

Quotation

To

Company :	Siemens AG	Name :	N. HOST
City / Country :	Duisburg / Germany	Dept :	Sales Dept.
Name :	Stoverink Simon	Tel :	+33 (0)3 69 20 51 50
Dept :		Fax :	+33 (0)3 88 67 60 75
Tel :		E-mail :	nhost@flender-graff.com
Fax :		Page(s) :	19
E-mail :		Copy :	
		Date :	16.03.2015

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

FLENDER GRAFFENSTADEN

FLENDER-GRAFFENSTADEN S.A., FRANCE
BP 84, F-67402 ILLKIRCH-CEDEX
1, rue du Vieux Moulin
F-67400 ILLKIRCH-GRAFFENSTADEN

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 AP1613/03
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

Job No. 41104 Item No. A
 P.O. No. _____ Date _____
 Revision No. _____
 Inquiry No. _____
 Revision 1 Date 09.03.2015 By HNI
 US Standards (1.7) ISO Standards (1.7)

Applicable To: Proposal Purchase As Built

For Siemens AG Duisburg
 Site Khuesanlyah Al Fadhill
 Unit STC-SV 08-4-A
 Service EMCC
 No. required 9

Manufacturer FLENDER-GRAFFENSTADEN
 Model No. TX5014C
 Serial No. _____
 Driver type electric motor
 Driven equipment centrifugal compressor

Information to be completed by purchaser

Information to be completed by manufacturer

UNITS OF MEASUREMENT

BASIC GEAR DATA

US Customary units
 SI units

RATING REQUIREMENTS

Single stage Single helical
 Double stage Double helical
 Epicyclic horizontal offset

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) _____ kW
 Torque @ max cont speed _____ Nm
 Max torque (2.2.1) _____ Nm @ _____ rpm
 Reducer Increaser
 Rated speed (2.1.5): _____ rpm
 Input 1800 rpm Specified Nominal
 Output 7285 rpm Specified Nominal
 Allow var in gear ratio (2.1.5) (+) (-) _____ %
 Max continuous speed (1.5) _____ rpm
 Trip speed (1.5) (2.1.7) 1980 / 8013.5 rpm
 Gear service factor (2.2.3.1) 1.4 API 613/2003 5 TH (min)
 Hardness (2.2.3.2) Pinion _____ Gear _____
 Shaft assembly designation (2.1.19) _____ L/R
 HS shaft rot fac'g cp'g (2.1.20.2) CW CCW
 LS shaft rot fac'g cp'g (2.1.20.2) CW CCW
 External loads (2.1.16) _____
 Other operating conditions (2.2.2) (2.6.1.3) _____

Mechanical rating (1.5.16) 9520 kW @ 1800 / 7309.1 rpm
 Gear service factor (2.2.3.1) 1.44 API 613/2003 5 TH (actual)
 Full load gear unit power loss _____ kW
 Gear Unit Mechanical efficiency _____ 99.03 %
 Rating speed Pinion 7,309.1 Gear 1,800.0 rpm
 Hardness used for Rating (HB or Rc) Pinion 58 HRC Gear 58 HRC
 Tooth pitting index, K_v (2.2.4.1) (2.2.4.2) _____
 Allowable 2.17 Actual 2.10 MPa
 Material index number (Fig 3, Table 4) _____ 3.03 MPa
 Bending stress number, S_t (2.2.5.1) (2.2.5.2) _____
 Pinion: Allowable 265.4 Actual 266.0 MPa
 Gear: Allowable 265.4 Actual 249.9 MPa
 Pitch line velocity 77.1 m/s
 Anticipated SPL (2.1.6) 82 dB(A) @ 1 m
 WR^2 referred to LS shaft 126.12 kgm²
 Breakaway torque _____ 412 Nm @ LS Shaft
 Pinion teeth hardness range _____ 58 - 63 HRC
 Pinion teeth hardening method _____ CARBURIZED
 HS shaft separate hardness range _____
 Gear teeth (fin) hardness range _____ 58 - 63 HRC
 Gear teeth hardening method _____ CARBURIZED
 Gear hub: Forged cylinder Forged & Copped Fabricated
 Gear to Shaft fit method (2.5.3.2) _____
 Integral Keyed interference Keyless interference
 Rim attachment (2.5.3.2) _____ FORGED GEAR WHEEL
 LS shaft hardness range _____ HB 230 - 274
 Journal static weight loads (2.6.6.3) _____
 Pinion 128 / 42 kg Gear 942 / 707 kg
 Total gear unit assembled weight _____ 4000 kg
 NOTES: _____
 1/1

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 _____ GIP _____ DIV _____
 Electrical area (2.1.10) Zone 2 GIP IIA Temp T1 °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
 Maximum 82 °C
 Minimum 0 °C
 Unusual conditions Dust Furness

