DESIGN FEATURES OF THE STANDARD GEAR SERIES

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MAAG ZURICH

Design Features of Standard Gear Series

1 Introduction

The inquiry for a specific gear with the given basic data of power and speed also includes numerous additional parameters such as climate, surrounding conditions, specifications of the end user, main contractor and turbomachinery manufacturer. The general specifications of ISO, API, AGMA, etc., are used as guidelines.

These specifications very often do not favour an optimised sizing of the gear. Compromises have to be proposed and, by making a few exceptions to the received specifications, a smaller, cheaper and also more reliable gear can be quoted.

MAAG has, with the enlarged turbo gear program, a complete series allowing an optimisation from both the technical and commercial points of view.

Ratio	small	medium	large
Gear types	GB basic GB Mark I GB Mark II	GN basic GN enlarged width GO center dist. and face width adjustable	GS center dist. and face width adjustable
see Fig.	1	2	3

The corresponding diagram Fig. 4 shows that it is not always obvious which type is more convenient.

In order to optimise the GB-series, Mark I and Mark II have been introduced with enlarged casing width for a larger gear face width or to allow space for the thrust collar. Fig. 5.

The GN-series can be adjusted in a similar way. See Fig. 6,7,8. For larger gears it is desirable to also vary the center distance. Therefore the casting patterns of the casings of the GO and GS-types have this feature. See Fig. 9.

All these variables are useful to propose a gear design with adequate safety factors with respect to the toothing, the bearings, the critical speed, and the coupling design.

1.1 Technical Details

1.1.1 Rotating Elements

With over 70 years of experience in toothing design MAAG has accumulated the know-how which, for each case, allows the design of the optimal toothing, the adequate quality standard and the general manufacture of the gear so as to obtain a trouble-free, reliable service throughout the entire life of the gear. In the table given in Fig. 10 a comparison is shown between the toothing quality according to AGMA and according to MAAG.

Above a pitch line velocity of approx. 120m/s the scoring factor is of increasing importance. As the most recent API specification does not consider this criteria, MAAG may request, in certain cases an exception to the API tooth layout where the pitch line velocity exeeds this value. Fig. 11 shows the relation between MAAG and API design criteria.

The use of standardized shaft ends according to ISO and Nema, helps to minimise the engineering work, and the amount of special tools required, and simplifies the quality assurance procedure.

1.1.2 Bearings

The design and layout of the white metal lined bearings is based on our own test stand results as well as our experience. Depending on the speed, 2 or 3, 4 lobe radial bearings are selected. For high speed applications, tilting pad radial bearings are provided.

The figures 12, 13, 14, 15, 16 show the various bearing designs and combinations with the axial thrust bearing.

1.1.3 Casing

The casings of the standard gear series are made of cast iron which

cast iron with the same casting pattern is also possible. A welded casing design can be provided on request for single stage gears but is normally supplied for multiple stage or special gears. Commercial optimization may lead to either solution. The use of bearing caps for securing the bearings to the casings provides the advantages of:

- higher accuracy of casing bore; as easier control of parallelism with control shafts is possible
- easier maintenance; as the rotating elements remain secured after removal of casing upper half
- simplified mounting of the instruments
- no oil leakage problems; as the casing upper part does not have to fix the bearings.

1.1.4 Lubricating Oil Requirement and the Lubricating Oil System

The oil requirement for the lubrication and cooling of the bearings and toothing is calculated by a computer program. The heat load distribution for one case is shown in Fig. 17. The lube oil system for the gear is in most cases combined with that of the driving or driven machine.

The use of synthetic oils has shown positive results. However the, as yet unknown, factors of humidity absorbtion and chemical aggressivness towards the bearing metal or seal rings (also in combination with the mediums of the compressors or pumps) require that further extensive testing be conducted. Mineral oils are therefore used in all cases where these influences are not predictable.

1.1.5 Instrumentation

The automatic supervision of turbomachinery, by means of instrumentation as specified by the end user or the main contractor, has become an integral part of manufacturing at MAAG.

The requirement, of either direct and/or remote, measurement of the oil temperature and vibration of rotors can be fullfilled for all gear types.

For optimization in this field we consider two main criteria which are:

- the use of as few measuring points as possible, i.e. only those which influence the running sequence of the installation
- the use of instruments mounted from outside, to improve servicability.

These criteria help to reduce both the initial capitalisation costs as well as the operational service costs.

1.1.5.1 Thermometers for Direct Measurement (see Fig. 18)

As the temperature range, of 20° C to 120° C. in gears is relatively narrow, the simplest and cheapest direct temperature measurement system, the mercury type thermometer, is both adequate and sufficient. The more sophisticated dial type themometer, as specified by API, with a very large temperature measurement range is many times more expensive and therefore not cost effective.

1.1.5.2 Temperature Measurement Devices for Remote Monitoring

Resistance Temperature Detector (RTD's) or Thermocouples (TC's) with a temperature measurement range of -220° C to +850° C are used for remote temperature monitoring of the gear box.

The advantages of RTD's are:

- accuracy, stability, exchangeability
- lower system costs
- safety (positive temperature coefficient)
- area measurement possible

Advantages of TC's:

- not sensitive to vibration
- small dimension (important for tilting pad bearings)
- short response time (point measurement)

The possible applications of RTD's and TC's (simplex and duplex types) are shown in Fig. 19, 20, 21, 22, 23.

1.1.5.3 Shaft Vibration Measurement

Presently shaft vibration measurements are made with non-contacting probes. The pickups of the various suppliers are made according to the same standards and are therefore interchangable. It seems that the eddy-current principle is the most suitable, as it allows the monitoring of shafts of any electrical conducting material and is not influenced by oil or gas between the pick-up and the surface to be scanned.

Special care has to be given to the mechanical runout during the manufacture of the shafts. MAAG uses a special protection after the shaft reference surfaces are ground. The electrical runout is influenced by the properties of the material. The demagnetisation or other treatment of the measured surface is easier when the surface is arranged according to Figure 24. The servicability of the measured surface is considerably increased by this design.

1.1.5.4 Axial Pickups

- The axial displacement measuring principle is the same as for the shaft vibration measurement.
- A Key-Phaser is used to show the torsion behaviour of the shaft system.

Both instruments can be arranged on the same shaft end. See Fig. 3 and 2.

1.1.5.5 Casing Vibration Measurment

Accelerometers are used for the monitoring of the tooth and shaft frequency and have been found to be a reliable measuring instruments. At a low additional cost, it is mounted on the outside of the casing where space is always available.

The interpretation of the received signals is not always easy, as the values may be influenced by the structure on which the instrument is mounted.

1.1.5.6 The Explosion Protection of the Instrumentation

Protection is required for electrical equipment and wiring, for all

voltages, in locations where fire or explosion hazards may exist due to flammable gases or vapors, flammable liquids or combustible dust.

In order to equip the gear instrumentation with the correct protection the required standard should be indicated by the end user and/or the main contractor, i.e. Class I, Division I, Group A - D, T 1 - 6.

The "Class" indicates the hazardous location.
The "Division" indicates the frequency of exposure to flammable material.
The "Group" indicates the kind of flammable material and the "T 1 - 6" indicates the ignition temperature in a range from 450°C to 85°C.

Taking into account the very large variety of standards NEC (USA), CSA (Canada) and CENELEC (mainly in Europe), MAAG worked out a preferred and possible explosion protection for instruments on gears, Fig. 25 for NEC and Fig. 26 for CENELEC. For division I we recommend the use of Zener-Diodes in order to make the system intrinsically safe. In this way excessive costs for flameproof applications can be avoided for the same safety level (API 670 standard), see Fig. 27 and 28. The MAAG quality assurance program has determined 8 MAAG standards in order to cover all applicable electrical safety codes, see Fig. 29-35.

2 Two Stage Gears

Above a gear ratio of approx. 10 there are two economical solutions possible:

- planetary gear (discussed later)
- two stage parallel shaft gear

The layout criteria for the toothing, bearings, instruments, and lube oil system are the same as for single stage gears. The two stage gear solution is only selected in the cases where the price optimization of the coupled machines gives an advantage. Additional free shaft ends can be used to drive other auxilliaries. For gas turbines, integrated two stage gears, covering 50 and 60 cycle generator speeds, can be designed in such a way that only one stage has to be altered in order to provide the other speed.

Figure 36 shows such an application.

3 Planetary Gears

Fig. 37 shows the increased gear ratio range of the planetary gear. Further advantages are the coaxial arrangement, the compactness, and the small interia.

The reason that planetary gears are used relatively infrequently in the turbo machinery field is the limited speed of the low speed side. Further disavantages of planetary gears are: the planet bearing temperature can not be measured, in case of the PU type; lower efficiency; the higher noise, if the annulus gear teeth are not ground; and finally, the higher price for individual production. However planetary gears are very succesful for lower speed high torque applications. See Fig. 38 of a vertical planetary gear on the test bed and Fig. 39 of a planetary gear between water turbine and generator.

For special applications i.e. gearsets for "gensets" (low speed), an integrated design with optimised layout (elimination of the high speed bearing) is possible. Improved efficiencies compared with parallel shaft gears and lower overall costs due to smaller parts can be achieved with a planetary gear solution. Fig. 40 shows the gear with shaft between a gas turbine and sun pinion. Fig. 41 shows a two stage planetary gear between a gas turbine and generator and Fig. 42 a two stage planetary gear with the flexpin design.

4. System Design

MAAG considers as the main goal of the system design to find, for each application, a reliable solution at reasonable costs. You, our customer feel the pulse of life, the dreams for new products, the requirements of new energy and the desire for more saftey. Feasibility studies have to be made and at this point we are in a position to assist you first. The optimization of the modern turbo machinery layout should be coordinated with a large variety of gear options in order to find the highest efficiency, and the easiest maintenance, at reasonable costs. Fig. 43,44.

