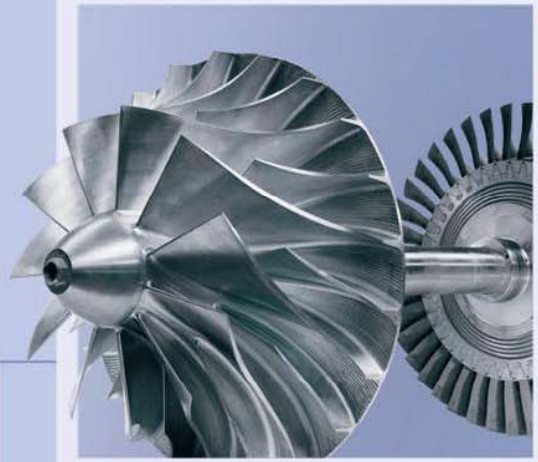
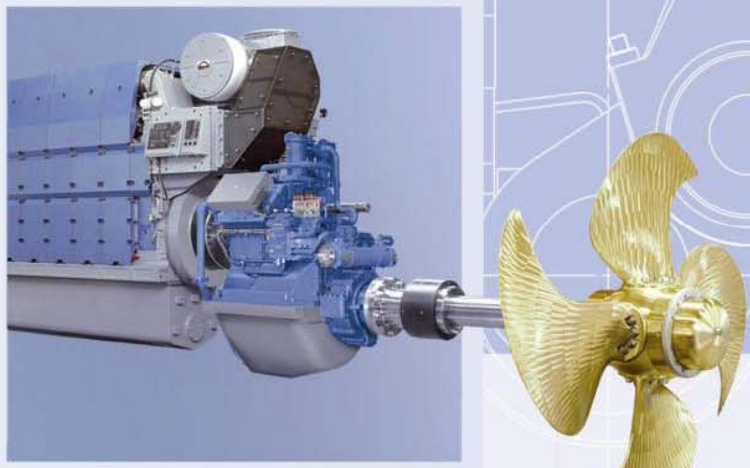
MAN Diesel
ATUC TC Information

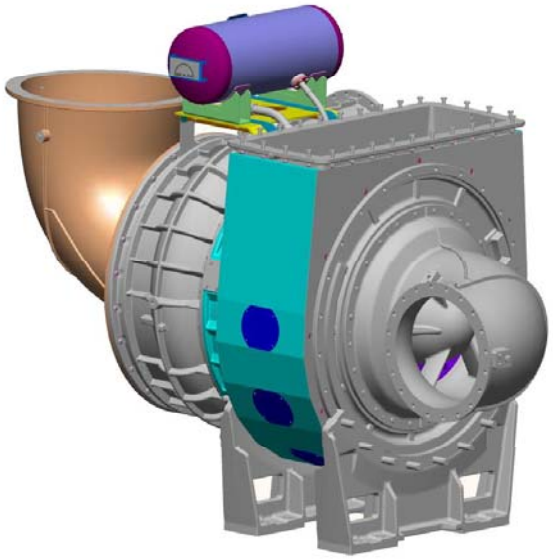


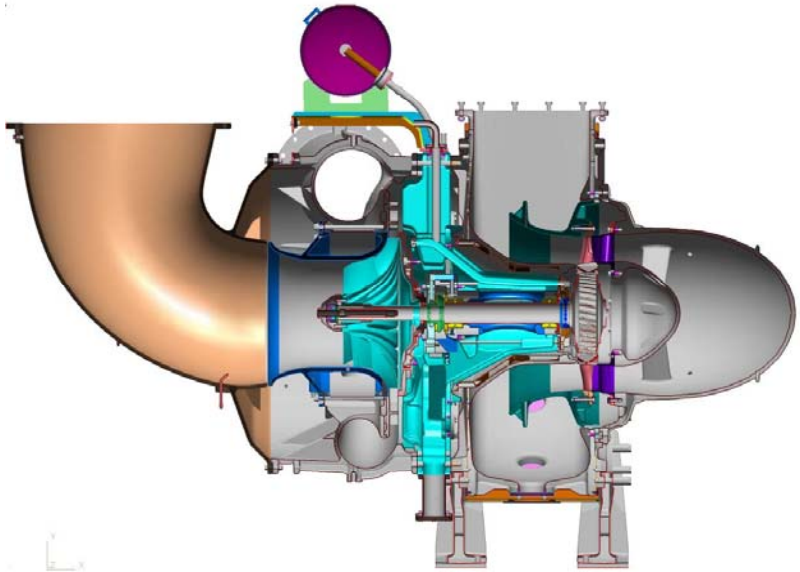


Atuc Turbocharger Service Information Content

Content

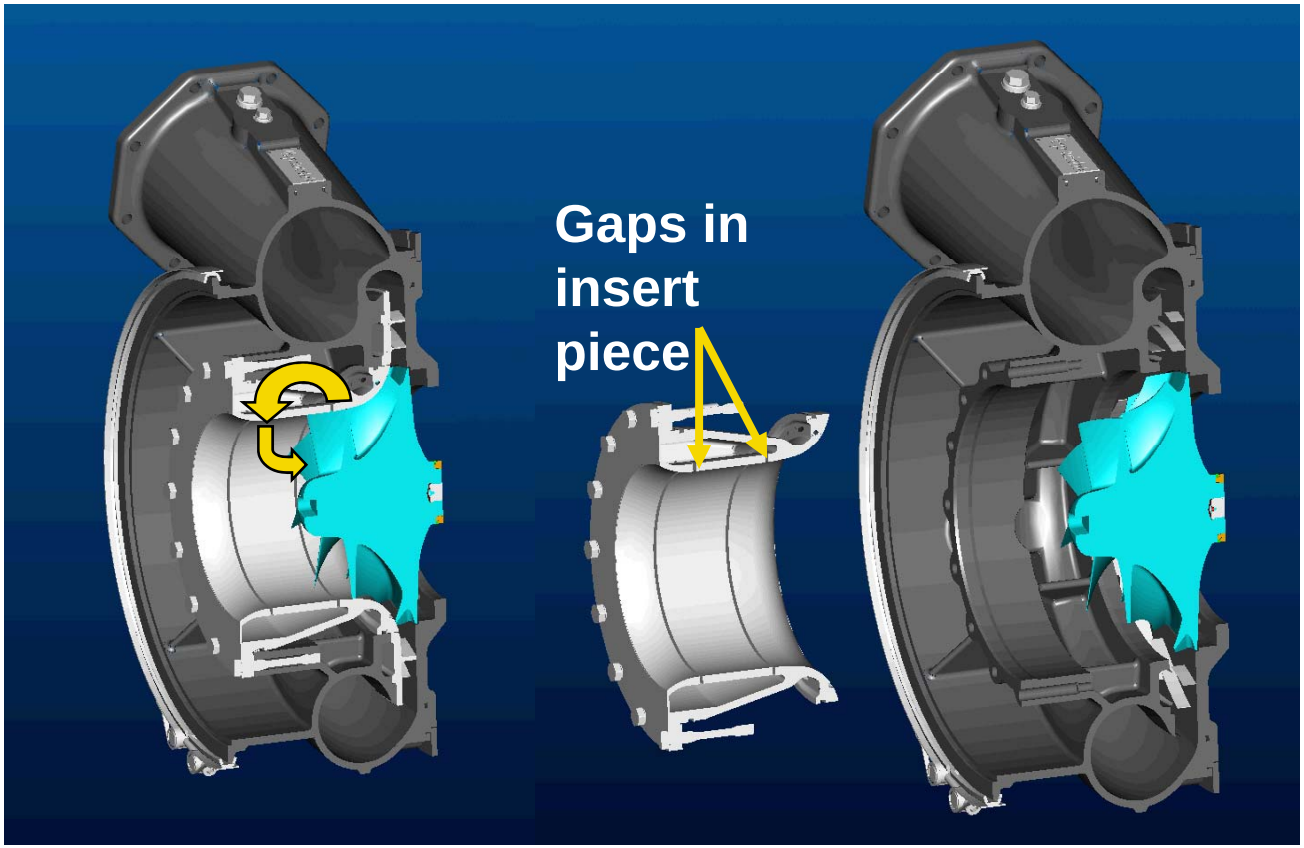
1. Internal Recirculation IRC
2. TCA 88-25 type approval
3. Lube Oil system and bearing for the TCA series
4. Experience with TCA blades
5. Silencer modification
6. Additional customer informations
7. TCR lube oil supply





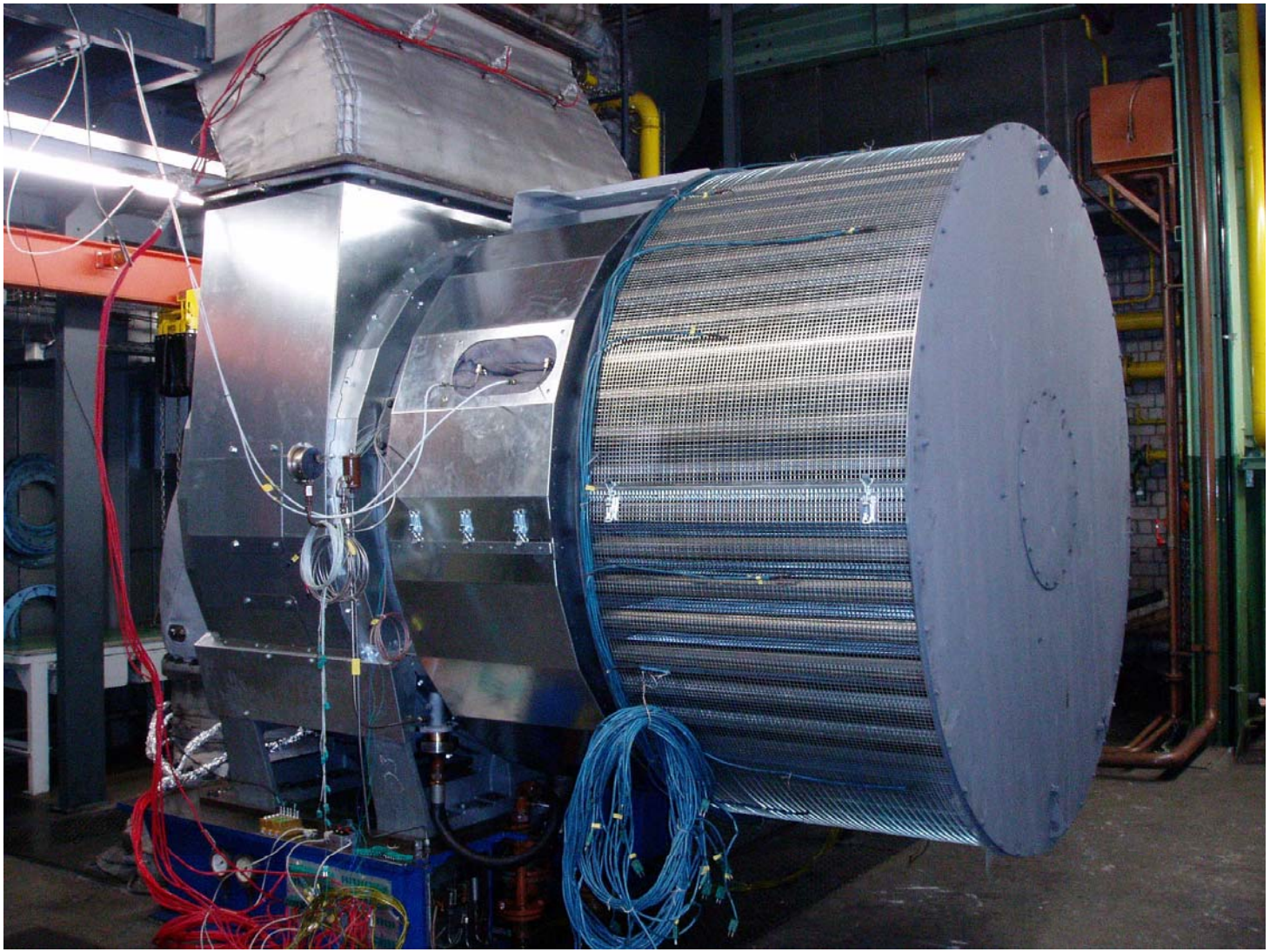
Internal Recirculation (IRC) Available on TCA/TCR

