hz/240v, 1ph./60Hz/120v , 24VDC

Cooling Medium required: *Water or Water/Glycol; 29 degC (85 degF) maximum supply temp., 6.4 bar(a) pressure*

Availability of Glycol Water – TBD

Instrument Air: 70psig (482kPa-g) → 100psig (689kPa-g) supply, 50degC, -60degC dew point.

Nitrogen Purge Gas: 230 psig minimum, 250 psig normal operating, 270 psig maximum, 120 degF design

API (American Petroleum Institute) Standards:

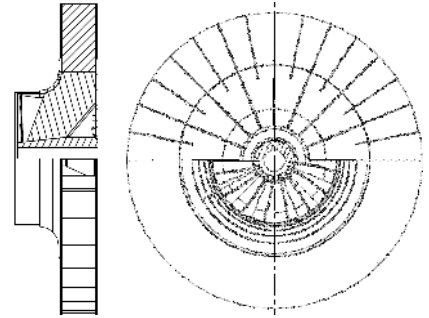
Some general compliance to API standards API 673, ~~544~~, & 614 Chapters 1 & 3 & ~~670~~ has been considered. Detailed Howden exceptions to those standards would apply (to be supplied as a submittal document).

This offer includes some design and features according to the stated API standards that are identified in this offer strictly as noted herein. The intended use of API standards is with fully completed data sheets by the Purchaser to specifically identify those items that are to apply from the respective standards; when fully completed data sheets are not received for an API standard, the offer is based on Non-Bullet compliance strictly as noted herein. Any bulleted item that is not specifically clarified in the data sheets or this offer is therefore understood to be wholly Not Applicable except at the sole discretion of the manufacturer and to the degree deemed applicable by the manufacturer.

ExVel Turbo-Fan

• Rotor

- Impeller: Alloy 2205 Duplex SS (Material Certs with NACE MR0103 listed)
Rigid, high speed design
Radial tip blades / inlet inducer section / heavy cone.
Fabricated plate, continuously welded, 100% NDE examined in-process.
Balanced to ISO 1940/1 Gr. 2.5

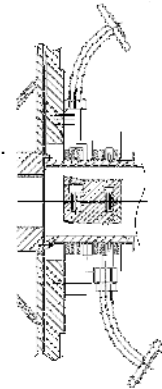


- Hub: Duplex SS (Material Certs with NACE MR0103 listed)
- Shaft: Duplex SS (Material Certs with NACE MR0103 listed)
Solid bar, finished at all bearing and connection areas.
Integrally machined thrust collars (when required).
~~Hydraulic-taper hub connection design for ease of installation / removal.~~
- Shaft Sleeve: Duplex SS (Material Certs with NACE MR0103 listed)
Integrally machined impeller connection collar: bolt through to impeller with seal.
Dual, integrally machined, rotating condensate flingers
METCO-106 protective coating in seal area



• Shaft Seal

- Multiple carbon ring type; segmented carbon rings with retaining springs.
- Alloy 2507 Super Duplex SS machined seal housing, horizontally split.
- (Material Certs with NACE MR0103 listed)
- Purge Provision; (note: seal operates as labyrinth without purge gas)
- Includes male-female G 1/2" to NPT 1/2" adapter when seal purge is by others.
- Connections is threaded NPT 1/2" (F) at top of seal housing unless purge system is purchased.
- Connection will be plugged if purge system is not provided by Howden.
- Drain:
- Flexible SS braided drain hose (not located)
- ANSI B16.5 1/2" 300# RF flange connection (not located).
- Needs to be piped to safe area (by others)
- INCLUDED - Howden Standard barrier gas system (separate skid mounted system package):
- Pressure Differential Control Valve (Direct Operating Regulator type)
- Pressure Differential Indicating Transmitter (Used for Safety / Shutdown / Permissive)
- Flow Indicating Transmitter (Variable Area Type; Used for Seal Condition Monitoring)
- SS tubing with double-ferrule (Swagelok) fittings
- Connection is ANSI B16.5, 1/2" 300# RF flange (not located).
- Incoming nitrogen should be clean and dry (no filters and/or traps included).