5 Quality Assurance Program

The MAAG quality assurance program is the umbrella that protects the customer against many kinds of perils. As an attachment to this paper, some examples of test plans used for turbo gears are provided. These take into consideration the various specifications such as AGMA, API, DIN etc., see Fig. 45, 46, 47.

COMPARISON AGMA - MAAG GEAR TOOTH ACCURACIES

Gear Data:

Type: GB-50

Z1 : 103 dia 27.05 in

Z2 : 46 dia 12.08 in

m : 6.5 diametral pitch 3.9

Tooth Accuracy: - AGMA 12

- MAAG S10

	AGMA	MAAG
Pinion		
Pitch variation fpt	2.9	1.3
Profil variation Ff	4.5	1.4
Runout	13.9	9.1
Gear		
Pitch variation	3.3	1.4
Profil variation	5.6	1.6
Runout	19.6	10.2

values in 1/1000 inch

Fig. 10 Comparison between AGMA Quality 12 and Maag Quality S10

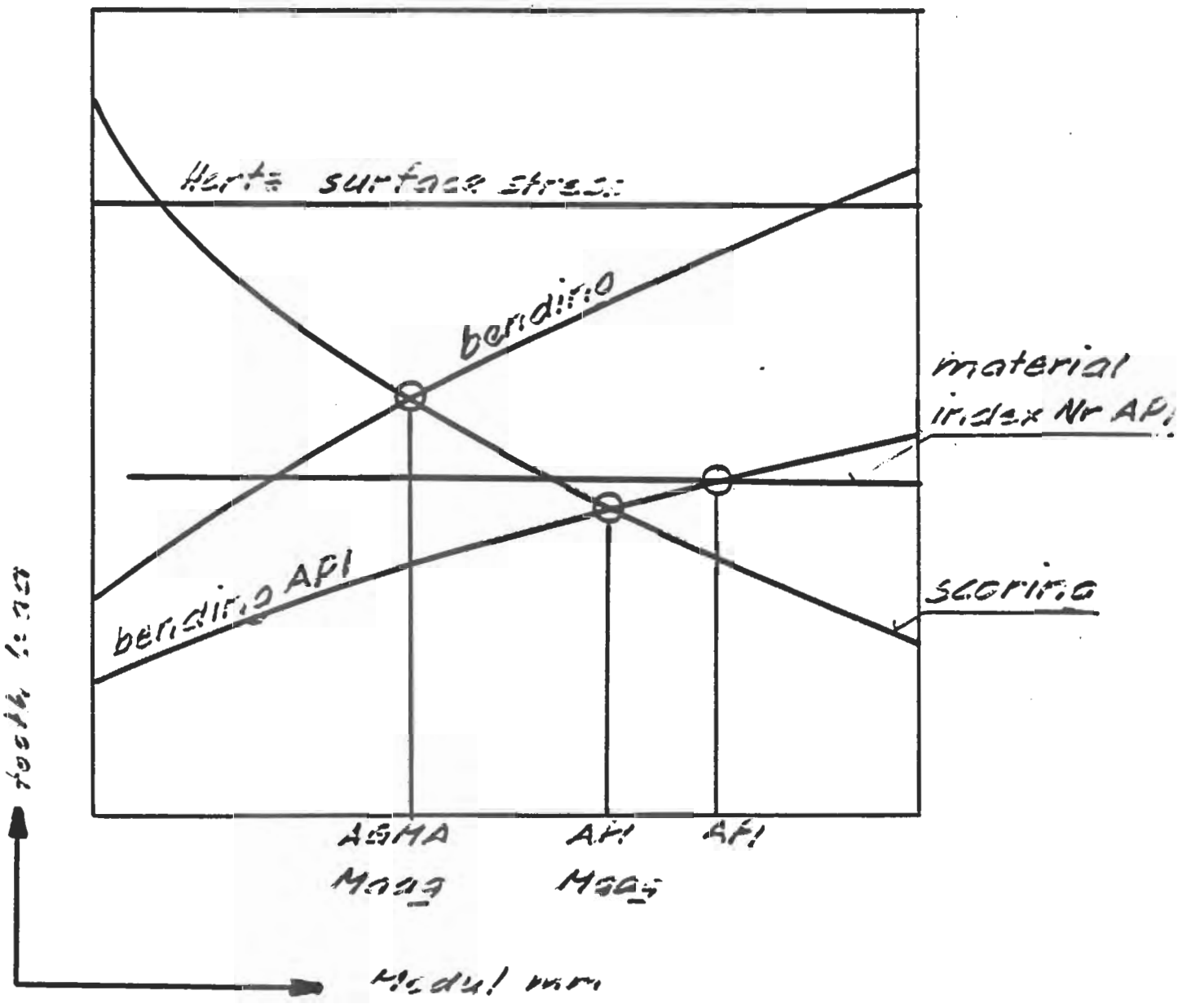


Fig. 11 Comparison between APJ tooth layout and Maag

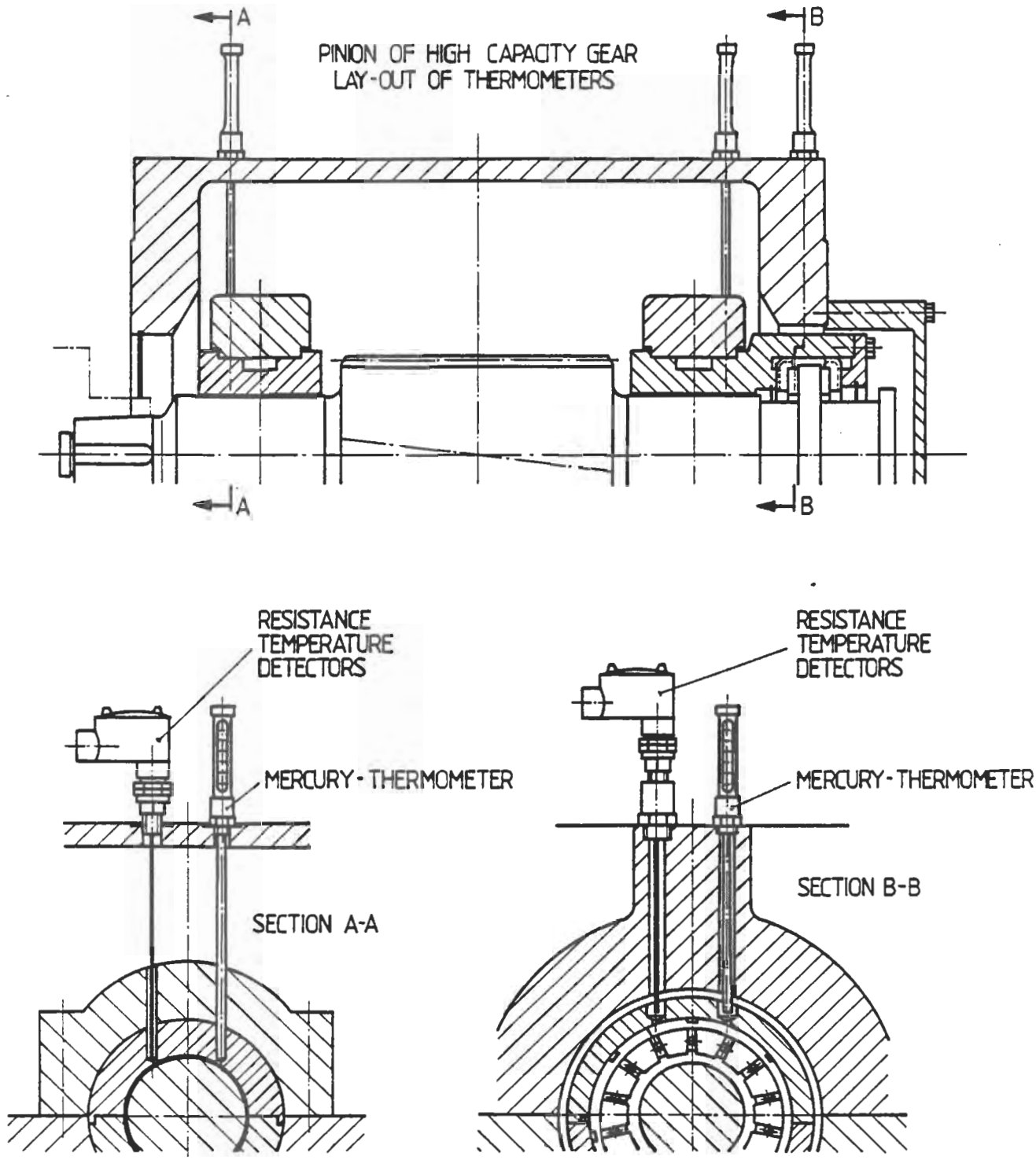


Fig. 18 Thermometers for direct measurement

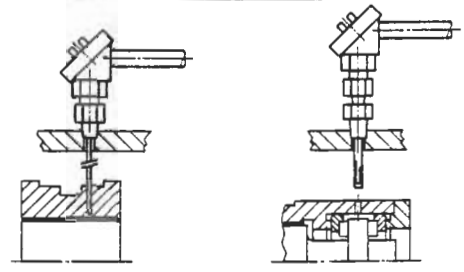
VERSION M

RIGID OR FLEXIBLE CONDUITS TO JUNCTION BOX SUPPLIED BY MAAG

PROBE TYPE INSTR. [SIMPLEX OR DUPLEX]

TIP SENSITIVE, FOR USE IN:
RADIAL BEARINGS
TILTING PAD THRUST BEARINGS AT OIL OUTLET

THERMOCOUPLES: TC356 [SIMPLEX]
TC357 [DUPLEX]
RESISTANCE TEMP. DETECTORS: S4044 [SIMPLEX]
S4046 [DUPLEX]