IRC shifts surge line in compressor map



TCA all types
can be equipped with IRC

TCA 88-25 (Extended Version) Type Appoval



TCA 88-25

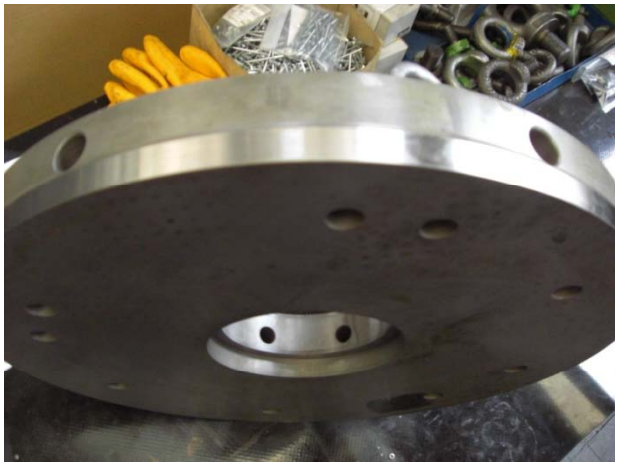
TCA 88-25
Turbine Rotor

TCA 88-25 extended application range with 49 blades instead of 41 blades of the smaller types

TCA 88-25
Bearing body and end cover

TCA 88-25
Bearing elements

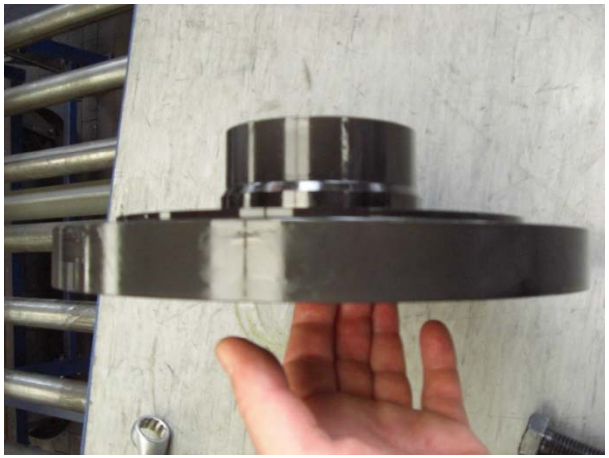
Thrust bearing



6 oil supply bores
2 labyrinth on the ring

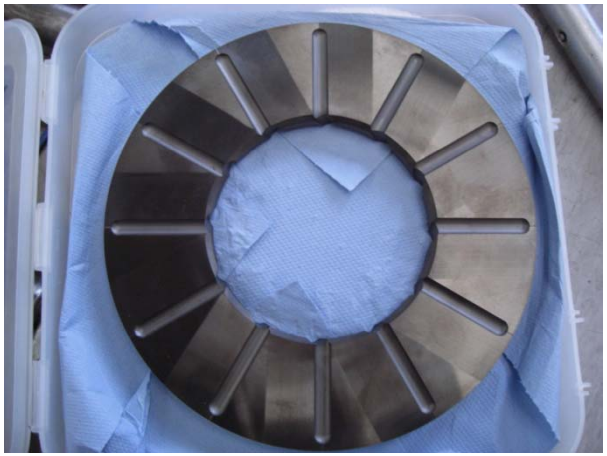
Labyrinth ring

Thrust ring



Diamond like coating (DLC)

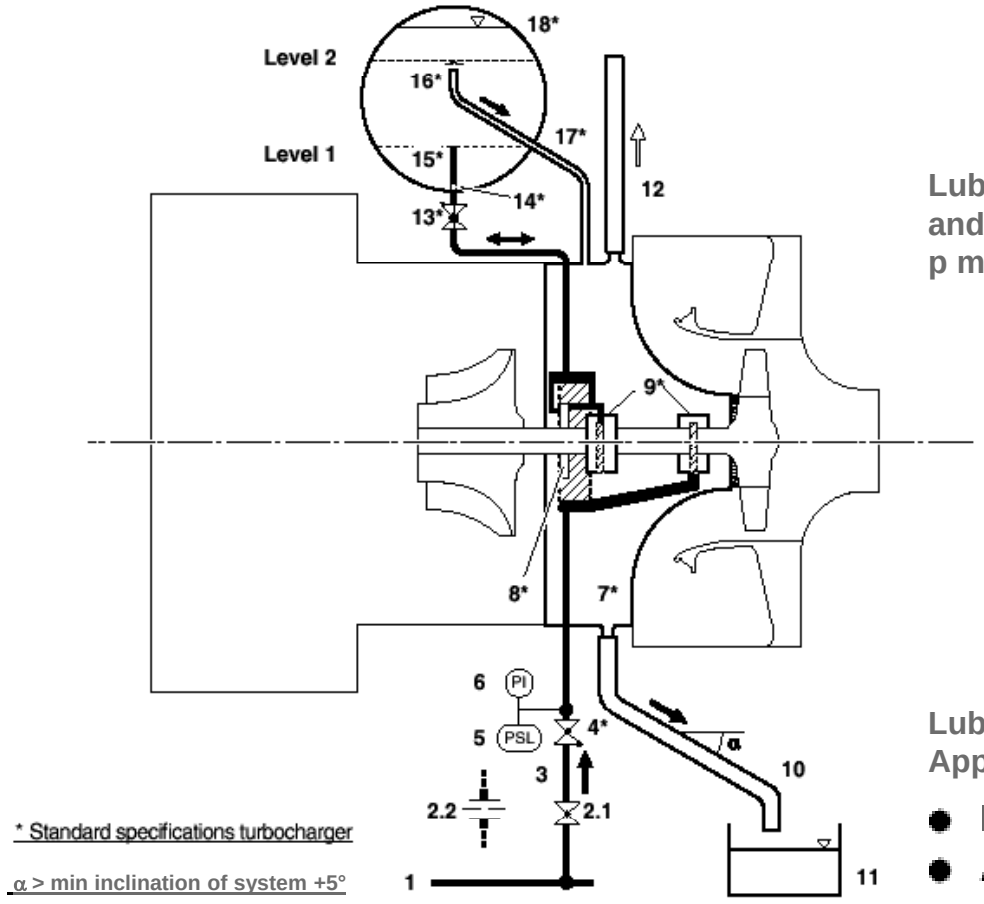
Floating disk



TCA
Welded Post Lubrication Tank

TCA 55 Lube oil supply with post lubrication

Limit values for alarm in case of too low lube oil pressure:
At 1.0 bar: Engine power at half load and at 0.8 bar: Engine stop.



* Standard specifications turbocharger

α > min inclination of system +5°

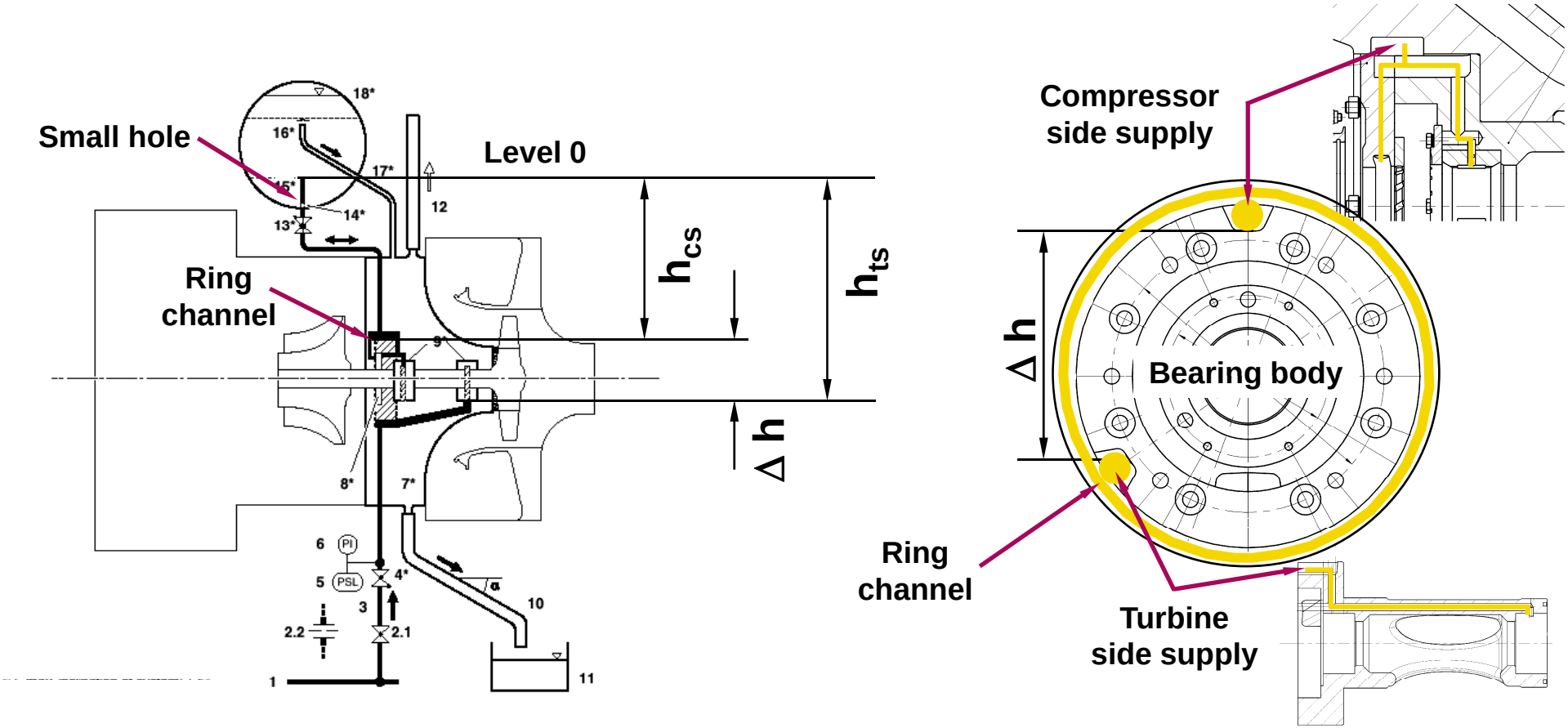
Lube oil pressure at full load and at operating temperature
p min: 1.3 bar p max: 2.2 bar

Lubeoil flow at 60° - 65°C:
Approx: 5 m³/h

1 *Supply pipe*
2.1 *Pressure reduction valve (4-stroke)*
2.2 *Orifice (2-stroke)*
3 *Turbocharger supply pipe*
4 *Non-return valve*
5 *Pressure monitor*
6 *Manometer*
7 *Bearing casing*
8 *Locating bearing*
9 *Bearing bush*
10 *Drain pipe*
11 *Service tank or crank-case*
12 *Venting*
13 *Non-return valve with bypass*
14 *Bore*
15 *Supply/drain pipe*
16 *Orifice*
17 *Overflow pipe*
18 *Post lubrication tank*

- Lube oil filter ≤ 0.050 mm
- Accumulation with water < 0.2 % amount of weight
- No accumulation with residue > 0.020 mm

TCA Lube oil supply of the turbine side bearing during post lubrication



After level 0 is reached, the oil is supplied via the small hole in the bottom of the tank. This hole is dimensioned in such way, that it only feeds the turbine side bearing. So the oil level in the ring channel is lowered under the inlet of the bearing body for the compressor side. Thus stopping the oil supply for the compressor side. Because the turbine side inlet is on a lower level a small amount of oil is still delivered to the turbine side bearing.

TCA Post Lubrication (CUS 234) Modification for 2-stroke engines (I)

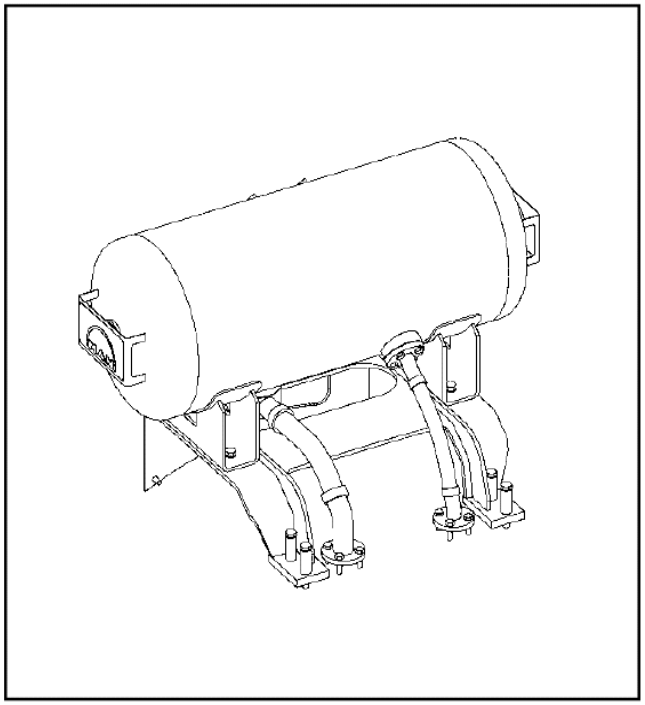


Fig. 1 Current design

The function of the TCA emergency and post lubrication system is based on compressed air in the lube oil tank of the turbocharger. With the current system (Fig. 1) it was noticed that the compressed air diffuses into the lube oil and is flushed out of the tank by a constant volume flow between the oil inlet and oil overflow. Thus the compressed air can disappear after approximately one week of continuous operation of the lube oil pump. As a consequence an immediate lube oil supply from the header tank to the bearings is not possible in case of a blackout event, i.e. emergency stop of lube oil pump and engine.

