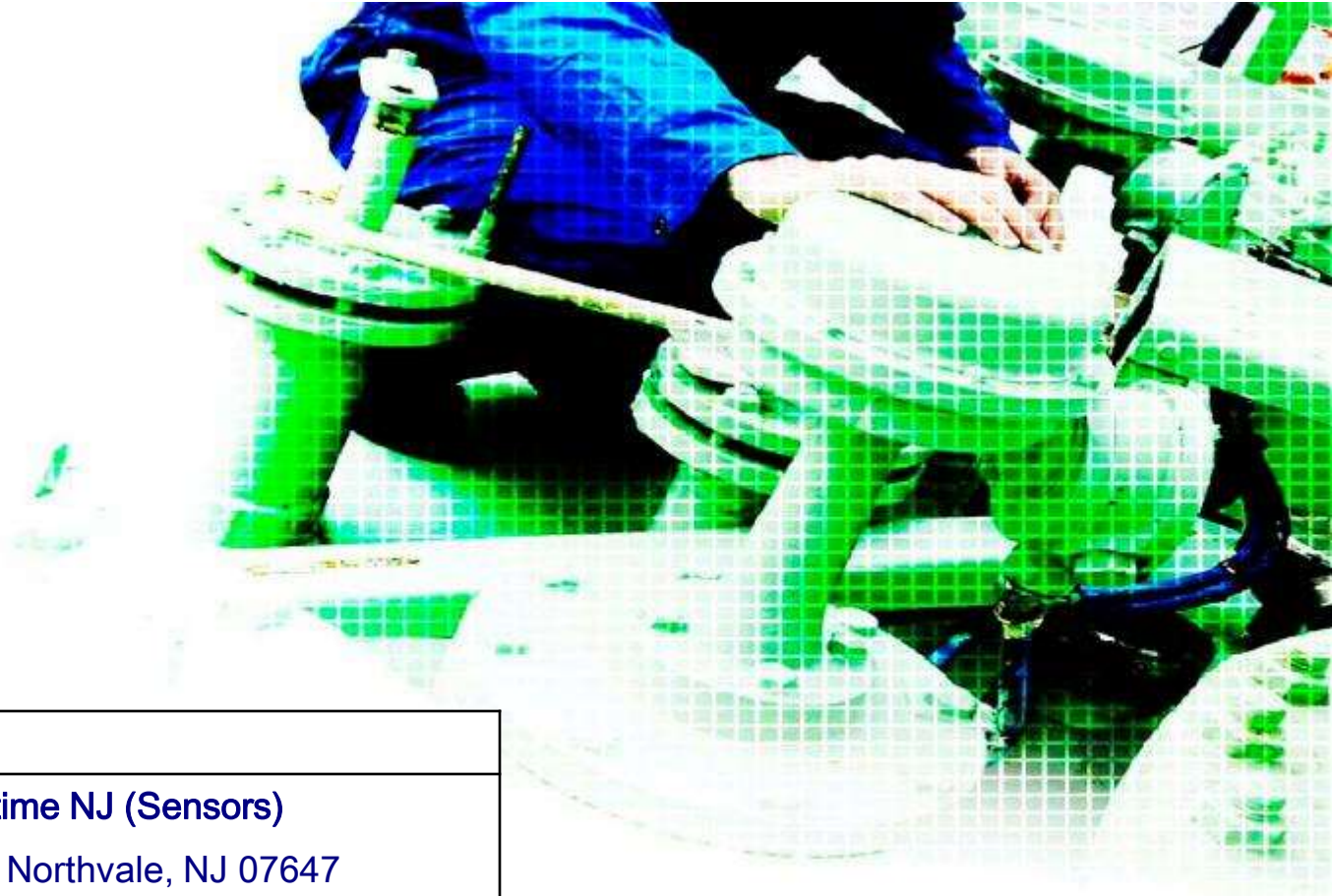


Passive Wireless SAW Temperature Sensors



Ed. Gemdjian

Kongsberg Maritime NJ (Sensors)

438 Crest Drive; Northvale, NJ 07647

Tel./Cellph. 1(201) 669-6857; (201)767-1566

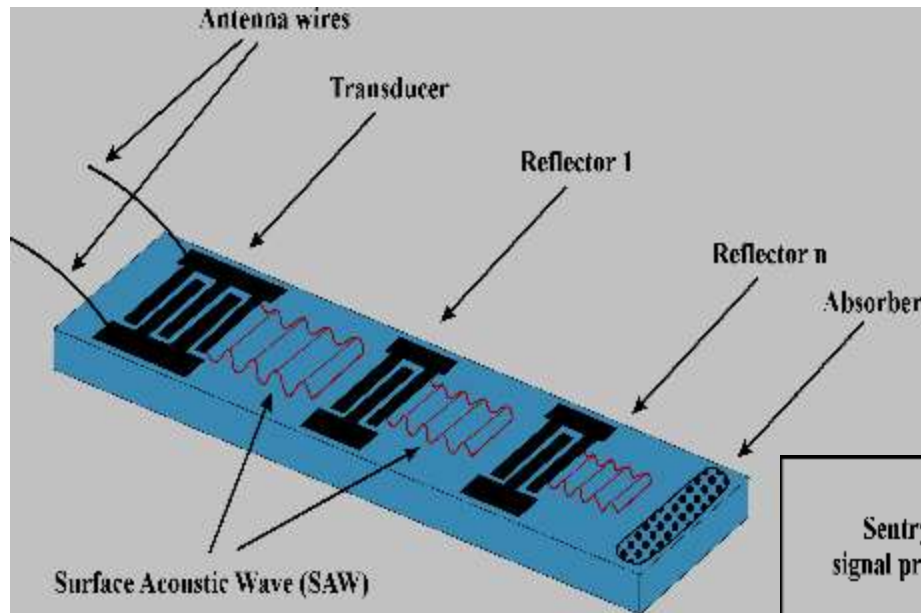
KongsbergNJ@verizon.net

SENTRY Wireless Temperature Monitoring

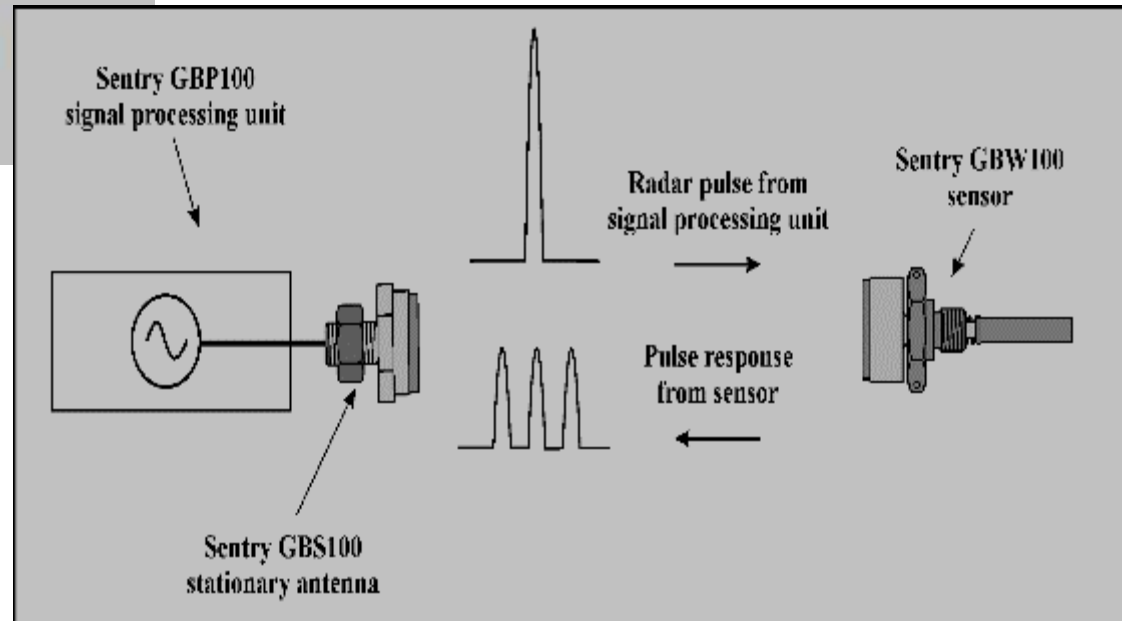


- **Fast and reliable temperature monitoring of moving or rotating bearings**
- **Improved overall operational safety for crew and machinery**

SENTRY Wireless Temperature Monitoring – Technology

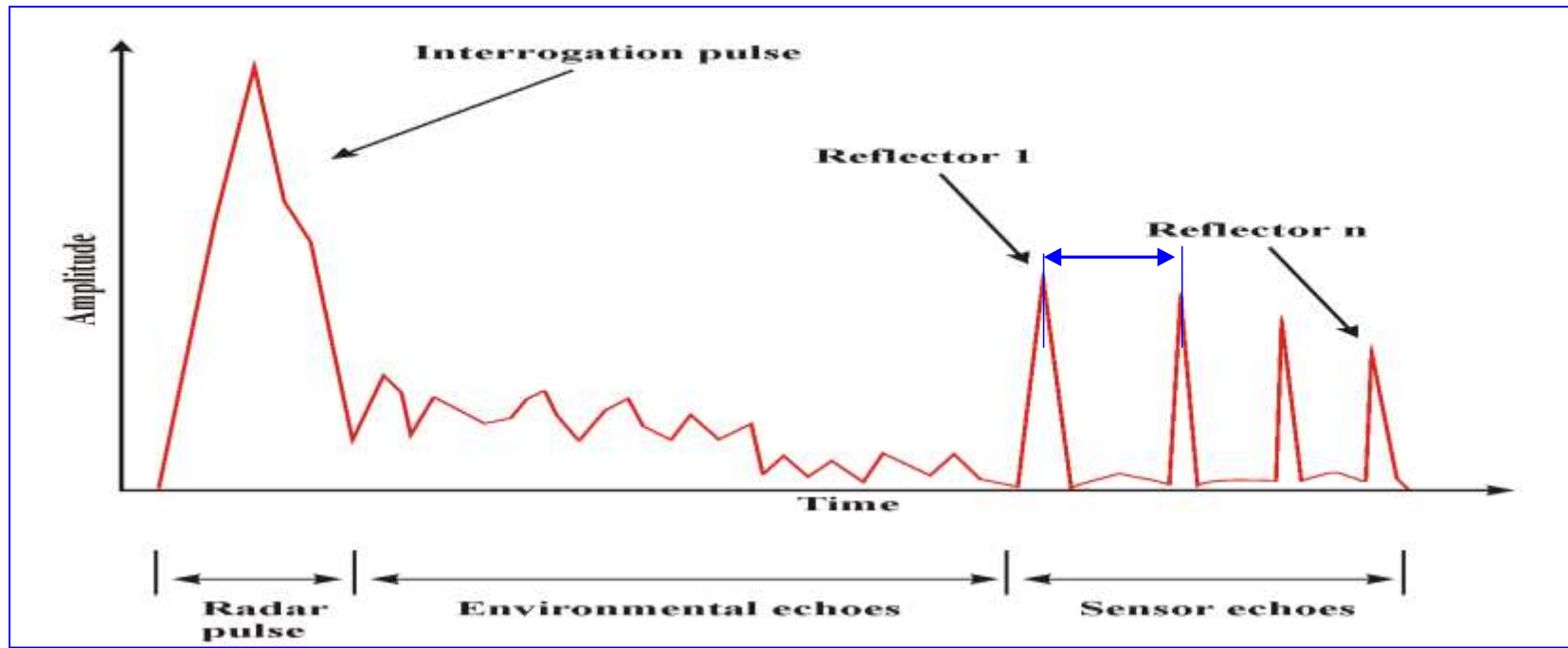


1. Typical SAW sensor



2. Measuring Principle

SENTRY – Wireless measurement by interrogation of the SAW chip by a radar wave



- The amplitude of the reflected pulses has no significance, only the time delay (peak-to-peak) between the echoes depends on the temperature of the SAW chip
- When the temperature of the chip (embedded in the sensor tip) rises, the chip expands, as do the distances between reflectors on the SAW chip, followed by a corresponding shift in their reflected waves (i.e. change of the peak-to-peak spacing of the reflected pulses) – in direct proportion to the sensor tip temperature (according to the physics law of expansion of solids). As this is a basic property of the material, there is no degrading of the sensor, no sensor calibration (similar to a thermocouple).
- No noise – noise is el-magnetic (light speed), SAW is acoustic (speed of sound)

SENTRY Wireless Temperature Monitoring

Generous, non-critical mounting tolerances

Overall specifications:

Measuring range: 0 to 200 °C (30 – 390 °F)

Amb. temp. SPU: -40 to 85 °C (-40 to 185 °F)

Amb. temp. antenna: 0 to 110 °C (30 – 230 °F)

Storage temp: -40 to 120 °C (-40 to 250 °F)

Accuracy: +/- 0,5 °C or +/- 2 °C

Sensor passage speed: 1 to 80 m/s (262 ft/s)

Sensor/antenna gap: 1 to 50 mm (0.1- 1.97")

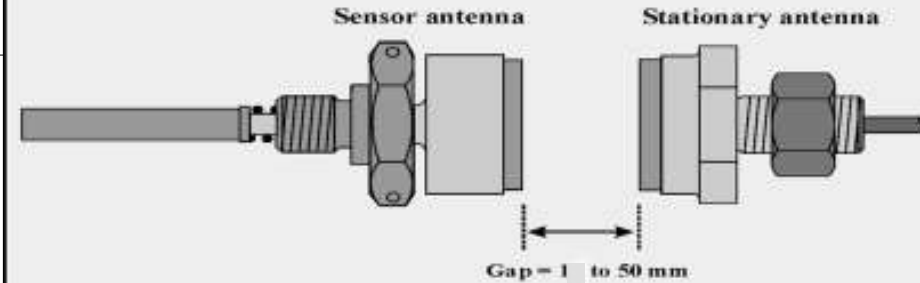
Communication: RS485 Modbus, 4-20 mA or RS232.

Max. antenna cable length: 25 m.(82 Ft.)