• Bearings

- Sleeve (Hydrodynamic) Type Bearings:

Sleeve bearings can be considered to have infinite life capability. The fan shaft rides on a film of oil inside of the bearing liner, so there is no mechanical contact between the shaft and bearing. Provided that the bearings and oil are maintained properly, the bearing life will be indefinite. The complete bearing and housing are horizontally split for ease of inspection and maintenance.
Split pillow-block housings
Forced oil lubrication with labyrinth seals
Machined for and supply of one each radial bearing RTD.
Machined for and supply of one axial RTD at thrust bearing
Transmitters included for those RTD's used for trip functionality
~~Machined for one each seismic vibration detector~~
Machined for one each spot-face, 25mm (1.0 in.) dia. on bearing housing for hand-held detector.
Included - Machined for and supply of two (2) each radial vibration sensors; one (1) per bearing - horizontal
Included - Machined for and supply of one vibration sensor at thrust bearing

• Coupling - fan to gear & gear to motor

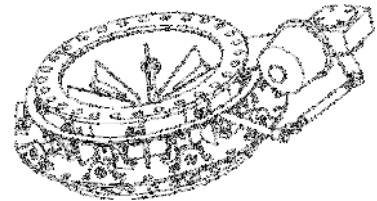
- API 671 Flexible disk type coupling. or Elastomeric Type Coupling (TBD by Howden)
For equipment trains designed for variable speed operation, if upon torsional analysis by Howden there is found to be a torsional interference within 10% of the operating frequency range, Purchaser will be notified and any costs to re-engineer and/or change the coupling would be to Purchaser's account.
- Non-lubricated
- Transitional interference fit, keyed to the driver and driven shafts
- Manufacturer's standard rust inhibitive coating
- Limited End Float design when specified by the Purchaser or when required for motor supplied by Howden.

• **Casing**

- A2507 Super Duplex material for internal parts in contact with process
- A2507 Super Duplex material for external parts
 - (Material Certs with NACE MR0103 listed)
- Fabricated plate, continuously welded
- **Designed for 18.8 bar(a)**
- Near center-line support design for controlled thermal expansion.
- Inlet side impeller removal.
- Discharge rectangular-to-round diffuser included; material and construction same as fan casing (ships loose).
- Inlet & outlet flanges drilled to match ANSI B16.5, 16.47-A, 300# FF connections
- Two (2) Access Ports:
 - Howden's standard design DN 100 ~~or DN 125 (TBD)~~
 - ~~Threaded (canning jar type) with 316 SS nut.~~
 - ~~Weld neck material will match casing material.~~
- One (1) Casing Drain
 - ~~Includes sight glass; Howden's standard DN 65 or DN 80 (TBD).~~
 - Connection flange ANSI B16.5, 2 or 2-1/2" 300# RF.
 - Liquid monitoring Device by others
- Two (2) Spray Nozzles near fan inlet for CIP use
 - Connection flange ANSI B16.5, 1/2" 300# RF.
- Refer to "Electrical, Piping, Instrumentation, and Connections" below for other details.

• **Inlet Guide Vanes**

- Alloy 2507 Super Duplex SS material for blades & shafts.
- Frame: Alloy 2507 Super Duplex SS
 - (Material Certs with NACE MR0103 listed)
- 316L SS materials for external linkage.
- Designed for same working pressure as casing.
- All linkage and mechanisms outside of gas stream.
- Bearings: Dodge LT-700 Carbon, located out of the gas stream.
 - Grease lubricated.
- Packing – Viton O-Ring (Machined High Pressure Packing Gland).
 - **NOTE:** There is no monitoring of leakage of these seals.
 - Nitrogen Purge connection at each IGV shaft seal – will be piped to a single connection
 - ~~Optional – External linkage positive seal enclosure~~
- Flanges drilled to match ANSI B16.5, 16.47-A, 300# FF connection.
- One (1) Pneumatic Rotork Actuator – GT Series (Metso-Neles brand typical, TBD)
 - Rated for min. 70 psig air supply, max 100 psig.
 - Siemens PS2 Positioner with I/P converter suitable for 4 - 20 mA, HART
 - Fail in Place
 - Siemens Internal Limit Switches
 - One (1) Air Filter & Regulator
- Refer to "Electrical, Piping, Instrumentation, and Connections" below for other details.