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

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

■ 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		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	Coupling vendor (3.2.3)			
Outside diameter	214,10	827,60	Vendor's model number (3.2.3)			
Root diameter	187,25	800,74	Coupling weight on shaft, kg	26,6	87,5	
Center groove diameter	177,00	790,00	CG inboard / outboard of shaft end	Outboard	Outboard	
Normal pressure angle	20,00		Hub drill template provided	<input type="checkbox"/>	<input type="checkbox"/>	
Normal diametral pitch	4,62		■ SHAFT END DETAIL (2.5.4.2)			
Helix angle	25,00		Shaft end detail specified by: <input checked="" type="radio"/> Purchaser <input type="radio"/> Gear vendor			
Center distance	510,00		(Integral unless otherwise specified)			
Backlash min	0,34		Shaft end detail if 'otherwise' specified:			
Net face width, "Fw"	260,00		Pinion	Gear		
Pinion L/D	1,71		Tapered / Keyless	<input type="radio"/>	<input type="radio"/>	
Face overlap ratio	6,36		Tapered / 1-Key	<input type="radio"/>	<input type="radio"/>	
Transverse contact ratio	1,45		Tapered / 2-Keys	<input type="radio"/>	<input type="radio"/>	
AGMA 6011 service factor	2,64		Cylindrical / 1-Key	<input type="radio"/>	<input type="radio"/>	
Rating based on ANSIVAGMA 6011 with SF=1.0			Cylindrical / 2-Keys	<input type="radio"/>	<input type="radio"/>	
Durability Power	21442		Other Flanged	<input checked="" type="radio"/>	<input type="radio"/>	
Strength Power	17946		Shaft diameter	120,0	190,0	
Tooth Surface Finish, Ra	0,4	0,4	(if integral flange use diameter immediately adjacent to flange)			
Tooth Generation Process	Hobbling	Hobbling	■ RADIAL BEARINGS			
Tooth Finishing Process	Grinding	Grinding	Type	Pinion	Gear	
Lead modification (2.2.4.6)	<input checked="" type="radio"/> Not Req'd	<input type="radio"/> Req'd	OFFSET / OFFSET	CYL. / CYL.		
Calculated Total Lead Mismatch			Diameter	130 / 130	200 / 200	
■ SCUFFING DATA (2.2.6)			Length	130 / 130	100 / 100	
Scuffing Data per ANSIVAGMA 926-A03			Journal velocity	49,8 / 49,8	18,8 / 18,8	
Scuffing Risk (2.2.6) <=5% (Low)	Calculation Method	AGMA925	Loading	2,78 / 2,81	2,87 / 2,71	
Composite surface roughness, σ_x	0,57	μm	Clearance (min-max)			
Specific film thickness, EHL λ_{min}	3,31	μm	Span	550	550	
Tooth temperature, θ_m	82	$^{\circ}\text{C}$	Power loss each bearing	13,8 / 13,8	3,0 / 3,0	
Maximum contact temperature, $\theta_{B\text{max}}$	101	$^{\circ}\text{C}$	Oil flow each bearing	42,0 / 42,0	10,0 / 10,0	
■ MATERIALS			■ THRUST BEARINGS			
Gear casing	Steel	Oil seals	aluminum	Location	OPP.CPLG.SIDE	
Pinion(s)	18CrNiMo7-6		Manufacturer	FLENDER	FLENDER	
Gear rim(s)	18CrNiMo7-6		Type	NO	COMB.TAP.LANDS	
HS Shaft	Integral	LS Shaft	42CrMo4	Size	BPK LEG 6"	
Radial bearings	Babbitt	Backing	Steel	Area	11615	
Thrust bearing(s)	Babbitt	Backing	Steel	Loading	1,14	
○ SHAFT END DETAIL			Rating	1,50	MPa	
<input checked="" type="checkbox"/> Gear shaft end for coupling integral flange (2.5.4.2)			Int. thrust load			
<input checked="" type="checkbox"/> Pinion shaft end for coupling integral flange (2.5.4.2)			Ext. thrust load	4.050	9.200	
<input checked="" type="checkbox"/> Other :	WITHOUT BOLTS		Power loss each	0,0	6,0	
			Oil flow each bearing	0,0	20,0	
			NOTES :			

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

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

○ LUBRICATION REQUIREMENTS

Oil system furnished by (2.8.3) _____
 Other _____ Gear vendor _____
 Oil visc. _____ cp @ 40°C _____ cp @ 100°C (2.8.6)
 ISO Grade _____ Load stage (2.2.6) 5,0

■ MESH

Mesh and windage power loss 26,4 kW
 Oil flow, mesh 40,0 l/min

■ LUBRICATION REQUIREMENTS

Min. startup oil temperature 20,0 °C
 Normal oil inlet temperature 60,0 °C
 Maximum oil inlet temperature 65,0 °C
 Unit oil flow (total) 164,0 l/min
 Unit oil pressure 2,5 bar
 Oil visc. _____ cp @ 40°C _____ cp @ 100°C (2.8.6)
 ISO Grade 46 Load stage (2.2.6) 5,0

■ PIPING CONNECTIONS

Service	No.	Size	Type
Lube oil inlet	1	2 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			

* Casing drain is 'dead bottom' housing drain, not lube oil outlet

○ MOUNTING PLATES

Gear furnished with (3.3.1.1)
 Baseplate Soleplate Subplate(s) (3.3.2.10)
 Mounting plates(s) furnished by (3.3.1.1) _____
 Baseplate leveling (3.3.2.3) _____
 Baseplate with leveling pads (3.3.2.3)
 Baseplate suitable for column mounting (3.3.2.4)
 Vendor review of purchaser's foundation dwgs. (2.1.13)
 Grout type (3.3.1.2.4) _____

○ CONTRACT DATA

Test data prior to shipment _____
 Progress report (5.3.3) _____
 Vendor signoff of inspector checklist (4.1.1.3)
 Information retained for 20 years (4.2.1.1) (4.2.2.6.1)
 Technical manual (5.3.5.4)
 PAINTING (4.4.3.1) Flender standard RAL5015 (blue)
 Painting housing interior not allowed (2.3.1.14)

○ SHIPMENT

	Contract unit	Spares
Export boxing	<input type="checkbox"/>	<input type="checkbox"/>
Domestic boxing	<input type="checkbox"/>	<input type="checkbox"/>
Outdoor storage over 6 mos.	<input type="checkbox"/>	3 years indoor <input type="checkbox"/> (4.4.3.8)

○ 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
 HSLS 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	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Vibration monitor supplied by	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Vibration shutdown delay time _____ seconds		
Temperature monitor supplied by	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Oscillator demodulator J-box by	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Temp. sensor termination J-box by	<input checked="" type="checkbox"/>	<input type="checkbox"/>
J-box type _____ Mount _____		

○ MISCELLANEOUS

Undamped critical analysis report (2.6.2.1)
 w/ dampd rotr respsn analys rpt (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)