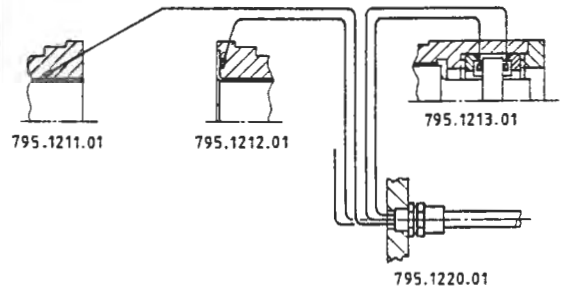


BEARING EMBEDDED TYPE INSTR. [SIMPLEX]

STEM SENSITIVE, FOR USE IN:
RADIAL BEARINGS
TAPERLAND BEARINGS
TILTING PAD THRUST BEARINGS AT OIL OUTLET

THERMOCOUPLES: TC344

RESISTANCE TEMP. DETECTORS: S341



BEARING EMBEDDED TYPE INSTR. [DUPLEX]

TIP SENSITIVE, FOR USE IN:
RADIAL BEARINGS ONLY

[TAPERLAND AND TILTING PAD THRUST BEARINGS: USE TWO EMBEDDED TYPE SIMPLEX INSTR. AS A SUBSTITUTE FOR 1 DUPLEX]

THERMOCOUPLES: TC357
APPLY FOR GEAR SIZES GN-_____ GS-_____
GB-_____ GO-72÷98

RESISTANCE TEMP. DETECTORS: S4046
APPLY FOR GEAR SIZES GN-45÷100 GS-100
GB-40÷60 GO-72÷98

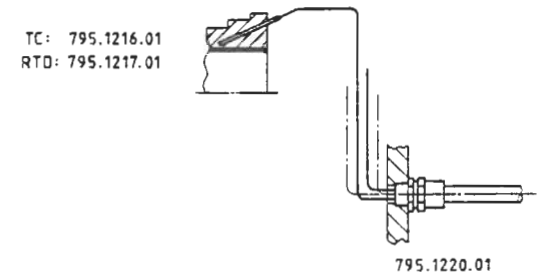


Fig. 19 Probe type and bearing embedded type instruments

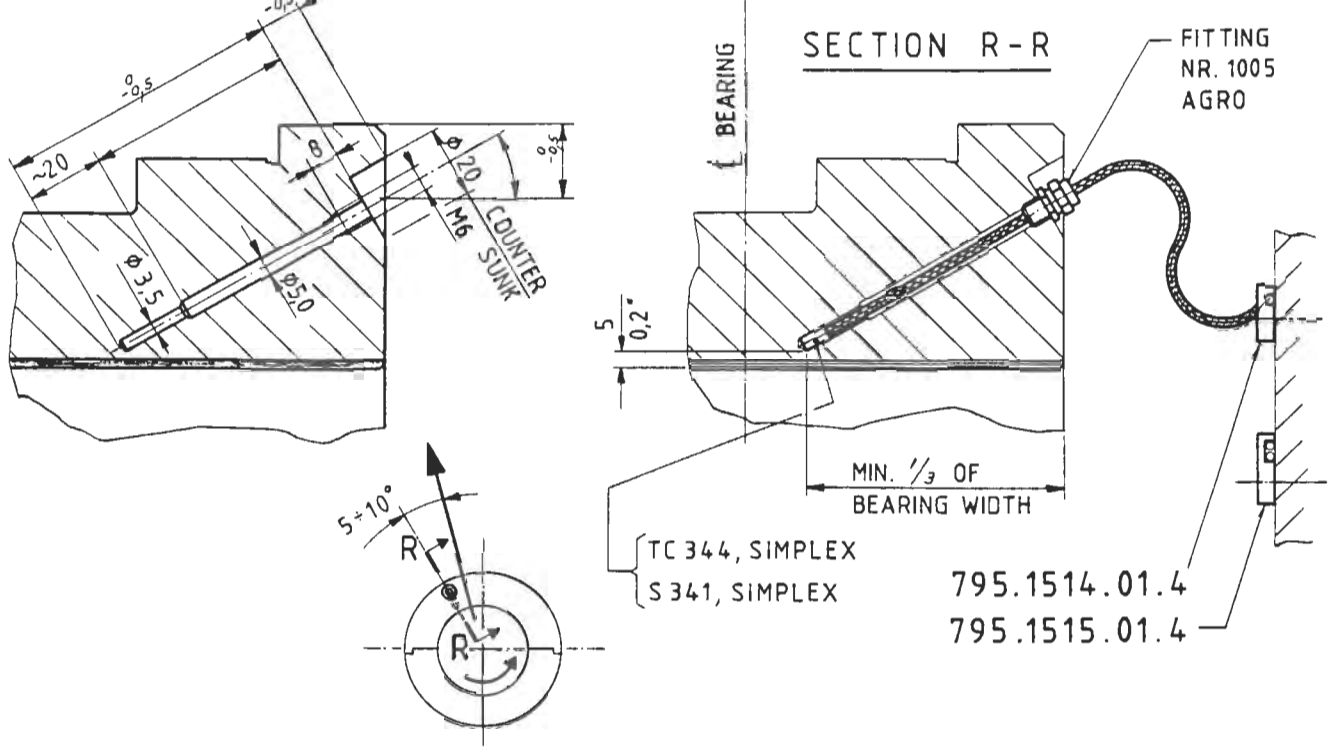


Fig. 20 Technical details of embedded type TC and RTD's in radial bearings

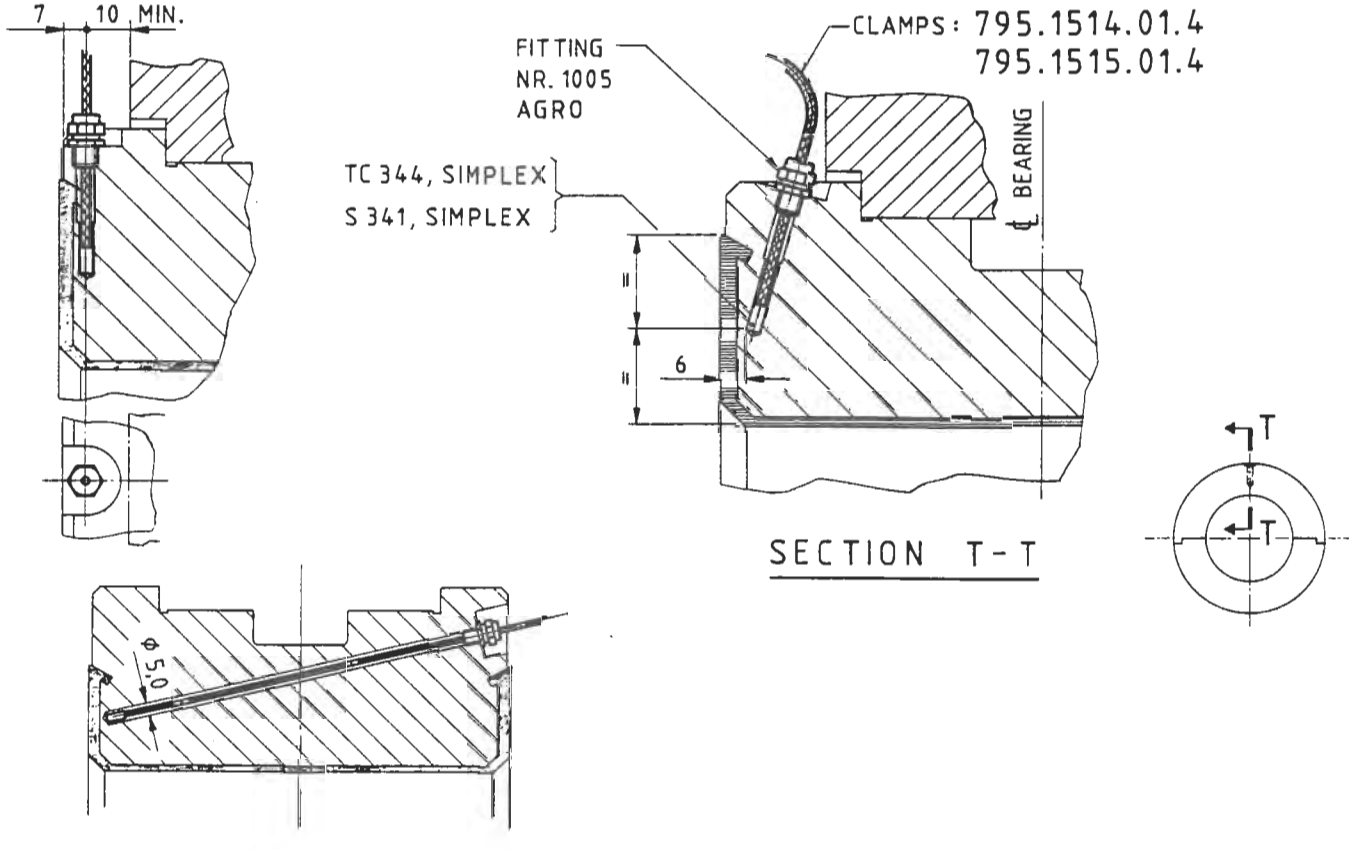


Fig. 21 Technical details of embedded type TC and RTD's in taper land axial thrust bearing