• **Guards**

- Coupling Guard included for coupling(s) supplied by Howden: Howden's standard aluminum or other non-sparking
- Shaft Guard will be included when required by design; Howden's standard aluminum or other non-sparking
- Shaft Seal Guard included: Howden's standard perforated metal, ventilated functionality.

• **Fan Base**

- Fabricated steel alignment base for fan bearings and casing drive-side.
- Fabricated steel casing inlet side support legs when required.
- Machined fan mounting surfaces.
- Designed to be leveled, aligned, and anchored to a concrete foundation and filled with non-shrink epoxy grout to integrate the assembly to the foundation (by others).
- Coated; refer to "Coating Systems" section.
- Includes Vertical Jacking Screws for base and inlet-supports for leveling on concrete (Howden's standard).
- No anchor bolts or shims included.
- Refer to "Equipment Foundation" section for more details.

• **Special Maintenance Tools**

- One (1) custom, puller type Tools Set used for installation/disassembly of the fan impeller from the shaft per fan design included. Designed and supplied by Howden; details will be included in the IOM manual.

- ~~— Includes machined sleeves, plates, threaded rod(s), and nuts / washers as designed by Howden and detailed in the drawings.~~
- ~~— Hydraulic oil pump (porta power) is considered commercially available and not included.~~
- ~~— Hydraulic jack (ram) is considered commercially available and not included.~~
- Any and all other tools are considered commercially available goods and are not included, such as but not limited to hand tools, power tools, hardware, etc.

Forced Oil Lubrication System – Fan & Motor Lube System and Gear Lube System ~~or one (1) combined system~~

- Scope and Features:
 - Howden standard API 614 5th Edition Chapters 1 and 3, non-bullet compliance (~~non-API system~~).
 - Oil Reservoir:
 - 304 stainless steel lube oil reservoir (coated).
 - No oil drip rim or other leak retaining provisions are included.
 - Main oil tubing and/or piping determined and routed according to manufacturer's preference.
 - Piping/Tubing: 304SS piping & 316SS tubing, Swagelok tube fittings (SS)
 - ~~Tubing where used will be manufacturer's standard.~~
 - ~~— Pipe where used will be CS pipe~~
 - Dual 100% oil pumps - one electric motor driven, and ~~one electric pump run on emergency back-up power~~ one belt driven from main shaft.
 - Dual oil filters with 3-way selection / transfer valve.
 - Includes hydraulic hose(s) for connections between lubrication skid to machine bearing oil supply & return connection points, and to a machine driven oil pump when included in the scope.
 - Refer to "Instrument & Control Component Schedule" section of this offer for scope details.
 - Refer to "Electrical, Piping, Instrumentation, and Connections" for other details.
 - Note: Machine bearings will be supplied with fan bearing oil drain connection / manifold system consisting of steel pipe and interconnecting hydraulic hose with hose clamps installed on the fan base fan. When a motor is supplied by Howden and motor oil drain connections are required, similar oil drain connection provisions will be supplied as designed and determined by Howden during contract engineering.
 - Note: Hydraulic hose for connections between lube skid and machine bearings (and machine driven oil pump(s) if any) must be routed and installed at the site by others. The location / access of the equipment supplied by Howden relative to any surrounding equipment within the plant is outside of Howden's control; therefore depending on the hose routing by others, support of the hose(s) may be required at site by others after routing has been determined.
 - Note: Lube skid components are sized to be located within close proximity, and adjacent to the fan bearing base. If the lube skid needs to be relocated by the plant designer / user then the location must be identified to Howden subject to resizing of some lube components, such as but not limited to, pumps, hoses, piping, tank, etc., and subject to contract price and lead time add as applicable.
 - Note: Start-up and operation permissive controls will be required for minimum oil supply / machine start-up / operating temperature. If the installation is subject to cold climate or equipment location is such that the minimum oil supply temperature in the bearings can not be achieved without suitable insulation or heat tracing, then insulation or heat tracing will be required as necessary at site by others.