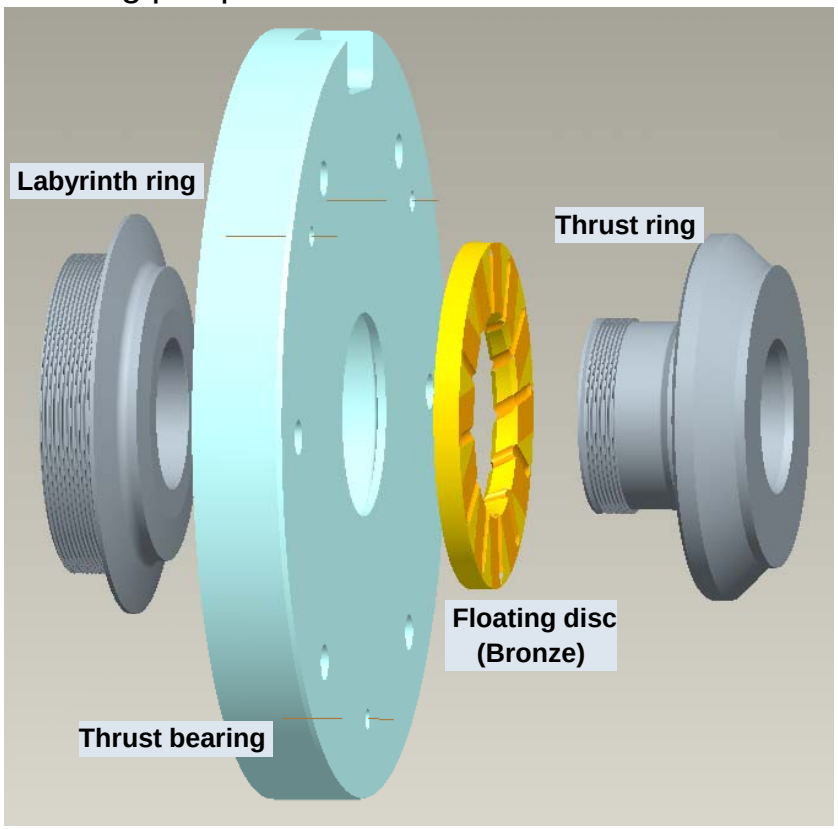
MAN Diesel recently experienced on TCA turbochargers on two-stroke engines a loss of the air cushion in the emergency and post lubrication system of the turbocharger.

TCA Post Lubrication (CUS 234) Modification for 2-stroke engines (I)

Floating Bearing

design status

Bearing priciple

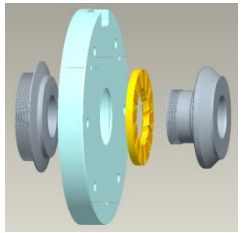


Service Experience

- Loosing the air cushion by permanent lubrication
- In case of black out insufficient lube oil supply
- predamaged bearings possible due to black out during sea
- in most cases the predamaged bearing fails during further operation and leads to severe T/C damage

Damaged floating disc

TCA Thrust Bearing
Damage statistics



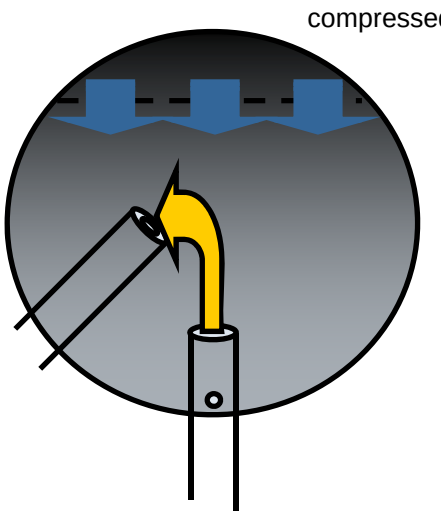
Floating Thrust Bearing
original postlubrication design

selected:	TCA 55	TCA 66	TCA 77	TCA 88
number of damages	3	13	8	5
on avarage at ..... hours of operation	8.000 h	7.400 h	9.200 h	8.500 h
Population 2-stroke approx.	71	351	252	58
error rate approx.	4 %	4 %	3 %	9 %

Info:
- 1 year operation is approx ca. 6,000 rh propulsion, ca. 8,000 rh stationary
- Data includes MAN Diesel Augsburg and Mitsui T/C
- From 2007-12-01

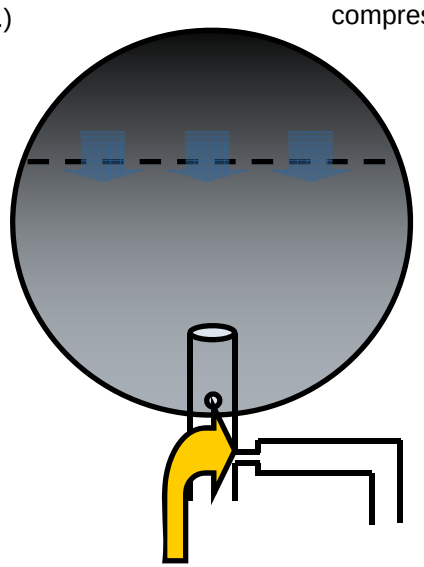
TCA Modified Emergency and Postlubrication System (EPLS)

Original Design until 02/2007



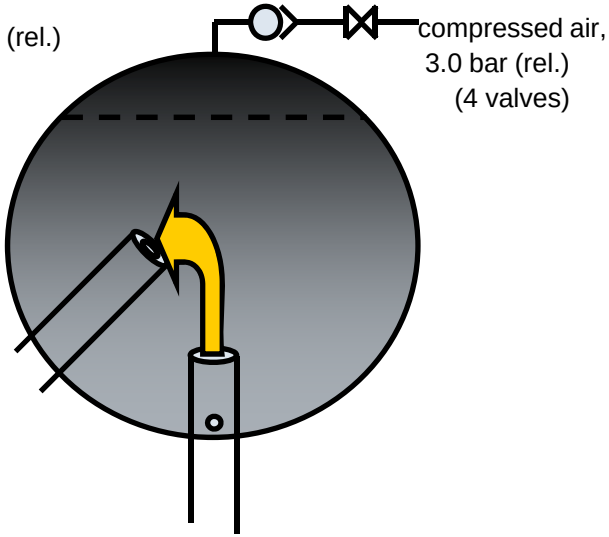
Disadvantages:
- Air disolveses into the oil and is flushed out; no pressure cushion (no emergeny lubrication) after 4 days

Modified EPLS from 03/2007 **series** with CUS 234



Disadvantages:
- less air disolves into the oil; no pressure cushion after more than 10-40 days
- Reset necessary after each 6 weeks

Mitsui PLS from 03/2007 Mitsui design



Disadvantages:
- more complicated installation
- Check necessary after each 4 weeks

TCA Post Lubrication (CUS 234) Modification for 2-stroke engines (III)

MAN Diesel has developed a new lube oil supply/overflow arrangement (Fig. 2). This arrangement bypasses the lube oil tank and thereby slows down the diffusion process and secures reliable emergency lubrication of the turbocharger.

MAN Diesel strongly recommends installing the conversion kit as soon as possible. It will be delivered free-of-charge and can be installed by the vessel´s crew.
Please contact MAN Diesel Turbocharger Service in Augsburg in order to arrange the update of your turbocharger.

1. After the installation of the kit the lube oil pump has to be stopped in each harbour or at the latest after six weeks continuous operation (whichever occurs soonest) for at least one hour in order to reset the system.
2. The time between blackout and shutdown shall not exceed 10 seconds in accordance to the engine builder´s instructions.
3. MAN Diesel recommends manual mode restart of the engine after a blackout. Please refer to your instruction manuals.

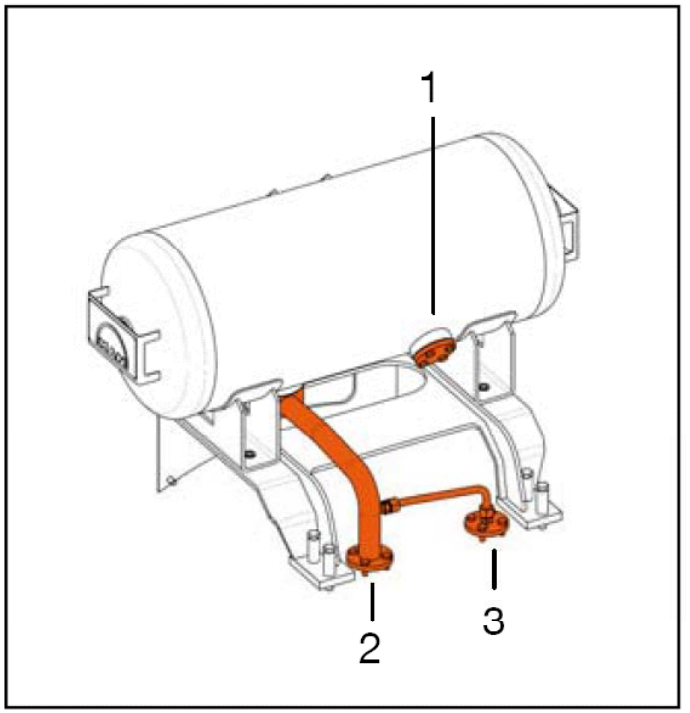


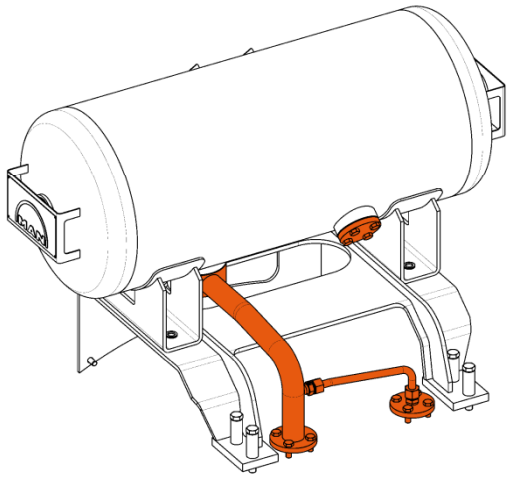
Fig. 2 New design

MAN Diesel offers a conversion kit consisting of the following parts:

1. Blind flange
2. Oil supply pipe
3. Overflow pipe

TCA Post Lubrication (CUS 234) conversion kit for 2-stroke engines

Conversion kit



TCA Post Lubrication (CUS 234) conversion kit (old tank design)

Old tank design

Umrüstkitt für TCA77 Notschmierbehälter

Verwendungsbereich:
Dieser Kitt ist gültig für die bestehenden Nachschmierbehälter
11.55400-0173
11.55400-0204

Neue Baugruppenzeichnung:
Nachschmierbehälter vollst. DRW11554000257

Zusätzlich benötigte Bauteile:

Pos	Menge	Benennung	Größe/Abmessung	Materialnummer
554.066	1	Rohrleitung		11.55460-0445
554.080	1	ZSB-Rohrleitung		11.55460-0431
554.081	1	Flansch		11.55484-0121
554.082	1	Blindflansch	R570 A98	06.83780-0102
554.083	2	Dichtring	M618 A35x95	06.56511-0121
554.084	1	Einschraubstutzen	DIN3901 S16B-M	06.71060-0117
554.096	12	6kt-Schraube	DIN933 M12x30 8.8	06.01283-1317
517.220	3	Dichtring	M618 A35*95	06.56511-0121
517.221	1	Blindflansch		11.51784-0015

Bild 1: Ölbehälter (modifiziert)

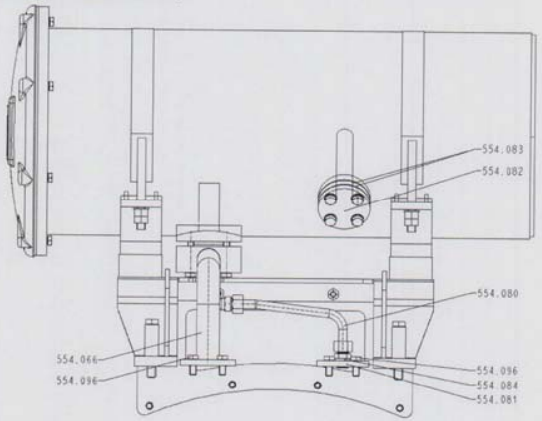


Bild 2: Entlüftungsstutzen am Lagergehäuse

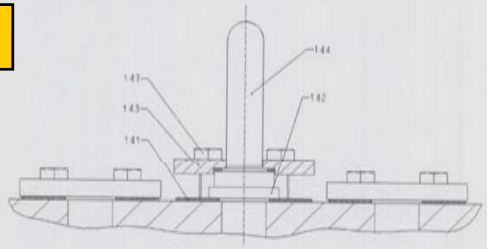
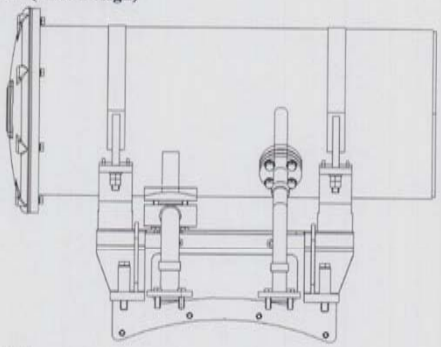


