

Quotation

To

Company : Siemens AG
City / Country : Duisburg / Germany
Name : Stoverink Simon
Dept :
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Fax :
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Name : N. HOST
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Page(s) : 19
Copy :
Date : 16.03.2016

Y/ref : Khursaniyah Al Fadhili - D43-K-1801 -
O/ref : D41104 quotation number 3

In response to your inquiry referenced above, we are pleased to confirm our quotation as follows :

ITEM A 1 : Flender Graffenstaden (FG) High Speed increaser, model TX50/4C

- *Rating conditions :* Rated power at **6800 kW**
Driven by a electric motor at **1800.0 rpm** (specified : 1800.0 rpm)
Driving a centrifugal compressor at **7309.1 rpm** (specified : 7285.0 rpm)
Service factor **1.45** according to **API613/03** (required : > 1.4)
- *Technical description :* Double helical
Manufacturing according to API standard
Flange on LS shaft end
Flange on HS shaft end
Estimated Weight : 4000 kg
- *Bearings description :* 2 cylindrical bearings on LS shaft
2 offset bearings on HS shaft
1 double acting tilting pad thrust bearing on low speed shaft non driven end
- *Mechanical running test :* Full speed, no load test during 4 hours according to the API 613 5th Edition standard.
- *Lubrication conditions :* 164 l/min of Oil ISO VG 46 at 60°C and 2.5 bar at inlet (calculated values only)
- *Miscellaneous:* Efficiency at full load : 99.03 %
Power losses at full load : 66 kW (calculated value only)
Anticipated Sound Pressure Level: 82.0 ± 2dB(A) at 1 meter

Base price : 117 900 EUR each gear box
Delivery time : 36 weeks after the FG acknowledgement of the order
Quantity : 8 gearboxes

Comments :

- Coupling data taken into account on HS Shaft:
 - o Weight: 26.6 kg
 - o Center of gravity position from shaft end: 30.9 mm
 - o Inertia: 0.266 kgm²
- Coupling data taken into account on LS Shaft:
 - o Weight: 87.5 kg
 - o Center of gravity position from shaft end: 40.9 mm
 - o Inertia: 0.875 kgm²

Including :

- Customer witness of test
- After test disassembly and inspection
- Noise level test report
- Lateral analysis undamped
- Documentation : downloadable electronic file in english

Instrumentation (see the complete package on additional technical data sheet):

- *Temperature package*
12 RTD's PT100 Duplex 3 wires from Thermo Electric Company Inc.
(2 per bearing and thrust bearing side) not wired with terminal heads..... Price included
- *Bently Nevada vibration package*
8 radial (4 per shaft) & 2 axial (on LS shaft) vibration probes, 2 accelerometers (1 per shaft), 2
keyphasors (1 per shaft) not wired Price included

Spare parts (Prices are net valid only if spares are ordered together with the gearbox):

- *Commissioning Spares*
2 RTD's, 2 BN vibration probes, 2 BN accelerometers 7 900 EUR Lot Net
- *2 Years Normal Operation Spares*
2 set of bearings with RTD's, 1 set of oil seals 48 420 EUR Lot Net
- *Strategic Spare Parts*
One complete set of rotating elements consisting of one pinion and one gear.
Tested if ordered together with the main gearbox according to API613/03
Full Speed, No Load, with Test Report..... 51 500 EUR Lot Net
- *Container for horizontal spare rotors storage painted according FG standard..... 17 100 EUR Lot Net*

SPECIAL PURPOSE GEAR UNITS
API 613 FIFTH EDITION
DATA SHEET SI UNITS

1 Applicable To: ☒ Proposal ☐ Purchase ☐ As Built 2 For <u>Siemens AG Dulsburg</u> 3 Site <u>Khursanlyah Al Fadhill</u> 4 Unit <u>STC-SV 08-4-A</u> 5 Service <u>EM/CC</u> 6 No. required <u>9</u>	Job No. <u>41104</u> Item No. <u>A</u> P.O. No. _____ Date _____ Requisition No. _____ Inquiry No. _____ Revision <u>1</u> Date <u>06.03.2015</u> By <u>HNI</u> ☐ US Standards (1.7) ☒ ISO Standards (1.7)
7 NOTE : Numbers within () refer to applicable API standard 613 paragraphs 8 ☐ Information to be completed by purchaser ☐ Information to be completed by manufacturer	
9 ○ UNITS OF MEASUREMENT 10 ☐ US Customary units 11 ☒ SI units 12 ○ RATING REQUIREMENTS 13 Driven equip. (2.1.4): Norm. _____ Max _____ kW 14 Driver: Rated _____ Max _____ kW 15 Normal transmitted power (2.2.2) _____ kW 16 Gear unit rated power (2.2.1) <u>6800</u> kW 17 Torque @ max cont speed _____ Nm 18 Max torque (2.2.1) _____ Nm @ _____ rpm 19 ☐ Reducer ☒ Increaser 20 Rated speed (2.1.5): 21 Input <u>1800</u> rpm ☐ Specified ☒ Nominal 22 Output <u>7285</u> rpm ☐ Specified ☒ Nominal 23 Allow var in gear ratio (2.1.6) (+) (-) _____ % 24 Max continuous speed (1.5) <u>1800 / 7285</u> rpm 25 Trip speed (1.5) (2.1.7) <u>1980 / 8013,5</u> rpm 26 Gear service factor (2.2.3.1) <u>1,4 API 613/2003 5 TH</u> (min) 27 Hardness (2.2.3.2) Pinion _____ Gear _____ 28 Shaft assembly designation (2.1.10) _____ L/R 29 HS shaft rot fac'g cpl'g (2.1.20.2) ☒ CW ☐ CCW 30 LS shaft rot fac'g cpl'g (2.1.20.2) ☒ CW ☐ CCW 31 External loads (2.1.16) _____ 32 Other operating conditions (2.2.2) (2.6.1.3) _____	10 ■ BASIC GEAR DATA 11 ☒ Single stage ☐ Single helical 12 ☐ Double stage ☒ Double helical 13 ☐ Epicyclic ☐ horizontal offset 14 Mechanical rating (1.5.16) <u>9520</u> kW @ <u>1800 / 7309,1</u> rpm 15 Gear service factor (2.2.3.1) <u>1,44</u> API 613/2003 5 TH (actual) 16 Full load gear unit power loss <u>66</u> kW 17 Gear Unit Mechanical efficiency <u>99,03</u> % 18 Rating speed Pinion <u>7,309,1</u> Gear <u>1,800,0</u> rpm 19 Hardness used for 20 Rating, (HB or Rc) Pinion <u>58 HRC</u> Gear <u>58 HRC</u> 21 Tooth pitting index, "K" (2.2.4.1) (2.2.4.2) 22 Allowable <u>2,17</u> Actual <u>2,10</u> MPa 23 Material index number (Fig 3, Table 4) <u>3,03</u> MPa 24 Bending stress number, "S_t" (2.2.5.1) (2.2.5.2) 25 Pinion: Allowable <u>265,4</u> Actual <u>256,0</u> MPa 26 Gear: Allowable <u>265,4</u> Actual <u>240,9</u> MPa 27 Pitch line velocity <u>77,1</u> m/s 28 Anticipated SPL (2.1.6) <u>82</u> dB(A) @ <u>1</u> m 29 WR² referred to LS shaft <u>126,12</u> kgm² 30 Breakaway torque <u>412</u> Nm @ LS Shaft 31 Pinion teeth hardness range <u>58 - 63 HRC</u> 32 Pinion teeth hardening method <u>CARBURIZED</u> 33 ☐ HS shaft separate hardness range _____ 34 Gear teeth (rim) hardness range <u>58 - 63 HRC</u> 35 Gear teeth hardening method <u>CARBURIZED</u> 36 Gear hub: 37 ☒ Forged cylinder ☐ Forged & Copped ☐ Fabricated 38 Gear to Shaft fit method (2.5.3.2) 39 ☐ Integral ☐ Keyed interference ☒ Keyless interference 40 Rim attachment (2.5.3.2) <u>FORGED GEAR WHEEL</u> 41 LS shaft hardness range <u>HB 230 - 274</u> 42 Journal static weight loads (2.6.6.3) 43 Pinion <u>128 / 42</u> kg Gear <u>942 / 707</u> kg 44 Total gear unit assembled weight <u>4000</u> kg 45 NOTES: _____ 46 _____ 47 _____ 48 _____ 49 _____ 50 _____
51 ○ INSTALLATION DATA (2.1.14) 52 ☐ Indoor ☐ Heated ☐ Under roof 53 ☒ Outdoor ☐ Unheated ☐ Partial sides 54 ☐ Grade ☐ Mezzanine ☒ ONSHORE 55 ☐ Winterization required ☐ Tropicalization required 56 Electrical area (2.1.10) Class _____ Grp _____ Div _____ 57 Electrical area (2.1.10) Zone <u>2</u> Grp <u>IIA</u> Temp <u>T1</u> °C 58 Max allow SPL (2.1.6) _____ dB(A) @ _____ m 59 Elevation _____ m Barometer _____ kPa abs 60 Range of ambient temperatures: 61 Dry bulb _____ °C Wet bulb _____ °C 62 Normal _____ °C _____ °C 63 Maximum <u>82</u> °C _____ °C 64 Minimum <u>0</u> °C _____ °C 65 Unusual conditions ☐ Dust ☐ Fumes 66 ☐ _____	