Gear Box ~~(included only where required by fan model)~~

- Manufacturer is Lufkin
- API 677, non-bullet compliance, based on a material index no. 245.5 and an API SF of 1.5
- Speed increasing gear between the driver and fan.
 - ~~– Gearing to be through hardened and ground (deviation from API 677)~~
- Coupling between main driver and gear will be included.
 - Will be designed similar to fan coupling stated elsewhere except no spacer.
- Gear Bearings:
 - ~~– Anti friction or~~ Sleeve (hydrodynamic) type on all shafts.
 - Machined for and supply of one each radial bearing RTD. – Quantity four (4) Minco brand - duplex
 - Machined for and supply of one each side axial RTD at thrust bearing(s) – Quantity two (2) Minco brand - duplex
 - Machined for and supply of one each seismic vibration detector – one per radial bearing – vertical (total quantity four (4))
 - Transmitters included for those RTD's used for trip functionality
 - Machined for (provisions only) one each seismic vibration detector – one per radial bearing – horizontal (total quantity four (4))
 - ~~– Machined for one each spot face, 25mm (1.0 in.) dia. on bearing housing for hand held detector.~~
 - ~~– Included Machined for and supply of two (2) each radial proximity probes; X&Y each radial bearing with proximitors – Total quantity eight (8)~~

- ~~— Included Two (2) keyphasor probes; one per shaft with proximitors and extension cables~~
- ~~— OPTIONAL — Machined for one axial proximity probe at thrust bearing~~
- Lube oil system when required for gear lubrication and/or gear bearing lubrication.
 - Included as stand-alone lubrication system; separate from fan and motor system
- Scope, notes, and comments apply as stated for Forced Oil Lubrication System elsewhere.
- Refer to, "Electrical, Piping, Instrumentation, and Connections" for other details.
- Manufacturer's standard 2-coat paint system; polyurethane top coat – RAL 7037
- Paint inspection
- Material test report for gearset
- Material test report for gear housing
- Final hardness check
- Contact check
- Contact check – tape lift
- Dynamic balancing of gearset
- Electrical and mechanical runout
- No load mechanical run test (1 hr w/ shop couplings)
- Sound level test
- Filter breather on gear housing
- 2x SS ground pads on gear casing
- Visual inspection of gear casing

Electric Motor – BY OTHERS

- ~~— Manufacturer is TBD by Howden (Siemens is preferred brand)~~
- ~~— API 541 non-bullet compliant design as noted.~~
- ~~— 1.0 SF, 3ph./60Hz/4160v~~
- ~~— WPII enclosure with SS Air Filters/Screens; Differential Pressure Switch (1ph.60Hz/120v)~~
- ~~— 29 → 40 deg C ambient, 4760 FASL max.~~
- ~~— Inverter duty start and operation as follows:

 - ~~— Rated to start and operate under inverter operation as well as bypass DOL start~~
 - ~~— Estimate speed variation between 75% – 100% normal and continuous only; non-permissive to be defined later.~~
 - ~~— Grounding brush to motor shaft and connected to site ground system should be provided at site by others.~~~~
- ~~— DOL start and operation as follows:

 - ~~— Rated to start fan inertia load (with gear effect if applicable) at IGV closed torque and 90% voltage.~~
 - ~~— 1C/1H starts per cooling period typical; maximum 3 starts per day average.~~
 - ~~— 650% max. LRC.~~~~
- ~~— Class F Insulation.~~
- ~~— Class B (80 degC) temp. rise at 1.0 SF by resistance.~~
- ~~— Hydrodynamic (sleeve) type bearings

 - ~~— Oil-lubricated;

 - ~~— Bearing will be self-oil lubricated unless forced oil lubrication is required as determined by Howden during contract engineering.~~
 - ~~— When forced oil lubrication is required by design, the provision for motor bearing oil supply and drain will be included only when the motor is purchased from Howden. The scope will be similar to or integrated to fan lube system.~~
 - ~~— Hydraulic type, flexible oil supply and return hoses to be installed and supported at site by others (refer to "Lubrication System" section for more details).~~
 - ~~— **Included** Provisions for, and/or supply of Proximity Probes (when proximity probe option is purchased).~~
 - ~~— Insulated brg(s) when VFD drive is applicable.~~~~~~
- ~~— RTDs for stator; 100 Ohm Platinum, 3 per phase.~~
- ~~— RTDs for bearings; 100 Ohm Platinum, dual element, 1 per bearing.~~
- ~~— Space Heater for motor frame, 1ph./60Hz/120v~~
- ~~— **Optional** – Zero speed switch only when starting time exceed safe stall time.~~
- ~~— Type II, NEMA 4X (IP 55 equiv.) Main Terminal Box.