Bild 3:Ölbehälter (altes Design)



Montageanleitung:

1. Demontage der Flexleitungen..
2. Verschließen der Überlaufbohrung am Ölbehälter mit Dichtring 554.083 und Blindflansch 554.082 (Bild1)
3. Austausch des Fansches 143 (Bild 2) auf Pos 517.221
4. Verschließen der Entlüftungsleitung mit Dichtring 517.220 und Blindflansch 517.221 und den Sechskantschrauben 554.096. (Bild 1)
5. Montage der Ölzulaufleitung mit Dichtung 554.062 und Rohrleitung 554.066 und den Sechskantschrauben 554.096 und Dichtung 554.220. (Bild 1)
6. Montage des Flansches 554.081 mit den Sechskantschrauben 554.096 und dem Dichtring 554.220 (Bild 1)
7. Verschrauben des Einschraubstutzens 554.084 mit dem Flansch 554.081 (Bild 1)
8. Montage der ZSB-Rohrleitung 554.080 (Bild 1)

TCA Post Lubrication (CUS 234) conversion kit (new tank design)

Umrüstkit für TCA77 Notschmierbehälter

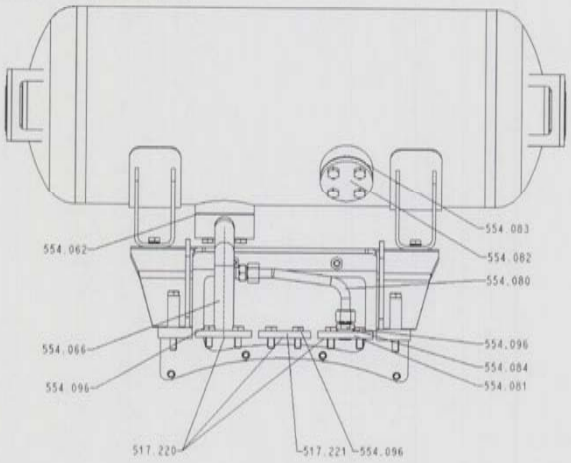
Verwendungsbereich:
Dieser Kit ist gültig für die bestehenden Nachschmierbehälter
11.55400-0244
11.55400-0224

Neue Baugruppenzeichnung:
Nachschmierbehälter vollst. DRW11554000254

Zusätzlich benötigte Bauteile:

Pos	Menge	Benennung	Größe/Abmessung	Materialnummer
554.062	1	Dichtung	AF-St	11.55487-0020
554.066	1	Rohrleitung		11.55460-0439
554.082	1	Blindflansch	R570 A98	06.83780-0102
554.083	1	Dichtring	M618 A35x95	06.56511-0121
554.080	1	ZSB Rohrleitung		11.55460-0431
554.084	1	Einschraub.Stutzen	DIN3901 S16B-M	06.71060-0117
554.096	12	6kt-Schraube	DIN933 M12x30 8.8	06.01283-1317
554.081	1	Flansch		11.55484-0121
517.220	3	Dichtring	M618 A35*95	06.56511-0121
517.221	1	Blindflansch		11.51784-0015

Bild 1: Ölbehälter (modifiziert)



New tank design

Bild 2: Entlüftungsstutzen am Lagergehäuse

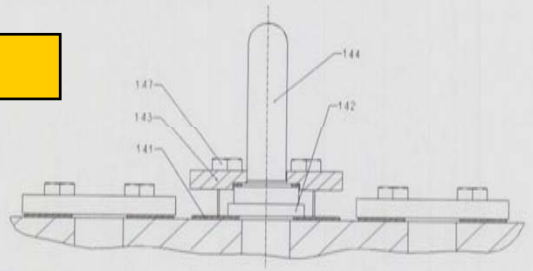
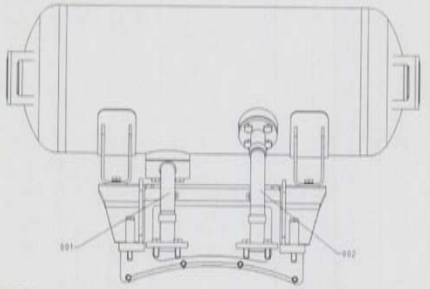


Bild 3:Ölbehälter (altes Design)



Montageanleitung:

1. Demontage der Flexleitungen Pos 001 und 002. Das Rückschlagventil in der Zulaufleitung 001 wird nicht mehr benötigt. (Bild3)
2. Verschließen der Überlaufbohrung am Ölbehälter mit Dichtring 554.083 und Blindflansch 554.082 (Bild1)
3. Austausch des Fansches 143 (Bild 2) auf Pos 517.221
4. Verschließen der Entlüftungsleitung mit Dichtring 517.220 und Blindflansch 517.221 und den Sechskantschrauben 554.096. (Bild 1)
5. Montage der Ölzulaufleitung mit Dichtung 554.062 und Rohrleitung 554.066 und den Sechskantschrauben 554.096 und Dichtung 554.220. (Bild 1)
6. Montage des Flansch 554.081 mit den Sechskantschrauben 554.096 und dem Dichtring 554.220 (Bild 1)
7. Verschrauben des Einschraubstutzens 554.084 mit dem Flansch 554.081 (Bild 1)
8. Montage der ZSB-Rohrleitung 554.080 (Bild 1)

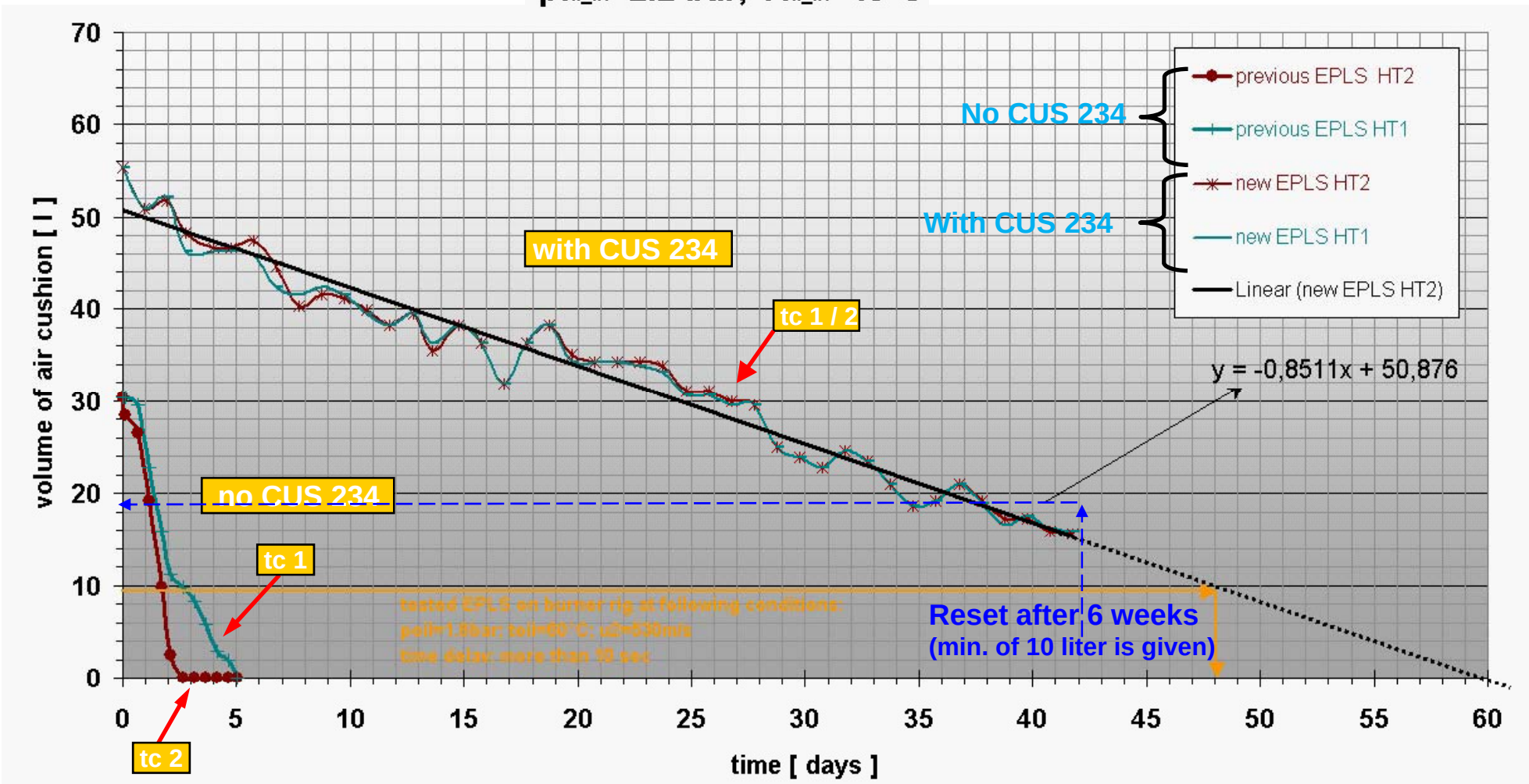
TCA Post Lubrication (CUS 234) conversion kit flanges

TCA Post Lubrication (CUS 234)
Reset information sticker

TCA
Field experience with CUS 234

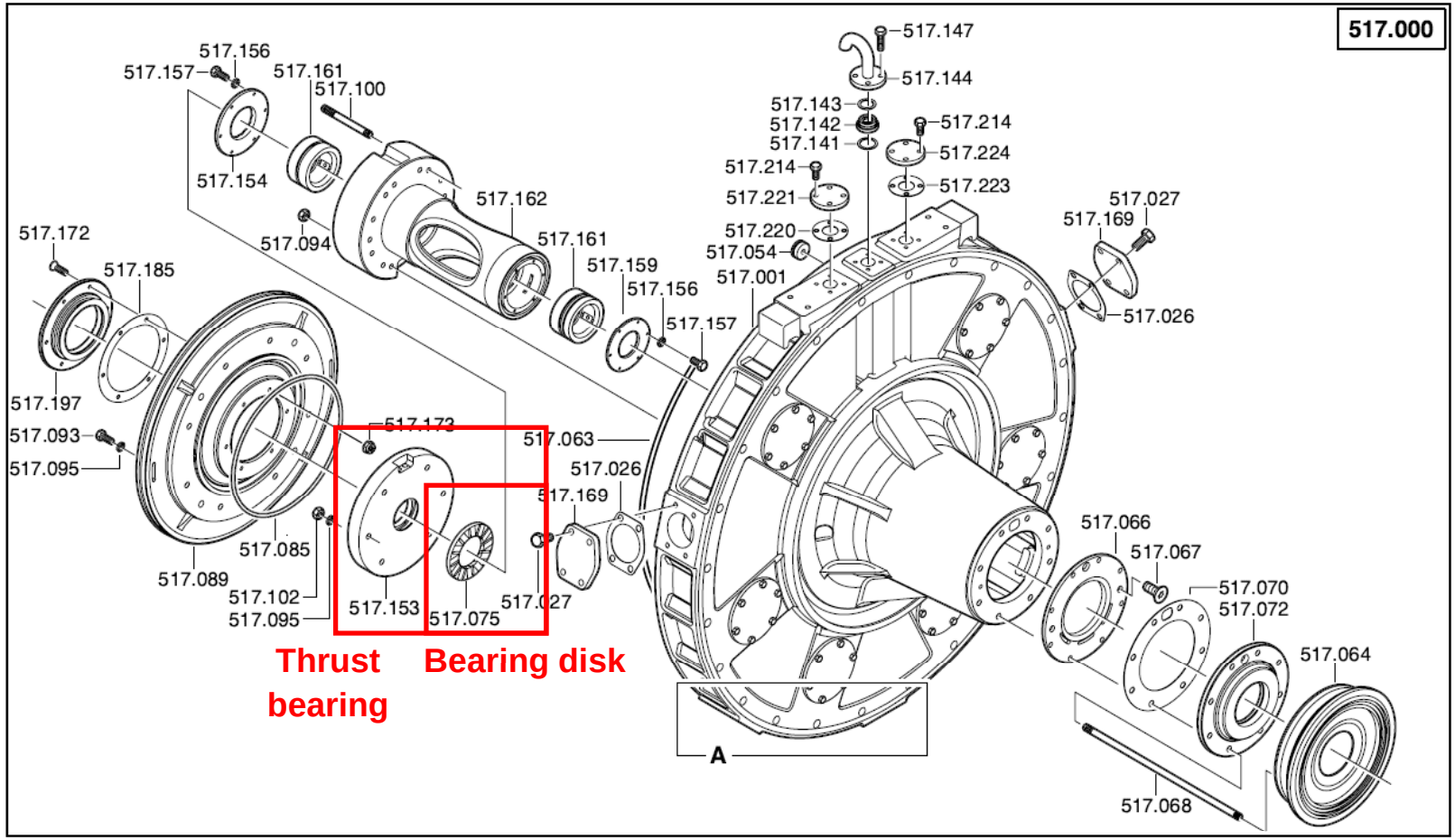
continuous lubrication emergency and post lubrication tank