SPECIAL PURPOSE GEAR UNITS
API 613 FIFTH EDITION
DATA SHEET SI UNITS

■ GEAR DATA				○ COUPLINGS AND GUARDS		
	Pinion	Gear			Pinion	Gear
Number of teeth	33	134		Coupling furnished by (3.2.1)	Compr. Supplier	Compr. Supplier
Gear ratio	4,06			Mount coupling halves (3.2.2)	Compr. Supplier	Compr. Supplier
Tangential load, "Wt" (2.2.4.2)	88,155		N	Cplg. guard adapter by (3.2.3)	Gear Supplier	Gear Supplier
AGMA Geometry factor "J"	0,55	0,57		Cplg. guard furnished by (3.2.3)	Compr. Supplier	Compr. Supplier
Pitch diameter	201,56	818,44	mm	Coupling vendor (3.2.3)		
Outside diameter	214,10	827,60	mm	Vendor's model number (3.2.3)		
Root diameter	187,25	800,74	mm	Coupling weight on shaft, kg	26,6	87,5
Center groove diameter	177,00	790,00	mm	CG Inboard / outboard of shaft end	Outboard	Outboard
Normal pressure angle	20,00		deg	Hub drill template provided	☐	☐
Normal diametral pitch	4,62		in ⁻¹	■ SHAFT END DETAIL (2.5.4.2)		
Helix angle	25,00		deg	Shaft end detail specified by: ☒ Purchaser ☐ Gear vendor		
Center distance	510,00		mm	(Integral unless otherwise specified)		
Backlash min	0,34		mm	Shaft end detail if 'otherwise' specified:		
Net face width, "Fw"	260,00		mm	Tapered / Keyless	☐ ☐	☐ ☐
Pinion L/D	1,71			Tapered / 1-Key	☐ ☐	☐ ☐
Face overlap ratio	6,36			Tapered / 2-Keys	☐ ☐	☐ ☐
Transverse contact ratio	1,45			Cylindrical / 1-Key	☐ ☐	☐ ☐
AGMA 6011 service factor	2,64			Cylindrical / 2-Keys	☐ ☐	☐ ☐
Rating based on ANSI/AGMA 6011 with SF=1.0				Other <u>Flanged</u>	☒ ☐	☒ ☐
Durability Power	21442		kW	Shaft diameter	120,0	190,0 mm
Strength Power	17946		kW	(If integral flange use diameter immediately adjacent to flange)		
Tooth Surface Finish, Ra	0,4	0,4	µm	■ RADIAL BEARINGS		
Tooth Generation Process	Hobbing	Hobbing		Type	Pinion	Gear
Tooth Finishing Process	Grinding	Grinding			OFFSET / OFFSET	CYL. / CYL.
Lead modification (2.2.4.6)	☒ Not Req'd	☐ Req'd		Diameter	130 / 130	200 / 200 mm
Calculated Total Lead Mismatch			µm	Length	130 / 130	100 / 100 mm
■ SCUFFING DATA (2.2.6)				Journal velocity	49,8 / 49,8	18,8 / 18,8 m/s
Scuffing Data per ANSI/AGMA 926-A03				Loading	2,78 / 2,81	2,87 / 2,71 N/mm²
Scuffing Risk (2.2.6) <=5% (Low)	Calculation Method	AGMA925		Clearance (min-max)		mm
Composite surface roughness, α_x	0,57		µm	Span	550	550 mm
Specific film thickness, EHL λ_{min}	3,31		µm	Power loss each bearing	13,8 / 13,8	3,0 / 3,0 kW
Tooth temperature, θ_m	82		°C	Oil flow each bearing	42,0 / 42,0	10,0 / 10,0 l/min
Maximum contact temperature, θ_{Bmax}	101		°C	■ THRUST BEARINGS		
■ MATERIALS				Location		OPP.CPLG.SIDE
Gear casing	Steel	Oil seals	aluminium	Manufacturer	FLENDER	FLENDER
Pinion(s)	18CrNiMo7-6			Type	NO	COMB.TAP.LANDS
Gear rim(s)	18CrNiMo7-6			Size		BPK LEG 6"
HS Shaft	Integral	LS Shaft	42CrMo4	Area		11615 mm²
Radial bearings	Babbitt	Backing	Steel	Loading		1,14 MPa
Thrust bearing(s)	Babbitt	Backing	Steel	Rating		1,50 MPa
○ SHAFT END DETAIL				Int. thrust load		N
☒ Gear shaft end for coupling integral flange (2.5.4.2)				Ext. thrust load	4,050	9,200 N
☒ Pinion shaft end for coupling integral flange (2.5.4.2)				Power loss each	0,0	6,0 kW
☐ Other:	WITHOUT BOLTS			Oil flow each bearing	0,0	20,0 l/min
				NOTES:		

Job No.	41104	Item No.	A
P.O. No.		Date	
Requisition No.			
Inquiry No.			
Revision	1	Date	06.03.2015
		By	HNI