 - ~~Space Heater in main terminal box, 1ph./60Hz/120/240v~~
 - ~~Optional items for main box; *Note: for any option below, terminal box will ship loose and will require site support by others.*~~
 - ~~— **Optional** – Space for stress cones (by others).~~
 - ~~— **Optional** – Lightning arrestors and surge capacitors.~~
 - ~~— **Optional** – Current transformers (3 pcs.).~~
 - ~~— **Optional** – Partial Discharge bus couplers max 6.9kV, connection wired to separate auxiliary box.~~~~
- ~~— **316SS** Auxiliary Box(es)

 - ~~— One (1) for Space Heater and powered instrument connections~~
 - ~~— One (1) for RTD Leads~~
 - ~~— One (1) for BN proximitors (when purchased)~~~~
- ~~— Two (2) copper ground pads, each on diagonally opposite corners of frame with ground connection provision.~~
- ~~— Manufacturer's standard paint system, SP-3 prep; high quality alkyd or zinc-rich powder primer of exterior surfaces; two-part high solids epoxy finish in~~

- Refer to, “Electrical, Piping, Instrumentation, and Connections” for other details.
- Motor will be shipped direct from motor factory for installation at site by others
- Independent Sole Plates or Sub-base (TBD by Howden) will be included when motor is purchased from Howden.
- Steel with motor mounting surfaces.
- Includes Vertical Jacking Screws.
- No anchor bolts or shims included.
- Refer to “Equipment Foundation” section for more details.
- Test/Inspection: Certified Copies of Test Data before Shipment (API 541 5th Ed. 8.6.2.a) – Unwitnessed
- Test/Inspection: Certified Data Prior to Shipment (API 541 5th Ed. 8.6.2, a – Line 42) – Unwitnessed

Motor Testing:

- ALL tests are WITNESSED except for Surge Comparison Test & Customer Report (API 541 5th Ed. 6.3.4.2 – Line 12)
- Manufacturer’s standard Factory Routine Test according to manufacturer’s test agenda [unwitnessed]; includes manufacturer’s standard test report.
- Manufacturer’s standard API 541 4th Ed. Routine Test to manufacturer’s standard test agenda; includes manufacturer’s standard test report.
- **INCLUDED** – Manufacturer’s standard API 541 4th Edition Complete Test to manufacturer’s standard test agenda; includes manufacturer’s standard test report. API 541 5th Ed. 6.3.5.1.1 – Lines 28-29
 - Determination of efficiency and power factor; Determination of locked-rotor current, power factor & torque; Determination of full-load current & slip; Determination of breakdown torque; Determination of the speed-torque curve
 - Note the following on Routine & Complete Tests:
 - A no load bearing temperature run (6.3.2.1.h) is not provided as standard when a Complete Test is purchased; we reserve the option to use the procedure per paragraph 6.3.3.11 for hot vibration evaluation.
 - Efficiency testing shall be per IEEE 112 Method F(1) or E(1) as standard. Method F(1) is typical for all units 3000 HP and lower. Method F(1) is used for all vertical motors.
 - A part of the complete test (6.3.5.1.1.g), the noise test shall be performed in accordance with ANSI/NEMA MG-1 Part 9 instead of ANSI S12.54 or ISO 3744.
- **Optional** – Witnessed Motor Tests at motor factory with 10 days prior notice available for price and lead time add.

Local Control Panel (Unit Control Module [UCM])

Not needed if direct plant PLC / DCS operation is available

Base Scope: specific control panel scope, features, and details must be discussed and agreed between Purchaser and Howden before a firm offer is made.