PRELIMINARY MASS ELASTIC DATA

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

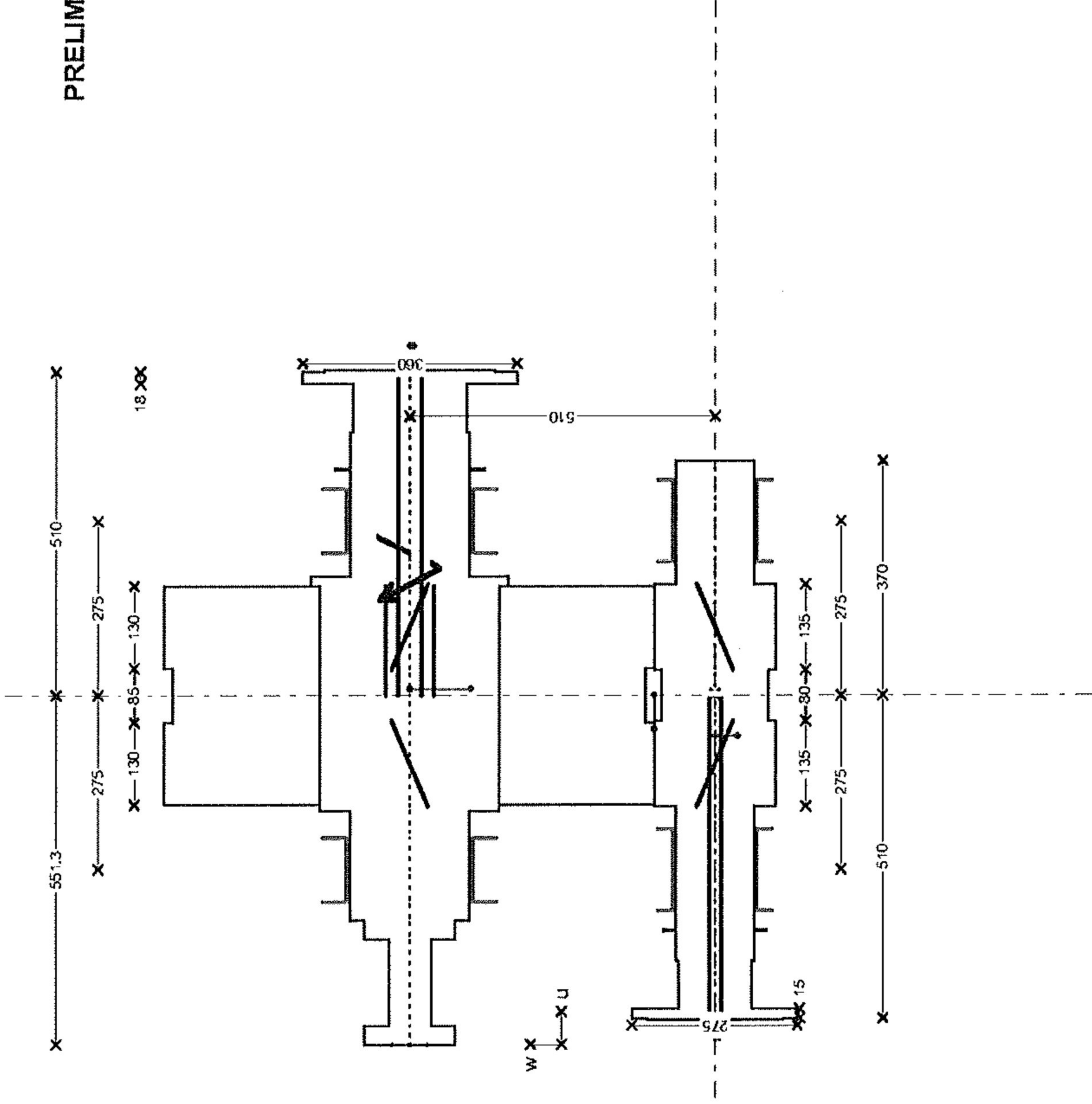
Power rating : 6800 kW
 Service factor : AP1613.03 $\geq 1,4$
 Input speed : 1800 rpm
 Output speed : 7309,1 rpm
 Speed ratio : 4,06