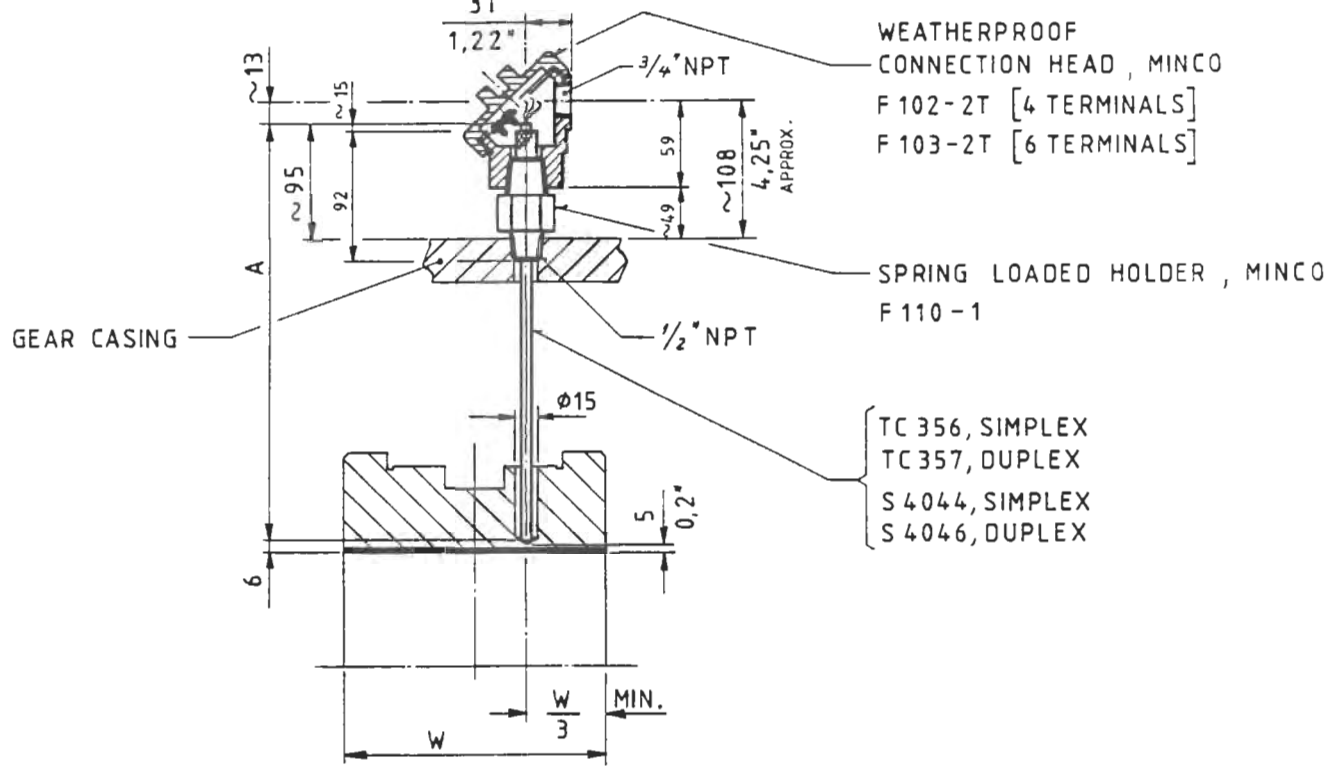


Fig. 22 Technical details of instruments for radial bearings mounted from outside of the casing

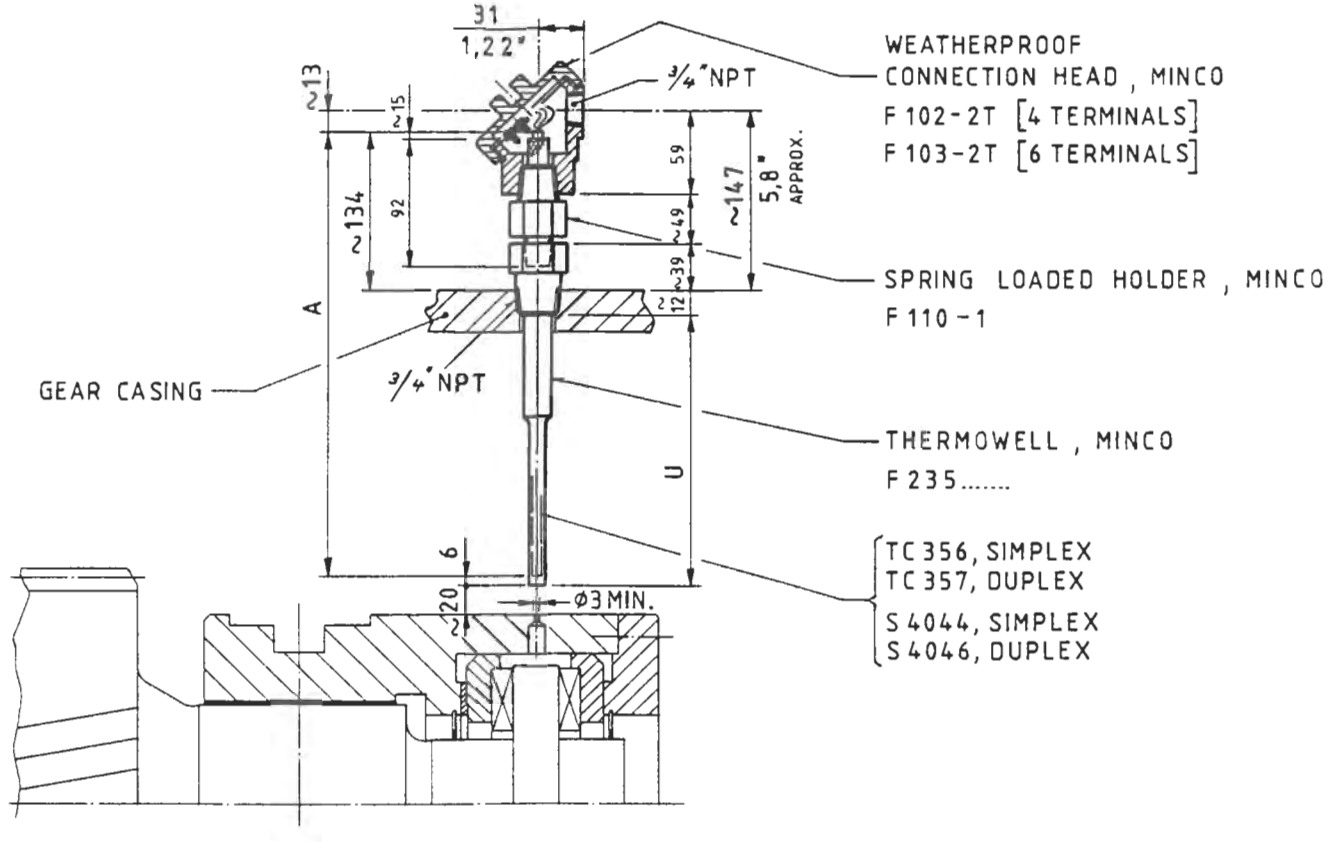
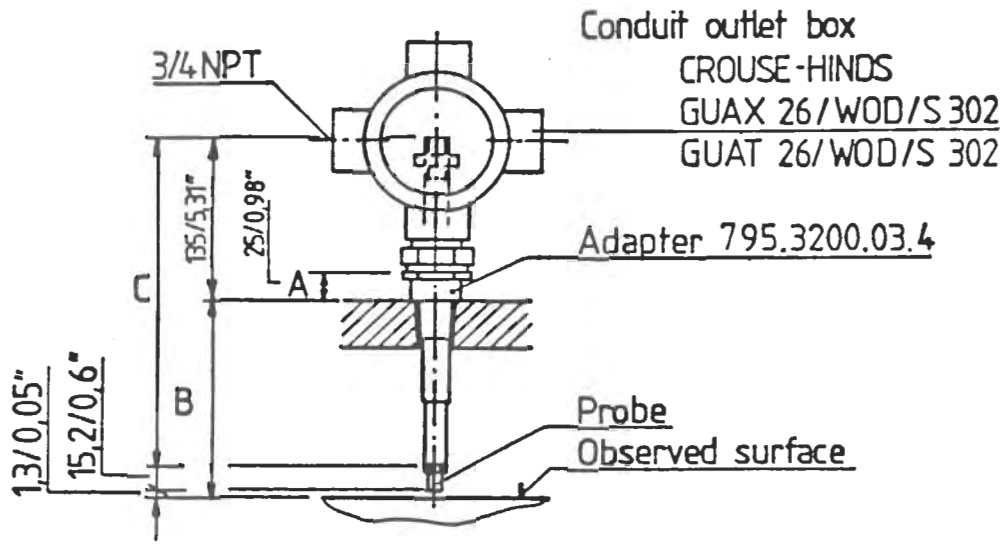


Fig. 23 Technical details of instruments for axial bearings mounted from outside of the casing