- Local Siemens 1200 series PLC for each turbo fan unit for local control and indication of fan, motor, gearbox and lube system operation.
 - SIMATIC S7-1200, CPU 1214C, 14 DI, 10 DO, 2 AI - SIEMENS 6ES7214-1HG40-0XB0
 - SIMATIC S7-1X00, MEMORY CARD - SIEMENS 6ES7954-8LC03-0AA0
 - SIMATIC S7-1200, 16 POINT DIGITAL INPUT MODULE, SM 1221 - SIEMENS 6ES7221-1BH32-0XB0, as needed.
 - SIMATIC S7-1200, 16 POINT DIGITAL OUTPUT MODULE, SM 1222 - SIEMENS 6ES7222-1BH32-0XB0, as needed.
 - SIMATIC S7-1200, 8 POINT ANALOG INPUT MODULE, SM 1231 - SIEMENS 6ES7231-4HF32-0XB0, as needed
 - SIMATIC S7-1200, 8 POINT ANALOG INPUT MODULE, SM 1231 - SIEMENS 6ES7231-4HF32-0XB0, as needed
 - SIMATIC S7-1200, 8 POINT RTD INPUT MODULE, SM 1231 - SIEMENS 6ES7231-5PF32-0XB0, as needed
 - HMI, 7" TOUCHSCREEN 6AV2124-0GC01-0AX0
- NEMA 4X or IP54 enclosure class.
- 40 °C, 1451 mASL maximum ambient.
- Capable of stand alone operation when connected to User’s starter controls with the following functions:
 - Controls, interlocks and sequencing for starting and stopping the turbo-fan system (not process system).
 - Starting of motors and any other electrical power is by others; signal for start OK only.
 - Monitoring of all fan system switches, meters, and transmitters with local alarm / shutdown.
 - Communications to the plant PLC or DCS via Ethernet IP.
 - Functions are: Start, Stop, remote Trip input, common Alarm output
 - Local / Remote control lockout
 - Emergency Stop button.
 - Light stack; green yellow, red
- ~~Vibration monitoring is to be performed separately when specific vibration monitoring equipment is required (i.e. BN 3500 series system) with output to this local PLC; connection between these different devices is to be done at site by others.~~

- ~~No~~ Transmitters (where required) will be located in or near this cabinet.
- No MCCs or any other starter or switchgear devices are included (by others).
- Includes ~~Allen Bradley~~, Siemens ~~or similar~~ brand PLC (~~TBD by Howden~~)
 - Includes front mounted operator interface and display.
- Includes internal power source.
- Equipped with cooling fan / system as required suitable for 40 degC.
- Auxiliary power may be required (TBD): either 1ph./60Hz/120v or 220v and/or 3ph./60Hz/480v
- Shipped loose as standard for customer choice of convenient local location at site by others.
 - Wiring between control panel and turbo-fan, motor, gearbox, and lube skid junction boxes is to be done at site by others.
- Final details are to be reviewed and agreed by Supplier / Purchaser ~~subject to scope and price adjustment prior to order placement.~~

Bently Nevada 3500 Monitor package

~~Base Scope: the scope and features stated are for basic system functionality as interpreted from the project specifications. Additional scope, features, or functionality may be available for a price add.~~

~~—29 to 40 °C, 1451 mASL maximum design and operating conditions.~~

~~—Monitored point count as follows:~~

~~—One (1) Blower Train each with~~

- ~~— fan bearing housing velocimeters: 2 per unit~~
- ~~— X&Y radial proximity probes each fan and motor bearings: 8 per unit~~
- ~~— axial proximity probe — Fan bearings: 1 per fan~~
- ~~— keyphase probe: 1 per fan shaft~~
- ~~— X&Y radial proximity probes gear bearings: 8 per unit~~
- ~~— keyphase probes: 2 per gearbox (HS & LS shaft)~~

~~Additional details to follow during detailed engineering~~

Coating Systems

Carbon steel fan parts only (~~not housing interior~~).

- Grit Blast Clean
 - SSPC-SP6, Sa 2.5 quality similar to ISO 8501-1, or similar preparation.
 - Surface profile is typically between Fine(G)-to-Medium(G) according to ISO 8503-2.
- Howden's standard coating system:
 - SEVERE ENVIRONMENTAL CORROSION (High Salinity Coastal or Tropical Climate).
 - ISO 12944-2 "C4" Environment.
 - Zinc rich epoxy paint and Acrylic top coat (2 pack) for carbon steel.
 - Nominal dry film thickness typically 200 microns (interior & insulated parts are primed 40 microns only)

Colors: Typical RAL 5005 Signal Blue for fan components (unless specified otherwise).
Typical RAL 1021 "Rape Yellow" or Tnemec "Safety Orange" 04SF.