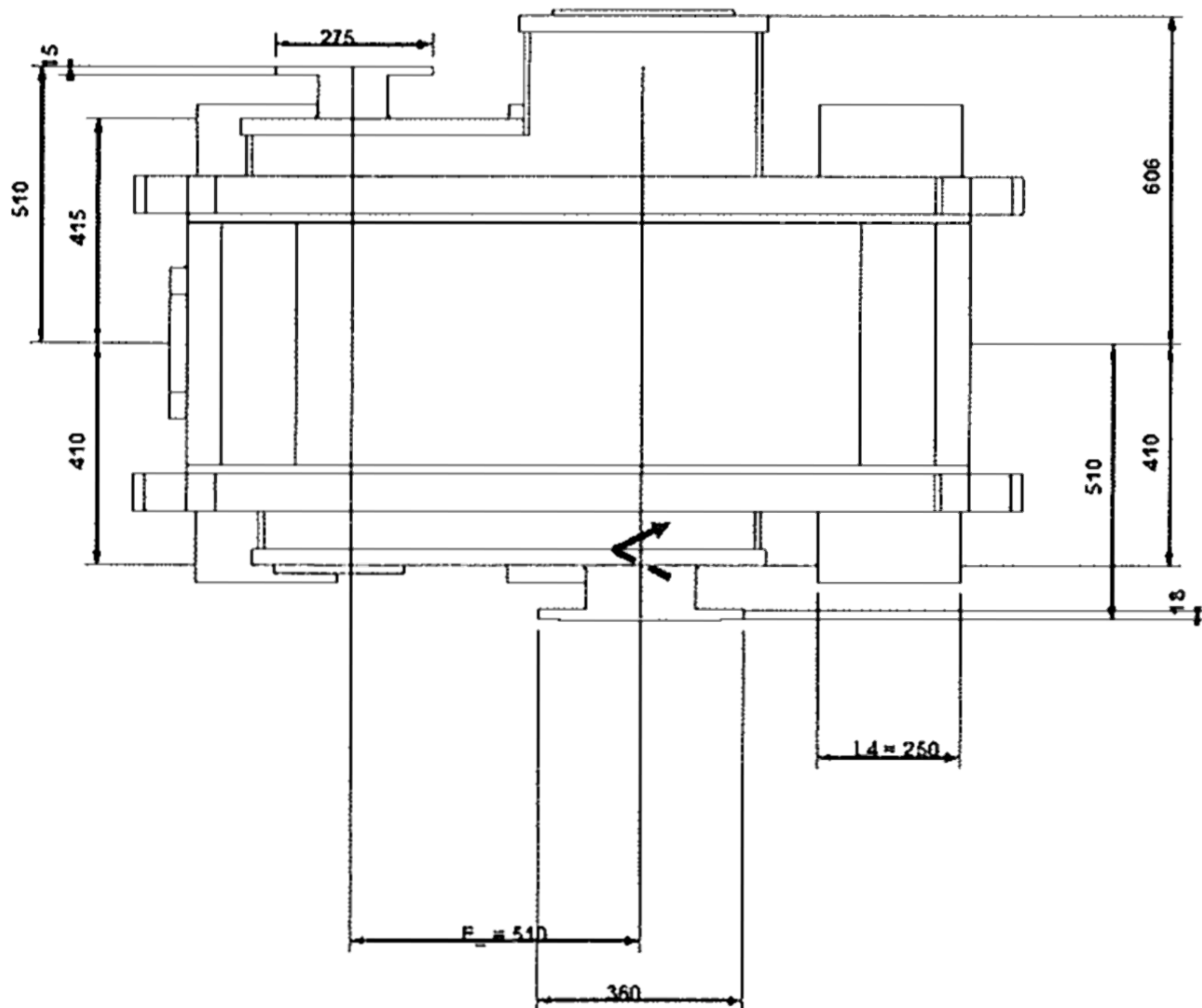
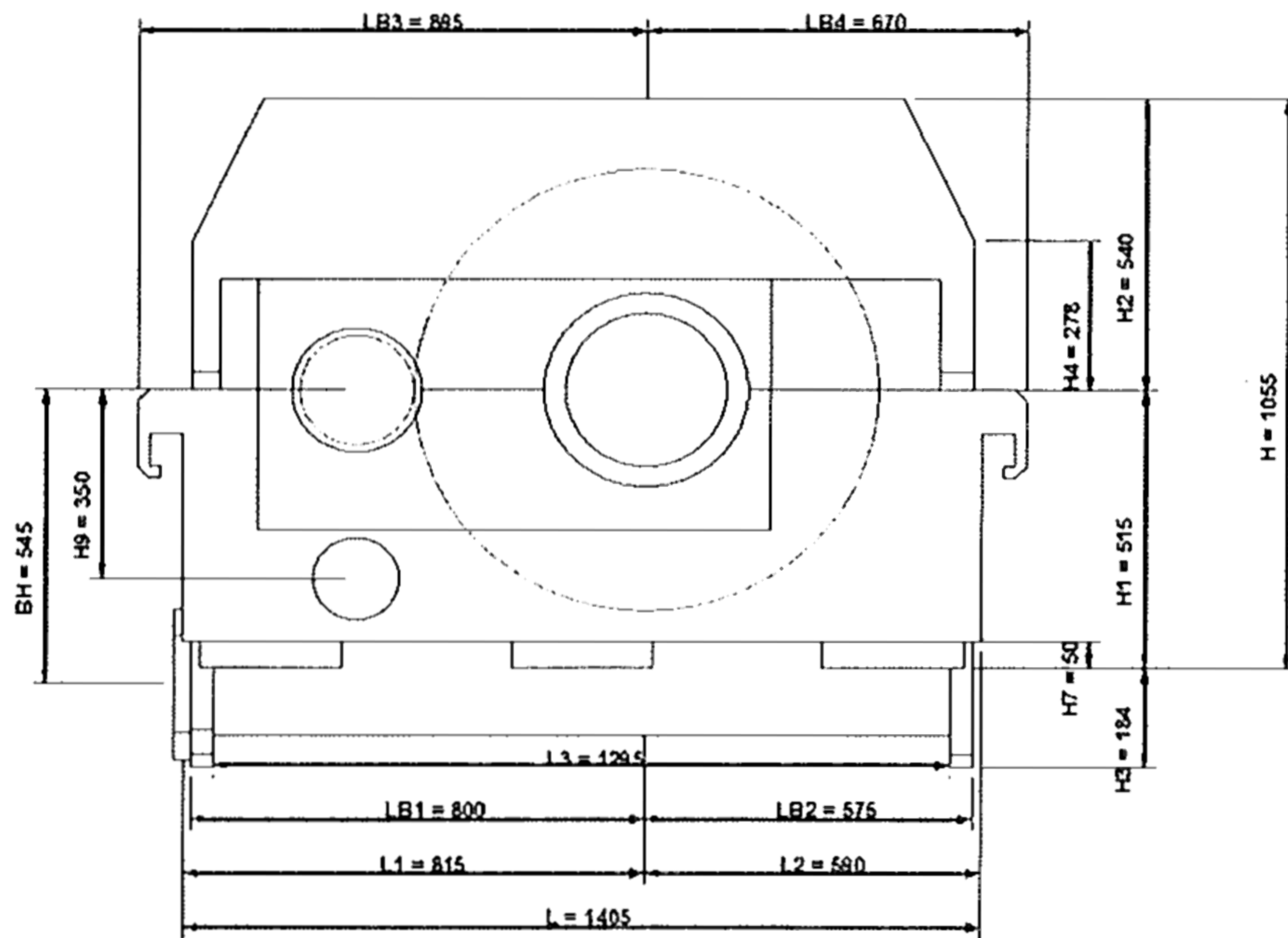
Weight HSS : 143,5 kg
 Weight pos. from teeth middle HSS : 63,4 mm
 Inertia HSS : 0,585 Kg.m²
 Stiffness HSS : 5,916 MN/m/rad
 Bearing type 1 : Offset 130 x 130
 Bearing type 2 : Offset 130 x 130
 Add. weight on brg. side 1 : 26,6 kg

Weight LSS : 1561,2 kg
 Weight pos. from teeth middle LSS : 10,5 mm
 Inertia LSS : 116,473 Kg.m²
 Stiffness LSS : 39,014 MN/m/rad
 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
 1/1





ADDITIONAL TECHNICAL DATASHEET		Job No. <u>41104</u> Item No. <u>A</u>																																			
		P.O. No. _____ Date _____																																			
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		Revision <u>1</u> Date <u>06.03.2016</u> By <u>HNI</u>																																			
<input checked="" type="checkbox"/> ADDITIONAL GEAR DATA		<input type="checkbox"/> TURNING GEAR (Dimensioning is preliminary !)																																			
Efficiency		Calculation results																																			
<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th>Percent of rated power</th> <th>Efficiency</th> </tr> </thead> <tbody> <tr> <td>100%</td> <td style="text-align: center;">99,03</td> </tr> <tr> <td>75%</td> <td style="text-align: center;">98,92</td> </tr> <tr> <td>50%</td> <td style="text-align: center;">98,79</td> </tr> <tr> <td>25%</td> <td style="text-align: center;">98,08</td> </tr> <tr> <td>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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Losses		Motor																																			
Power loss at no load _____ kW Heat rejection _____ kcal/h		Supplier _____ Power _____ kW Voltage _____ V Frequency _____ Hz Speed _____ rpm Electric standard _____																																			
<input type="checkbox"/> PUMP DETAILS (Dimensioning is preliminary !)																																					
Design : _____ Speed : _____ rpm Oil flow : _____ l/min Oil pressure : _____ bar NPSH : _____ m Safety valve : _____ Driving method : _____ Material : _____ Flanges : _____ Testing : _____ Furniture of ATEX certificate : _____		Turning gear Type _____ Ratio _____																																			
		Clutch																																			
		Type _____ Max. allowable torque _____ Nm																																			
		Miscellaneous																																			
		Starting device _____ Switch details _____																																			
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mounting kit				Yes																																	
Junction box(es)		Miscellaneous																																			
Qty _____ Manufacturer _____ Material _____ ATEX _____ None		Identification <input checked="" type="checkbox"/> wire <input checked="" type="checkbox"/> conduit <input type="checkbox"/> junction box Conduit type _____ Transmitter type _____ Qty _____ Terminal block type _____ Qty _____																																			