p_{oil_in}=2.2 bar, T_{oil_in}=45°C



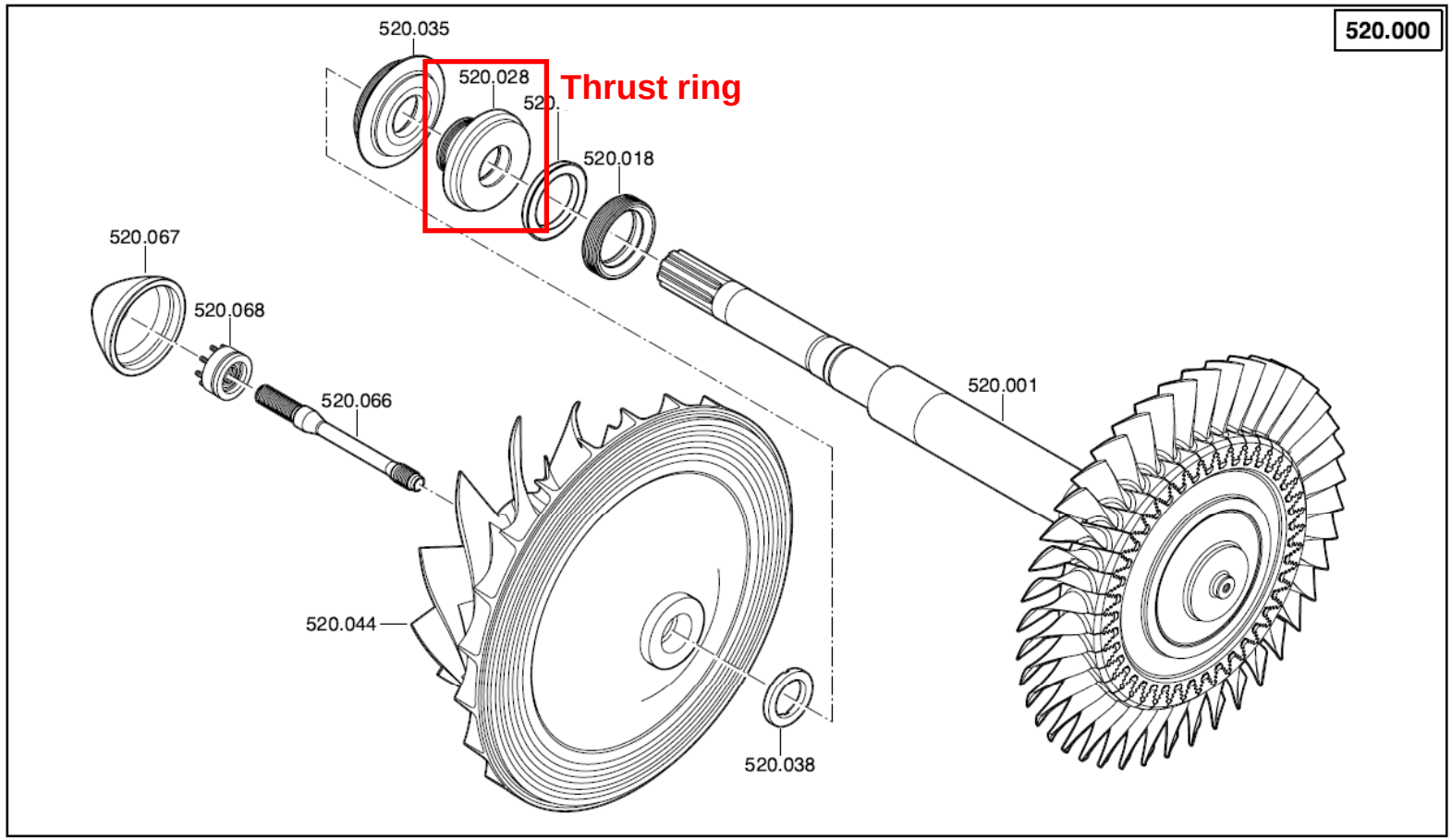
TCA CUS 239 (01/08)
Thrust bearing inspection after blackout during sea trail (I)

Bearing casing **517.01**



TCA CUS 239 (01/08)
Thrust bearing inspection after blackout during sea trail (II)

Rotor, complete **520.01**

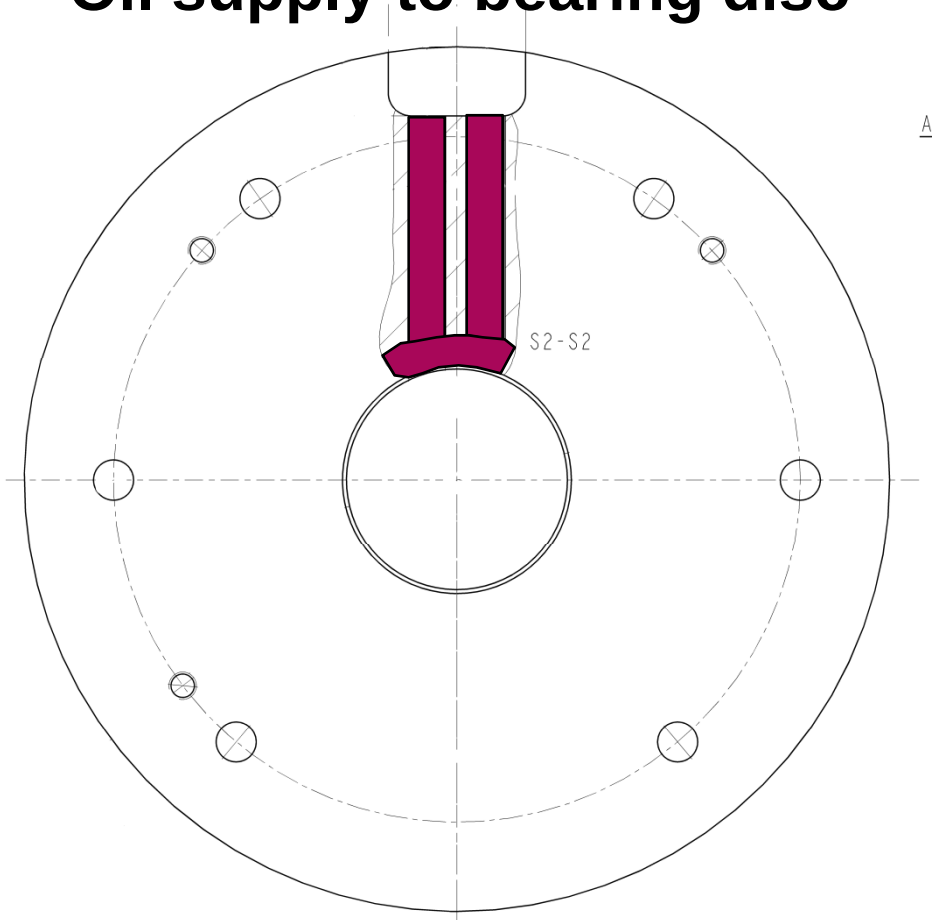


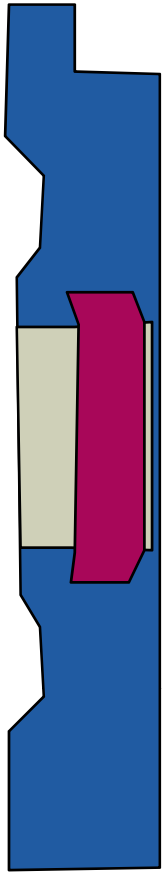
232

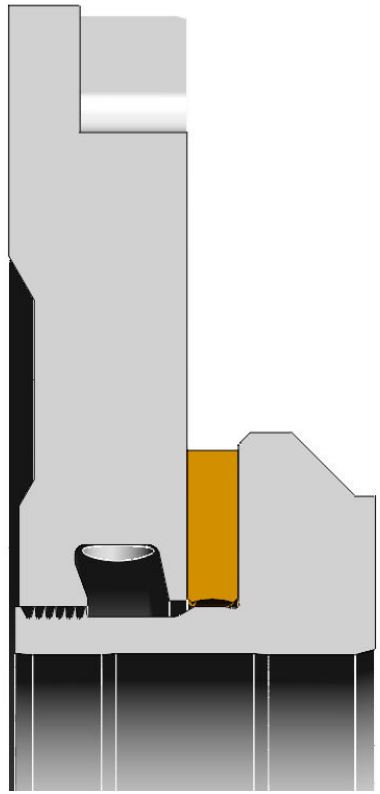
6672 C3 520.01 E 02.06 TCA77 TCA 77 520.01.fm 232

TCA
Thrust bearing (EPLS)