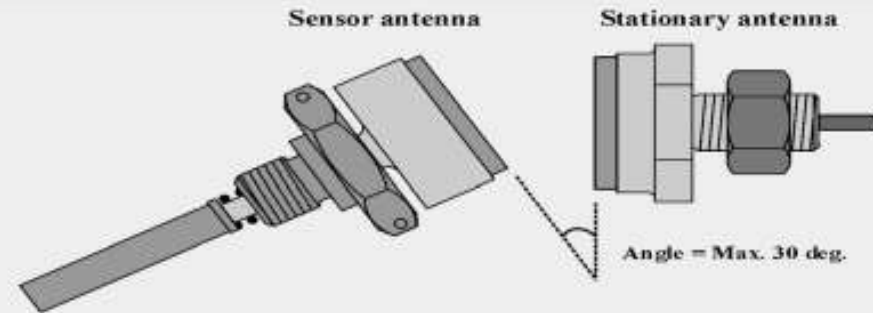
Sensor diameter: 5 – 10 mm (0.2 - 0.4")

Automatic gain control (AGC)

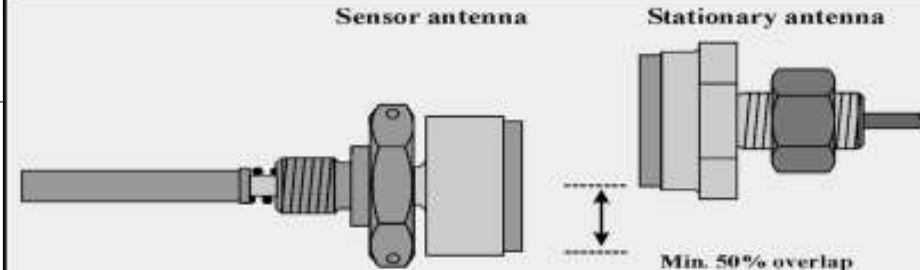
Gap between antennas



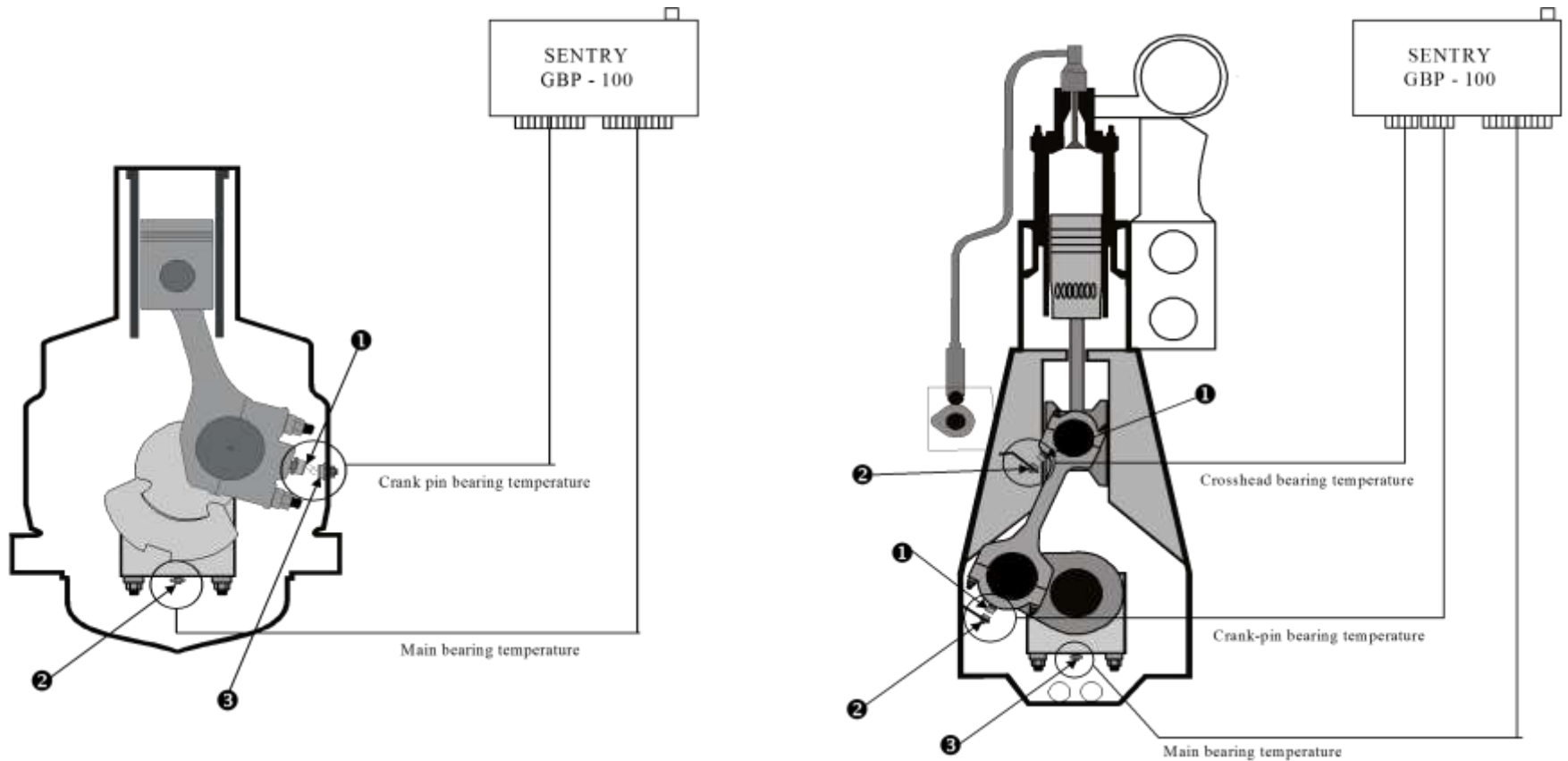
Angle between antennas



Lateral position between antennas



SENTRY - Diesel engine & compressor installations

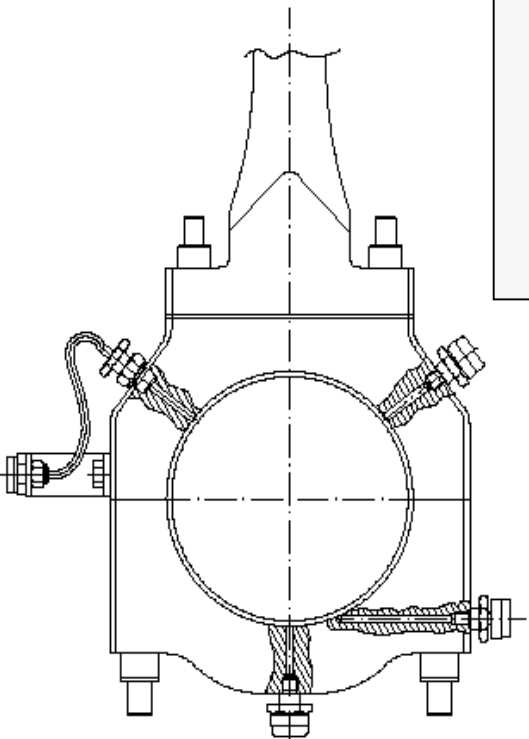
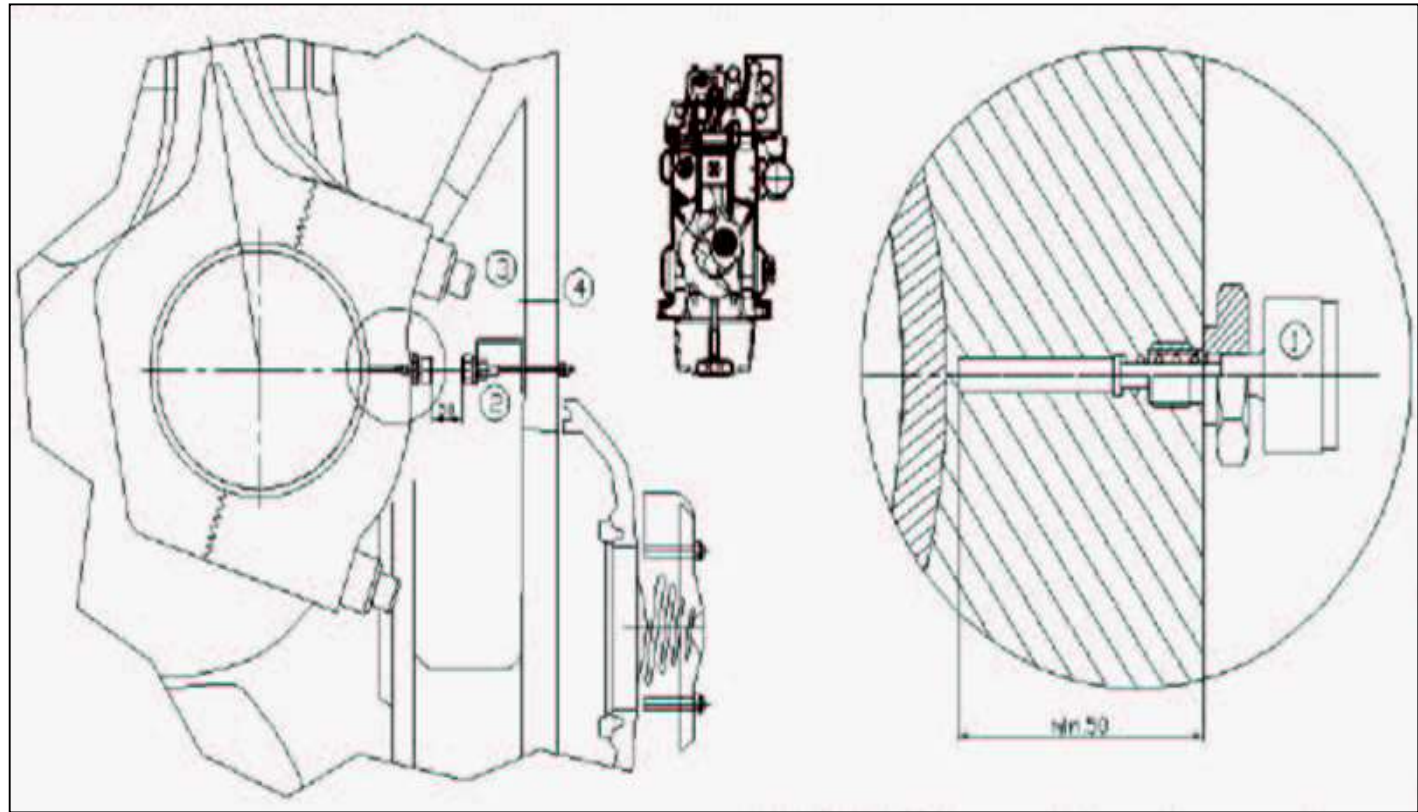


① Wireless Temperature Sensor

② Stationary Antenna

③ Main Bearing Temperature Sensor

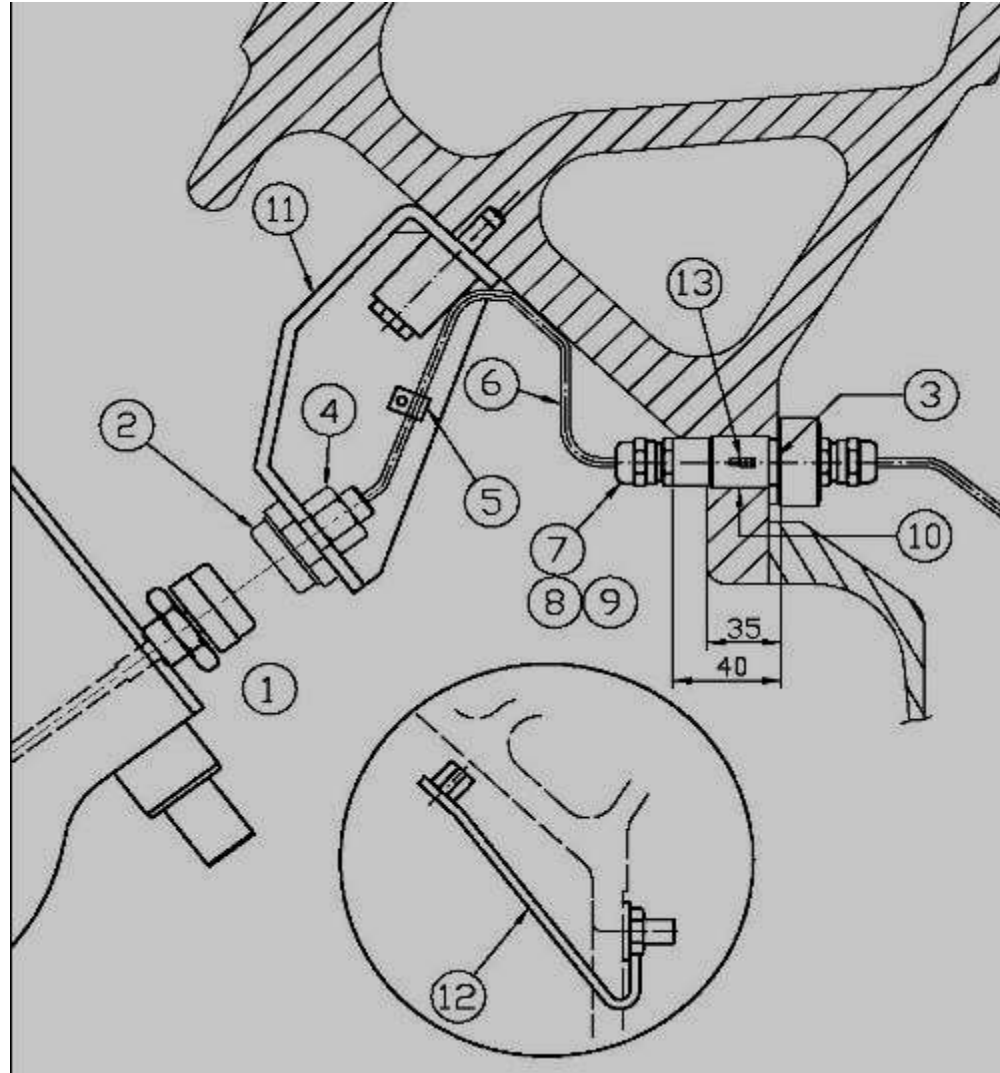
SENTRY Typical Installation



SENTRY – 4-stroke Diesel engine installation



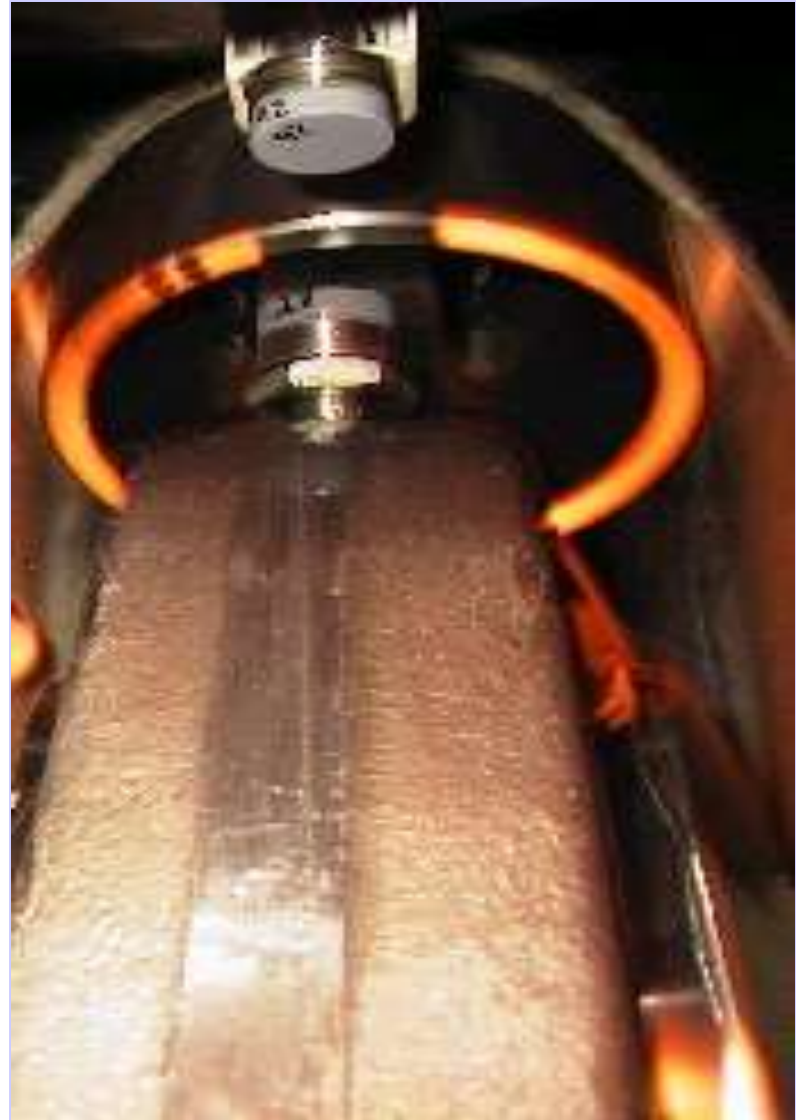
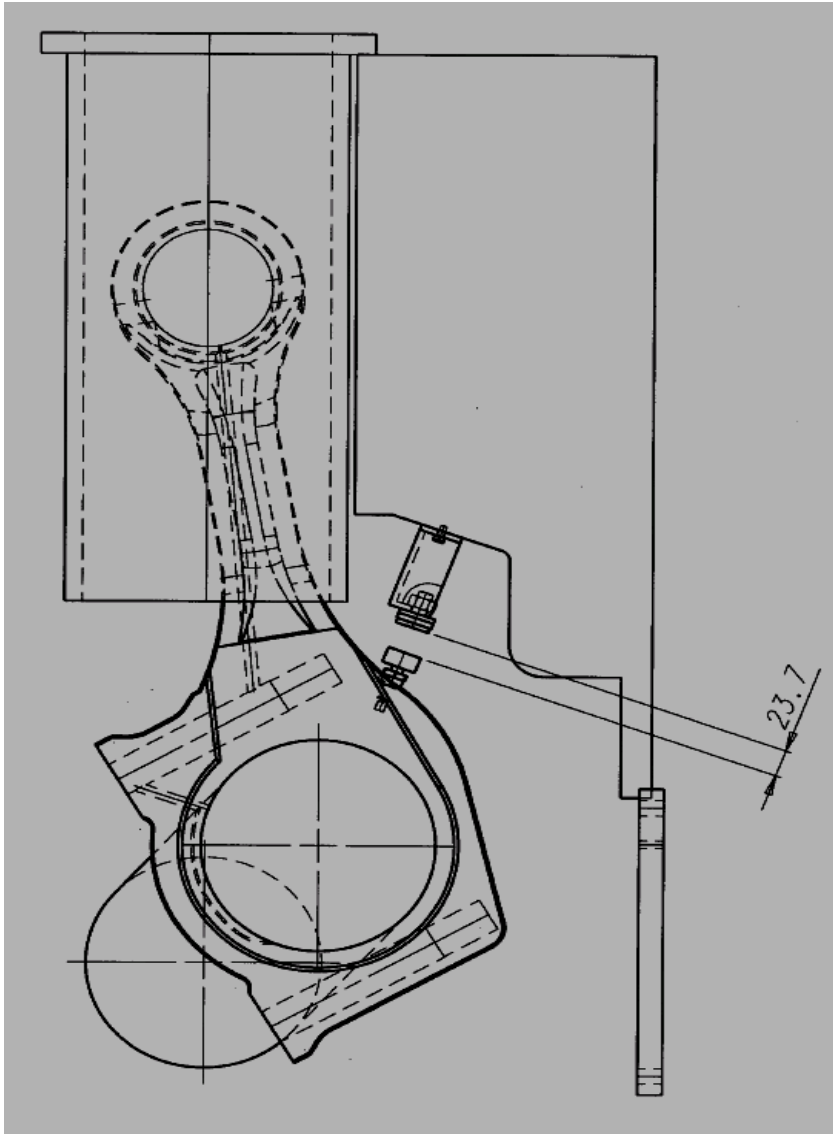
Installation Photo