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SPECIAL PURPOSE GEAR UNITS
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Job No. 41104 Item No. A
P.O. No. _____ Date _____
Requisition No. _____
Inquiry No. _____
Revision 1 Date 06.03.2015 By HNI

O INSPECTIONS AND TESTS (4.1)				
	Req'd	Witness	Observe	Test Log
☐ Advance notice of witness testing required (4.1.3)				
Number calendar days _____				
Shop Inspection (4.1.1)	☐	☐	☐	
Cleanliness Inspection (4.2.3.1)	☐	☐	☐	
Hardness Verification (4.2.3.3)	☒	☐	☐	☒
Dismantle-reassembly (4.3.2.3.1)	☒	☐	☐	☐
Contact Check (2.5.2.2)	☒	☐	☐	☐
Contact Check Tape Lift (2.5.2.2)	☒	☐	☐	☒
Gear accuracy check (2.5.2.1)	☒	☐	☐	☐
Double helical axial stability (2.5.2.3)	☒	☐	☐	☒
Special testing Integral forged gears (2.5.3.3)				
(testing per mutual agreement)	☐	☐	☐	☐
Residual unbalance check (2.6.6.2)	☒	☐	☐	☒
Mechanical Run Test (Main) (4.3.2)	☒	☐	☐	☒
Mechanical Run Test (Spare) (4.3.2.4)	☐	☐	☐	☐
Addl. Mechanical Tests (4.3.2.2.16)	☐	☐	☐	☐
Part or Full Load And Full Speed				
Test (4.3.3.1)	☐	☐	☐	☐
Full torque, reduced speed (4.3.3.2)	☐	☐	☐	☐
Full Torque Static Test (4.3.3.3)	☐	☐	☐	☐
Back-To-Back Locked Torque				
Test (4.3.3.4)	☐	☐	☐	☐
Sound Level Test (4.3.3.5)	☒	☐	☐	☒
Additional gear tooth test (4.2.2.8)	☐	☐	☐	☐
Use shop Lube System	☒	☐	☐	
Use Job lube system	☐	☐	☐	
Use shop Vibration Probes, Etc.	☐	☐	☐	
Use Job Vibration Probes, Etc.	☒	☐	☐	
Final Assembly, Maintenance &				
Running Clearance (4.2.1.1.e)	☒	☐	☐	☒
Oil System Cleanliness (4.2.3.2)	☐	☐	☐	
Oil System-Casing Joint				
Tightness (4.3.2.1.4)	☐	☐	☐	
Warning And Protection				
Devices (4.3.2.1.5)	☐	☐	☐	
Seismic Vibration Data (4.3.2.2.3)	☐	☐	☐	☐
Vibration, Phase Plots (4.3.2.2.12)	☒	☐	☐	☒
Oil Inlet Range test (4.3.2.2.13)	☐	☐	☐	☐
Tape recorded Vibration Data	☒	☐	☐	☒
(4.3.2.2.14) (4.3.2.2.15)	☐			
Purchaser copy				
NON-DESTRUCTIVE TESTING (4.2.1.2) (4.2.2.1)				
Surface	Sub surface			Log
☐ Casing	☐	☐		☐
☒ Rot. Elemts.	☒	☒		☒
☒ Bearings	☒	☒		☒
☐ Other :	☐	☐		☐
(Specify)				

NOTES : _____

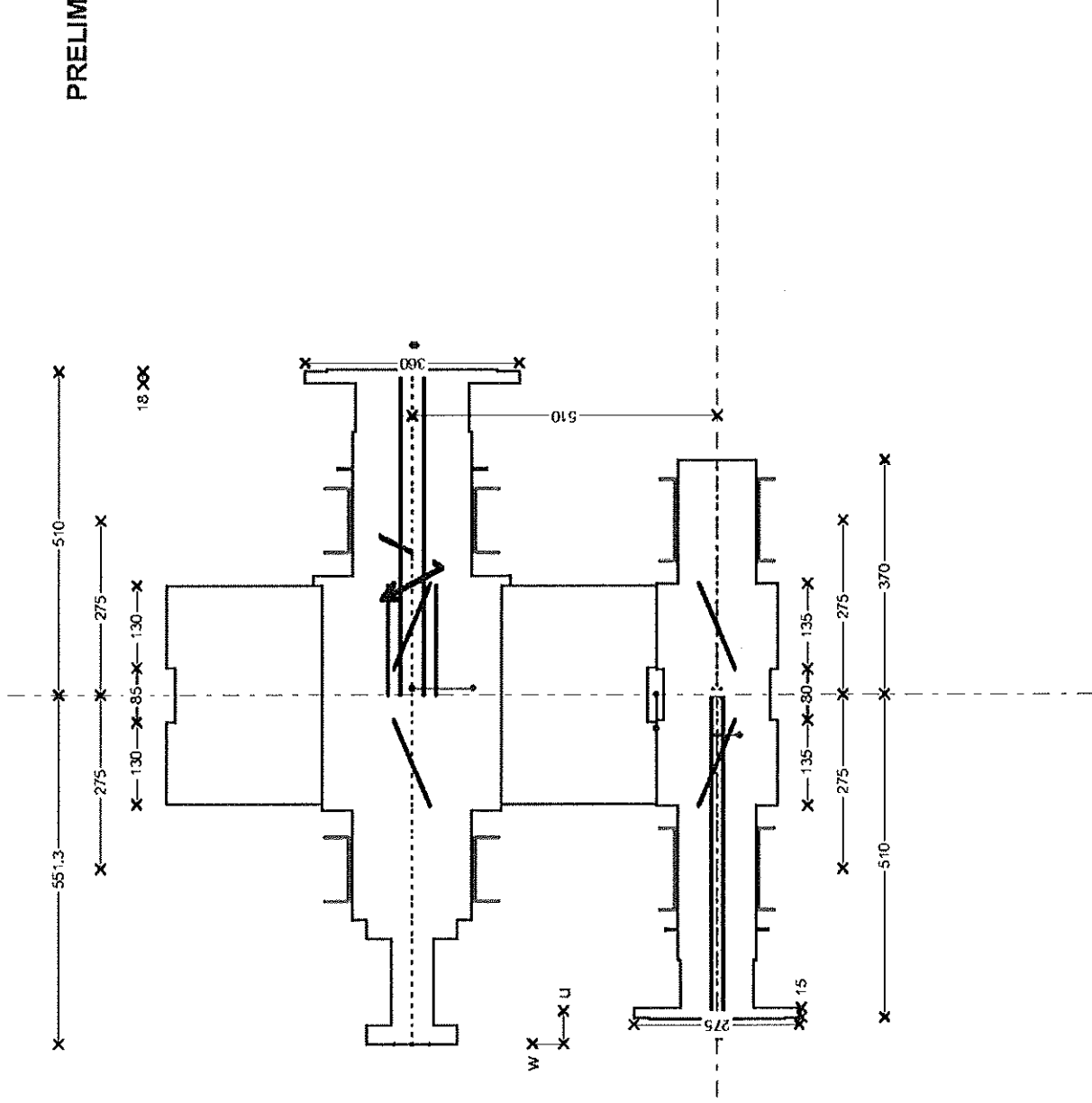
During start-up, gears can exhibit a transient spike reading of vibration levels that will exceed shutdown settings. Therefore a trip multiplier is recommended in the control system.