Oil supply to bearing disc

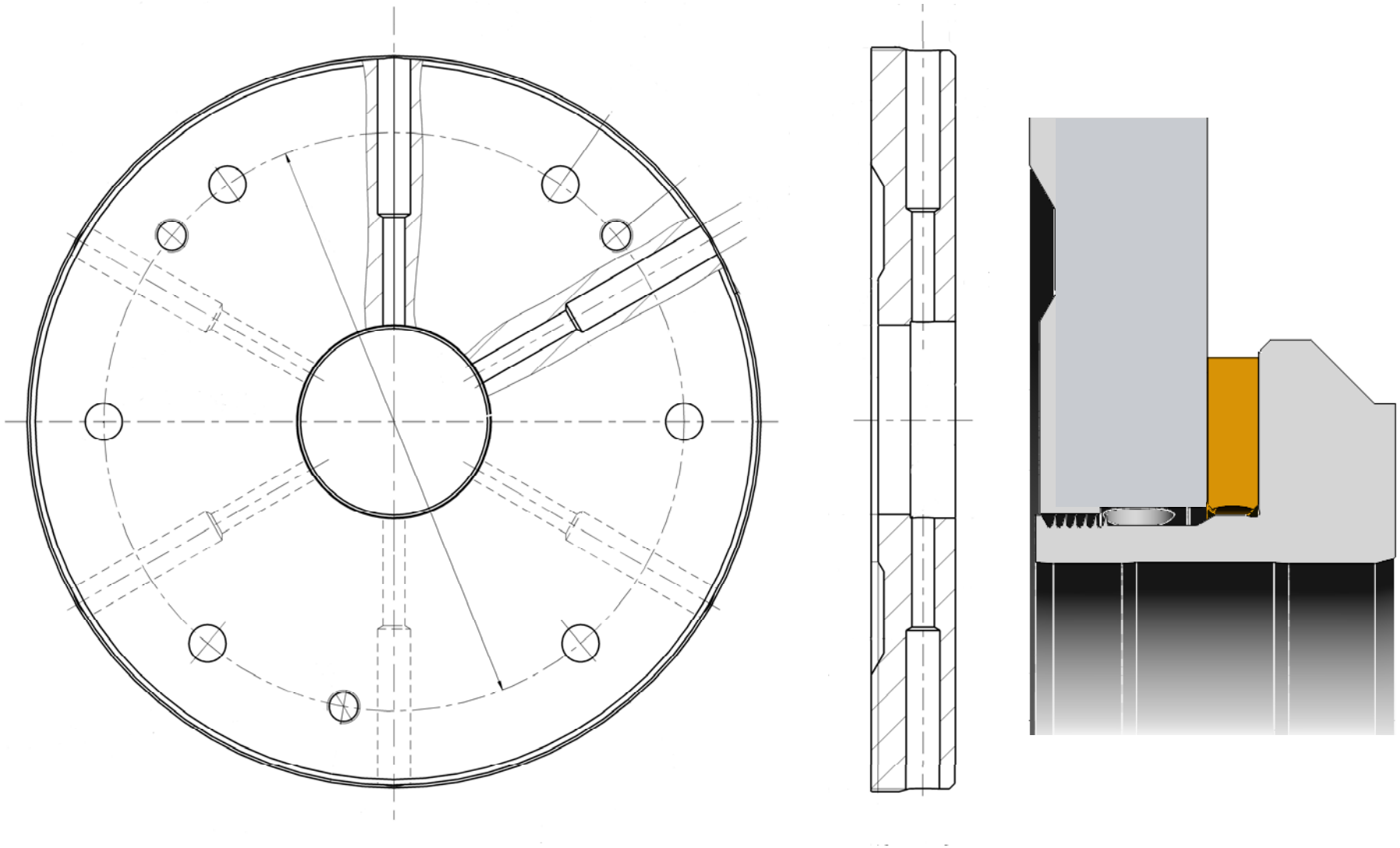






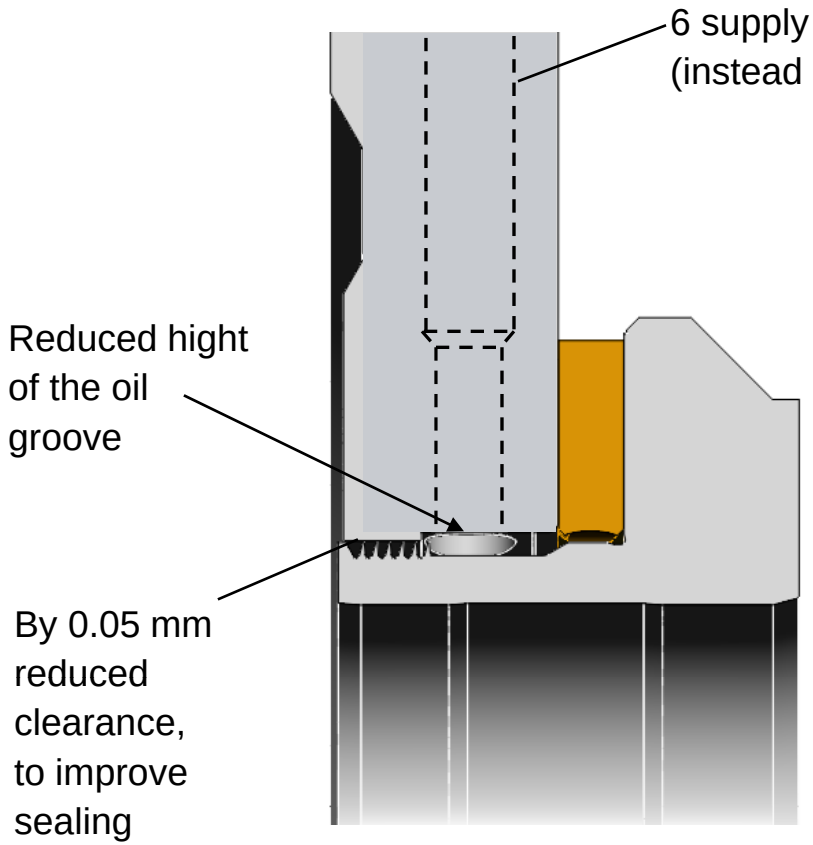
Thrust bearing

TCA
Variant 1: Thrust Bearing



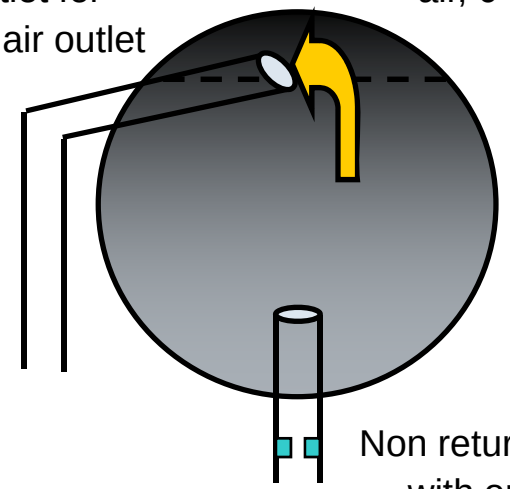
TCA
Gravity Tank + Variant 1

Modified Thrust Bearing (Var1)

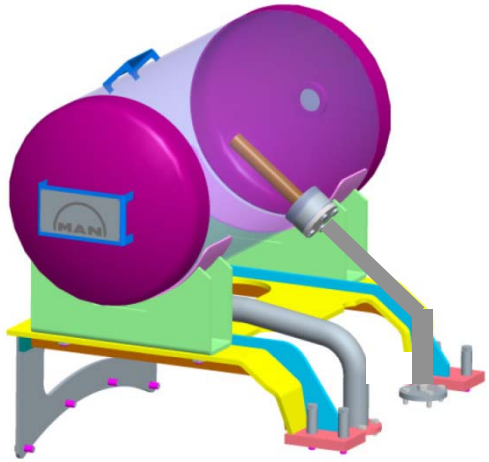


Large diameter
at outlet for
oil and air outlet

air, 0 bar

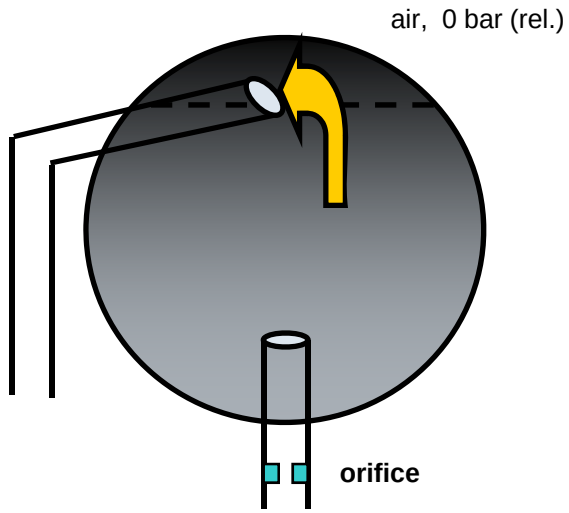


Non return valve
with orifice

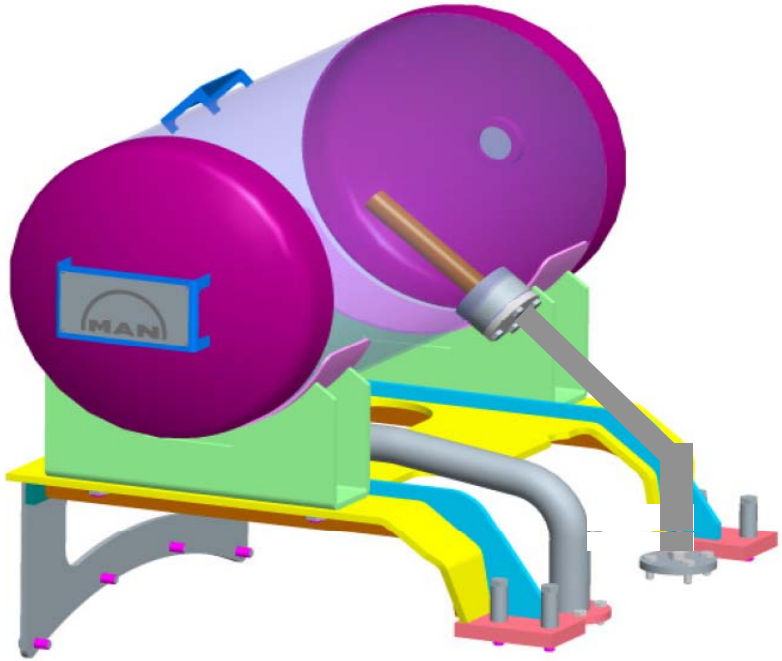


TCA Gravity Tank (Var 1)
Delivery Status February 2008

Gravity Post Lubrication Tank



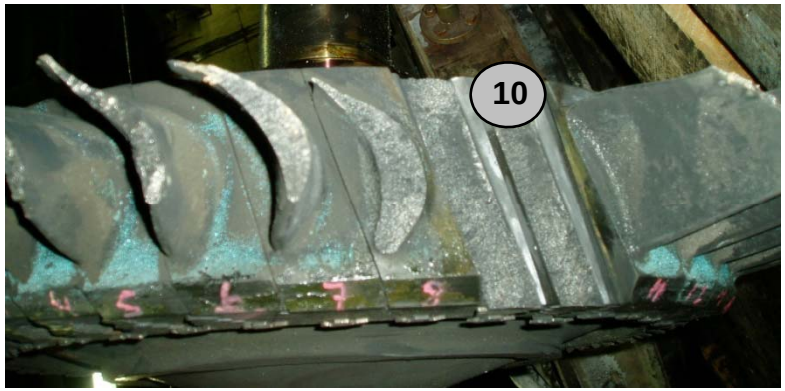
Gravity Tank
(non pressurised)
intermediate design

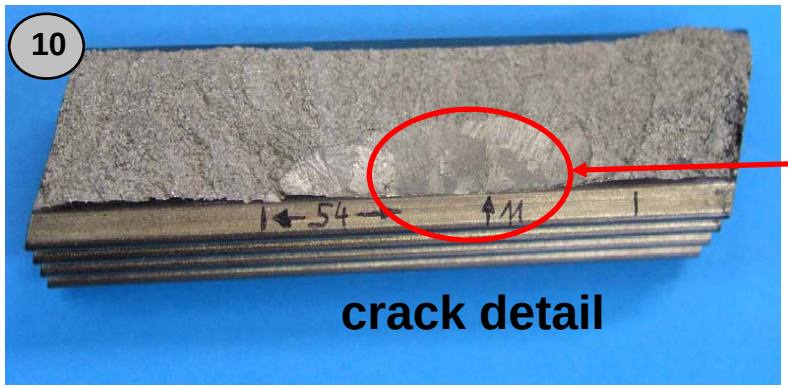


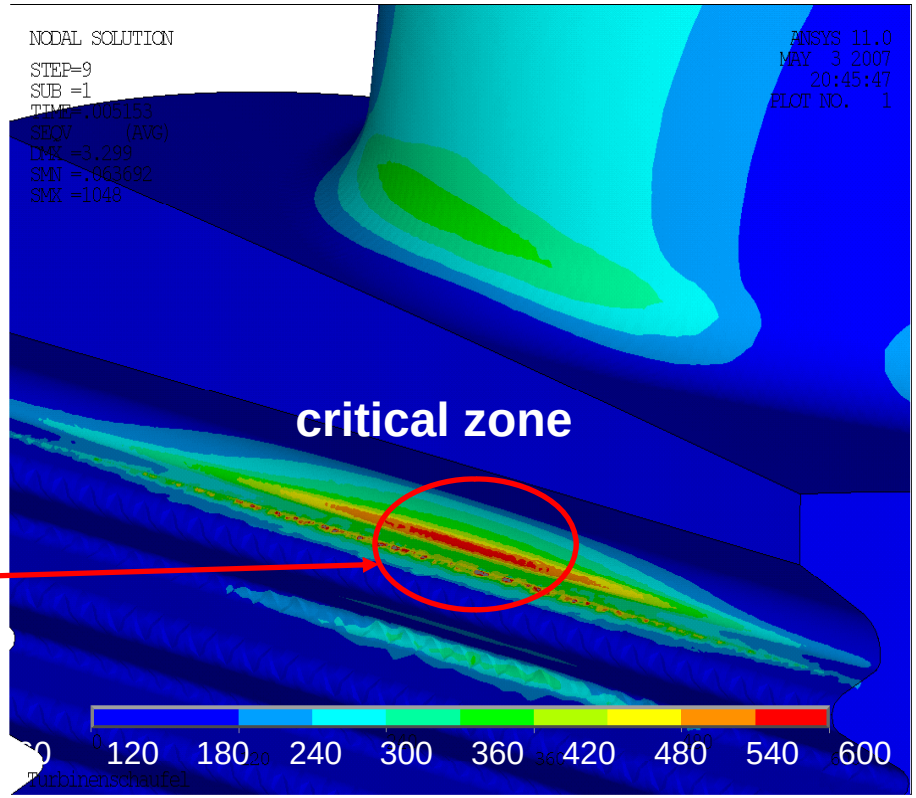
Advantages:
- Simple gravity tank
- Tankvolume is reduced from approx. 140 to 70 liitre of oil
  (cooling down of T/C bearings by main lube oil pump)

Needs:
- Introduction only possible in combination with a modified bearing (Var 1)!
- Design status on 2-strokes applications since February 2008

TCA Troubles and causes
Cracks in blades (II)







Solution: Bigger radial gap between shroud ring and blades.
Shroud ring with conical shape

TCA Troubles and Causes
Cracks in blades (III)

Cast Turbine Blades
Wide cordlength blade, 41 blades

selected:	TCA 55	TCA 66	TCA 77	TCA 88
No. of incidents	-	10	2	6
Average running hours	8.000 Bh	7.400 Bh	9.200 Bh	8.500 Bh
Population	71	351	252	58
Percentage	-	3 %	1 %	10 %

Info:
- 1 year operation is approx ca. 6,000 rh propulsion, ca. 8,000 rh stationary
- Data includes MAN Diesel Augsburg and Mitsui T/C
- From 2007-12-01

TCA Troubles and causes
Cracks in blades (I)