Installation drawing

SENTRY - Wärtsilä W20

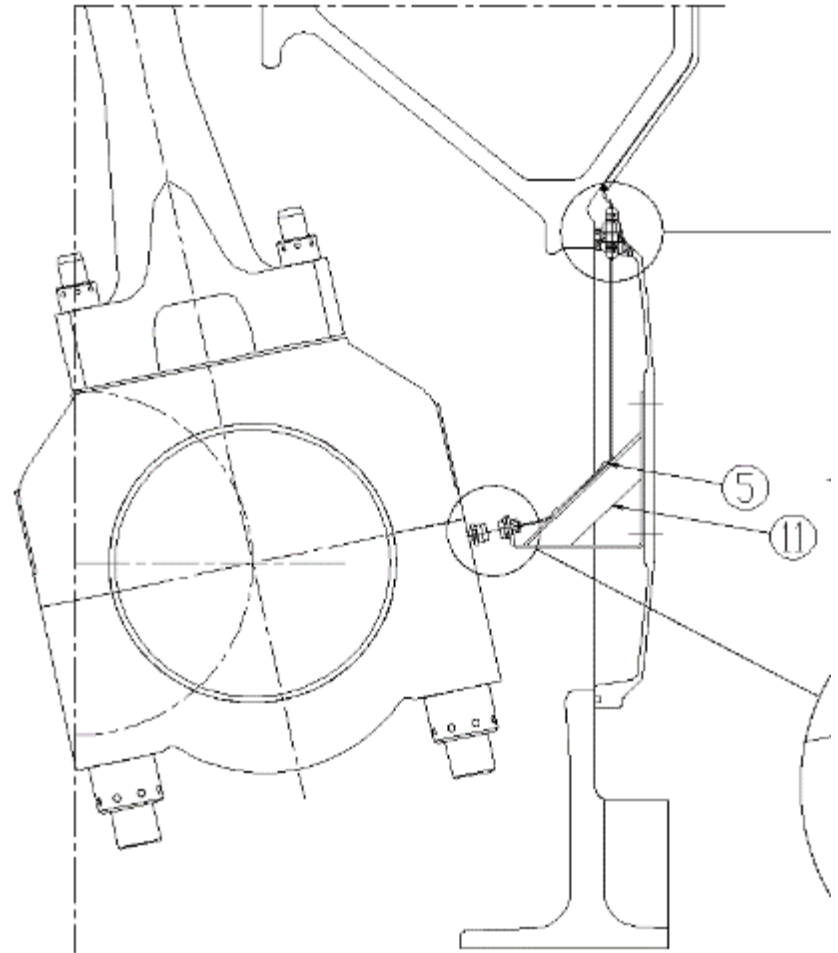
Installation in con-rod



SENTRY - WÄRTSILÄ 46 (Refit engines)

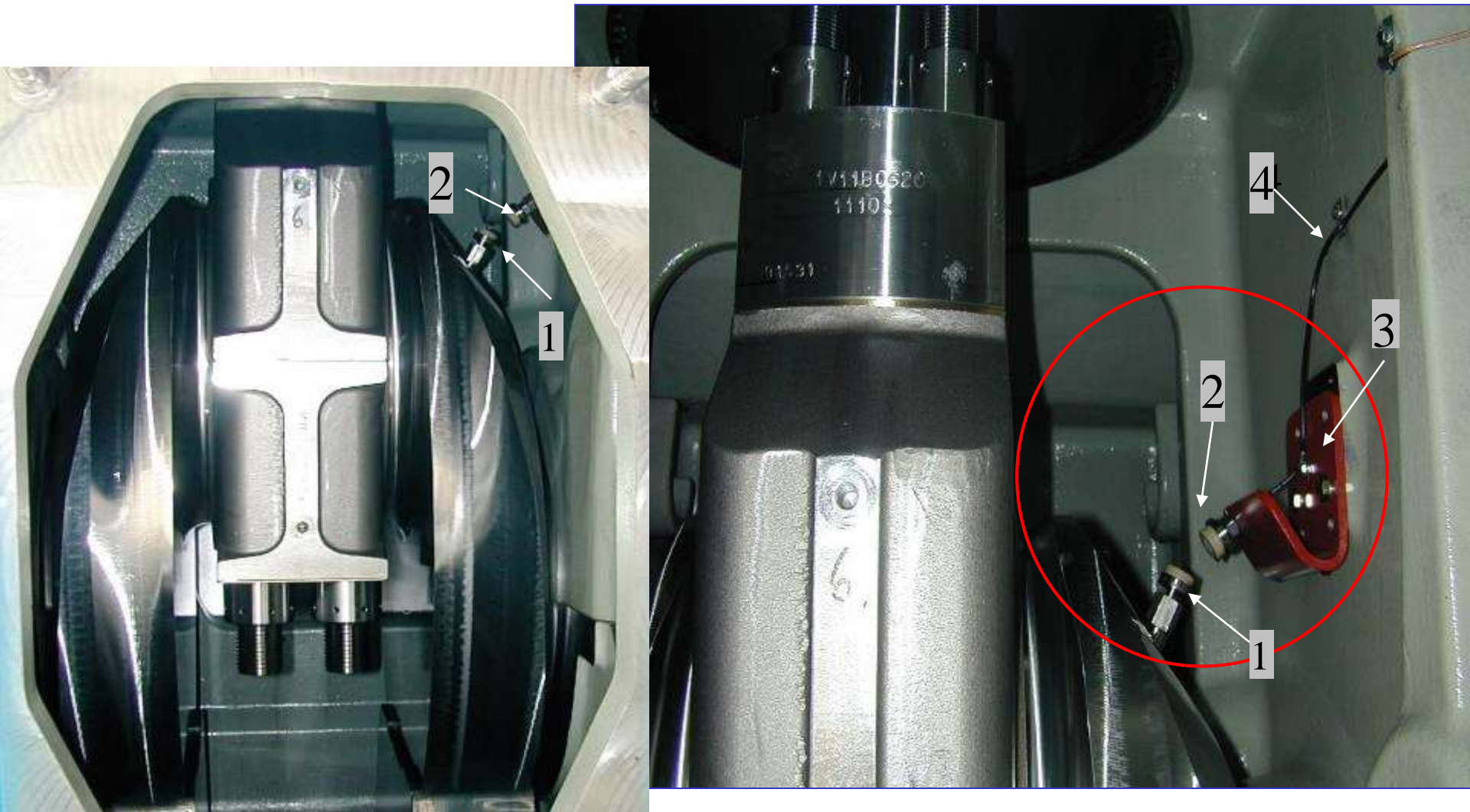


Engine installation



Principal drawing

SENTRY - WÄRTSILÄ 46F (New engines)



1. Wireless temperature sensor; 2. Antenna; 3. Bracket
4. Antenna coaxial cable

SENTRY – 2-stroke Diesel engine installations



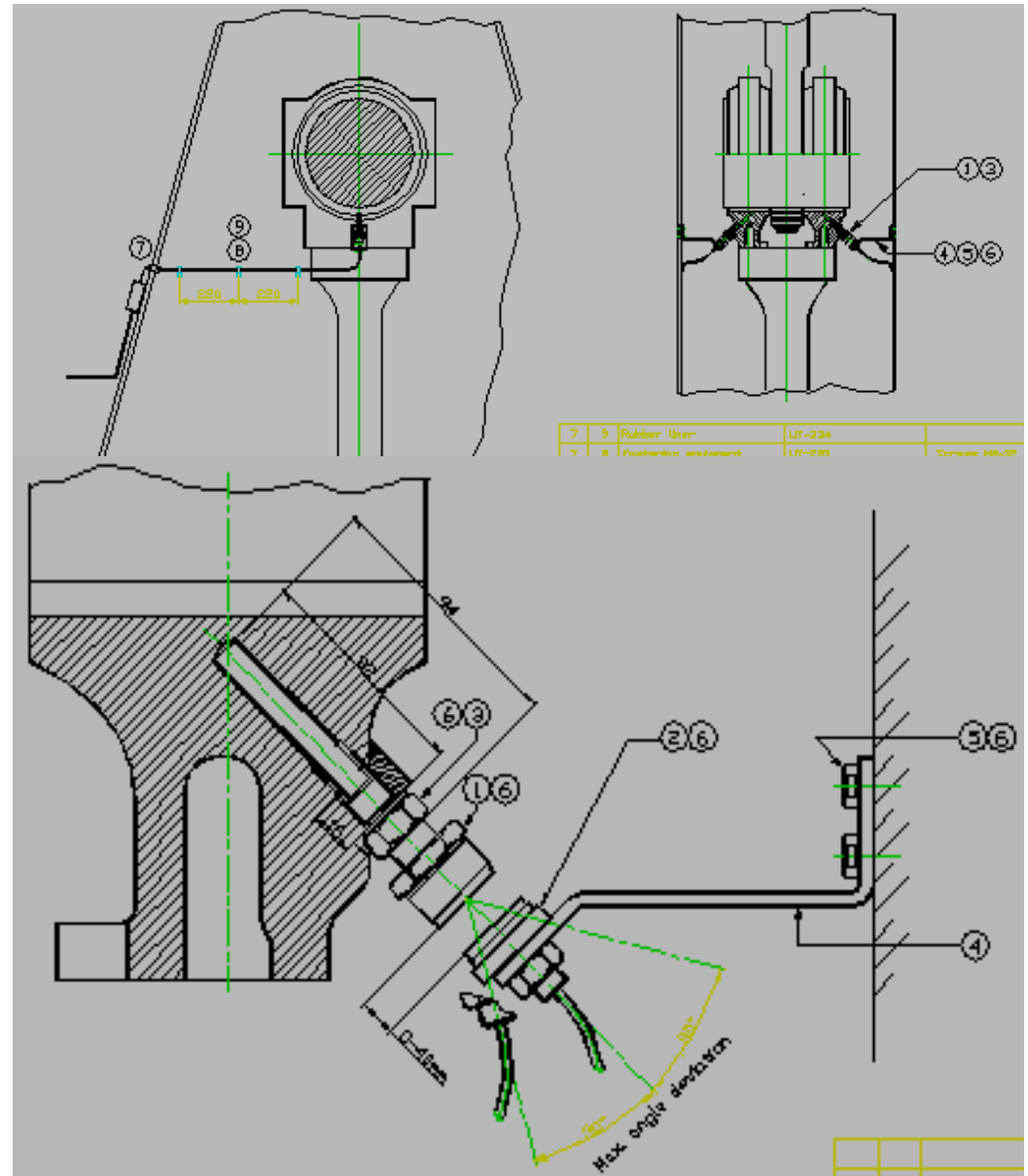
"M/V Thebeland"

**Crosshead installation
on MAN B&W 12L45**



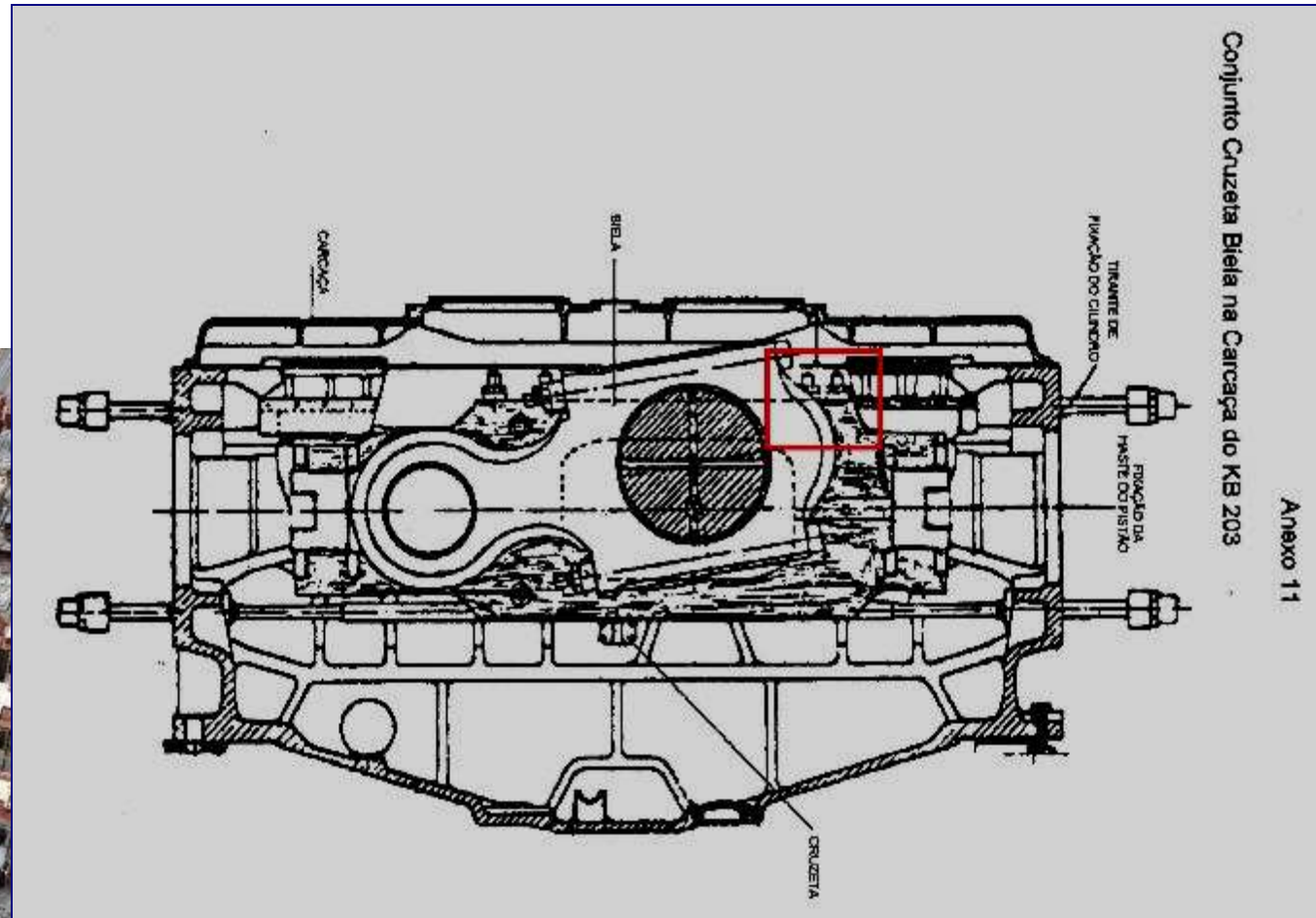
SENTRY – MAN B&W Installation

- Ship: M/V Thebeland
- Owner: Seapartner AB
- Engine: MITSUBISHI B&W
- (12 cyl./2-stroke)
- *Replacement of an older Autronica inductive wireless system (GB)*
- *Installation in Cross-Head of all cylinders, 2 sensors per cylinder*
- *Sensor diameter: 10mm*