Mechanical running test duration 4 hours including

- Shaft vibration record using Job vibration probes if ordered
- Bearings temperature records
- Casing vibration measurement
- Sound level pressure measurement
- Power losses measurement at oil outlet
- Performed with oil ISO VG 32

Oil flow requirement and power losses are calculated values only, add normal safety margins for sizing heat exchangers.

PRELIMINARY MASSE ELASTIC DATA



Customer : Siemens AG Duisburg
 Destination : Khursaniyah Al Fadhili
 Purchaser order :
 F-G job number : D 41104A1 OL:
 Type and serial N° : TX50/4C

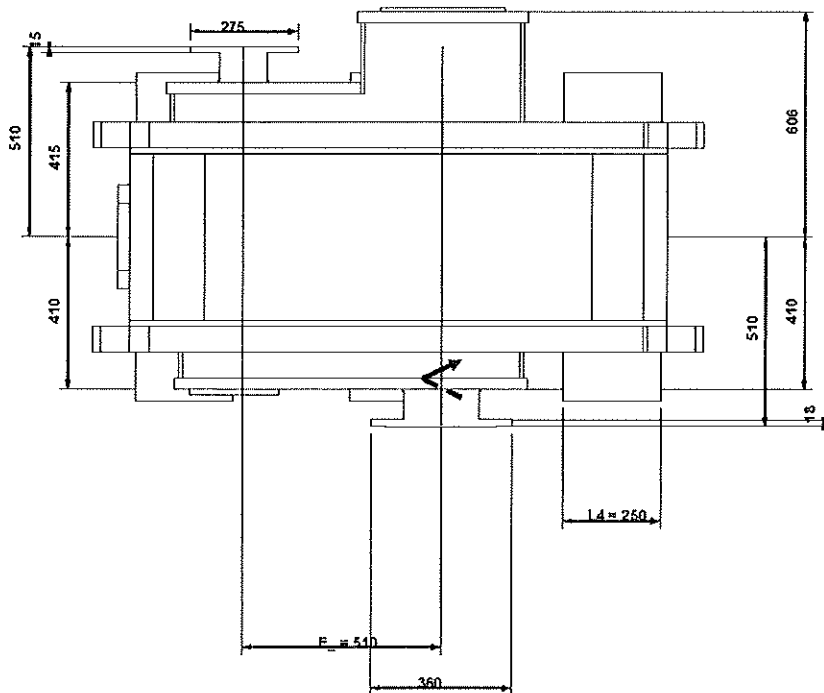
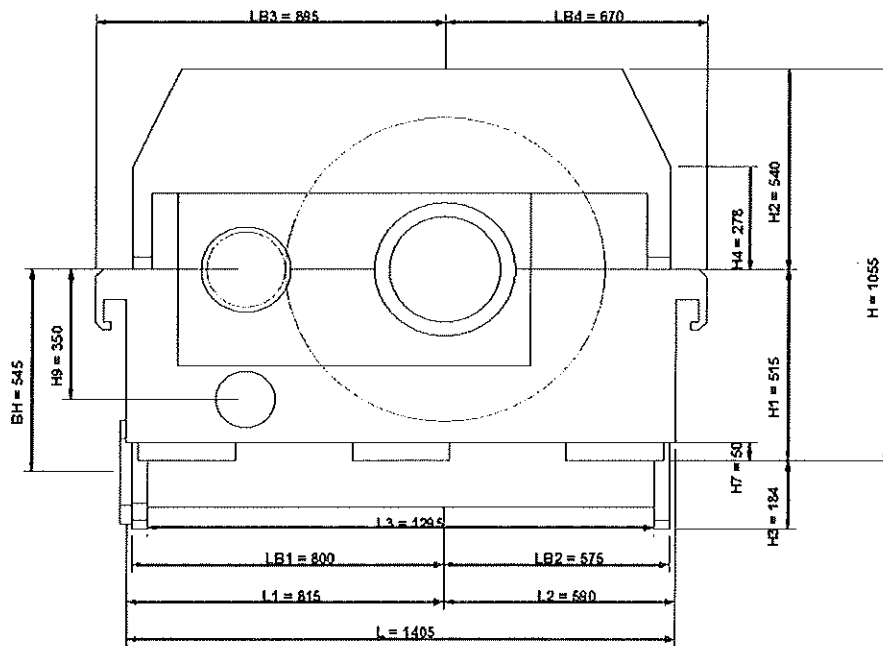
Power rating : 5800 kW
Service factor : API613403 >=1.4
Input speed : 1800 rpm
Output speed : 7309.1 rpm
Speed ratio : 4.06

Weight HSS : 143,5 kg
Weight pos. from teeth middle HSS : 63,4 mm
Inertia HSS : 0,585 Kg.m²
Stiffness HSS : 5,916 MN/mrad
Bearing type 1 : Orifset 130 x 130
Bearing type 2 : Orifset 130 x 130
Add. weight on brg. side 1 : 26,6 kg

Weight: LSS : 1561,2 kg
Weight: pos. from rear middle LSS : 10,5 mm
Inertia LSS : 116,473 Kg.m²
Stiffness LSS : 39,014 MN/m²
Bearing type 4 : Cylindrical 200 x 100
Bearing type 3 : Cylindrical 200 x 100
Add. weight on brg. side 4 : 87,5 kg