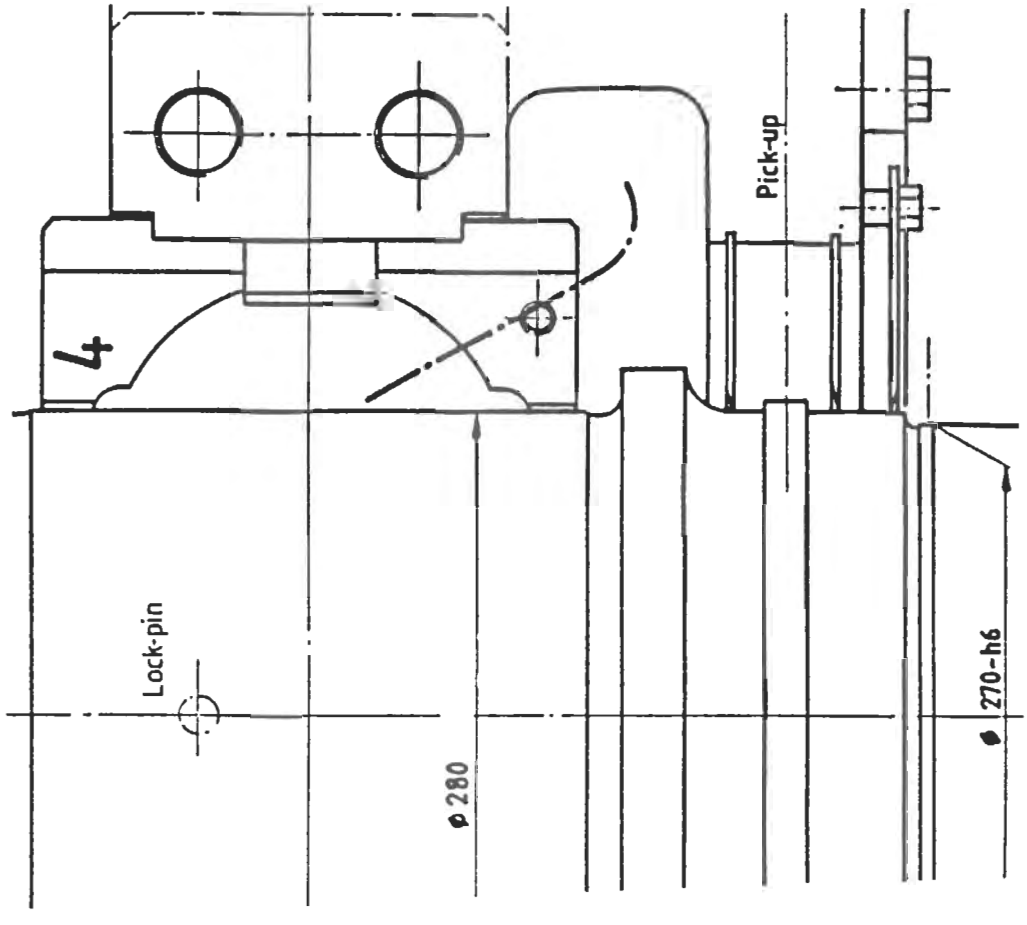
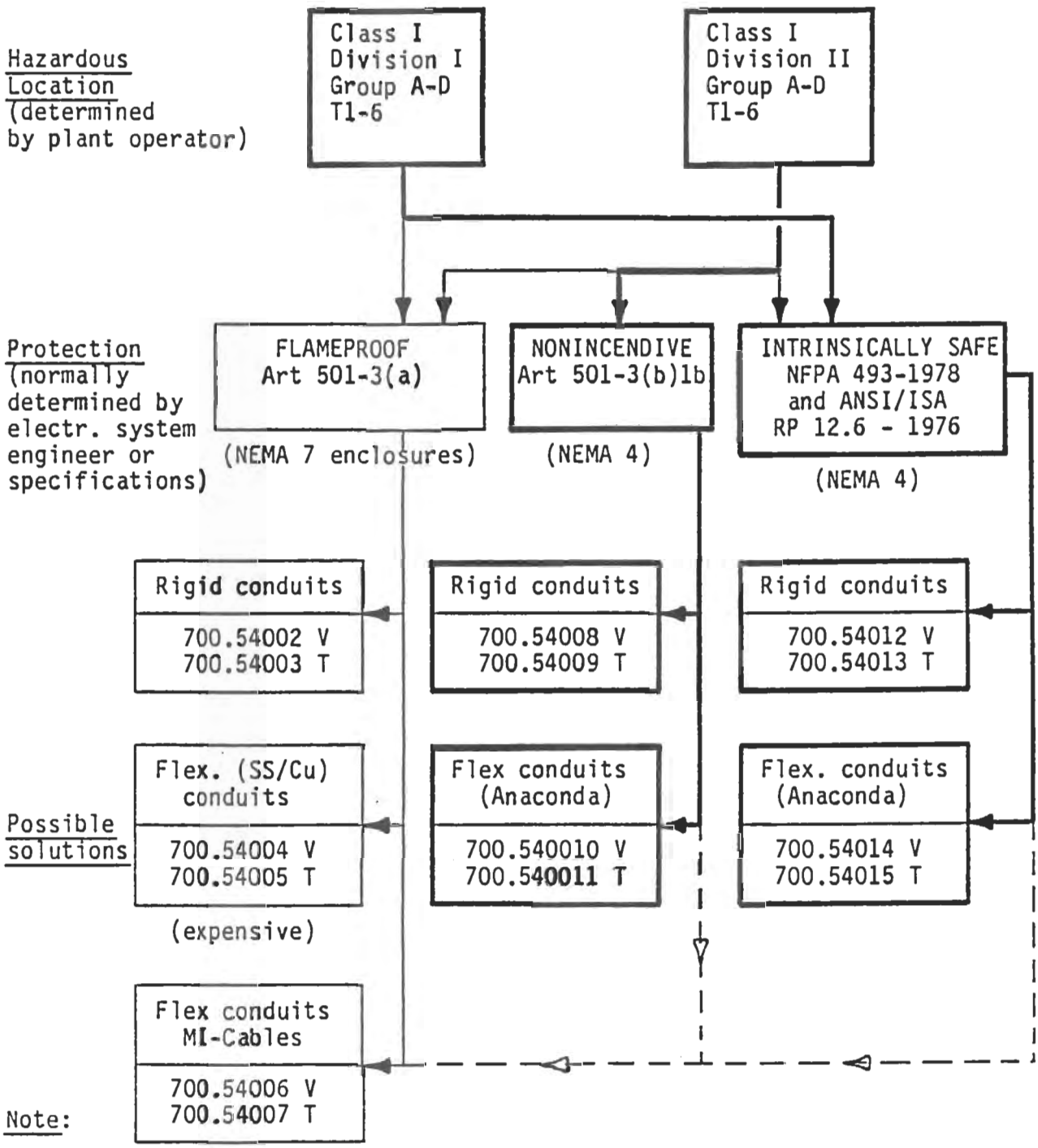


Fig. 24

Technical details of the measured surface for a pick-up

NEC - NATIONAL ELECTRICAL CODE
Article 501 - Class I Locations
EXPLOSION PROTECTON FOR INSTRUMENTS ON GEARS

Preferred (▬) and possible (-) solutions for
Vibration and Temperature Monitoring Instruments



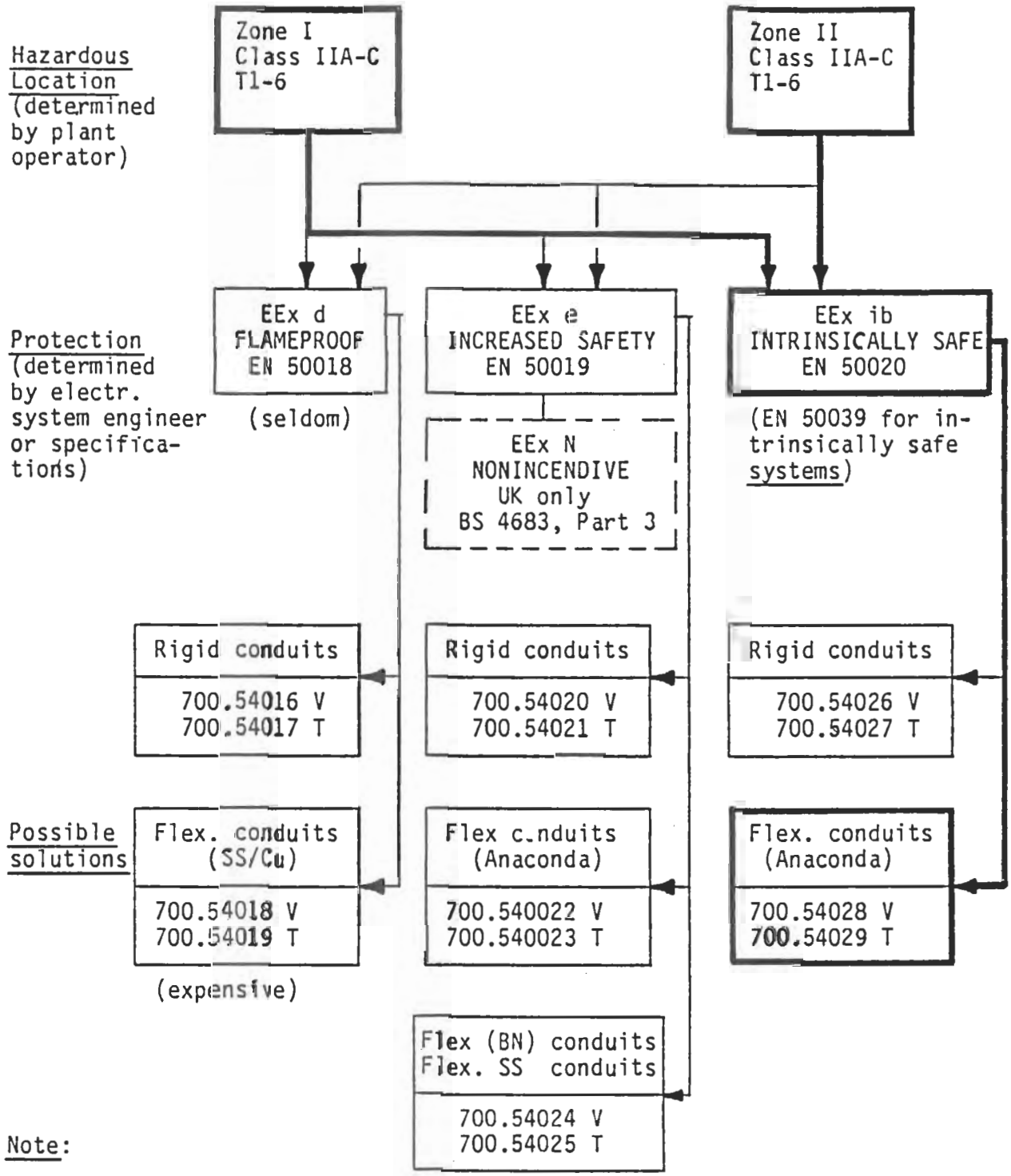
Care shall be exercised with respect to selection of components as customer specifications may call for requirements beyond the NE-Code.