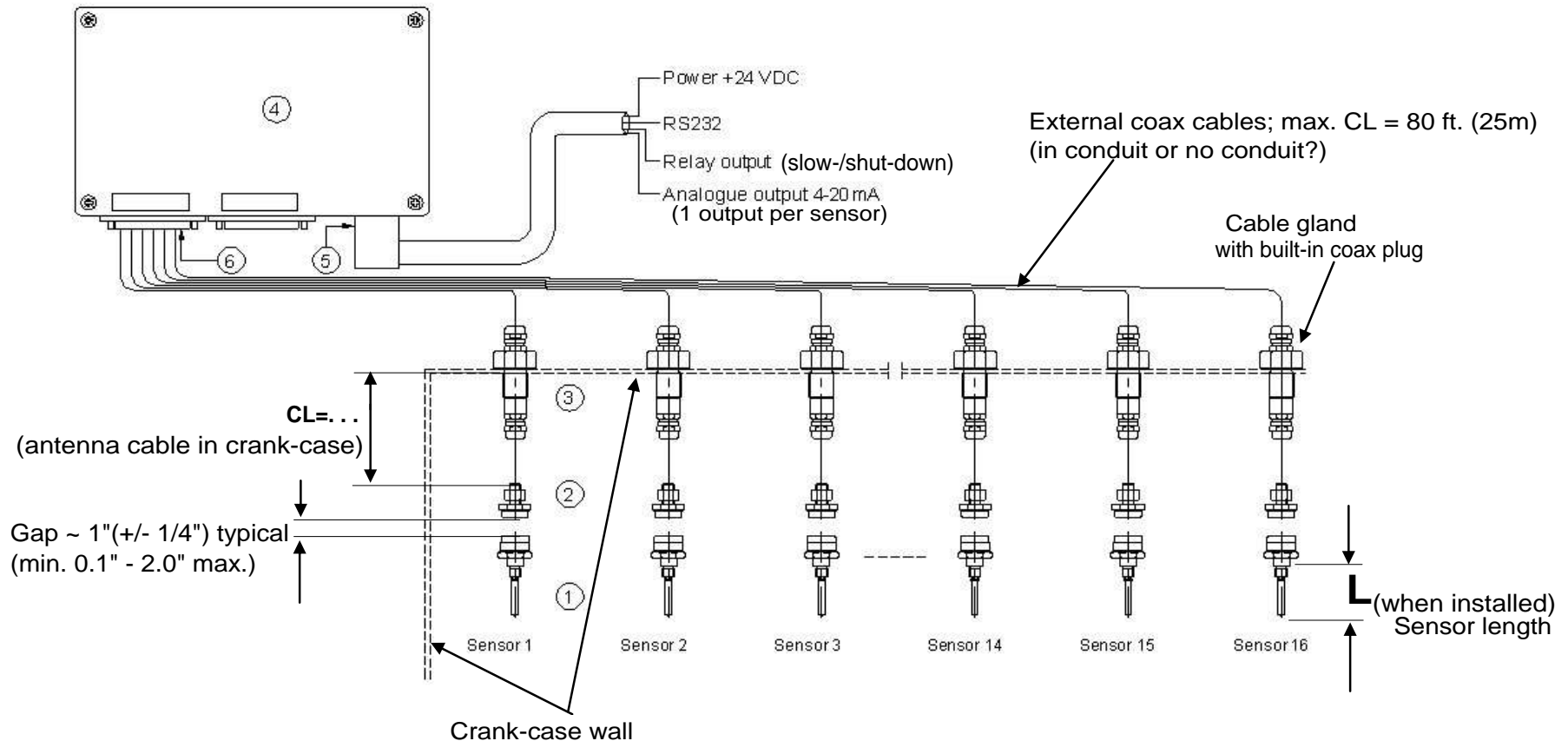


SENTRY - Reciprocating Compressors (1)

Monitoring of **cross pin and/or connecting rod** bearings temperatures on reciprocating compressors.

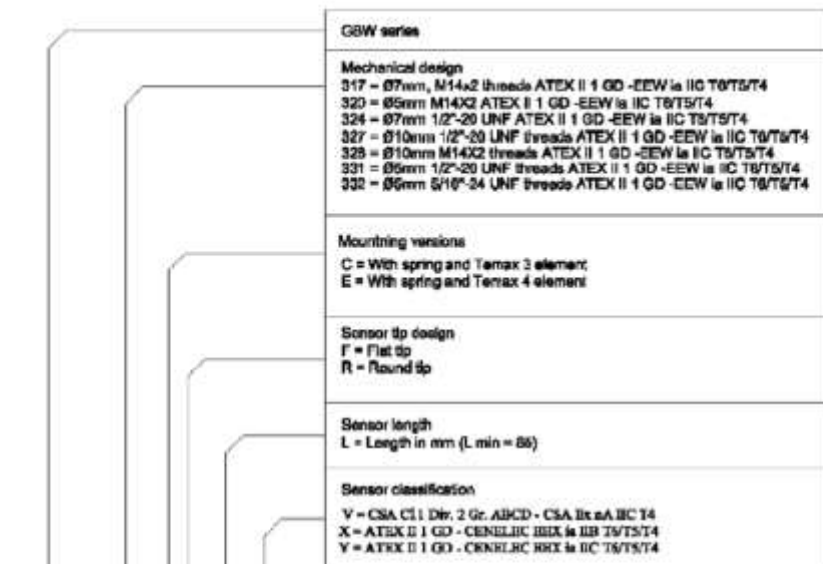
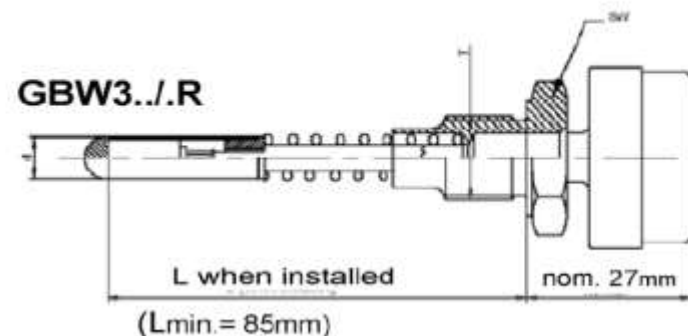
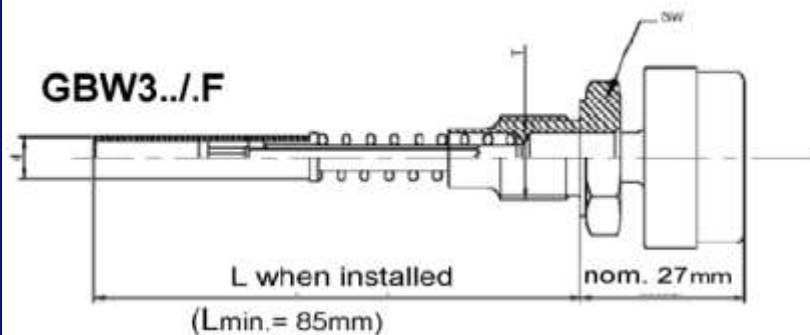


SENTRY System Layout



1. sensor; 2. stationary antenna; 3. cable gland in machine wall;
4. SPU; 5. signal & power plug/cable; 6. coax plug/cable

SENTRY SENSOR



ORDERING EXAMPLE: GBW327CF-85V

Mechanical design
 Element type
 Tip type
 L in mm
 Sensor classification

Mechanical design	Sensor diameter (d)	Sensor thread (T)	SW
317	Ø7mm	M14x2	22
320	Ø5mm	M14x2	22
324	Ø7mm	1/2"-20 UNF	22
327	Ø10mm	1/2"-20 UNF	22
328	Ø10mm	M14x2	22
331	Ø5mm	1/2"-20 UNF	22
332	Ø5mm	5/16"-24 UNF	22



ATEX
Schedule drawing
 No modification permitted
 without reference to the
 Notified body

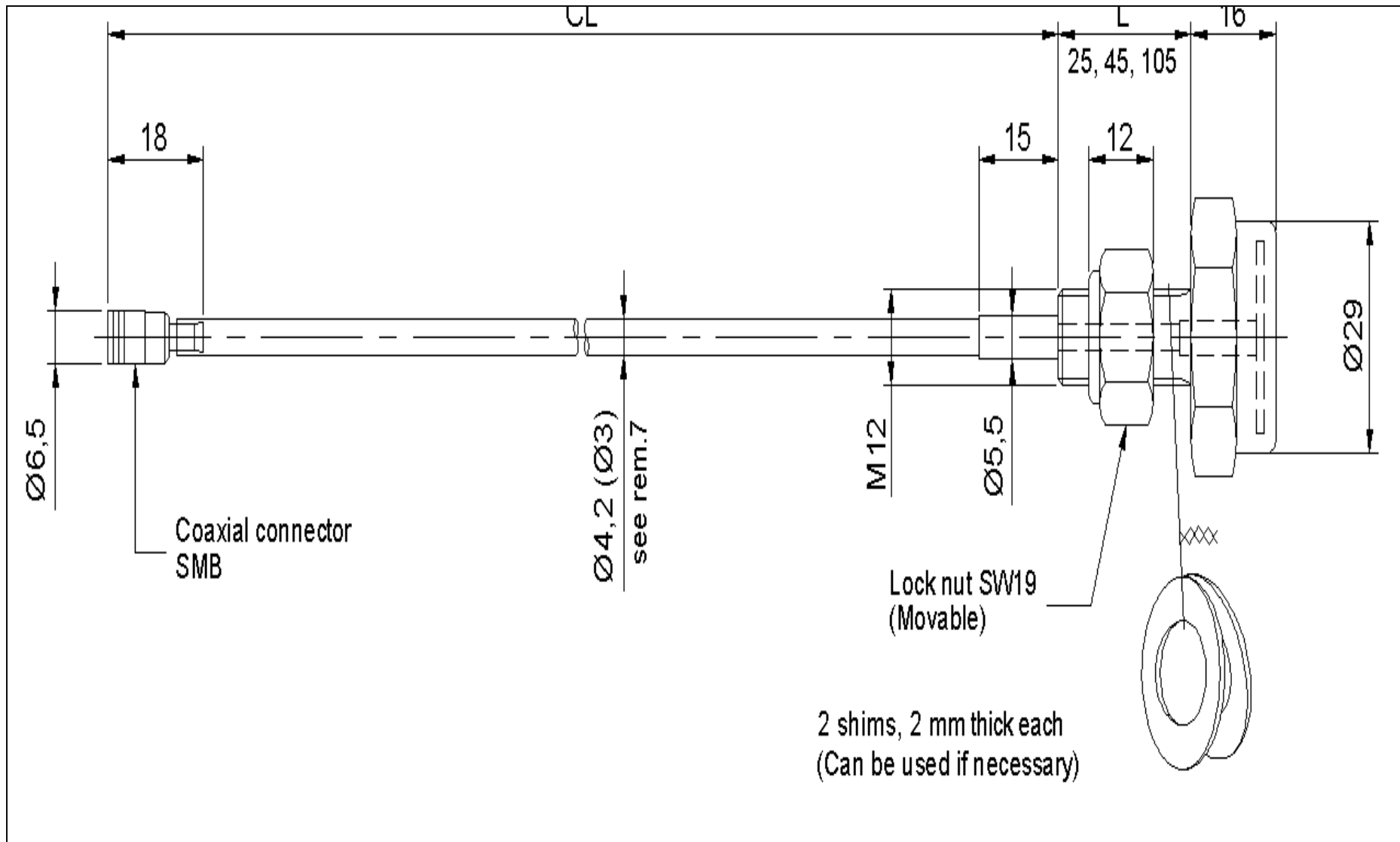
Date 2006-08-07	Design/Drawn ABL	Time	Scale/Format 1:1 (A3)	Kongsberg Maritime AS Automation Trondheim
Checked AJA	Spec. Ctrl.	Approved AJA		
SENTRY wireless temperature monitoring Wireless temperature sensor, spring loaded GBW3--/F-- and GBW3-/R--				Repl. for GB-1030 A
Repl. by Sh. no.				Next sh. Rev.

Item	Lotus	Description
1	100	100
2	100	100
3	100	100
4	100	100
5	100	100
6	100	100
7	100	100
8	100	100
9	100	100
10	100	100
11	100	100
12	100	100
13	100	100
14	100	100
15	100	100
16	100	100
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18	100	100
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100	100	100