FLENDER GRAFFENSTADEN

FLENDER-GRAFFENSTADEN S.A., FRANCE
BP 84, F-67402 ILLKIRCH-CEDEX
1, rue du Vieux Moulin
F-67400 ILLKIRCH-GRAFFENSTADEN

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

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

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

1 Applicable To: Proposal Purchase As Built
 2 For Siemens AG Duisburg Manufacturer FLENDER-GRAFFENSTADEN
 3 Site Khursaniyah Al Fadhili Model No. TX40/5C
 4 Unit STC-SV 06-3-A Serial No. _____
 5 Service EM/CC Driver type electric motor
 6 No. required 1 Driven equipment centrifugal compressor

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

14 Driven equip. (2.1.4): Norm. _____ Max _____ kW
 15 Driver: Rated _____ Max _____ kW
 16 Normal transmitted power (2.2.2) _____ kW
 17 Gear unit rated power (2.2.1) 1620 kW
 18 Torque @ max cont speed _____ Nm
 19 Max torque (2.2.1) _____ Nm @ _____ rpm
 Reducer Increaser
 21 Rated speed (2.1.5):
 22 Input 1800 rpm Specified Nominal
 23 Output 10736 rpm Specified Nominal
 24 Allow var in gear ratio (2.1.5) (+) (-) _____ %
 25 Max continuous speed (1.5) 1800 / 10736 rpm
 26 Trip speed (1.5) (2.1.7) 1980 / 11809,6 rpm
 27 Gear service factor (2.2.3.1) 1,4 API 613/2003 5 TH (min)
 28 Hardness (2.2.3.2) Pinion _____ Gear _____
 29 Shaft assembly designation (2.1.19) L/R
 30 HS shaft rot fac'g cpl'g (2.1.20.2) CW CCW
 31 LS shaft rot fac'g cpl'g (2.1.20.2) CW CCW
 32 External loads (2.1.16) _____
 33 Other operating conditions (2.2.2) (2.6.1.3) _____

INSTALLATION DATA (2.1.14)

36 Indoor Heated Under roof
 37 Outdoor Unheated Partial sides
 38 Grade Mezzanine **ONSHORE**
 39 Winterization required Tropicalization required
 40 Electrical area (2.1.10) Class _____ Grp _____ Div _____
 41 Electrical area (2.1.10) Zone 2 Grp IIA Temp T1 °C
 42 Max allow SPL (2.1.6) _____ dB(A) @ _____ m
 43 Elevation _____ m Barometer _____ kPa abs
 44 Range of ambient temperatures:
 45 Dry bulb _____ Wet bulb _____
 46 Normal _____ °C _____ °C
 47 Maximum 82 °C _____ °C
 48 Minimum 0 °C _____ °C
 49 Unusual conditions Dust Fumes
 50

BASIC GEAR DATA

Single stage Single helical
 Double stage Double helical
 Epicyclic horizontal offset

Mechanical rating (1.5.16) 2268 kW @ 1800 / 10737,9 rpm
 Gear service factor (2.2.3.1) 1,46 API 613/2003 5 TH (actual)
 Full load gear unit power loss 21 kW
 Gear Unit Mechanical efficiency 98,70 %
 Rating speed Pinion 10.737,9 Gear 1.800,0 rpm
 Hardness used for
 Rating, (HB or Rc) Pinion 58 HRC Gear 58 HRC
 Tooth pitting index, "K" (2.2.4.1) (2.2.4.2)
 Allowable 2,17 Actual 2,06 MPa
 Material index number (Fig 3, Table 4) 3,03 MPa
 Bending stress number, "S_t" (2.2.5.1) (2.2.5.2)
 Pinion: Allowable 265,4 Actual 251,0 MPa
 Gear: Allowable 265,4 Actual 238,8 MPa
 Pitch line velocity 63,0 m/s
 Anticipated SPL (2.1.6) 82 dB(A) @ 1 m
 WR² referred to LS shaft 29,88 kgm²
 Breakaway torque 90 Nm @ LS Shaft
 Pinion teeth hardness range 58 - 63 HRC
 Pinion teeth hardening method CARBURIZED
 HS shaft separate hardness range _____
 Gear teeth (rim) hardness range 58 - 63 HRC
 Gear teeth hardening method CARBURIZED
 Gear hub:
 Forged cylinder Forged & Copied Fabricated
 Gear to Shaft fit method (2.5.3.2)
 Integral Keyed interference Keyless interference
 Rim attachment (2.5.3.2) FORGED GEAR WHEEL
 LS shaft hardness range HB 230 - 274
 Journal static weight loads (2.6.6.3)
 Pinion 37 / 4 kg Gear 347 / 253 kg
 Total gear unit assembled weight 1900 kg
 NOTES: _____

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

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

○ COUPLINGS AND GUARDS		
	Pinion	Gear
Coupling furnished by (3.2.1)	Compr. Supplier	Compr. Supplier
Mount coupling halves (3.2.2)	Compr. Supplier	Compr. Supplier
Cplg. guard adapter by (3.2.3)	Gear Supplier	Gear Supplier
Cplg. guard furnished by (3.2.3)	Compr. Supplier	Compr. Supplier
Coupling vendor (3.2.3)		
Vendor's model number (3.2.3)		
Coupling weight on shaft, kg	10,4	26,4
CG Inboard / outboard of shaft end	Outboard	Outboard
Hub drill template provided	<input type="checkbox"/>	<input type="checkbox"/>

■ SHAFT END DETAIL (2.5.4.2)		
Shaft end detail specified by:	<input checked="" type="radio"/> Purchaser <input type="checkbox"/> Gear vendor	
(Integral unless otherwise specified)		
Shaft end detail if 'otherwise' specified:	Pinion	Gear
Tapered / Keyless	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>
Tapered / 1-Key	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>
Tapered / 2-Keys	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>
Cylindrical / 1-Key	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>
Cylindrical / 2-Keys	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>
Other <u>Flanged</u>	<input checked="" type="radio"/> <input type="checkbox"/>	<input checked="" type="radio"/> <input type="checkbox"/>
Shaft diameter	75,0	120,0 mm
(If integral flange use diameter immediately adjacent to flange)		