Positive direction of external

APPAREIL.xls _ Edition du :06.03.2015
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ADDITIONAL TECHNICAL DATASHEET				Job No. 41104 Item No. A																																																		
				P.O. No. _____ Date _____																																																		
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1	☒ ADDITIONAL GEAR DATA			☐ TURNING GEAR (Dimensioning is preliminary !)																																																		
2	Efficiency			Calculation results																																																		
3	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;">Percent of rated power</th> <th style="width: 50%;">Efficiency</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">100%</td> <td style="text-align: center;">99,03</td> </tr> <tr> <td style="text-align: center;">75%</td> <td style="text-align: center;">98,92</td> </tr> <tr> <td style="text-align: center;">50%</td> <td style="text-align: center;">98,79</td> </tr> <tr> <td style="text-align: center;">25%</td> <td style="text-align: center;">98,08</td> </tr> <tr> <td style="text-align: center;">10%</td> <td style="text-align: center;">90,80</td> </tr> </tbody> </table>			Percent of rated power	Efficiency	100%	99,03	75%	98,92	50%	98,79	25%	98,08	10%	90,80	Required turning speed _____ rpm Actual turning speed _____ rpm Required breakaway torque _____ Nm Actual breakaway torque _____ Nm Actual maximum torque _____ Nm Actual acceleration time _____ s																																						
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10	Losses			Motor																																																		
11	Power loss at no load _____ kW			Supplier _____																																																		
12	Heat rejection _____ kcal/h			Power _____ kW																																																		
13				Voltage _____ V																																																		
14				Frequency _____ Hz																																																		
15	☐ PUMP DETAILS (Dimensioning is preliminary !)			Speed _____ rpm																																																		
16				Electric standard _____																																																		
17	Design : _____			Turning gear																																																		
18	Speed : _____ rpm			Type _____																																																		
19	Oil flow : _____ l/min			Ratio _____																																																		
20	Oil pressure : _____ bar			Clutch																																																		
21	NPSH : _____ m			Type _____																																																		
22	Safety valve : _____			Max. allowable torque _____ Nm																																																		
23	Driving method : _____			Miscellaneous																																																		
24	Material : _____			Starting device _____																																																		
25	Flanges : _____			Switch details _____																																																		
26	Testing : _____																																																					
27	Furniture of ATEX certificate : _____																																																					
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42	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th></th> <th style="width: 20%;">Radial</th> <th style="width: 10%;">HS</th> <th style="width: 10%;">Axial</th> <th style="width: 10%;">LS</th> <th style="width: 20%;">Keyphasor</th> <th style="width: 30%;">Accelerometer</th> </tr> </thead> <tbody> <tr> <td>Type</td> <td>B.N. 3300 XL 8mm Sys. 9M</td> <td></td> <td>No</td> <td></td> <td>B.N. 3300 XL 8mm Sys. 9M</td> <td>ACCELEROMETER BENTLY</td> </tr> <tr> <td>Probe</td> <td>Yes</td> <td>HS</td> <td>No</td> <td>LS</td> <td>Yes</td> <td></td> </tr> <tr> <td>Proximitior</td> <td>Yes</td> <td>HS</td> <td>No</td> <td>LS</td> <td>Yes</td> <td></td> </tr> <tr> <td>Probe holder</td> <td>Yes</td> <td>HS</td> <td>No</td> <td>LS</td> <td>Yes</td> <td></td> </tr> <tr> <td>Connection head</td> <td>Yes</td> <td>HS</td> <td>No</td> <td>LS</td> <td>Yes</td> <td></td> </tr> <tr> <td>mounting kit</td> <td></td> <td>LS</td> <td>Yes</td> <td></td> <td></td> <td>Yes</td> </tr> </tbody> </table>						Radial	HS	Axial	LS	Keyphasor	Accelerometer	Type	B.N. 3300 XL 8mm Sys. 9M		No		B.N. 3300 XL 8mm Sys. 9M	ACCELEROMETER BENTLY	Probe	Yes	HS	No	LS	Yes		Proximitior	Yes	HS	No	LS	Yes		Probe holder	Yes	HS	No	LS	Yes		Connection head	Yes	HS	No	LS	Yes		mounting kit		LS	Yes			Yes
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55	Junction box(es)			Miscellaneous																																																		
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58	Manufacturer _____			Transmitter type _____ Qty _____																																																		
59	Material _____			Terminal block type _____ Qty _____																																																		
60	ATEX None																																																					
61																																																						

Y/ref : Khursaniyah Al Fadhili - D43-K-3801 -
O/ref : D41104 quotation number 3

ITEM B 1 : Flender Graffenstaden (FG) High Speed increaser, model **TX40/5C**

- *Rating conditions :* Rated power at **1620 kW**
Driven by a electric motor at **1800.0 rpm** (specified : 1800.0 rpm)
Driving a centrifugal compressor at **10737.9 rpm** (specified : 10736.0 rpm)
Service factor **1.47** according to **API613/03** (required : > 1.4)
- *Technical description :* Double helical
Manufacturing according to API standard
Flange on LS shaft end
Flange on HS shaft end
Estimated Weight : 1900 kg
- *Bearings description :* 2 cylindrical bearings on LS shaft
2 tilting pads bearings on HS shaft
1 double acting tilting pad thrust bearing on low speed shaft non driven end
- *Mechanical running test :* Full speed, no load test during 4 hours according to the API 613 5th Edition standard.
- *Lubrication conditions :* 64 l/min of Oil ISO VG 46 at 60°C and 2.5 bar at inlet (calculated values only)
- *Miscellaneous:* Efficiency at full load : 98.70 %
Power losses at full load : 21 kW (calculated value only)
Anticipated Sound Pressure Level: 82.0 ± 2dB(A) at 1 meter

Base price : **103 850 EUR** each gear box

Delivery time : **36 weeks** after the FG acknowledgement of the order

Quantity : **1 gearbox**

Comments :

- Coupling data taken into account on HS Shaft:
 - o Weight: 10.4 kg
 - o Center of gravity position from shaft end: 28.2 mm
 - o Inertia: 0.104 kgm²
- Coupling data taken into account on LS Shaft:
 - o Weight: 26.4 kg
 - o Center of gravity position from shaft end: 30.9 mm
 - o Inertia: 0.264 kgm²

Including :

- Customer witness of test
- After test disassembly and inspection
- Noise level test report
- Lateral analysis undamped
- Documentation : downloadable electronic file in English

Instrumentation (see the complete package on additional technical data sheet):

- *Temperature package*
12 RTD's PT100 Duplex 3 wires from Thermo Electric Company Inc.
(2 per bearing and thrust bearing side) not wired with terminal heads..... Price included
- *Bently Nevada vibration package*
8 radial (4 per shaft) & 2 axial (on LS shaft) vibration probes, 2 accelerometers (1 per shaft), 2 keyphasors (1 per shaft) not wired Price included

Spare parts (Prices are net valid only if spares are ordered together with the gearbox):

- *Commissioning Spares*
2 RTD's, 2 BN vibration probes, 2 BN accelerometers 7 900 EUR Lot Net
- *2 Years Normal Operation Spares*
1 set of bearings with RTD's, 1 set of oil seals 26 010 EUR Lot Net
- *Strategic Spare Parts*
One complete set of rotating elements consisting of one pinion and one gear.
Tested if ordered together with the main gearbox according to API613/03
Full Speed, No Load, with Test Report..... 37 100 EUR Lot Net
- *Container for horizontal spare rotors storage painted according FG standard*..... 15 850 EUR Lot Net