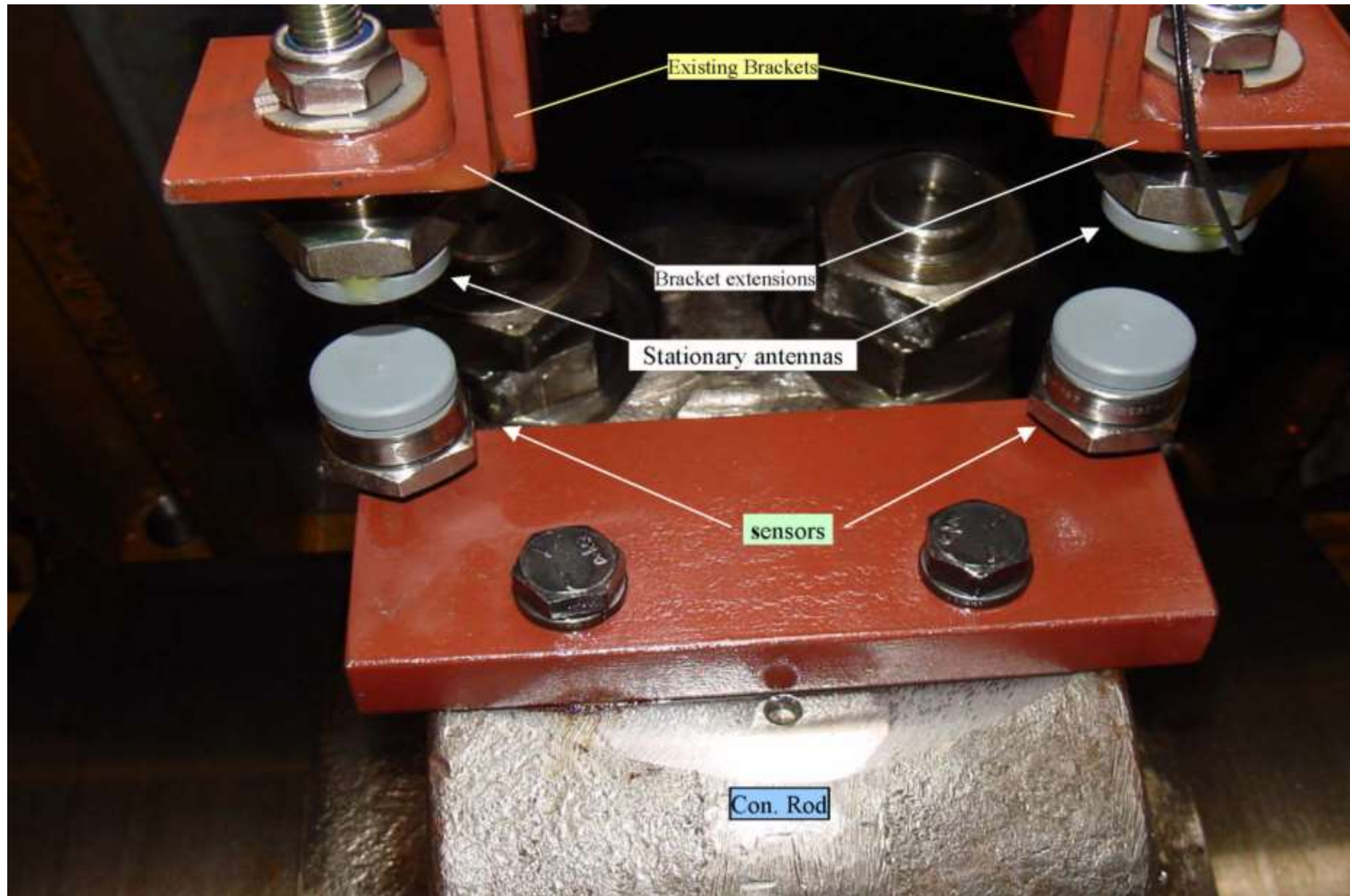
0104

SENTRY - Stationary Antenna

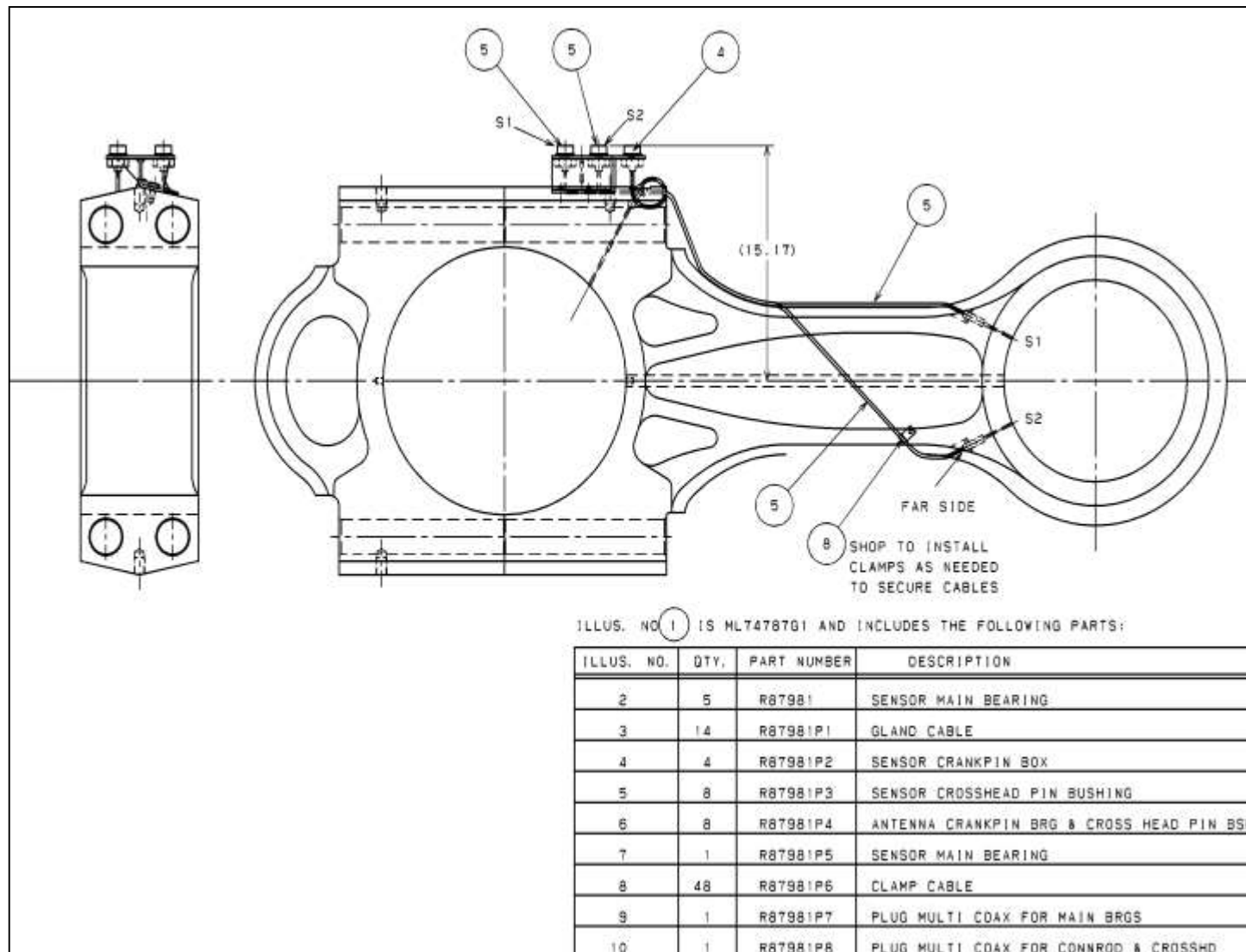


Same C/B JM-7 Compressor – installed;

(2 sensors, recommended by Cooper, on each side of the very wide oil channel)

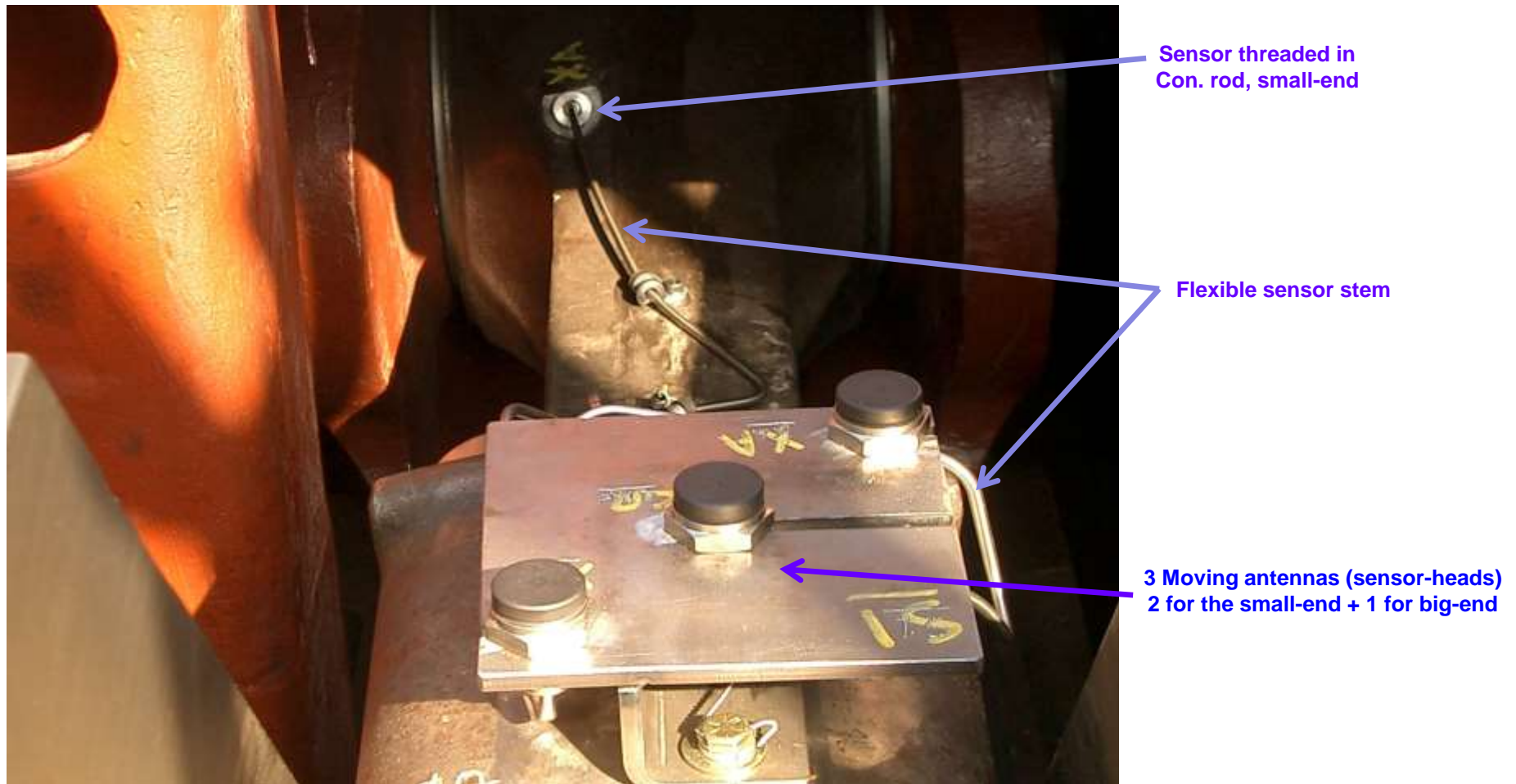


SENTRY - Dresser HHE 4 Compressor, **Installation dwg.**

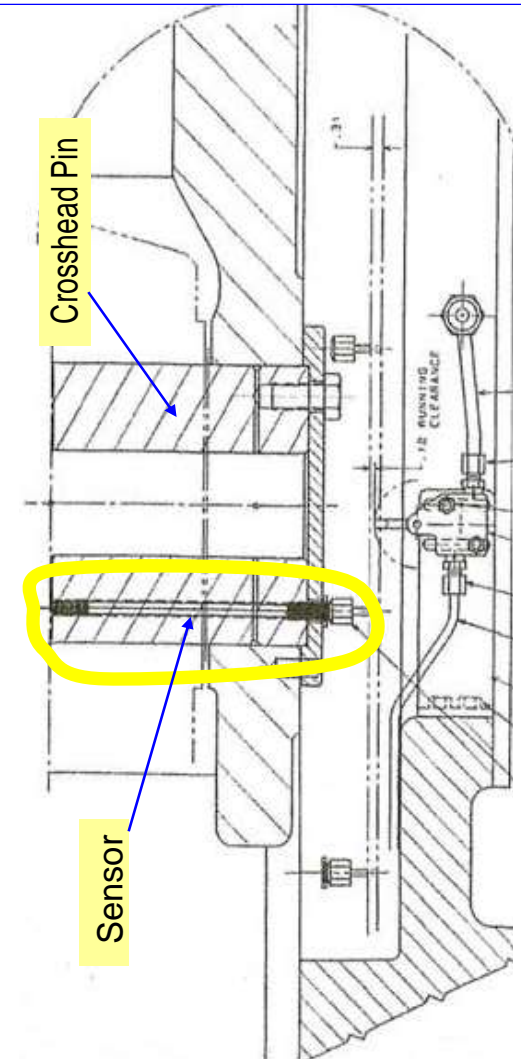
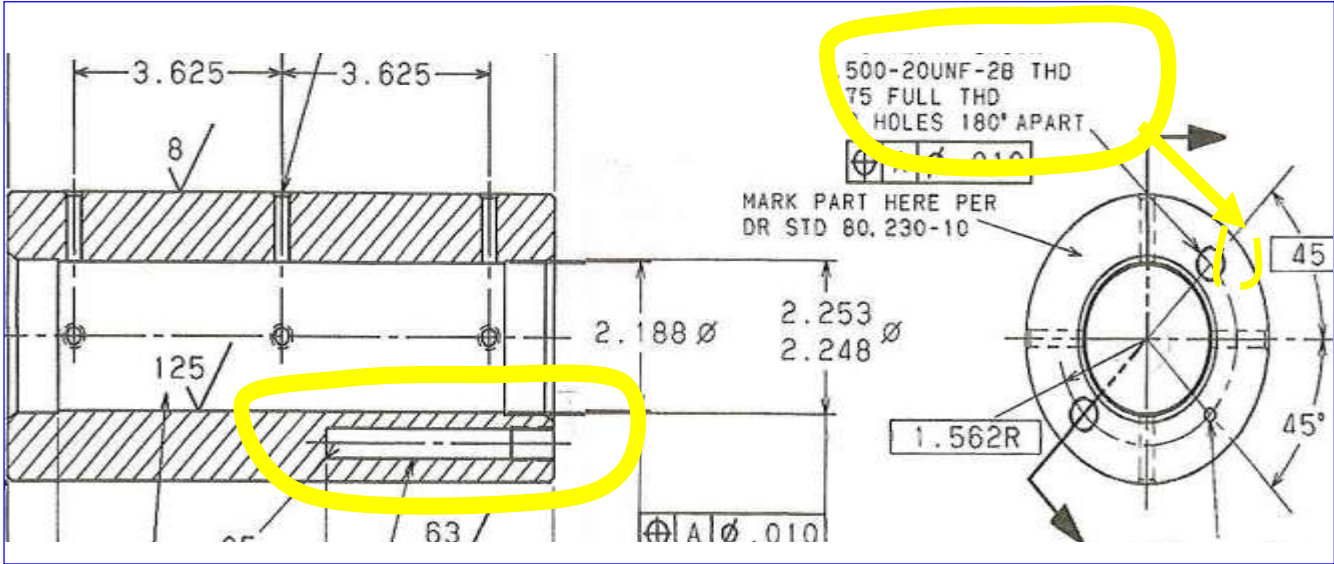
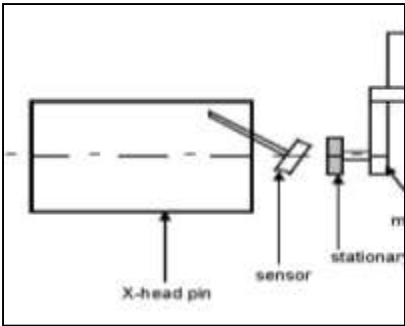


CONNECTING ROD WITH 3 RADAR-WIRELESS SENSORS – 2 IN SMALL + 1 IN BIG-END

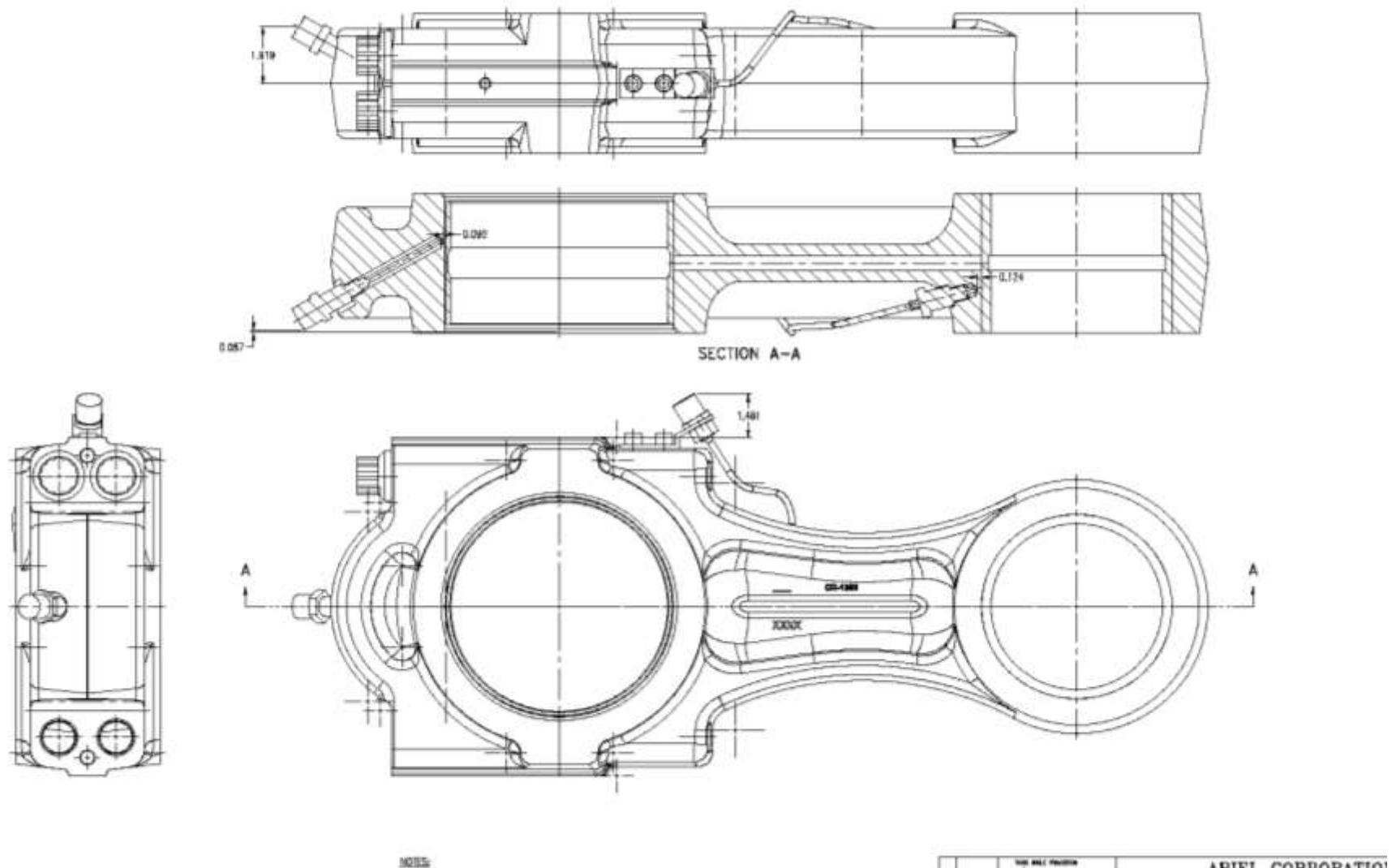
p. 1.