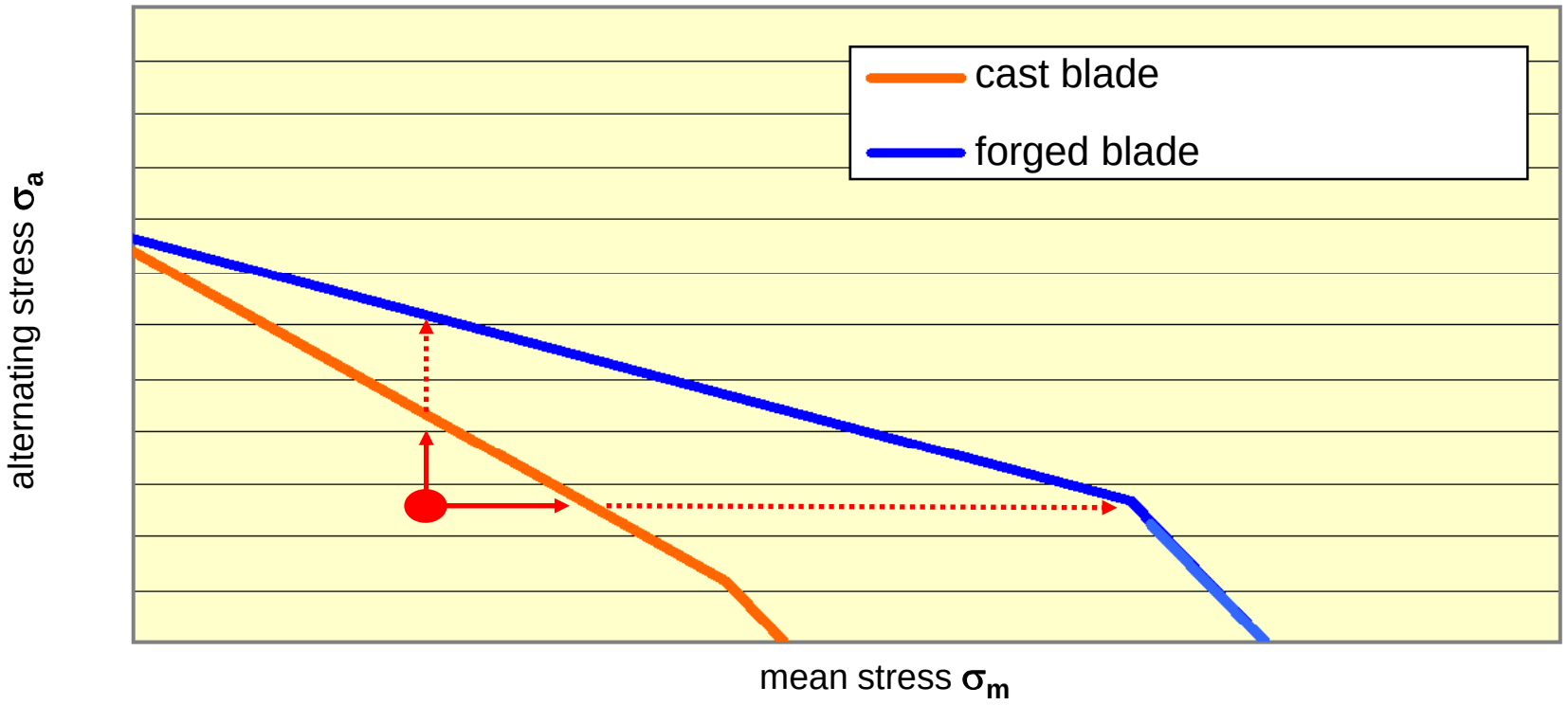
New nozzle ring has 27 vanes

Changing the number of vanes on the nozzle ring from 26 to 27 in new TCA (since August 2006) reduces:

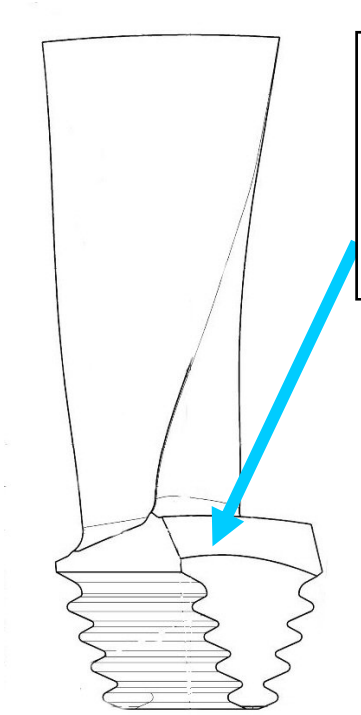
- **the forces on the turbine blades at least 20-30%**
- **changes the blades resonance frequency**

TCA
Advantages of forged turbine blades

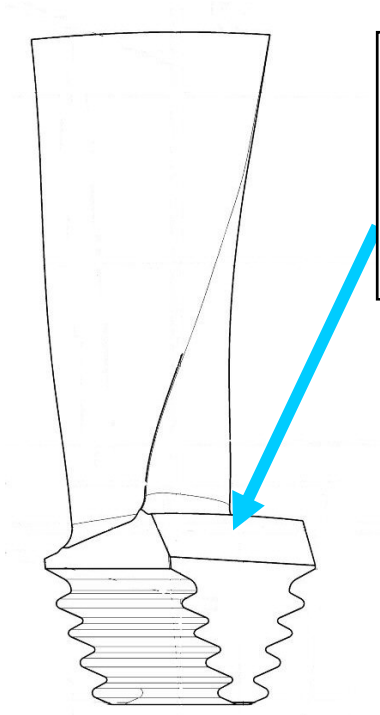
- the mechanical properties of forged blades are on higher level compared to cast blades: **Static = + 42%; Dynamic = + 25%**
- **Fatigue strength (**Haigh):



TCA
Forged and Cast Turbine Blades



Inlet face on the blade foot of a cast blade



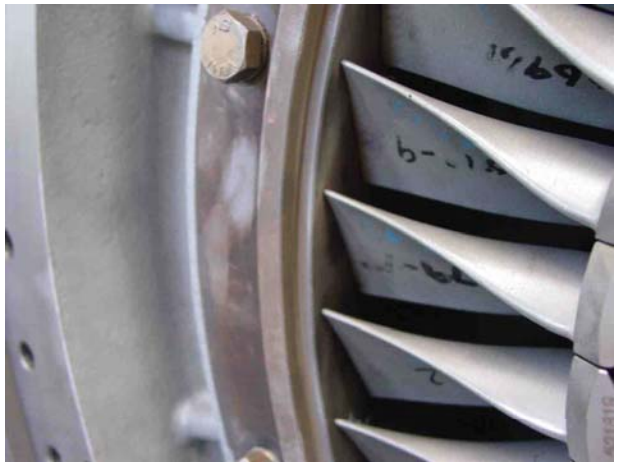
Inlet face on the blade foot of a forged blade

On TCA forged turbine blades are introduced.
Differences can be identified by COC number.

TCA
Shroud ring

Shroud ring in outlet casing

The shroud ring is flanged against the outlet casing (without clamping ring).

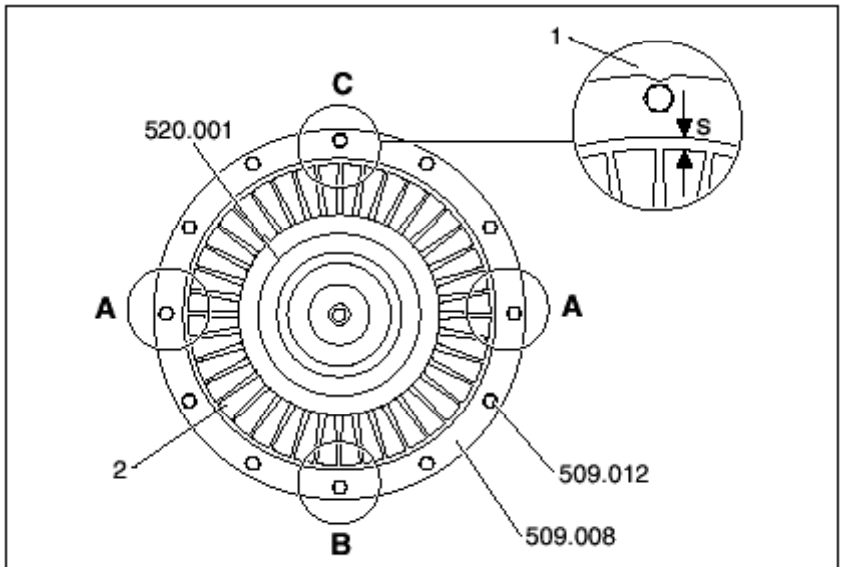


Shroud ring detail

Rezess in the outlet casing

With four grooves around the circumference of the ring it is possible to remove the shroud ring with a lever.

TCA 55
Shroud ring installation



509.008	*Shroud ring*	*S*	*Gap clearance*
509.012	*Hexagon bolt*	*A,B,C*	*Measuring points*
520.001	*Turbine rotor*	*1*	*Recess, top*
		2	*Turbine blade*

Fig. 39. Measuring points for gap clearance of turbine blade/shroud ring

A	*B = A - 0.1 mm*	*C = A + 0.1 mm*
0.7	0.6	0.8
0.8	0.7	0.9
0.9	0.8	1.0

Table 4. Gap clearances at measuring points B and C are dependent of A in new condition

Turbine rotor **[500.53]** installed, gas-admission casing **[500.51]** removed.

1. Screw two guide rods (596.050) into diffuser (509.001) of the gas-outlet casing (506.001).
2. Place on the shroud ring (509.008) and secure with three hexagon bolts and lock washer pairs. Unscrew the guide rods.
3. Screw in all hexagon bolts (509.012) with lock washer pairs (509.014) around the circumference, and lightly tighten.

△ △ *Important! Always use new lock washer pairs when mounting.*

4. Measure gap dimension S between turbine blade/shroud ring at both locations A with feeler gauge. Lightly loosen hexagon bolts (509.012) and align shroud ring (509.008) horizontally to the center (gap dimensions left and right must be equal).
5. Lightly tighten the hexagon bolts.
6. Measure gap dimension S at the vertical measuring points B and C and align shroud ring (509.008).

△ △ *Important! Due to the floating bearing of the turbine, the turbine rotor is lightly elevated during operation by the oil. Therefore, the shroud ring must be fastened 0.4 mm higher than the turbine rotor upon mounting (in the neutral position).*

7. Compare all 4 measured values again with the permitted gap clearances (see Chapter 2.2) and record in the inspection report (Volume C1 - Chapter 6.6).
8. Tighten all hexagon bolts (509.012) with the specified torque.

▲ ***Caution! Observe torque settings upon installation, and lubricate contact surfaces and threads (e. g. with Molykote HSC).***

▲ ***Caution! Renew lock washer pairs (509.014).***

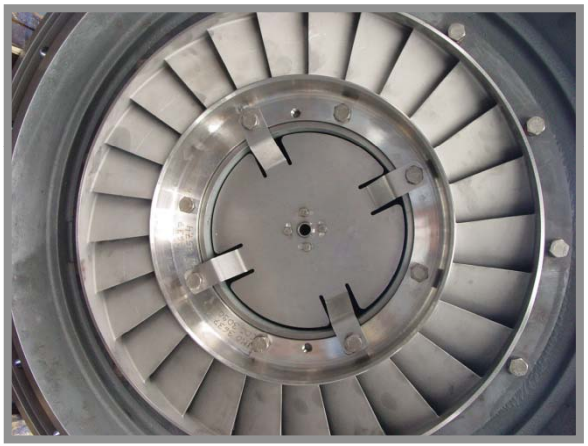
Hexagon bolt (509.012): 70 Nm.