■ RADIAL BEARINGS		
Type	Pinion	Gear
Diameter	80 / 80	120 / 120 mm
Length	56 / 56	60 / 60 mm
Journal velocity	45,0 / 45,0	11,3 / 11,3 m/s
Loading	3,08 / 3,10	2,52 / 2,26 N/mm ²
Clearance (min-max)		mm
Span	340	340 mm
Power loss each bearing	6,3 / 6,3	0,7 / 0,7 kW
Oil flow each bearing	15,0 / 15,0	5,0 / 5,0 l/min

■ THRUST BEARINGS		
Location		OPP.CPLG.SIDE
Manufacturer	FLENDER	FLENDER
Type	NO	COMB.TAP.LANDS
Size		BPK LEG 4"
Area		5160 mm ²
Loading		1,35 MPa
Rating		1,50 MPa
Int. thrust load		N
Ext. thrust load	2.700	4.250 N
Power loss each	0,0	5,0 kW
Oil flow each bearing	0,0	15,0 l/min

NOTES: _____

■ GEAR DATA			
	Pinion	Gear	
Number of teeth	29	173	
Gear ratio	5,97		
Tangential load, *Wt* (2.2.4.2)	25.731		N
AGMA Geometry factor *J*	0,52	0,54	
Pitch diameter	111,98	668,02	mm
Outside diameter	120,30	673,50	mm
Root diameter	103,05	656,32	mm
Center groove diameter	93,00	640,00	mm
Normal pressure angle	20,00		deg
Normal diametral pitch	7,26		in ⁻¹
Helix angle	24,25		deg
Center distance	390,00		mm
Backlash min	0,28		mm
Net face width, *Fw*	130,00		mm
Pinion L/D	1,74		
Face overlap ratio	4,86		
Transverse contact ratio	1,45		
AGMA 6011 service factor	2,87		
Rating based on ANSI/AGMA 6011 with SF=1.0			
Durability Power	5404		kW
Strength Power	4652		kW
Tooth Surface Finish, Ra	0,4	0,4	µm
Tooth Generation Process	Hobbing	Hobbing	
Tooth Finishing Process	Grinding	Grinding	
Lead modification (2.2.4.6)	<input checked="" type="radio"/> Not Req'd	<input type="radio"/> Req'd	
Calculated Total Lead Mismatch			µm
■ SCUFFING DATA (2.2.6)			
Scuffing Data per ANSI/AGMA 925-A03			
Scuffing Risk (2.2.6) <=5% (Low)	Calculation Method	AGMA925	
Composite surface roughness, ox	0,57	µm	
Specific film thickness, EHL λmin	2,54	µm	
Tooth temperature, θm	80	°C	
Maximum contact temperature, θBmax	93	°C	
■ MATERIALS			
Gear casing	Steel	Oil seals	aluminium
Pinion(s)	18CrNiMo7-6		
Gear rim(s)	18CrNiMo7-6		
HS Shaft	Integral	LS Shaft	42CrMo4
Radial bearings	Babbitt	Backing	Steel
Thrust bearing(s)	Babbitt	Backing	Steel
○ SHAFT END DETAIL			
<input type="checkbox"/> Gear shaft end for coupling integral flange (2.5.4.2)			
<input checked="" type="checkbox"/> Pinion shaft end for coupling integral flange (2.5.4.2)			
<input checked="" type="checkbox"/> Other: WITHOUT BOLTS			

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

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

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**

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			

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 Grou 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)

	Contract unit	Spares
Export boxing	<input type="checkbox"/>	<input type="checkbox"/>
Domestic boxing	<input type="checkbox"/>	<input type="checkbox"/>
Outdoor storage over 6 mos.	<input type="checkbox"/>	3 years indoor <input type="checkbox"/> (4.4.3.9)

1 **○ ADDITIONAL REQUIREMENTS**

2 **○ 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 _____

3 **○ 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

HSAS bearings no. sensors each 2 / 2

Thrust number of sensing elements each face 2

4 **○ 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 _____

5 **○ MISCELLANEOUS**

Undamped critical analysis report (2.6.2.1)

w/ dampd rotr respsn analys rpt (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

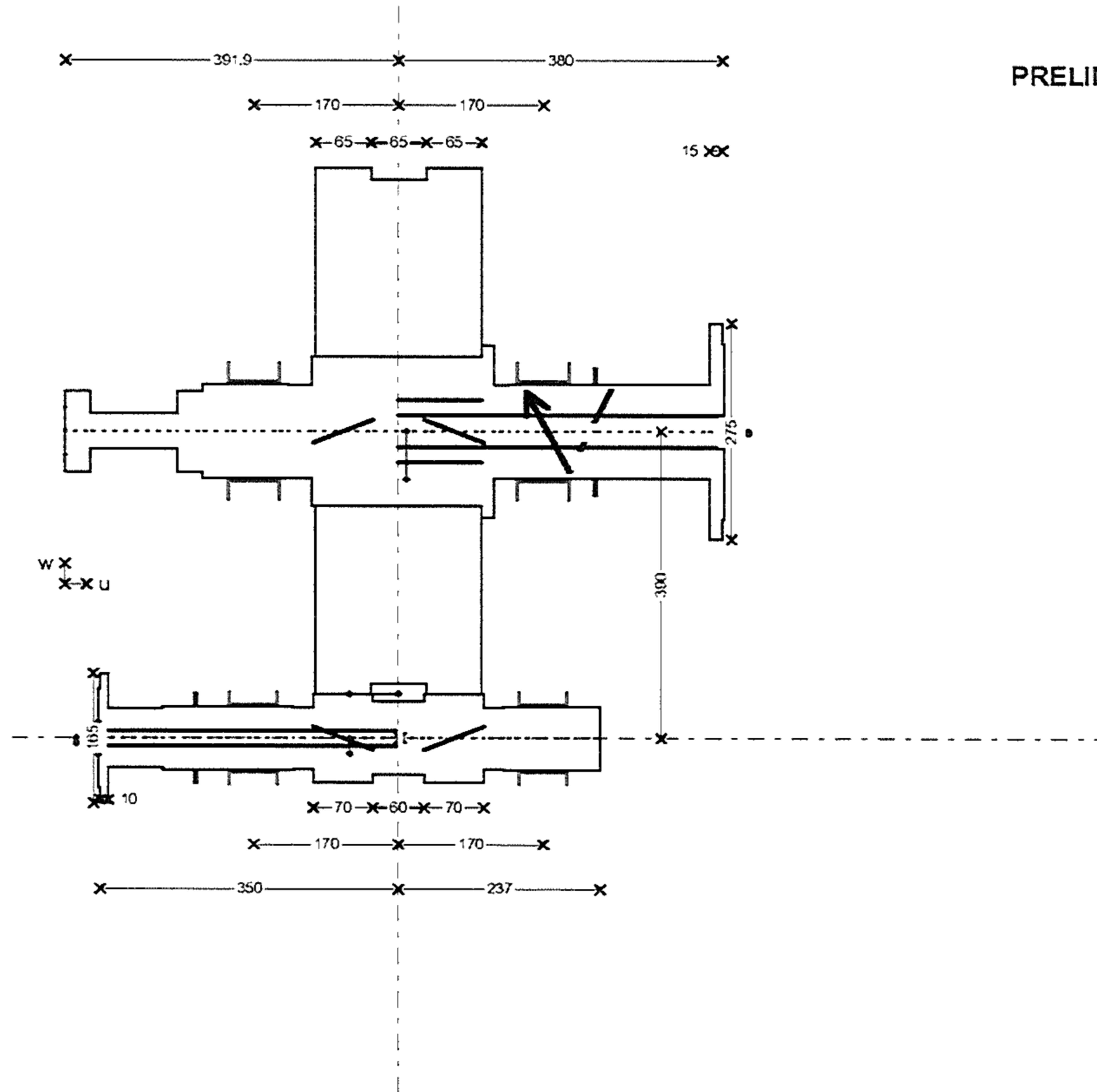
Torsional device provisions (2.5.4.5) _____