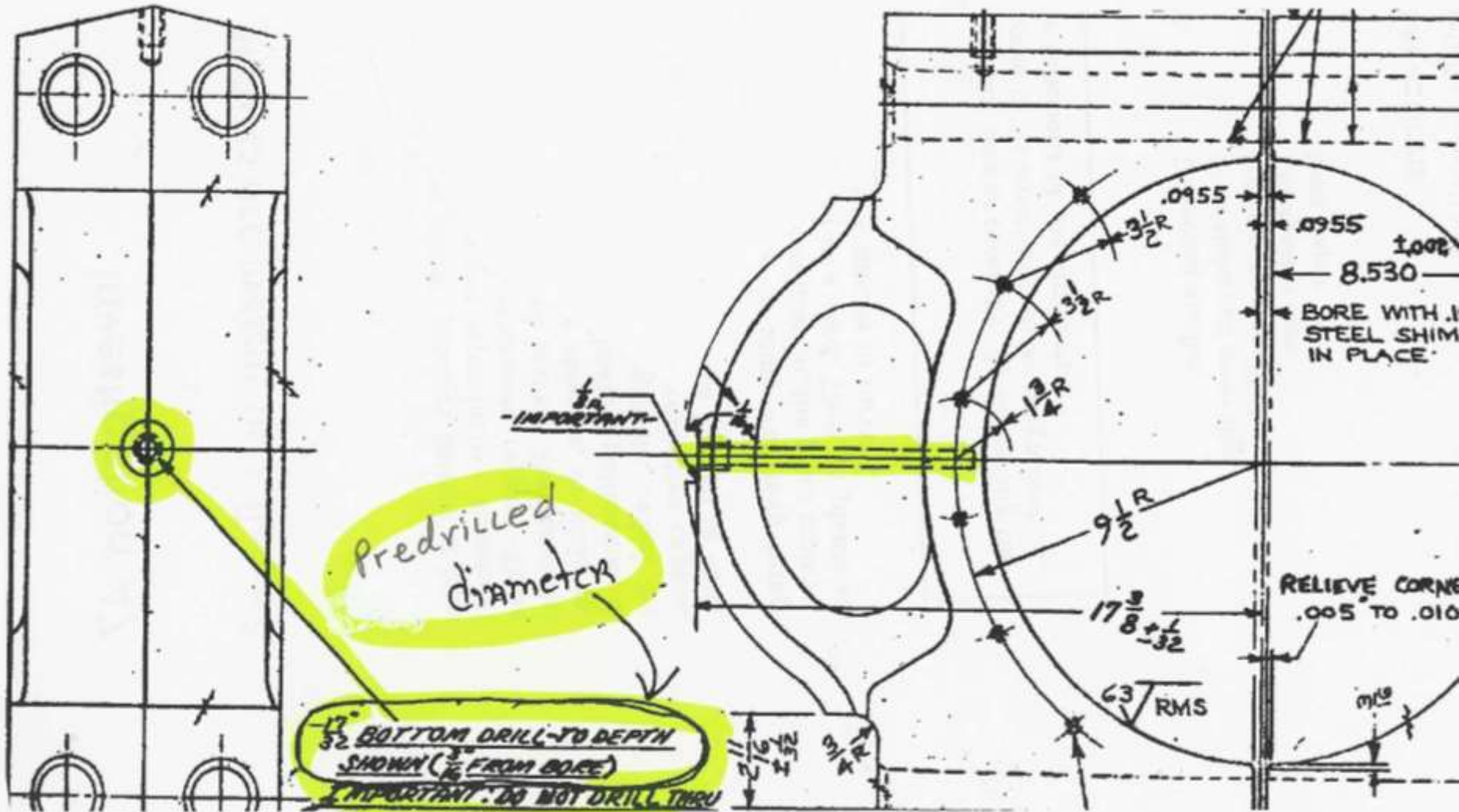
**CROSSHEAD PIN – IN THE EXISTING EUTECTIC PROBE DRILLINGS. (DRESSER
PROCESS COMPRESSORS)**



SENTRY - Installation drwg., JGC Compressor



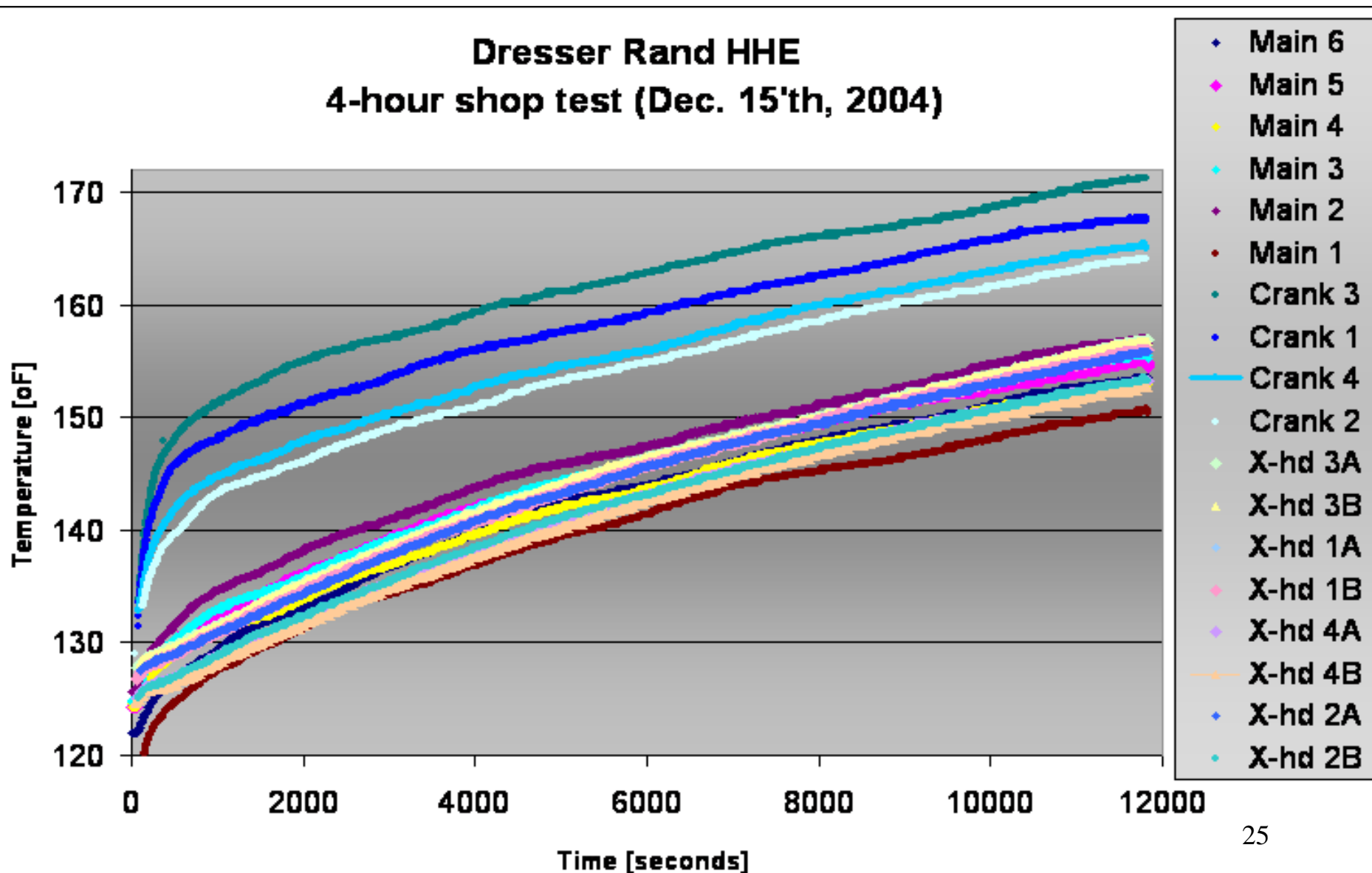
SENTRY - PRE-DRILLED CON. ROD – BIG END (drilled & tapped when manufactured)