Fig. 25

Recommendation for explosion protection for instruments on gears for NEC

C E N E L E C
EN 50014
EXPLOSION PROTECTION FOR INSTRUMENENTS ON GEARS

Prefered —) and possible -) solutions for
Vibration and Temperature Monitoring Instruments



Note:

Care shall be exercised with respect to selection of components as customer specifications may call for requirements beyond the Code.

Fig. 26

Recommendation for explosion protection for instruments on gears for CENELEC

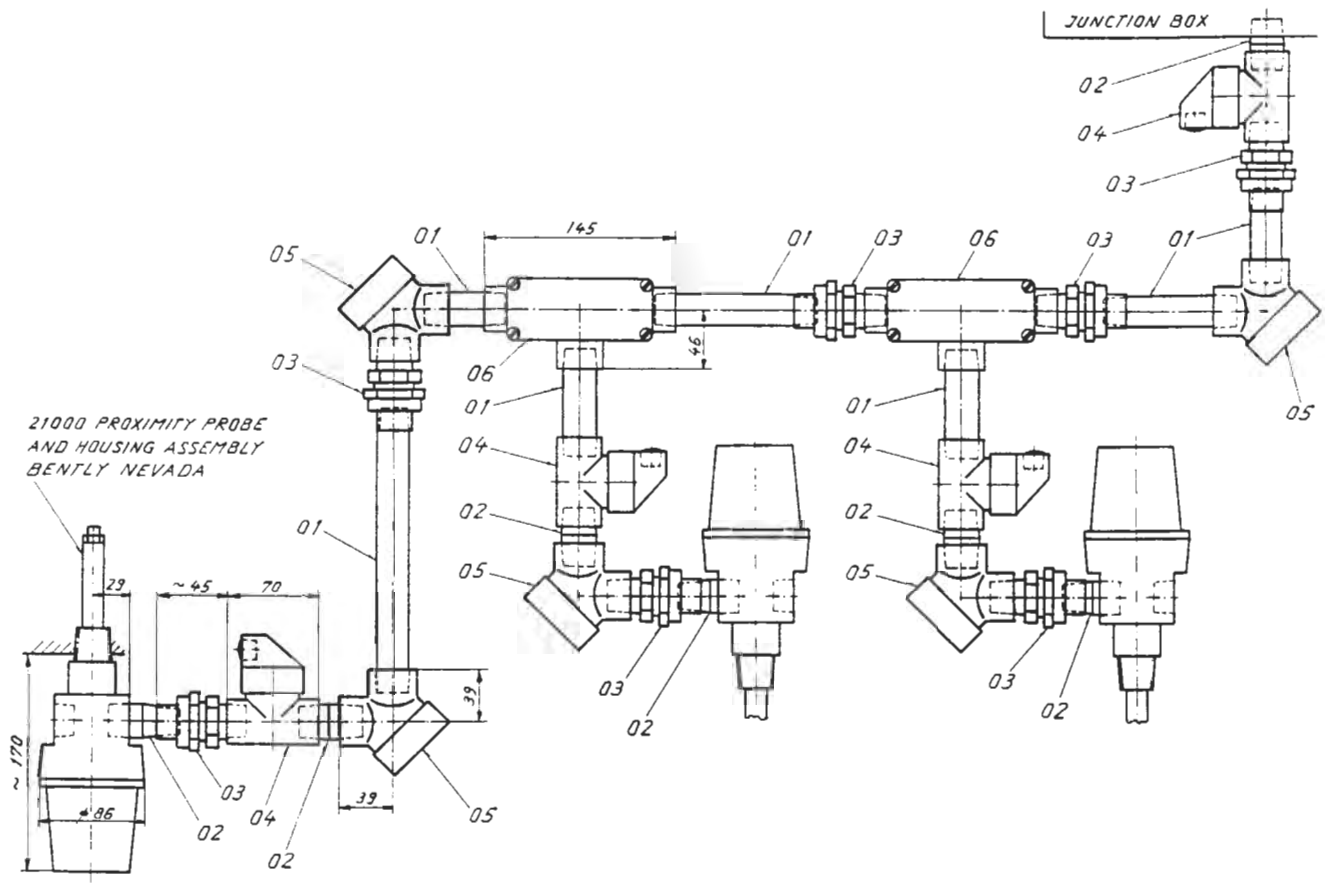


Fig. 27 Example of rigid conduit connection for vibration equipment

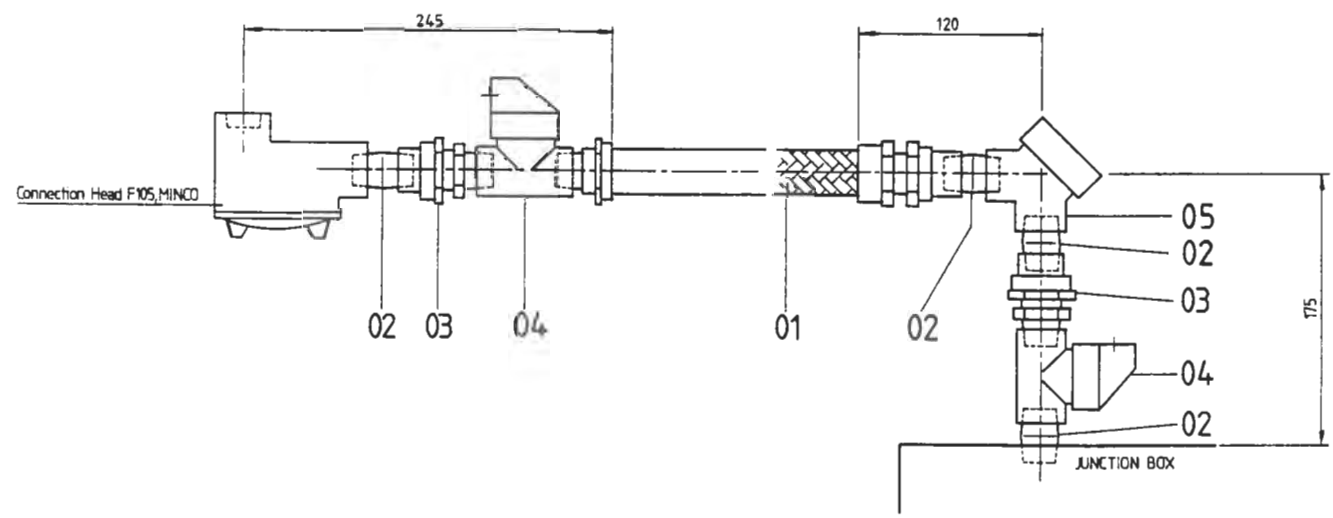


Fig. 28 Example of flexible conduit for stencil type thermometers

M A A G Q U A L I T Y A S S U R A N C E

INSTRUMENTS ON GEARS IN HAZARDOUS AREAS
(NATIONAL ELECTRICAL CODE - ART. 500)

*** MAAG Standard 1 ***
NONINCENDIVE EQUIPMENT FOR VIBRATION AND TEMPERATURE MONITORING SYSTEMS
GALVANIZED RIGID CONDUITS

Protection: Nonincendive equipment (NEC Art. 501.3(b)1b)
NEMA 4 (min) enclosures
Rigid conduits

Hazardous Location: Class I/Division 2/Group C & D/T1-4

1 **Electrical Equipment:** approved for specified location (by FM or CSA)

1.1 Probe, extension cable and proximitor
Supplier : Bently Nevada, 7200 Series

1.2 RTD/TC probe and extension cable
Supplier : Minco
Approval : not required

2 **Proximitor Housing/RTD/TC Marshalling Box:**

Supplier : BENTLY NEVADA/CROUSE HINDS
Type : NEMA 4
Material : hot dip galvanized steel sheet
Approval : UL/CSA
Inlet/Outlet : 3/4"/1 1/4" NPT

3 **Vibration Probe Holder:** approved by UL/CSA

Supplier : Crouse-Hinds
Type : GUAX 26/NEMA 7
Material : Feralloy

4 **Conduits:**

Type : rigid
Material : galvanized steel pipe 1/2 "
Fittings:

Fitting	Type	Material	Supplier
Red. nippel 3/4-1/2	RE 21	galv. steel	Crouse-Hinds
Nippel	NP 1	galv. steel	Crouse-Hinds
Union	UNY 105	galv. steel	Crouse-Hinds
Capped elbow	LBY 15	feralloy	Crouse-Hinds
T-type conduit body	OET 1	feralloy	Crouse-Hinds
Gland fitting	MAAG	ss	MAAG

Fig. 29-36 Instruments on gears in hazardous areas
Maag Standard 1-8

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M A A G Q U A L I T Y A S S U R A N C E

INSTRUMENTS ON GEARS IN HAZARDOUS AREAS
(NATIONAL ELECTRICAL CODE - ART. 500)

***** MAAG Standard 2 *****
NONINCENDIVE EQUIPMENT FOR VIBRATION AND TEMPERATURE MONITORING SYSTEMS
FLEXIBLE CONDUITS (ANACONDA "SEALTITE")

Protection: Nonincendive equipment (NEC Art. 501.3(b)1b)
NEMA 4 (min) enclosures
Flexible conduits

Hazardous Location: Class I/Division 2/Group C & D/T1-4

1 **Electrical Equipment:** approved for specified location (by FM or CSA)