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Applicable To: ☒ Proposal ☐ Purchase ☐ As Built For: <u>Siemens AG Dulsburg</u> Site: <u>Khursaniyah Al Fadhlili</u> Unit: <u>STC-SV 06-3-A</u> Service: <u>EM/CC</u> No. required: <u>1</u>	Job No. <u>41104</u> Item No. <u>B</u> P.O. No. _____ Date _____ Requisition No. _____ Inquiry No. _____ Revision <u>1</u> Date <u>06.03.2015</u> By <u>HNI</u> ☐ US Standards (1.7) ☒ ISO Standards (1.7)
NOTE : Numbers within () refer to applicable API standard 613 paragraphs ☐ Information To be completed by purchaser ☐ Information to be completed by manufacturer	
○ UNITS OF MEASUREMENT ☐ US Customary units ☒ SI units ○ RATING REQUIREMENTS Driven equip. (2.1.4): Norm. _____ Max _____ kW Driver: Rated _____ Max _____ kW Normal transmitted power (2.2.2) _____ kW Gear unit rated power (2.2.1) <u>1620</u> kW Torque @ max cont speed _____ Nm Max torque (2.2.1) _____ Nm @ _____ rpm ☐ Reducer ☒ Increaser Rated speed (2.1.5): Input <u>1800</u> rpm ☐ Specified ☒ Nominal Output <u>10736</u> rpm ☐ Specified ☒ Nominal Allow var in gear ratio (2.1.5) (+) (-) _____ % Max continuous speed (1.5) <u>1800 / 10736</u> rpm Trip speed (1.5) (2.1.7) <u>1980 / 11809,6</u> rpm Gear service factor (2.2.3.1) <u>1,4</u> API 613/2003 5 TH (min) Hardness (2.2.3.2) Pinion _____ Gear _____ Shaft assembly designation (2.1.10) _____ L/R HS shaft rot fac'g cpl'g (2.1.20.2) ☒ CW ☐ CCW LS shaft rot fac'g cpl'g (2.1.20.2) ☒ CW ☐ CCW External loads (2.1.16) _____ Other operating conditions (2.2.2) (2.6.1.3) _____	■ BASIC GEAR DATA ☒ Single stage ☐ Single helical ☐ Double stage ☒ Double helical ☐ Epicyclic ☐ horizontal offset Mechanical rating (1.5.16) <u>2268</u> kW @ <u>1800 / 10737,9</u> rpm Gear service factor (2.2.3.1) <u>1,46</u> API 613/2003 5 TH (actual) Full load gear unit power loss <u>21</u> kW Gear Unit Mechanical efficiency <u>98,70</u> % Rating speed Pinion <u>10.737,9</u> Gear <u>1.800,0</u> rpm Hardness used for Rating, (HB or Rc) Pinion <u>58 HRC</u> Gear <u>58 HRC</u> Tooth pitting index, "K" (2.2.4.1) (2.2.4.2) Allowable <u>2,17</u> Actual <u>2,06</u> MPa Material index number (Fig 3, Table 4) <u>3,03</u> MPa Bending stress number, "S_t" (2.2.5.1) (2.2.5.2) Pinion: Allowable <u>265,4</u> Actual <u>251,0</u> MPa Gear: Allowable <u>265,4</u> Actual <u>238,8</u> MPa Pitch line velocity <u>63,0</u> m/s Anticipated SPL (2.1.6) <u>82</u> dB(A) @ <u>1</u> m WR² referred to LS shaft <u>29,88</u> kgm² Breakaway torque <u>90</u> Nm @ LS Shaft Pinion teeth hardness range <u>58 - 63 HRC</u> Pinion teeth hardening method <u>CARBURIZED</u> ☐ HS shaft separate hardness range _____ Gear teeth (rim) hardness range <u>58 - 63 HRC</u> Gear teeth hardening method <u>CARBURIZED</u> Gear hub: ☒ Forged cylinder ☐ Forged & Capped ☐ Fabricated Gear to Shaft fit method (2.5.3.2) ☐ Integral ☐ Keyed interference ☒ Keyless interference Rim attachment (2.5.3.2) <u>FORGED GEAR WHEEL</u> LS shaft hardness range <u>HB 230 - 274</u> Journal static weight loads (2.6.6.3) Pinion <u>37</u> / <u>4</u> kg Gear <u>347</u> / <u>253</u> kg Total gear unit assembled weight <u>1900</u> kg NOTES: _____
○ INSTALLATION DATA (2.1.14) ☐ Indoor ☐ Heated ☐ Under roof ☒ Outdoor ☐ Unheated ☐ Partial sides ☐ Grade ☐ Mezzanine ☒ ONSHORE ☐ Winterization required ☐ Tropicalization required Electrical area (2.1.10) Class _____ Grp _____ Div _____ Electrical area (2.1.10) Zone <u>2</u> Grp <u>IIA</u> Temp <u>T1</u> °C Max allow SPL (2.1.6) _____ dB(A) @ _____ m Elevation _____ m Barometer _____ kPa abs Range of ambient temperatures: Dry bulb _____ °C Wet bulb _____ °C Normal _____ °C _____ °C Maximum <u>82</u> °C _____ °C Minimum <u>0</u> °C _____ °C Unusual conditions ☐ Dust ☐ Fumes ☐ _____	

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Inquiry No.			
Revision	1	Date	06.03.2015
		By	HNI