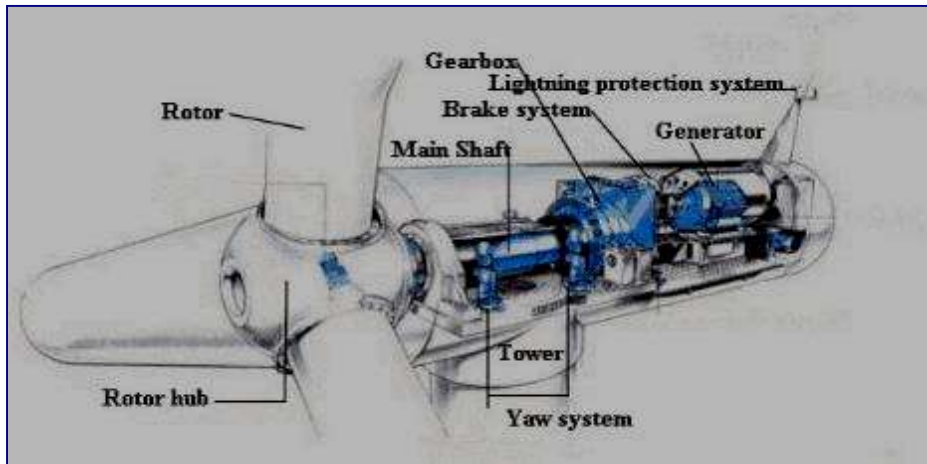
SENTRY –

Main, Crank & Crosshead Bearing Temperatures

Dresser Rand 13.000 HP, HHE-4 Hydrogen Compressor



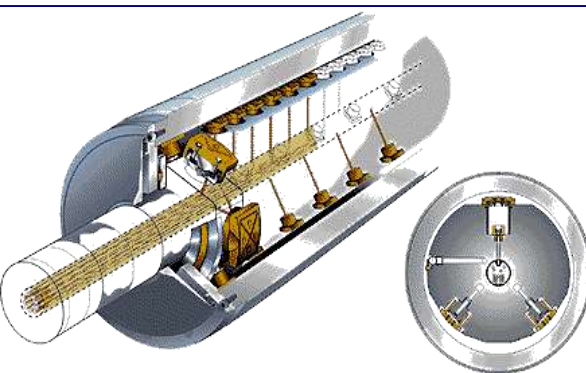
SENTRY Applications



Wind turbine gears



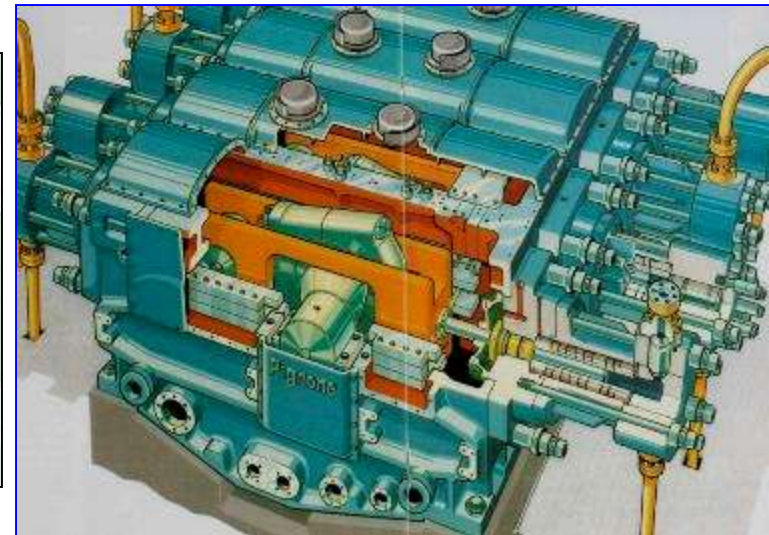
Diesel engines



Paper Machines' drum



El. Motors & Generators

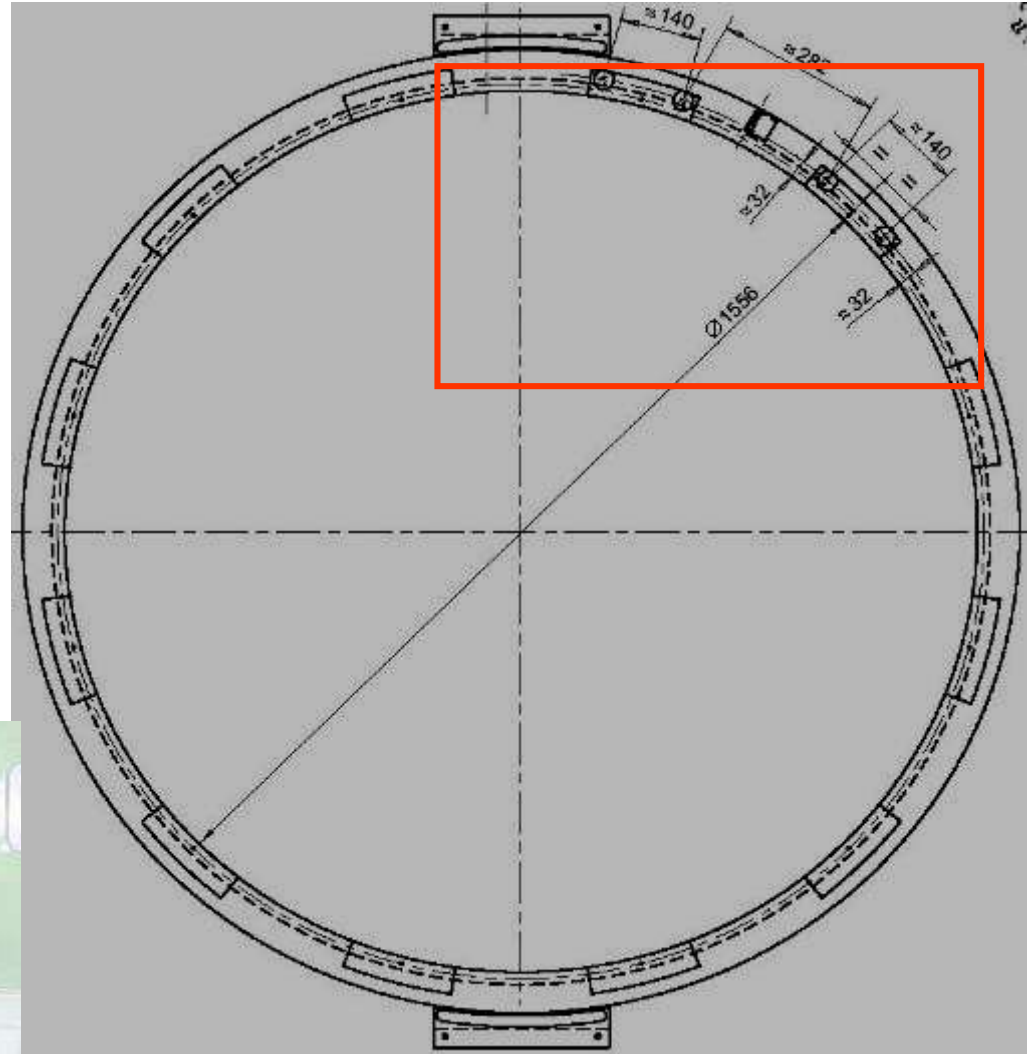


Recipro. Compressors 26

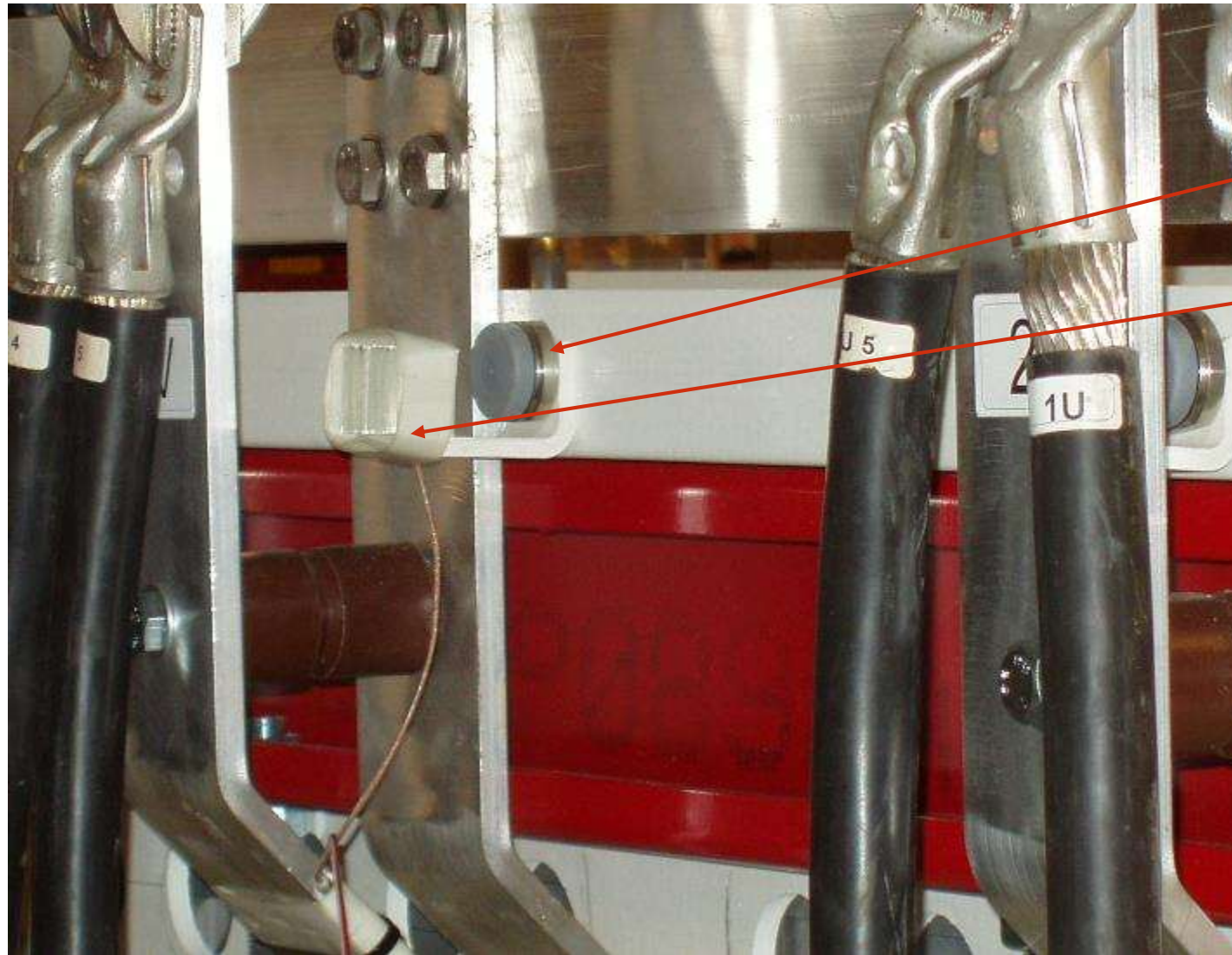
SENTRY - Eletrical Motor/Generator's Rotor

Windings Temperature

- Illustration of Sentry installed on a 3 MW generator. The system is installed to measure winding temperatures on the rotating part.
- Installation consists of 4 sensors all being read by one stationary antenna.



SENTRY - High voltage power transformers

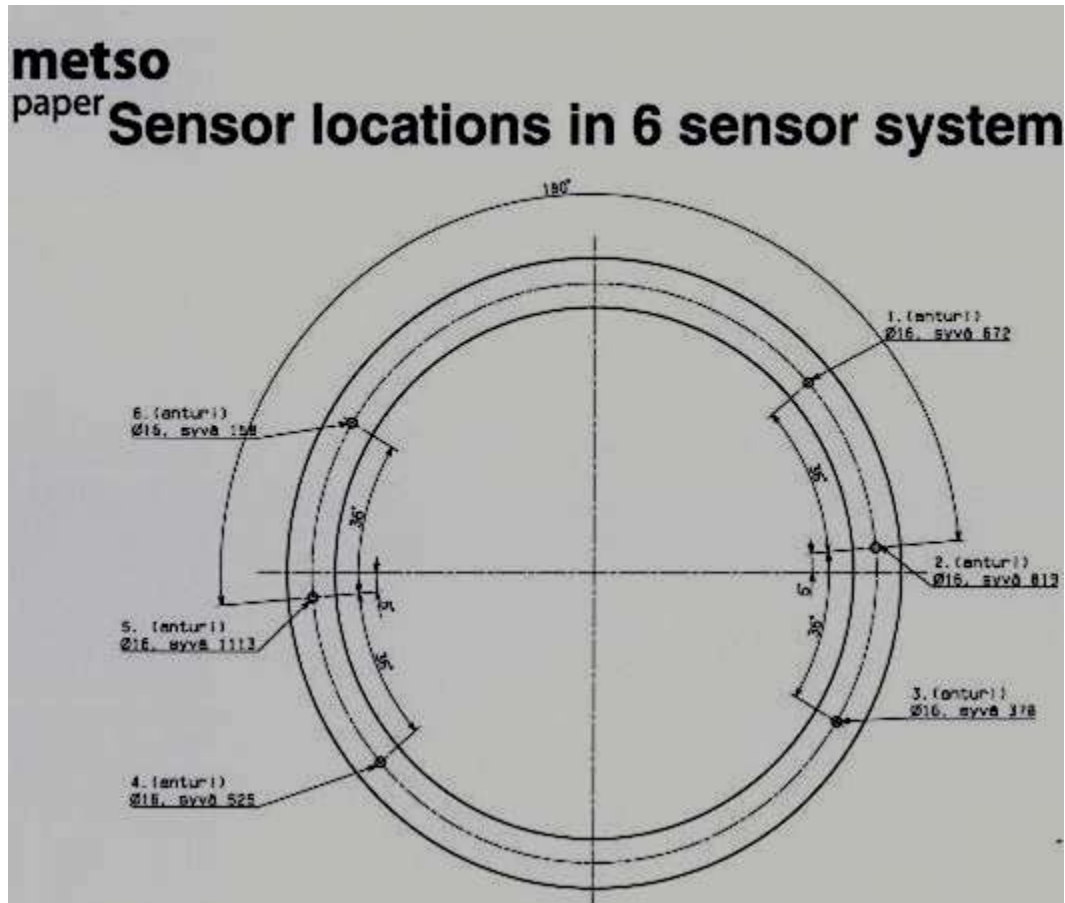


Stationary antenna

Wireless sensor

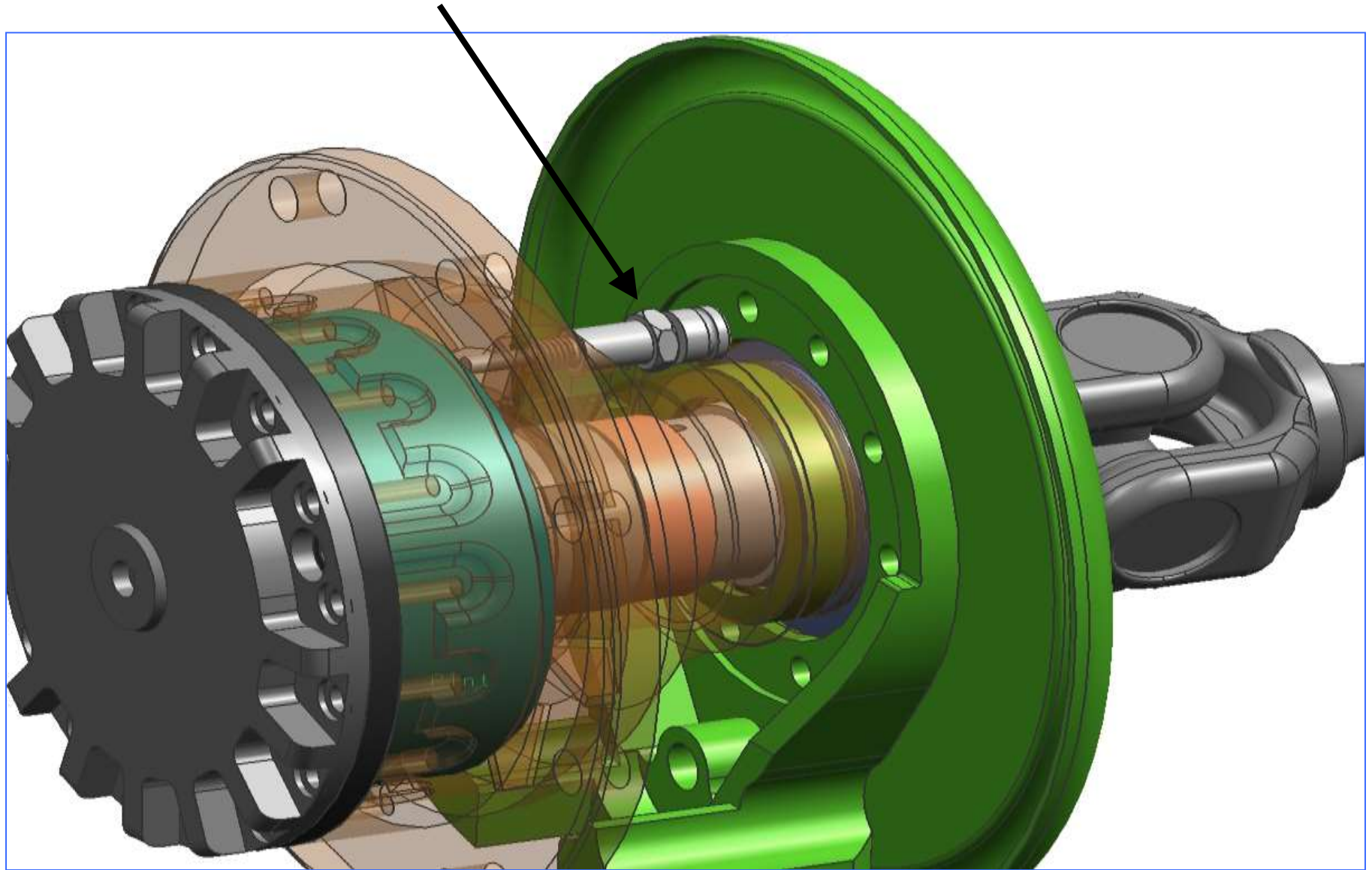
Sentry used for stationary winding temperature measurements on high voltage power transformers.

SENTRY - Paper Machines Rotating Drum

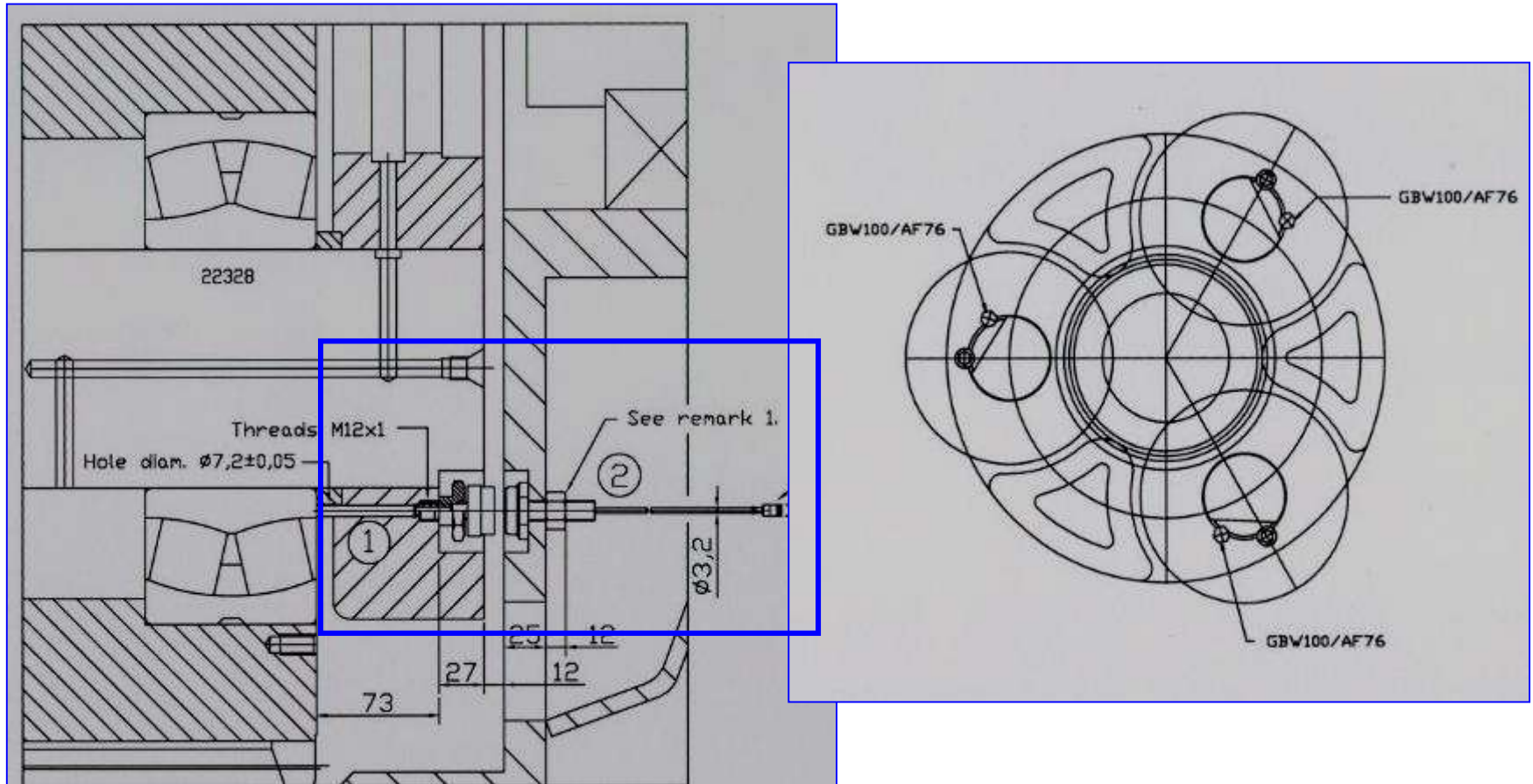


Monitoring of shell temperatures of large paper rolls, 6-12 sensors all read by 1 stationary antenna. Sensor identification by RPM trigger, 1 pulse per revolution.