1.1 Probe, extension cable and proximitor
Supplier : Bently Nevada, 7200 Series

1.2 RTD/TC probe and extension cable
Supplier : Minco
Approval : not required

2 **Proximitor Housing/RTD/TC Marshalling Box:**

Supplier : BENTLY NEVADA/CROUSE HINDS
Type : NEMA 4
Material : hot dip galvanized steel sheet
Approval : UL/CSA
Inlet/ Outlet : 3/4"/1 1/4" NPT

3 **Vibration Probe Holder:** approved by UL/CSA

Supplier : CROUSE-HINDS
Type : GUAX 26/NEMA 7
Material : Feralloy

4 **Conduits:**

Manufacturer : ANACONDA
Type : U.A., flexible, sealtight with T & B fitings, 1/2" NPT
Ingress Protection : IP 66
Approval : UNDERWRITERS LABORATORIES (UL)

Fig. 30

M A A G Q U A L I T Y A S S U R A N C E

INSTRUMENTS ON GEARS IN HAZARDOUS AREAS
(NATIONAL ELECTRICAL CODE - ART. 500)

***** MAAG Standard 3 *****
INTRINSIC SAFETY FOR VIBRATION AND TEMPERATURE MONITORING EQUIPMENT
GALVANIZED RIGID CONDUITS

Protection: Intrinsically safe equipment
NEC Art. 500-1/NFPA 493-1978
ANSI/ISA RP 12.6
NEMA 4 enclosures
Rigid conduits

Hazardous Location: Class I/Division 1 & 2/Group A-D/T1-6

1 **Electrical Equipment:** approved for specified location (by FM or CSA)

1.1 Probe, extension cable and proximitor
Supplier : Bently Nevada, 7200 Series

1.2 RTD/TC probe and extension cable
Supplier : Minco
Approval : not required

2 **Proximitor Housing/RTD/TC Marshalling Box:**

Supplier : BENTLY NEVADA/CROUSE HINDS
Type : NEMA 4
Material : Steel sheet or feralloy
Blue label on box: INTRINSICALLY SAFE CIRCUIT
Terminals : blue
Inlet/Outlet : 3/4"/1 1/4" NPT

3 **Vibration Probe Holder:**

Supplier : Crouse-Hinds
Type : GUAX 26/NEMA 7
Material : Feralloy

4 **Conduits:**

Type : rigid
Material : galvanized steel pipe 1/2"

Fitting	Type	Material	Supplier
Red. nippel 3/4-1/2	RE 21	galv. steel	Crouse-Hinds
Nippel	NP 1	galv. steel	Crouse-Hinds
Union	UNY 105	galv. steel	Crouse-Hinds
Capped elbow	LBY 15	feralloy	Crouse-Hinds
T-type conduit body	OET 1	feralloy	Crouse-Hinds
Gland fitting	MAAG	ss	MAAG

Fig. 31

M A A G Q U A L I T Y A S S U R A N C E

INSTRUMENTS ON GEARS IN HAZARDOUS AREAS
(NATIONAL ELECTRICAL CODE - ART. 500)

***** MAAG Standard 4 *****
FLAMEPROOF EQUIPMENT FOR VIBRATION AND TEMPERATURE MONITORING SYSTEMS
RIGID CONDUITS

Protection: Flameproof equipment (NEC Art. 501)
NEMA 7 enclosures
Rigid conduits

Hazardous Location: Class I/Division 1 & 2/Group C & D/T1-4

1 **Electrical Equipment:** approved for specified location (by FM or CSA)

1.1 Probe, extension cable and proximitor
Supplier : Bently Nevada, 7200 Series

1.2 RTD/TC probe and extension cable
Supplier : Minco
Approval : not required

2 **Proximitor Housing/RTD/TC Marshalling Box:** approved by UL/CSA

Supplier : BENTLY NEVADA/CROUSE HINDS
Type : NEMA 7
Material : Galvanized feralloy
Inlet/Outlet : 3/4"/1 1/4" NPT

3 **Vibration Probe Holder:** approved by UL/CSA

Supplier : Crouse-Hinds
Type : GUAX 26/NEMA 7
Material : Galvanized feralloy

4 **Conduits:** approved by UL/CSA
Type : rigid
Material : galvanized steel pipe 1/2 "
Fittings:

Fitting	Type	Material	Supplier
Red. nippel 3/4-1/2	RE 21	galv. steel	Crouse-Hinds
Nippel	NP 1	galv. steel	Crouse-Hinds
Union	UNY 105	galv. steel	Crouse-Hinds
Capped elbow	LBY 15	feralloy	Crouse-Hinds
T-type conduit body	OET 1	feralloy	Crouse-Hinds
Sealing fitting	EYS 1	alu	Killark
Gland fitting	MAAG	ss	MAAG

Fig. 32

M A A G Q U A L I T Y A S S U R A N C E

INSTRUMENTS ON GEARS IN HAZARDOUS AREAS
(CENELEC - EN 50014)

***** MAAG Standard 5 *****
INTRINSIC SAFETY FOR VIBRATION MONITORING EQUIPMENT
INCREASED SAFETY FOR TEMPERATURE MONITORING EQUIPMENT
GALVANIZED RIGID CONDUITS

Protection: Intrinsic safety - EEx ib 2A-C T1-6 (EN 50020)
Increased safety - EEx e 2A-C T1-6 (EN 50019)
IP 65 enclosures in acc with IEC 144
Galvanized rigid conduits

Hazardous Location: Zone 1 & 2 / Group IIA-C / T1-6

1 **Electrical Equipment:** approved for specified location (by BASEEFA or equal)

1.1 Probe, extension cable and proximitor
Supplier : Bently Nevada, 7200 Series

1.2 RTD/TC probe and extension cable
Supplier : Minco
Approval : not required

2 **a) Proximitor Housing, b) Marshalling Box (RTD,TC):**

Supplier : KLIPPON, STAHL or BBC
Ingress Protection : IP 65
Material : Hot dip galvanized steel sheet
a)Blue label on box: **INTRINSICALLY SAFE CIRCUIT**
b)Certification : **BASEEFA certified unit**

3 **Vibration Probe Holder:**
Supplier : Crouse-Hinds
Type : GUAX 26/NEMA 7
Material : Feralloy

4 **Conduits** : rigid, galvanized steel pipe 1/2"

Fitting	Type	Material	Supplier
Red. nippel 3/4-1/2	RE 21	galv. steel	Crouse-Hinds
Nippel	NP 1	galv. steel	Crouse-Hinds
Union	UNY 105	galv. steel	Crouse-Hinds
Capped elbow	LBY 15	feralloy	Crouse-Hinds
T-type conduit body	OET 1	feralloy	Crouse-Hinds
Gland fitting	MAAG	ss	MAAG

Fig. 33

MAAG ZURICH

M A A G Q U A L I T Y A S S U R A N C E

INSTRUMENTS ON GEARS IN HAZARDOUS AREAS
(CENELEC - EN 50014)

***** MAAG Standard 6 *****
INTRINSIC SAFETY FOR VIBRATION MONITORING EQUIPMENT
INCREASED SAFETY FOR TEMPERATURE MONITORING EQUIPMENT
FLEXIBLE SEALTITE CONDUITS

Protection: Intrinsic safety - EEx ib 2A T1-4 (EN 50020)
Increased safety - EEx e 2A T1-4 (EN 50019)
IP 65 enclosures in acc with IEC 144
Flexible conduits (Anaconda "Sealtite")

Hazardous Location: Zone 1 & 2 / Group IIA / T1-4

1 **Electrical Equipment:** approved for specified location (by BASEEFA or equal)

1.1 Probe, extension cable and proximitor
Supplier : Bently Nevada, 7200 Series

1.2 RTD/TC probe and extension cable
Supplier : Minco
Approval : not required

2 **a) Proximitor Housing, b) Marshalling Box (RTD,TC):**

Supplier : KLIPPON, STAHL or BBC
Ingress Protection : IP 65
Material : Hot dip galvanized steel sheet
a)Blue label on box: **INTRINSICALLY SAFE CIRCUIT**
b)Certification : BASEEFA certified unit

3 **Vibration Probe Holder:**

Supplier : Crouse-Hinds
Type : GUAX 26/NEMA 7
Material : Feralloy

4 **Conduits:**

Manufacturer : Anaconda
Type : E.F., flexible, sealtight with T & B fitings, 1/2" NPT
Ingress Protection : IP 66
Approval : VDE

Fig. 34

M A A G Q U A L I T Y A S S U R A N C E

INSTRUMENTS ON GEARS IN HAZARDOUS AREAS
(CENELEC - EN 50014)

***** MAAG Standard 7 *****
INTRINSICALLY SAFE EQUIPMENT FOR VIBRATION TEMPERATURE MONITORING SYSTEMS GALVANIZED RIGID CONDUITS

Protection: Intrinsic safety - EEx ib 2A-C T1-6
in acc with EN 50020
IP 54 enclosures in acc with IEC 144
Rigid conduits

Hazardous Location: Zone 1 & 2 / Group IIA-C / T1-6

1 **Electrical Equipment:** approved for specified location
(by BASEEFA or equal)

1.1 Probe, extension cable and proximitor
Supplier : Bently Nevada, 7200 Series

1.2 RTD/TC probe and extension cable
Supplier : Minco
Approval : not required

2 **Proximitor Housing/RTD/TC Marshalling Box:**

Supplier : KLIPPON, STAHL or BBC
Type : IP 54
Material : Steel sheet, epoxy coating
Blue label on box: INTRINSICALLY SAFE CIRCUIT
Terminals : blue

3 **Vibration Probe Holder:**

Supplier : Crouse-Hinds
Type : GUAX 26/NEMA 7
Material : Feralloy

4 **Conduits:**

Type : rigid
Material : galvanized steel pipe 1/2"
Fittings :

Fitting	Type	Material	Supplier
Red. nippel 3/4-1/2	RE 21	galv. steel	Crouse-Hinds
Nippel	NP 1	galv. steel	Crouse-Hinds
Union	UNY 105	galv. steel	Crouse-Hinds
Capped elbow	LBY 15	feralloy	Crouse-Hinds
T-type conduit body	OET 1	feralloy	Crouse-Hinds
Gland fitting	MAAG	ss	MAAG

Fig. 35

M A A G Q U A L I T Y A S S U R A N C E

INSTRUMENTS ON GEARS IN HAZARDOUS AREAS
(CENELEC - EN 50014)

*** MAAG Standard 8 ***
FLAMEPROOF EQUIPMENT FOR VIBRATION AND TEMPERATURE MONITORING SYSTEMS
RIGID CONDUITS

Protection: Flameproof - EEx d IIA T1-4
in acc with EN 50018,
Flameproof enclosures,
Rigid conduits.