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1 ○ LUBRICATION REQUIREMENTS 2 ☐ Oil system furnished by (2.8.3) _____ 3 ☐ Other _____ ☐ Gear vendor _____ 4 ☐ Oil visc. _____ cp @ 40°C _____ cp @ 100°C (2.8.6) 5 ☐ ISO Grade _____ Load stage (2.2.6) 7,0 6 7 ■ MESH 8 Mesh and windage power loss 2,0 kW 9 Oil flow, mesh 9,0 l/min 10 11 ■ LUBRICATION REQUIREMENTS 12 Min. startup oil temperature 20,0 °C 13 Normal oil inlet temperature 60,0 °C 14 Maximum oil inlet temperature 65,0 °C 15 Unit oil flow (total) 64,0 l/min 16 Unit oil pressure 2,5 bar 17 ☐ Oil visc. _____ cp @ 40°C _____ cp @ 100°C (2.8.6) 18 ☐ ISO Grade 46 Load stage (2.2.6) 7,0 19 20 ■ PIPING CONNECTIONS <table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th>Service</th> <th>No.</th> <th>Size</th> <th>Type</th> </tr> <tr> <td>Lube oil inlet</td> <td>1</td> <td>1,5 in.</td> <td>ANSI 150 LBS</td> </tr> <tr> <td>Lube oil outlet</td> <td>1</td> <td>6 in.</td> <td>ANSI 150 LBS</td> </tr> <tr> <td>Casing drain *</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Vent</td> <td>1</td> <td>1,5 in.</td> <td>ANSI 150 LBS</td> </tr> <tr> <td>Casing purge</td> <td></td> <td></td> <td></td> </tr> </table> 27 * Casing drain is 'dead bottom' housing drain, not lube oil outlet 28 ○ MOUNTING PLATES 29 ☐ Gear furnished with (3.3.1.1) 30 ☐ Baseplate ☐ Soleplate ☐ Subplate(s) (3.3.2.10) 31 ☐ Mounting plates(s) furnished by (3.3.1.1) _____ 32 ☐ Baseplate leveling (3.3.2.3) _____ 33 ☐ Baseplate with leveling pads (3.3.2.3) 34 ☐ Baseplate suitable for column mounting (3.3.2.4) 35 ☐ Vendor review of purchaser's foundation dwgs. (2.1.13) 36 ☐ Grout type (3.3.1.2.4) _____ 37 38 ○ CONTRACT DATA 39 ☐ Test data prior to shipment _____ 40 ☒ Progress report (5.3.3) _____ 41 ☐ Vendor signoff of inspector checklist (4.1.1.3) 42 ☒ Information retained for 20 years (4.2.1.1) (4.2.2.6.1) 43 ☐ Technical manual (5.3.5.4) 44 ☒ PAINTING (4.4.3.1) ☒ Flender standard RAL5015 (blue) 45 ☒ Painting housing interior not allowed (2.3.1.14) 46 ○ SHIPMENT 47 ☐ Steel rotor storage container (4.4.5) ☐ Shaft covers (4.4.4) 48 <table style="width:100%;"><tr><td></td><td>Contract unit</td><td>Spares</td></tr><tr><td>Export boxing</td><td>☐</td><td>☐</td></tr><tr><td>Domestic boxing</td><td>☐</td><td>☐</td></tr><tr><td>Outdoor storage over 6 mos.</td><td>☐</td><td>3 years indoor ☐ (4.4.3.9)</td></tr></table>	Service	No.	Size	Type	Lube oil inlet	1	1,5 in.	ANSI 150 LBS	Lube oil outlet	1	6 in.	ANSI 150 LBS	Casing drain *				Vent	1	1,5 in.	ANSI 150 LBS	Casing purge					Contract unit	Spares	Export boxing	☐	☐	Domestic boxing	☐	☐	Outdoor storage over 6 mos.	☐	3 years indoor ☐ (4.4.3.9)	Job No. 41104 Item No. B P.O. No. _____ Date _____ Requisition No. _____ Inquiry No. _____ Revision 1 Date 08.03.2015 By HNI ○ ADDITIONAL REQUIREMENTS ○ VIBRATION DETECTORS RADIAL (3.4.2.1) (2.7.4.5) (2.7.4.6) ☒ Manufacturer BENTLY NEVADA ☒ Total No. 8 ☒ X-Y probes pinion bearings ☒ Coupling end ☒ Blind end ☒ X-Y probes gear bearings ☒ Coupling end ☒ Blind end ☐ Other _____ AXIAL (3.4.2.1) (2.7.4.5) (2.7.4.6) ☒ Manufacturer BENTLY NEVADA ☒ Total No. 2 ☐ Dual probes at each thrust bearing ☐ Single probe any shaft without thrust bearing ☐ Other _____ ONE EVENT PER REVOLUTION PROBE (2.7.4.5) (2.7.4.6) ☒ Manufacturer BENTLY NEVADA Total No. 2 ☒ One on input shaft ☒ One on output shaft ☐ Other _____ ACCELEROMETER (3.4.2.1) (2.7.4.5) (2.7.4.6) ☒ Manufacturer BENTLY NEVADA ☒ No. required 2 ☒ Pinion coupling end ☒ Gear coupling end ☐ Other _____ ○ TEMPERATURE DETECTORS ☐ Dial type thermometers (3.4.2.7) _____ ☒ Type brg. temp. sensors (3.4.2.7) (2.7.1.3) PT100 ☐ RTD ☐ Thermocouple / ☐ Simplex ☒ Duplex Calibration Yes ☒ HS/LS bearings no. sensors each 2 / 2 ☒ Thrust number of sensing elements each face 2 ○ OTHER VIBRATION AND TEMPERATURE (3.4.2.5) (3.4.2.6) Other Gear vendor Oscillator demodulator supplied by ☐ ☒ Vibration monitor supplied by ☒ ☐ ☐ Vibration shutdown delay time _____ seconds Temperature monitor supplied by ☒ ☐ Oscillator demodulator J-box by ☒ ☐ Temp. sensor termination J-box by ☒ ☐ J-box type _____ Mount _____ ○ MISCELLANEOUS ☒ Undamped critical analysis report (2.6.2.1) ☐ w/ damped rotor response analysis report (2.6.2.4.3) (2.6.2.6) Torsional analysis by (2.6.5.2) ☐ Gear vendor ☒ Other ☒ Spare set of gear rotors (4.3.2.4) ☐ Gear case furnished with inlet purge connection (2.4.3) ☐ Orientation of oil inlet & drain conns. (2.4.6) _____ ☒ Filter breather location (2.3.1.12) Prov. on upper casing ☐ Torsional device provisions (2.5.4.5) _____ ☐ Rotor vertical storage provisions (2.5.4.8) _____ ☐ Rotor vertical storage fixture(s) (3.6.2) _____ ☐ Vendor service rep. on site (2.1.13)
Service	No.	Size	Type																																		
Lube oil inlet	1	1,5 in.	ANSI 150 LBS																																		
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Job No. 41104 Item No. B
P.O. No. _____ Date _____
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Inquiry No. _____
Revision 1 Date 06.03.2015 By HNI

O INSPECTIONS AND TESTS (4.1)				
☐ Advance notice of witness testing required (4.1.3) Number calendar days _____				
	Req'd	Witness	Observe	Test Log
6	Shop Inspection (4.1.1)	☐	☐	☐
7	Cleanliness Inspection (4.2.3.1)	☐	☐	☐
8	Hardness Verification (4.2.3.3)	☒	☐	☒
9	Dismantle-reassembly (4.3.2.3.1)	☒	☐	☐
10	Contact Check (2.5.2.2)	☒	☐	☐
11	Contact Check Tape Lift (2.5.2.2)	☒	☐	☒
12	Gear accuracy check (2.5.2.1)	☒	☐	☐
13	Double helical axial stability (2.5.2.3)	☒	☐	☒
14	Special testing integral forged gears (2.5.3.3)			
15	(testing per mutual agreement)	☐	☐	☐
16	Residual unbalance check (2.6.6.2)	☒	☐	☒
17	Mechanical Run Test (Main) (4.3.2)	☒	☐	☒
18	Mechanical Run Test (Spare) (4.3.2.4)	☐	☐	☐
19	Addl. Mechanical Tests (4.3.2.2.16)	☐	☐	☐
20	Part or Full Load And Full Speed			
21	Test (4.3.3.1)	☐	☐	☐
22	Full torque, reduced speed (4.3.3.2)	☐	☐	☐
23	Full Torque Static Test (4.3.3.3)	☐	☐	☐
24	Back-To-Back Locked Torque			
25	Test (4.3.3.4)	☐	☐	☐
26	Sound Level Test (4.3.3.5)	☒	☐	☒
27	Additional gear tooth test (4.2.2.8)	☐	☐	☐
28	Use shop Lube System	☒	☐	☐
29	Use job lube system	☐	☐	☐
30	Use shop Vibration Probes, Etc.	☐	☐	☐
31	Use job Vibration Probes, Etc.	☒	☐	☐
32	Final Assembly, Maintenance &			
33	Running Clearance (4.2.1.1.e)	☒	☐	☒
34	Oil System Cleanliness (4.2.3.2)	☐	☐	☐
35	Oil System-Casing Joint			
36	Tightness (4.3.2.1.4)	☐	☐	☐
37	Warning And Protection			
38	Devices (4.3.2.1.5)	☐	☐	☐
39	Seismic Vibration Data (4.3.2.2.3)	☐	☐	☐
40	Vibration, Phase Plots (4.3.2.2.12)	☒	☐	☒
41	Oil Inlet Range test (4.3.2.2.13)	☐	☐	☐
42	Tape recorded Vibration Data	☒	☐	☒
43	(4.3.2.2.14) (4.3.2.2.15)	☐	Purchaser copy	
44	NON-DESTRUCTIVE TESTING (4.2.1.2) (4.2.2.1)			
	Surface	Sub surface	Log	
46	☐ Casing	☐	☐	☐
47	☒ Rot. Elmts.	☒	☒	☒
48	☒ Bearings	☒	☒	☒
49	☐ Other :	☐	☐	☐
50	(Specify)			

NOTES : _____

During start-up, gears can exhibit a transient spike reading of vibration levels that will exceed shutdown settings. Therefore a trip multiplier is recommended in the control system.