Rotor vertical storage provisions (2.5.4.8) _____

Rotor vertical storage fixture(s) (3.6.2) _____

Vendor service rep. on site (2.1.13)

PRELIMINARY MASS ELASTIC DATA



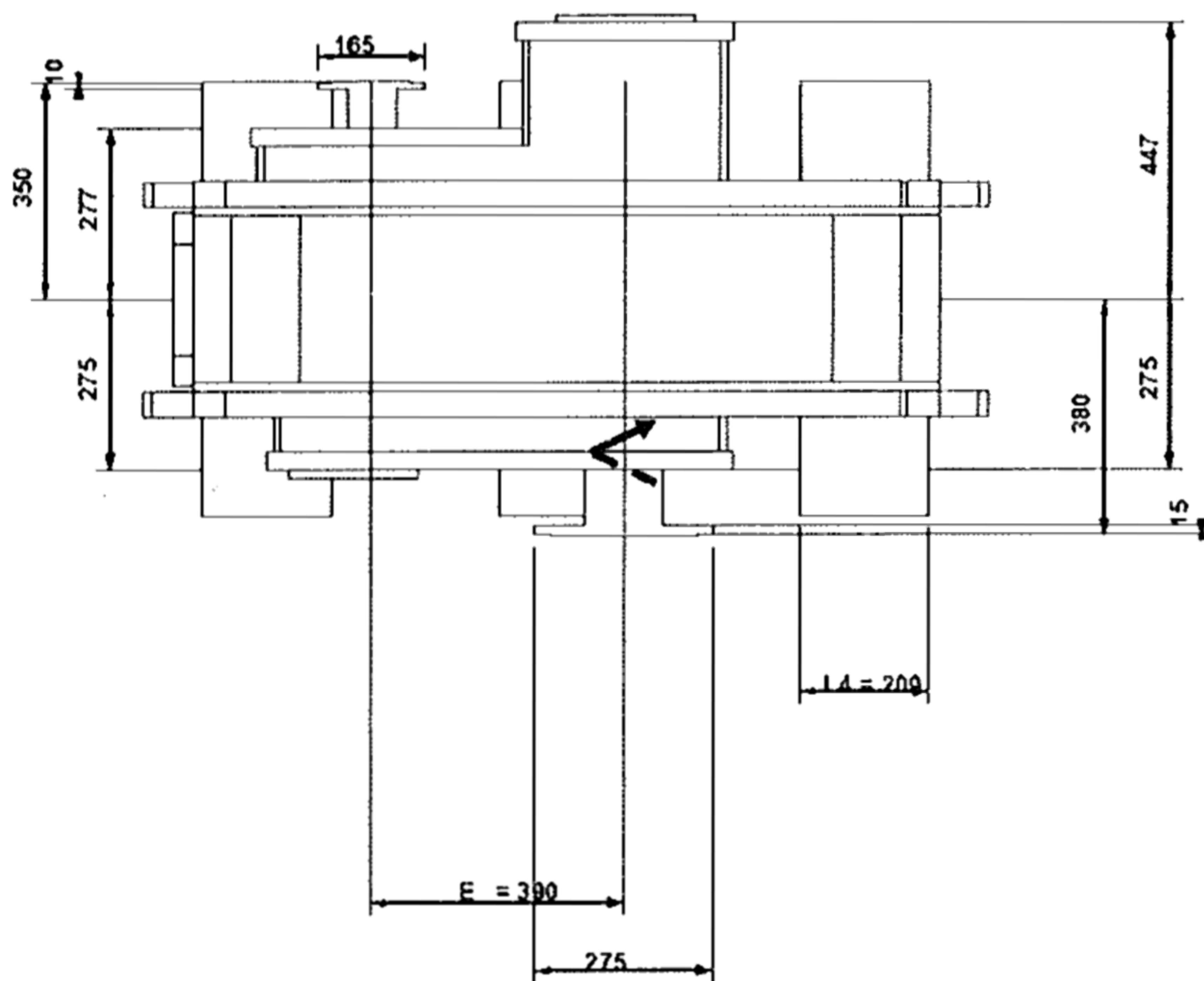
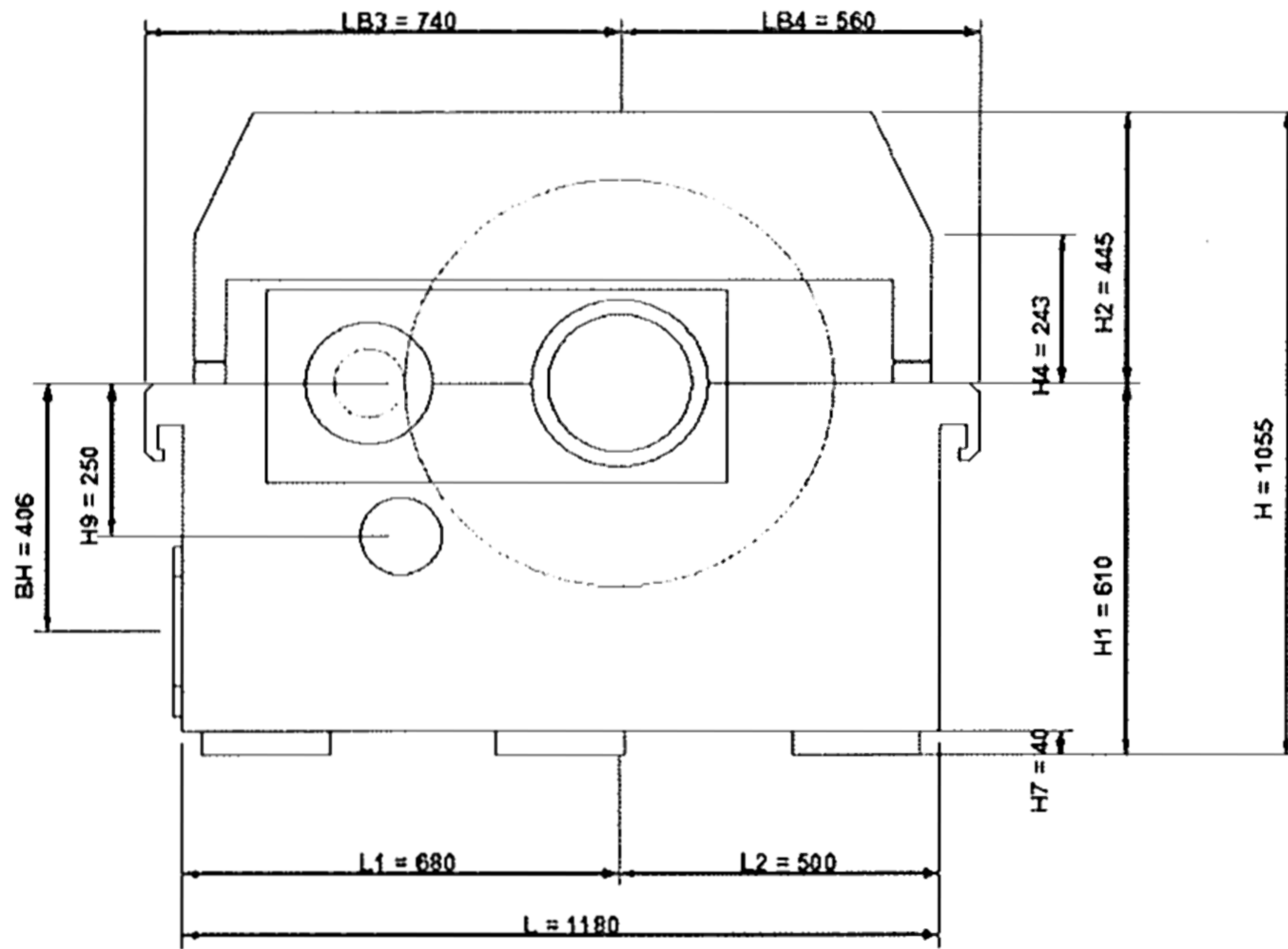
Customer : Siemens AG Duisburg
 Destination : Khursaniyah Al Fadhli
 Purchaser order :
 F-G job number : D 41104B1 OL:
 Type and serial N° : TX40/5C