All Other Equipment

- All motors and other accessories are manufacturer's standard coating system and color.

General

- SS components will not be painted.
- Machined mounting surfaces will have a suitable rust inhibitor applied only.

~~IGV parts only.~~

~~SSPC-SP10 Sandblast and painted~~

Motor, Gearbox and Lube skid to receive manufacturer's standard paint system

Equipment Foundation Design Basis

Fan Rotor Support:

- Fan bearings will be installed on a fabricated steel base with machined equipment mounting pads.
- The fan base is designed to be aligned, leveled, and anchored to a concrete foundation and filled using non-shrink epoxy grout at site by others.

Fan Casing Support:

- Fan casing will be designed to be supported directly from the rotor base on the drive side using machined mounting pads, and from two steel support legs on the inlet side which are to be anchored and grouted to the concrete foundation at site by others (when required).

Driver Support:

- For any driver component purchased from Howden, (i.e. motor, gear, turbine, etc.) the components will be designed to be installed on independent sole plates ~~or sub-base as determined and designed by Howden.~~
- When the driver component is purchased from Howden, the sole plates ~~or sub-base~~ will be included and designed to be aligned, leveled, anchored grouted to a concrete foundation using non-shrink epoxy grout.

Lubrication System Support:

- The lubrication systems ~~are to~~ be installed on a separate concrete pad next to fan base.
- Oil tank will include manufacturer's standard anchoring flanges.
- Pre-set anchors may be used as will be detailed in the foundation layout, or otherwise the anchoring flanges on the tank may be anchored and grouted to the concrete foundation using non-shrink epoxy grout.

Nitrogen Purge / Barrier Gas System Support:

- ~~The purge gas system is to be installed to concrete next to the fan base.~~

Foundation:

- Foundation is to be a suitably stiff and rigid, reinforced concrete pier type foundation.
- Foundation design and installation by others.
- Concrete foundations should have the following properties:
 - The lowest natural frequency of the foundation when the machine is installed and operating should be above $1.3 \times N_{max}$, where N_{max} denotes the highest running speed of the shaft.
 - To ensure that the machine's weight and loading is properly distributed across the foundation, a layer of non-shrink grout no less than 25 mm (1 inch) and no greater than 75 mm (3 inch) in depth should be used between the top surface of the concrete and all foundation contact area of the machine base.
 - The flatness of the finished concrete surface across the foundation is recommended to be within +/-2 mm (80 mils) of variance.
 - The surface roughness of the foundation at each shim and jack bolt contact area is recommended to be within 1 mm (40 mils).

Degree of Assembly

Hardware:

- Galvanized or zinc-plated steel hardware (TBD by Howden) for drive train and mounting connections.
- Includes vertical jacking bolts for steel fan base and casing front supports (when required).
- Includes vertical jacking bolts for gear and/or motor sole plates / sub-base when purchased from Howden.
- Includes horizontal (X only) jacking bolts for fan bearings.
- Includes horizontal (X & Y) jacking bolts for gear and/or main driver when purchased from Howden.
- Interconnecting hardware and seals / gasketing for components supplied by Howden which must be assembled at site will ship loose.
- Interconnecting hardware and seals / gasketing between Howden's and Purchaser's scope are not included.
- All shims, anchor bolts, and any other installation hardware is by others.

Seals and Gaskets:

- ~~PTFE Teflon tape material~~ Silicone gaskets for all casing flanges.
- Viton™ o-ring materials for in-process locations.
- Nitrile rubber (NBR) o-ring materials for out-of-process locations.

Degree of Assembly:

Site assembly of some components as noted below is required for this model:

- Installation of each main, shipped loose component, and installation of all components to the foundation, is required at site by others.
- Inlet Guide Vanes may ship loose for protection to be installed at site by others.
- Guide vane actuator will be mounted on a bracket on the guide vane assembly.
- Discharge diffuser ships loose.
- Driver Half Coupling may ship loose.