SENTRY – in a PLANETARY GEAR



SENTRY - Wind Turbine gearboxes

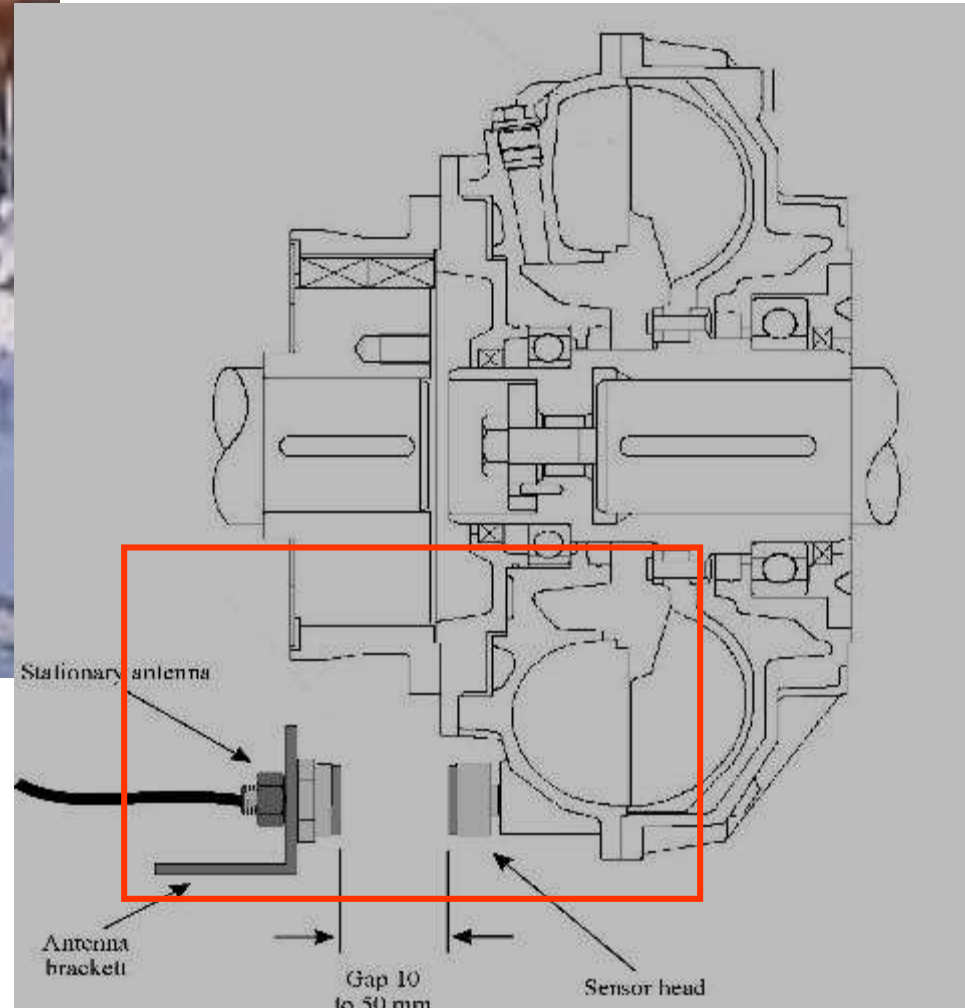


Temperature monitoring of the roller bearings in the planetary unit of the gearbox.

SENTRY – in Hydraulic Clutches



On-line monitoring of Hydraulic clutches' oil temperature



Sentry US Ref./Order Book

#	Job/Ref. #	P.O. Date	COMPANY	Description	End User/ Project/Plant
1	N040028	5/6/04	Ariel Corp.	GBP100/L8A2X	Ariel-JGC-2
2	N040094	9/30/04	Ariel Corp.	GBW-241/CT-21-351	Ariel-JG...
3	N050138	1/6/05	Ariel Corp.	GBW-241/CT-21-351	sp
4	N050186	5/12/05	Ariel Corp.	GBW-241/CT-21-351	sp
5	N050270	12/19/05	Ariel Corp.	GBW-241/CT-21-351	sp
6	N070612	10/4/07	Ariel Corp.	GBW324/CT-89 Repl. for GBW-335/...	Ariel-JG...
7	N080792	6/16/08	Ariel Corp.	JGE/JGK"light" compr.GBW305/CT-50,	JGE/JGK"light" compr.
8	N080876	10/13/08	Ariel Corp.	JGT-4, GBS-138/25-3; ant. w/male conn. L=25; C	JGT-4
9	N090972	2/23/09	Ariel Corp.	GBP 100/L08A2 S/N 0728SPU, non I.S./ non Ex	Ariel-JG...
10	N091049	7/6/09	Ariel Corp.	GBW-338/CR50-350 Sentry Flex.sensor, L=50; A	Ariel-JG...
11	N101278	8/4/10	Ariel Corp.	GB-265	Ariel-JG...
12	N091119	11/6/09	BP TX Co. - (see also "End User" Column)	BDC 0F18H2-GBW-327/CF-102 L=102mm; 1/2"	BP Tx.C1.modif.
13	N050230	9/2/05	BP-Industrial Air	UX-638/100 Multicable w/17-pin Connector	sp - BP
14	N050242	10/13/05	BP-Industrial Air	Rubber liner for UT-283	sp - BP
15	N050243	10/18/05	BP-Industrial Air	GB-708, Main brgs.(6)	sp - BP
16	N050248	11/1/05	BP-Industrial Air	GB-704 □(4 x-head brgs.)	sp - BP
17	N050250	11/4/05	BP-Industrial Air	GB-	sp - BP
18					
19	N080905	11/25/08	CHEVRON PHILLIPS CHEMICAL CO. LP	Clark HMALB- GBP-100/M04A2X Signal Processing Unit	CHEVRON PHILLIPS, Baytown,TX
20	N050174	4/6/05	Dow Chem--*(see also "End User" Column)	GBW227	sp. Dow Chem
21	N101240	6/15/10	Dow Chemical	NP- 6PH2 compr.(3 con.rods/6 cyl - 2 p	Dow Freeport3, NP-6PH2
22	N080786	6/5/08	Dresser Rand / BP	BDC 0F18H2-R87981P21	BP-ML75331G1
23	N070598	9/18/07	Dresser Rand CLRA	2pcs.Clark-HMALB-GBP-100/M04A2X (in expl. proof box)	BP Milline Point, AK
24	N080791s	8/13/08	Dresser Rand ,CA/BP,AK		0 sv
25	N040031	6/1/04	Dresser Rand - Services Div.	HHE4 -Signal Proces. Unit (SPU), output	Dow Freeport1 HHE4
26	N040054	8/4/04	Dresser Rand - Services Div.	Travel and upkeep expenses for a Kong	sv
27	N040079	9/16/04	Dresser Rand - Services Div.	HHE-3-SPU, outputs: 4-20mA and RS4	Dow Freeport2 HHE-3
28	N040128	12/28/04	Dresser Rand - Services Div.	GBS140/25-3.05 dm.	sp
29	N050137	1/6/05	Dresser Rand - Services Div.	Sentry, □GBS140/25-3.05 dm.	sp
30	N060339	6/2/06	Dresser Rand - Services Div.	Start-up of the Sentry Radar/Wireless T	sv.BP, TX. City
31	N040028	5/13/04	Dresser Rand Co. *(see also "End User" Column)	HHE-4VM-Main bearings temp. sensor,	BP, TX. City
32	N040037	8/4/04	Dresser Rand Co.	Travel and upkeep expenses for a Kong	sv
33	N040066	8/30/04	Dresser Rand Co.	Cable gland with 1/2"NPT-F,	sp
34	N040099	10/8/04	Dresser Rand Co.	GB-502-15.5; CL=15.5 dm.(60"), extens	sp
35	N040119d-r	12/9/04	Dresser Rand Co.	GBS-150/25-19.5; CL=19.5 dm.(M12 x	sp
36	N040124	12/28/04	Dresser Rand Co.	GBW238/CF-175/432, same as pos.5 o	sp
37	N050166	3/9/05	Dresser Rand Co.	GBS140/25-19.5	sp
38	N050218	7/28/05	Dresser Rand Co.	GBS140/45-19.5	sp
39	N060420	11/3/06	Dresser Rand Co.	Clark HMALB-GBP-100/M04A3X (in expl. proof box)	CHEVRON PHILLIPS, Cedar Bayou,TX
40	N060421	11/6/06	Dresser Rand Co.	GBW-327/CF-206□L=206 mm (8.12")□	CHEVRON PHILLIPS, Cedar Bayou,TX

41	n080672m	3/5/08	Dresser Rand Co.	2pcs. Clark-HMALB, GBW-338/CF110-1067 L= 110mm/4.34"A=1067mm/42" d=5mm; T =1/2"-20 UNF	BP Milne Point, AK - modif.to CSA
42	N080818	7/21/08	Dresser Rand Co.	Clark-HMALB (CLRA)/ GBP-100/M04A4X (CSA)	Spares for 2 x Clark-HMALB (CLRA) Compr.@ BP Milne Point, AK
43	N080856	9/17/08	Dresser Rand Co.	sets of CABLE GLAND ends for GB815	sp
44	N080912	12/9/08	Dresser Rand Co.	R87981P36	
45	N080919	12/18/08	Dresser Rand Co.	R87981P36x	sp
46	N090943	1/29/09	Dresser Rand Co.	R87981P28	sp
47	N091000	4/12/09	Dresser Rand Co.	2-week rental of Sentry Test Kit , consist	sp
48	N091064s	8/1/09	Dresser Rand Co.	Service/ Start-up of Sentry system #2 at	sv.BP Milne P.AK
49	N080760	4/28/08	Dresser Rand-Ken.Crosby	COAX SERVICE KIT GB-265,	sp
50	n070606	10/4/07	Dresser Rand-Motiva	3x 6BDC-0F18H3, GB-815/155	Motiva(Shell/Arab), P.Arthur
51	n070463w	2/27/07	Eastman/Westlake Chem., Longview, TX	Nuovo Pignone (8PK) Compressor	Easman Chemical, Longview, TX
52	N060292	2/27/06	Equistar Chemicals, LP	Cooper-BessemerJM-7 JM-72-7, GBP100/M8A4XF	Equist/Lyond.Victoria, TX
53	N060419	11/2/06	Equistar Chemicals, LP		sp.Eq/Lyond-Victoria, TX
54	N080916	12/16/08	Equistar Chemicals, LP	Burckh. F10-GB-815	Equistar, LA PORTE, TX
55	N080917	12/16/08	Equistar Chemicals, LP	Burckh. F10-GB-504 / 8-9000 - 0	Equistar, LA PORTE, TX
56	N080922s	12/22/08	Equistar Chemicals, LP	Service/installation supervision & start-u	sv. Equistar, LA PORTE, TX
57	N070535	6/27/07	GE Energy/Bently	GB815(ConduitCablegland)	
58	N070569	8/13/07	GE Energy/Bently	4BDC-OF18H2-GBW-238/CF164-432	BP Whiting1, #801C
59	N070580	8/23/07	GE Energy/Bently	GBW-238/CF164-432	BP Whiting2, #801A
60	n070641	12/13/07	GE Energy/Bently	4BDC-OF18H2, GBW-338/CF164-381	BP Whiting3, #801A
61	N090971	2/23/09	GE Energy/Bently	4BDC-OF18H2,GBW-338/CF164-432	add. BP Whiting1, #801C
62	N090975	3/4/09	GE Energy/Bently	4BDC-OF18H2, GB 815 (Conduit Ca	add. BP Whiting1, #801C
63	N101245	6/24/10	GE Energy/Bently	HHE-VL-4 (new type) K-601A	BP Whiting
64	n080748	6/27/08	GE Transp.	6L250	GEVO 6L250eng.
65	n080749	6/27/08	GE Transp.	8L250	GEVO 6L250 engine
66	N070567	8/8/07	Industrial Air Tool	HHE-VM4-GBP100/L08A2X, SIGNAL P	BP Tx. City
67	N080784	5/27/08	Industrial Air Tool	GBP100/L10A4X (repl. for GBP100/L10	BP Tx. City
68	N080839	8/14/08	Industrial Air Tool	GBS-140/25-19.5 st. antenna	BP Tx. City
69	N080871	10/2/08	Industrial Air Tool	MN43415X-18.3, CL=18.3dm	BP Tx. City
70	N070472	3/7/07	Neuman & ESSER USA, Inc	2compr.x2-throwea.-GBP100/L8A2X	PetroTrin
71	N070473	3/7/07	Neuman & ESSER USA, Inc	GBW324/CF100, Wireless temp sensor	PetroTrin
72	N101153s	1/21/10	Neuman & Esser USA	Site Rep. #2 for Kongsberg Sentry Rad	sv. PetroTrin
73	N101222	4/29/10	Shell Canada Energy- - *(see also "End User" Column)	N.P.-GBS150/25-4 STATIONARY ANTE	Shell, Calgary
74	N070501	4/25/07	Shell Canada Products	2 x 3-HHE-(VL-old?) 5/8"-11 UNC- Crank bearing Wireless temperature sensor in Con. Rod : spring loaded, Probe =10 mm./ 0.4"; Flat tip	Shell Canada Products, Montreal East Ref.

User's View (5)

BP Reciprocating Compressor Monitoring Guidance Note

Frame and Running Gear			
Signal	Location	Transducer	Recommended
Main Bearing Temperatures	Bearing shell	Radar Sensor, Thermocouple or RTD	X
Con. Rod Bearing Temperature	Con. Rod Big End	Radar Sensor (Preferred)	X
Wrist Pin/Crosshead Pin Temperature	Con. Rod Small End or Crosshead	Radar Sensor (Preferred)	X
Eutectic (Amot) Point Status	Con. Rod and/or Crosshead	Eutectic Device and Pressure Switch	
Oil Header Pressure	End of Header	Pressure Transducer	X
Oil Return Temperature	Return Line at Frame	Thermocouple or RTD	X
Crankcase Oil Level	Frame	Level Transmitter	

“ ... 5.3.8 Kongsberg Temperature Monitoring Devices

Installation of Kongsberg systems needs to be discussed with Kongsberg and the compressor OEM.

The installation requirements need to be broken down to the following categories:

•Main Bearings

- ***Direct wired main bearing transducers can be supplied to Kongsberg. These systems typically mount in the standard OEM holes located in the main bearing cap***

•Crank Pin Bearing (Con-rod Big End)

- ***Sensors are typically installed in the standard OEM eutectic holes on the con rod cap.***
- ***Sensor location needs to be reviewed for antenna location and routing***

•Wrist pin/Cross pin bushing

- ***Sensors are typically located to monitor the connecting rod wrist pin. This can be done either through the wrist pin and mounted directly on the connecting rod. If the crosshead is equipped with floating pins the crosshead bushings can be monitored. This is done on the crosshead.... ”***

Wärtsilä chooses Kongsberg



- Finnish engine manufacturer Wärtsilä has selected our Sentry wireless temperature monitoring system **as the standard fit for temperature monitoring in the big end bearings** of the groundbreaking new 46F engine. Sentry is based on sophisticated wireless technology that provides accurate, reliable data to prevent engine damage through overheating.
- Extended monitoring. The Wärtsilä 46F is a medium speed diesel with a modular and compact design ...

GE Nuovo Pignone too

GE Nuovo Pignone S.p.A. to standardize on Sentry - Wireless Temperature Monitoring System



GE imagination at work



Sentry
Signal Processing Unit
with Ex[d] encapsulation

Based on experience from several revamping projects on reciprocating compressors **GE Nuovo Pignone** have decided to offer the Ex type of the **Kongsberg Maritime Sentry** system as an instrumentation option for all new machines. **Nuovo Pignone** is the world wide **No. 1** manufacturer of reciprocating compressors. The following arguments have been put forward for the introduction of the system;

"Abnormal lubrication conditions cause temperature increases and overheating of all moving parts. Moreover, particular transient operating conditions or breakage of a discharge valve can result in the absence of thrust inversion on the crosshead pin, making correct lubrication impossible. Under these conditions, this critical part of the machine heats up quickly. Therefore, rapid indication of the rising temperature is essential because a lack of lubrication would be catastrophic to the compressor, resulting not only in an expensive repair, but also losses due to the unavailability of the machine."

GE Nuovo Pignone CM&Us
Conversions, Modifications & Upgrades