Power rating : 1620 kW
 Service factor : AP1613/03 $\approx 1,4$
 Input speed : 1800 rpm
 Output speed : 10737,9 rpm
 Speed ratio : 5,96

Weight HSS : 30,5 kg
 Weight pos. from teeth middle HSS : -57,5 mm
 Inertia HSS : 0,038 Kg.m²
 Stiffness HSS : 1,11 MNm/rd
 Bearing type 1 : Tilting pads 80 x 56
 Bearing type 2 : Tilting pads 80 x 56
 Add. weight on brg. side 1 : 10,4 kg

Weight LSS : 574,3 kg
 Weight pos. from teeth middle LSS : 9 mm
 Inertia LSS : 28,526 Kg.m²
 Stiffness LSS : 6,5 MNm/rd
 Bearing type 4 : Cylindrical 120 x 60
 Bearing type 3 : Cylindrical 120 x 60
 Add. weight on brg. side 4 : 26,4 kg

→
 Positive direction of external
 APPAREIL.xls _ Edition du :06.03.2015



ADDITIONAL TECHNICAL DATASHEET		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>																																	
<input checked="" type="checkbox"/> ADDITIONAL GEAR DATA		<input type="checkbox"/> TURNING GEAR (Dimensioning is preliminary !)																																	
<i>Efficiency</i>		<i>Calculation results</i>																																	
<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th>Percent of rated power</th> <th>Efficiency</th> </tr> </thead> <tbody> <tr> <td>100%</td> <td style="text-align: center;">98,70</td> </tr> <tr> <td>75%</td> <td style="text-align: center;">98,66</td> </tr> <tr> <td>50%</td> <td style="text-align: center;">98,38</td> </tr> <tr> <td>25%</td> <td style="text-align: center;">97,42</td> </tr> <tr> <td>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																																		
75%	98,66																																		
50%	98,38																																		
25%	97,42																																		
10%	87,68																																		
<i>Losses</i>		<i>Motor</i>																																	
Power loss at no load _____ kW Heat rejection _____ kcal/h		Supplier _____ Power _____ kW Voltage _____ V Frequency _____ Hz Speed _____ rpm Electric standard _____																																	
<input type="checkbox"/> PUMP DETAILS (Dimensioning is preliminary !)		<i>Turning gear</i>																																	
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 _____																																	
		<i>Clutch</i>																																	
		Type _____ Max allowable torque _____ Nm																																	
		<i>Miscellaneous</i>																																	
		Starting device _____ Switch details _____																																	
<input checked="" type="checkbox"/> INSTRUMENTATION PACKAGE																																			
<i>Thermometer</i>		<i>Thermoelements</i>																																	
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<i>Shaft vibrations</i>																																			
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	Radial	Axial	Keyphasor	Accelerometer																															
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Probe holder	Yes	HS LS	No Yes																																
Connection head	Yes	HS LS	No Yes																																
mounting kit					Yes																														
<i>Junction box(es)</i>		<i>Miscellaneous</i>																																	
Qty _____ Manufacturer _____ Material _____ ATEX _____		Identification <input checked="" type="checkbox"/> wire <input checked="" type="checkbox"/> conduit <input type="checkbox"/> junction box Conduit type _____ Transmitter type _____ Qty _____ Terminal block type _____ Qty _____																																	

FLENDER GRAFFENSTADEN

FLENDER-GRAFFENSTADEN S.A., FRANCE
BP 84, F-67402 ILLKIRCH-CEDEX
1, rue du Vieux Moulin
F-67400 ILLKIRCH-GRAFFENSTADEN

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!"**