Electrical, Piping, Instrumentation, and Connections:**Site Connections:**

- All customer tie-in connections will match ANSI standard connections.
- The equipment offered is a rotating machinery package with critical internal clearances, and subject to normal operating vibrations. Howden designs the equipment package with the understanding that all site connections will have suitable flexible / expansion joints and/or the connecting equipment will be designed to prevent transmission of loads between the equipment supplied by Howden and the site connections supplied by others.

Piping:

- No piping is included in this scope except for piping included with the oil lubrication system; refer to "Forced Oil Lubrication System" for details.
- Fan casing drain pipe is strictly manufacturer' standard design. Pipe is not rated as this is not designed for pressure containment. Suitable expansion or flexible connection provisions should be made when connecting at site to prevent transmission of loads between site piping and casing drain.

Electrical Wiring & Terminations:

- All electrical components and devices will be UL or FM approved or recognized.
- All local fan instruments will be wired to a local terminal box(es) on the fan base.
- All lube system instruments will be wired to a local terminal box(es) on the **individual lube skids.**
- **All gearbox instruments will be wired to local terminal boxes on the gearbox.**
- ~~All motor components will be wired to the local motor junction boxes using motor manufacturer's standard routing and wiring methods only.~~
- Devices that require 3-phase power will be terminated in the local device enclosure only (i.e. motors, heaters, monitors, etc.)
- All power supply, controls, and monitoring equipment for instrument alarm and shutdown are by others.
- All wiring to power supply, controls, and monitoring junction points are to be done at site by others.

Segregation:

- Analogue and Discrete instrument signals may be run to the same local junction box but segregated on separate terminal blocks.
- No Power wiring is included.

Terminal Boxes:

- Local Instrument Terminal Boxes will be NEMA 4X (IP 66 equiv.), 304 SS; Weidmuller, Rittal, Crouse-Hinds, AE type or similar.
- Terminals will be screw type, 600v, Weidmuller typical.
- Terminal boxes / terminations for any device requiring power (i.e. motor, heater, vibration device, etc.) will be the device manufacturer's standard.

Wire, Cable:

- Wire and cable will be used generally as follows, with the division of wire vs. cable as deemed appropriate by the equipment manufacturer.
 - o Typ: Ölflex 135 or similar; fine copper strand with PVC core insulation and PVC oil-resistant outer jacket, typically 1.0mm² (AWG 17), Black conductor with white numbers.
- Vibration detector wire / cable: Device manufacturer's recommended cable for the specific device.

Conduit:

- Wire will be run inside of conduit.
- Liquid tight flexible metal conduit and fittings will be used; Anamet Anakonda or similar.
- ¾" for main conduit runs (subject to Howden determination).
- ½" or 3/8" for short runs or end-runs or where connecting to an instrument with ½" connection.

Cable Tray:

- Cable will not be run inside of conduit; cable tray may only be used where long, straight, unsupported runs are required.
- Manufacturer's standard galvanized steel cable tray will be used for any long, straight horizontal runs on the skid, but may not be practical for all runs.
- Tray will be fastened to the equipment skid / frame using appropriate fasteners such as clamp supports or similar for the purpose (TBD by Howden).

Grounding:

- One (1) ground lug or similar provision will be included in each main terminal box for connection to user's ground system at site by others.
- **Two (2) SS ground pads will be installed on each main skid / frame (i.e. fan, gear, motor, lube), one each on diagonally opposite corners. Connection will be 2-hole NEMA pattern; 14.4mm (9/16") dia. through-holes spaced 44.5mm (1-3/4") apart.**
- No ground wires are included for equipment; connection to user's ground system to be at site by others.

Vibration Detection Equipment:

- Refer to “Instrument and Control Component Schedule” below.

Instrumentation & Regulating Equipment:

- Devices identified in this offer are only included when the associated main component is purchased from Howden (i.e. actuator, gear, motor, lube skid, etc.).
- Some instruments or regulating devices may be added or deleted by HRO during the engineering design phase of a project when it deemed necessary or practical for the operation and control of the fan system; any such changes would be reflected in project documents.
- No transmitters or monitoring devices are included unless explicitly stated otherwise.
- Refer to “Instrument and Regulation Component Schedule” elsewhere in this offer for more details.

Instrument and Control Component Schedule

See separate attachment – HROBNB0099-Prelim-IL submitted during proposal phase. This will be revised as necessary and become a formal document submittal during the execution phase.