Mechanical running test duration 4 hours including

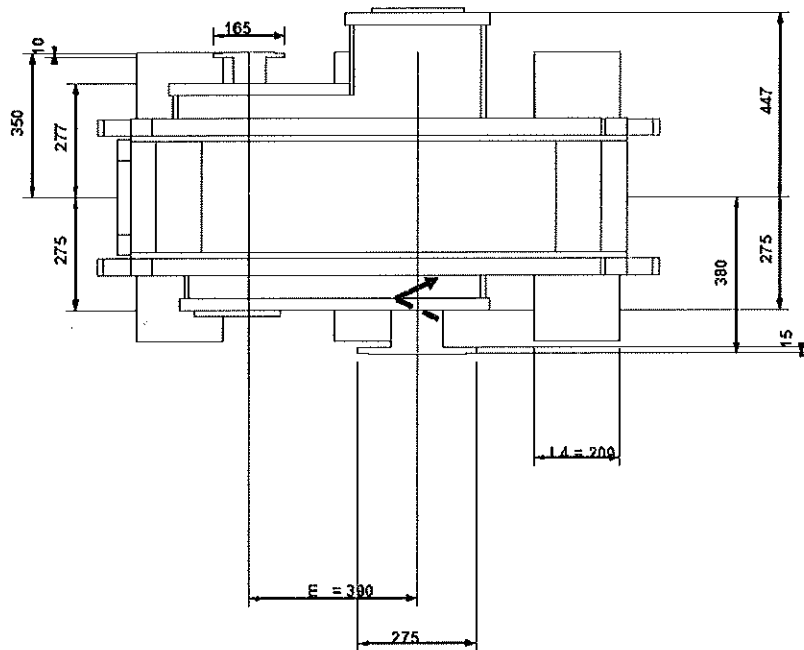
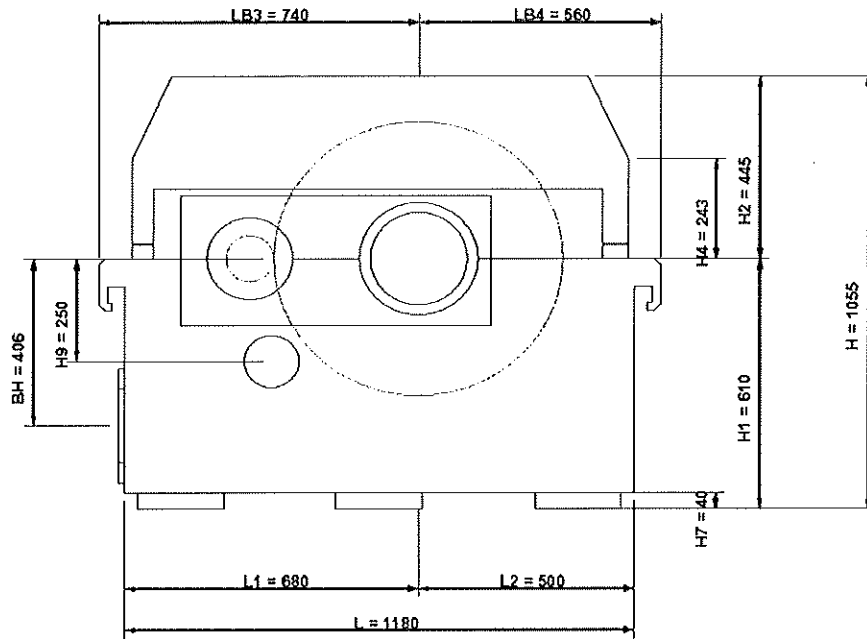
- Shaft vibration record using job vibration probes if ordered
- Bearings temperature records
- Casing vibration measurement
- Sound level pressure measurement
- Power losses measurement at oil outlet
- Performed with oil ISO VG 32

Oil flow requirement and power losses are calculated values only, add normal safety margins for sizing heat exchangers.



Positive direction of external

APPAREILS _ Edition du :06.03.2015
1/1



ADDITIONAL TECHNICAL DATASHEET				Job No. 41104 Item No. B																																											
				P.O. No. _____ Date _____																																											
				Requisition No. _____																																											
				Inquiry No. _____																																											
				Revision 1 Date 06.03.2015 By HNI																																											
☒ ADDITIONAL GEAR DATA			☐ TURNING GEAR (Dimensioning is preliminary I)																																												
Efficiency			Calculation results																																												
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;">Percent of rated power</th> <th style="width: 50%;">Efficiency</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">100%</td> <td style="text-align: center;">98,70</td> </tr> <tr> <td style="text-align: center;">75%</td> <td style="text-align: center;">98,66</td> </tr> <tr> <td style="text-align: center;">50%</td> <td style="text-align: center;">98,38</td> </tr> <tr> <td style="text-align: center;">25%</td> <td style="text-align: center;">97,42</td> </tr> <tr> <td style="text-align: center;">10%</td> <td style="text-align: center;">87,68</td> </tr> </tbody> </table>			Percent of rated power	Efficiency	100%	98,70	75%	98,66	50%	98,38	25%	97,42	10%	87,68	Required turning speed _____ rpm Actual turning speed _____ rpm Required breakaway torque _____ Nm Actual breakaway torque _____ Nm Actual maximum torque _____ Nm Actual acceleration time _____ s																																
Percent of rated power	Efficiency																																														
100%	98,70																																														
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Losses			Motor																																												
Power loss at no load _____ kW Heat rejection _____ kcal/h			Supplier _____ Power _____ kW Voltage _____ V Frequency _____ Hz Speed _____ rpm Electric standard _____																																												
☐ PUMP DETAILS (Dimensioning is preliminary I)			Turning gear																																												
Design : _____ Speed : _____ rpm Oil flow : _____ l/min Oil pressure : _____ bar NPSH : _____ m Safety valve : _____ Driving method : _____ Material : _____ Flanges : _____ Testing : _____ Furniture of ATEX certificate : _____			Type _____ Ratio _____																																												
			Clutch																																												
			Type _____ Max. allowable torque _____ Nm																																												
			Miscellaneous																																												
			Starting device _____ Switch details _____																																												
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Commercial Conditions

- Prices are quoted FCA Illkirch-Graffenstaden following Incoterms 2010 including packing cat 1A of SEI, 1999 issue, ind. 2.
- Progress payments : 100% at delivery.
- This quotation is subjected to the Flender Graffenstaden Standard Terms and Conditions of Sales and valid for acceptance until the 15th of July 2015.
- Where approval of drawings is required, approval must be in line with the document schedule.
- Warranty period is 18 months of operation or 24 months after delivery whichever occurs first. We recommend the supervision of our engineer for the commissioning.
- Flender-Graffenstaden SAS shall not be obligated to fulfill this agreement if such fulfillment is prevented by any impediments arising out of national or international foreign trade or customs requirements or any embargoes or other sanctions.

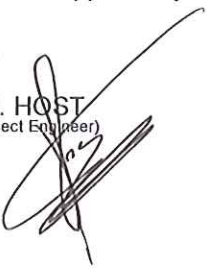
Applicable documents for the quotation (available on demands)

Documents schedule,
Quality plan
Painting standard,
Standard Terms and Conditions of Sales

We thank you for the opportunity of quoting and look forward to the pleasure of serving you.

Very truly yours,

N. HOST
(Project Engineer)



Y. FRIEDMANN
(Sales Manager)



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**** "This quotation is subject to confidentiality. Information thereof may not be shared with or forwarded to any third parties!"**