Hazardous Location: Zone 1 & 2/Group IIA/T1-4

1 Electrical Equipment: approved for specified location
(by BASEEFA or equal)

1.1 Probe, extension cable and proximitor
Supplier : Bently Nevada, 7200 Series

1.2 RTD/TC probe and extension cable
Supplier : Minco
Approval : not required

2 Proximitor Housing/RTD/TC Marshalling Box:

Supplier : PETREL/STAHL
Type : Flameproof
Material : Hot dip galvanized cast iron
with epoxy coating
Approval : BASEEFA or equal

3 Vibration Probe Holder:

Supplier : PETREL
Type : 8720 series/flameproof
Material : Hot dip galvanized cast iron
Approval : BASEEFA or equal

4 Conduits:

Type : rigid
Material : galvanized steel pipe 1/2"
Fittings : flameproof (BASEEFA or equal where applic.)

Fitting	Type	Material	Supplier
Red. nippel 3/4-1/2	RE 21	galvanized	PETREL/STAHL
Nippel	NP 1	cast iron	"
Union	UNY 105	"	"
Capped elbow	LBY 15	"	"
T-type conduit body	OET 1	"	"
Sealing fitting	EYS 1	"	"

Fig. 36

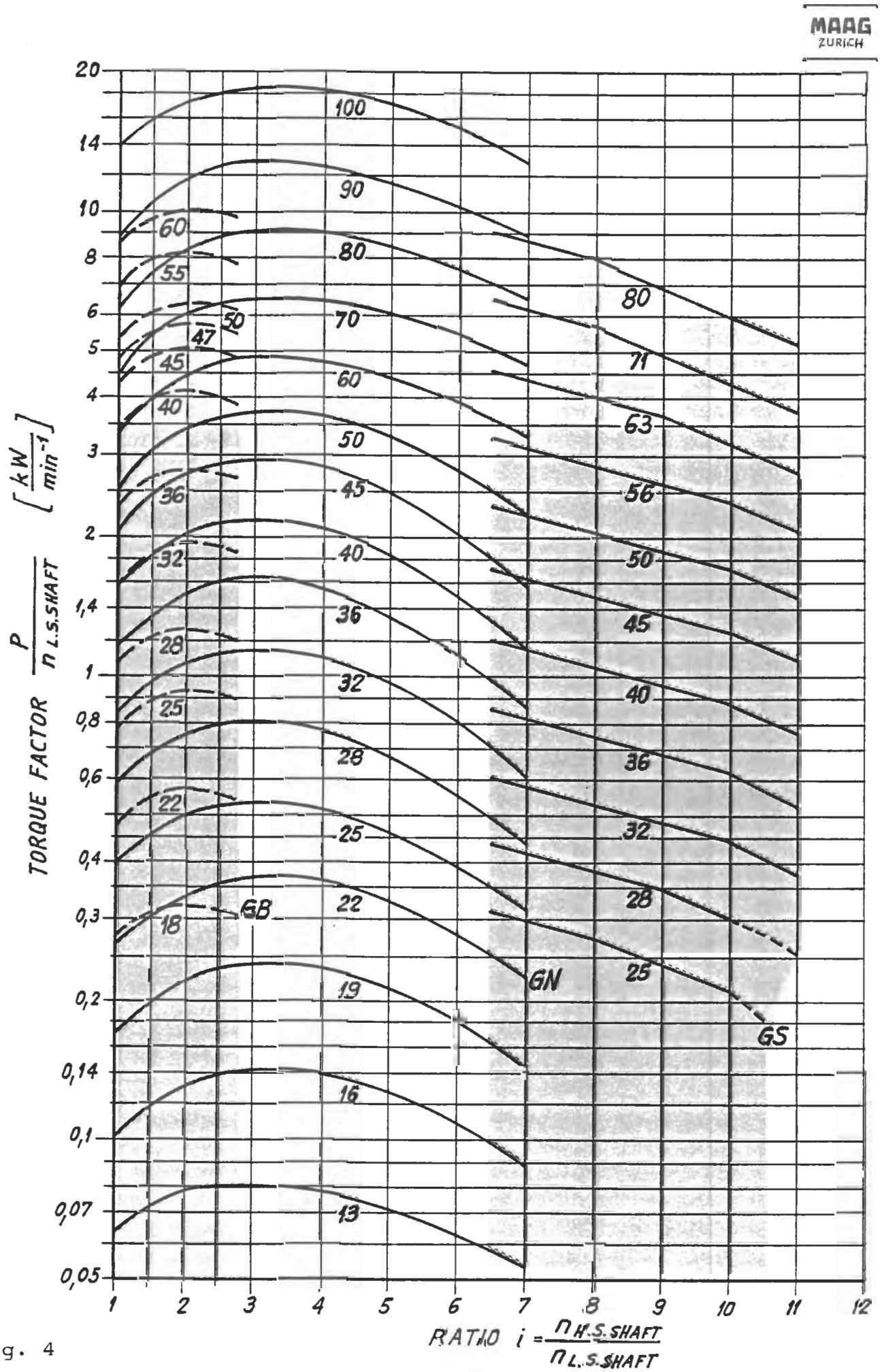

Fig. 4

Torque capacity for parallel shaft gears

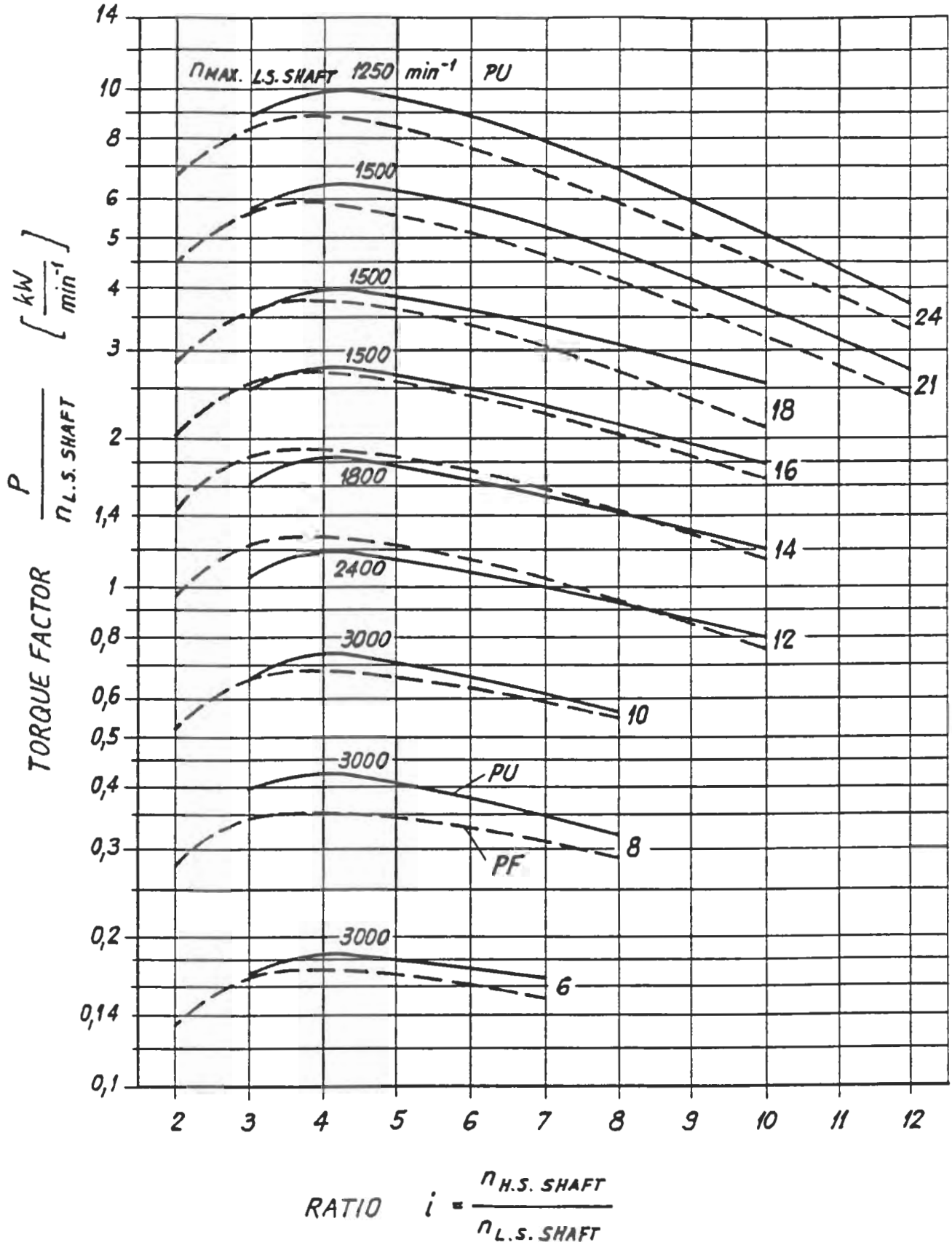

Fig. 38 Torque capacity for planetary gears TPU3-TPF3-Series