TCA
Gas admission casing

Axial admission casing

Axial admission casing with disc cooling (4-stroke)

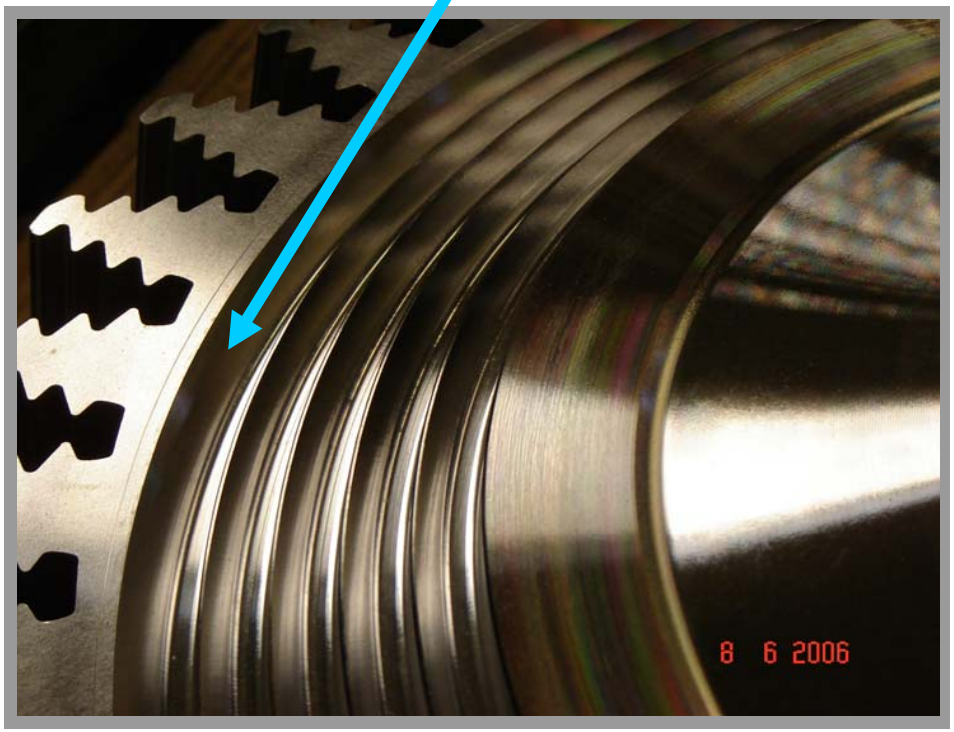
Axial admission casing with cooling pipe

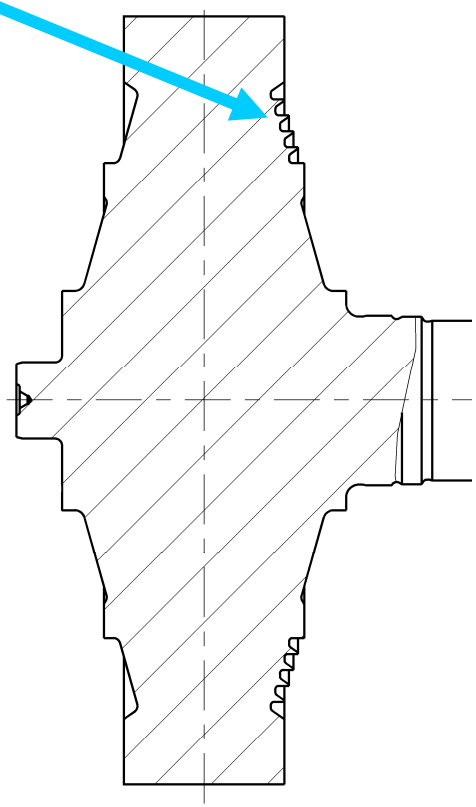


Cooling pipe on admission side

TCA
Steel Disk

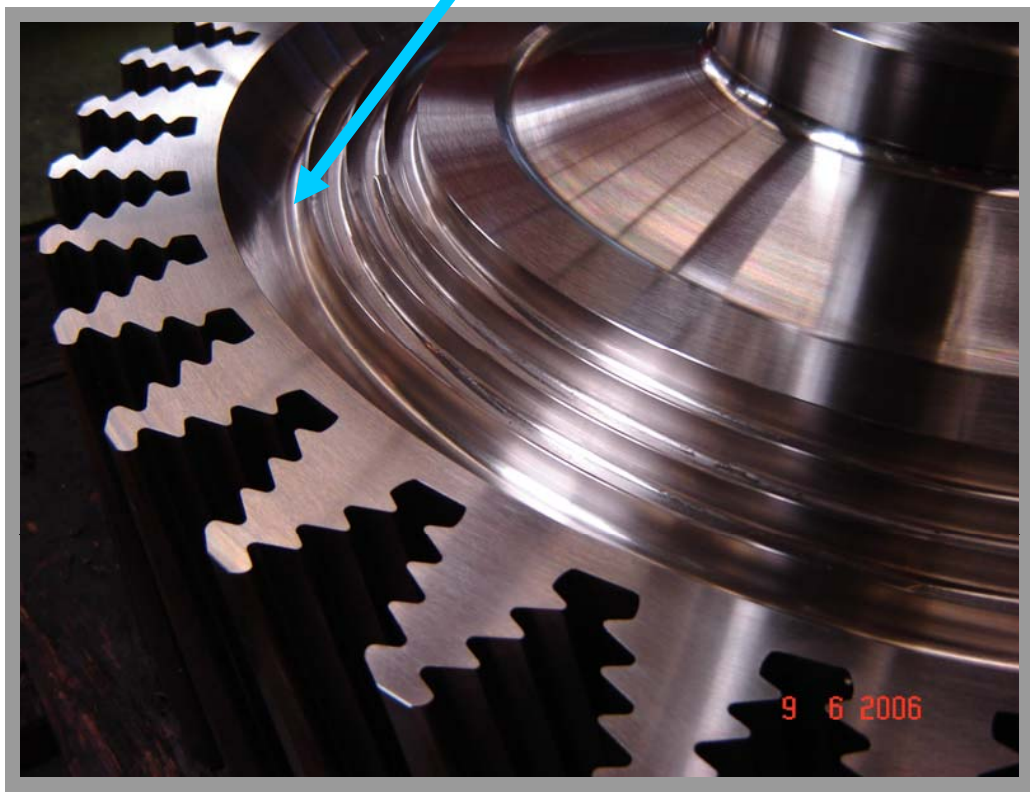
4 labyrinth tips are on the same level as disk rim

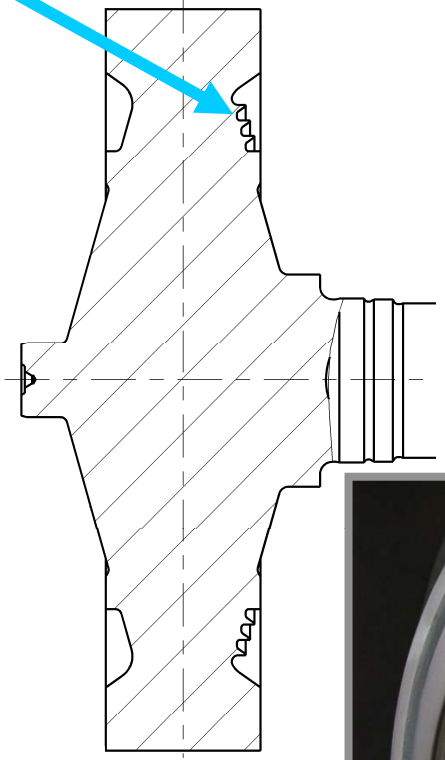




TCA Inconell Disk on 4 Stroke Power Plant Applications

3 Labyrinth tips are deeper than disk rim





TCA

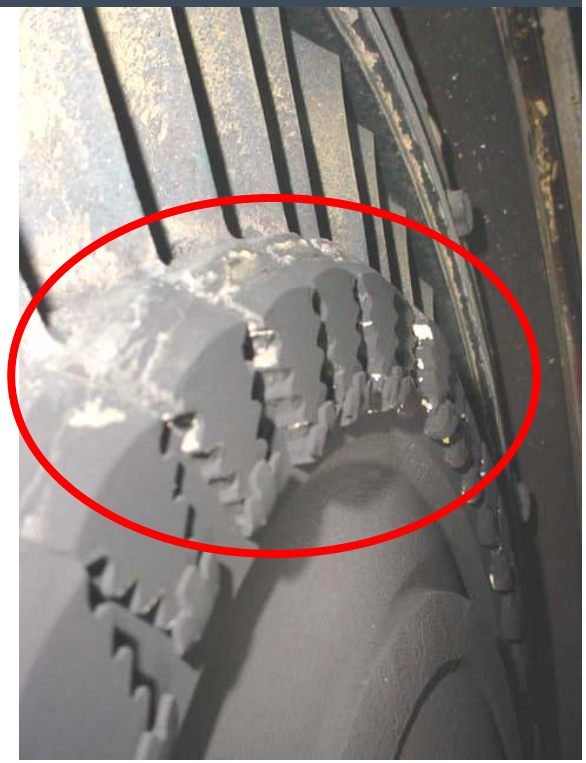
Movement of turbine blades

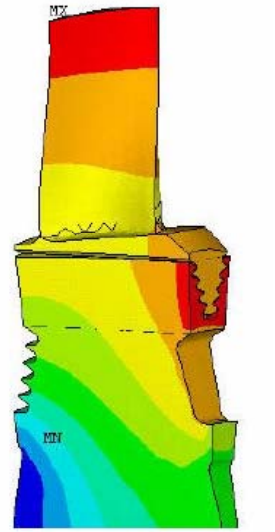
Service experience:

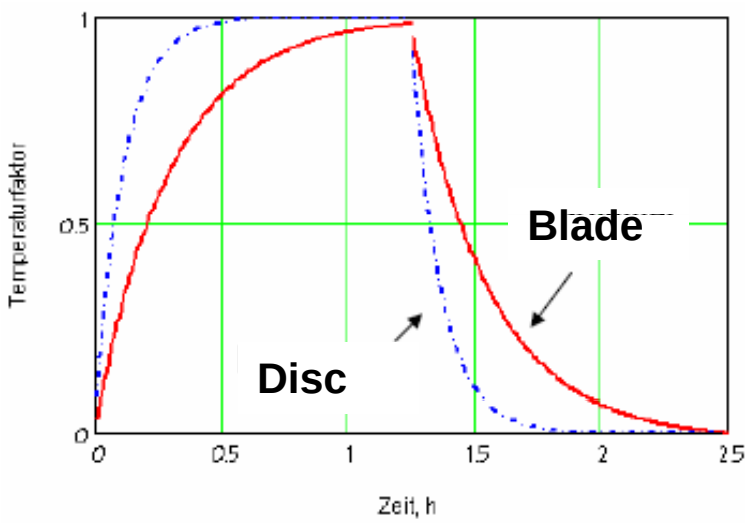
- Blades move in axial direction towards admission side

Reason:

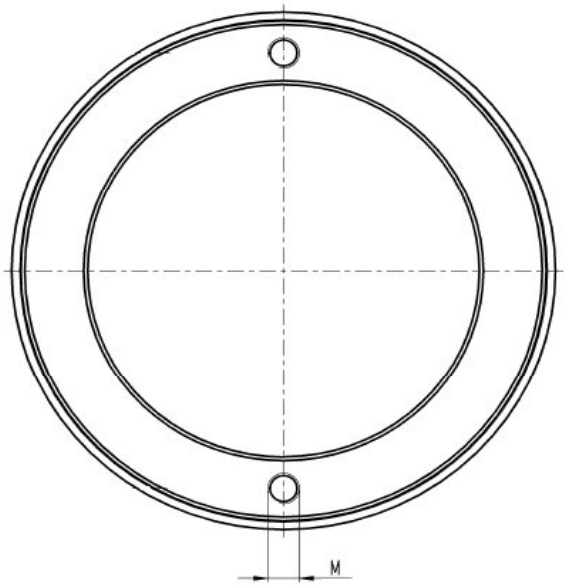
- Load changes in part load operation
- Different temperature distribution and coeffitient between turbine disc and blades

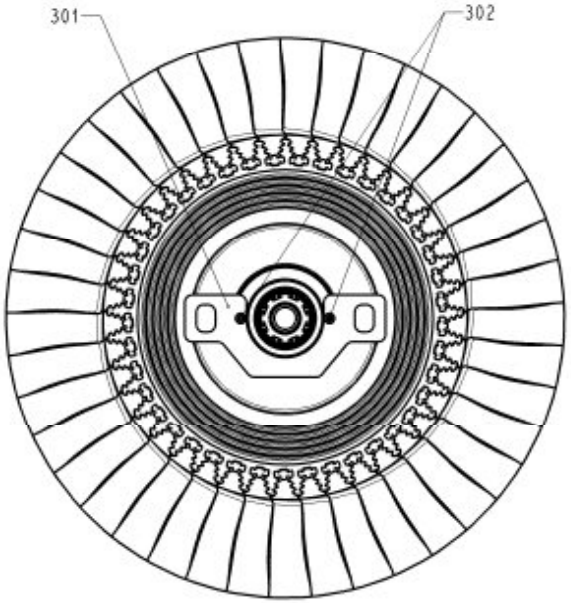






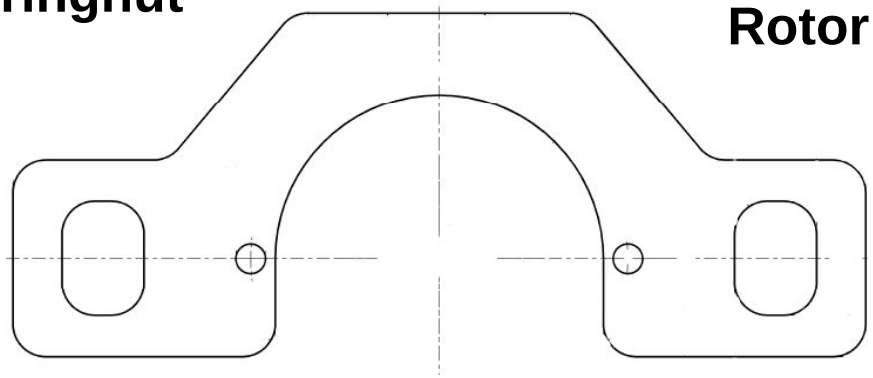
TCA
Rotor turning device





Modified ringnut

Rotor turning device

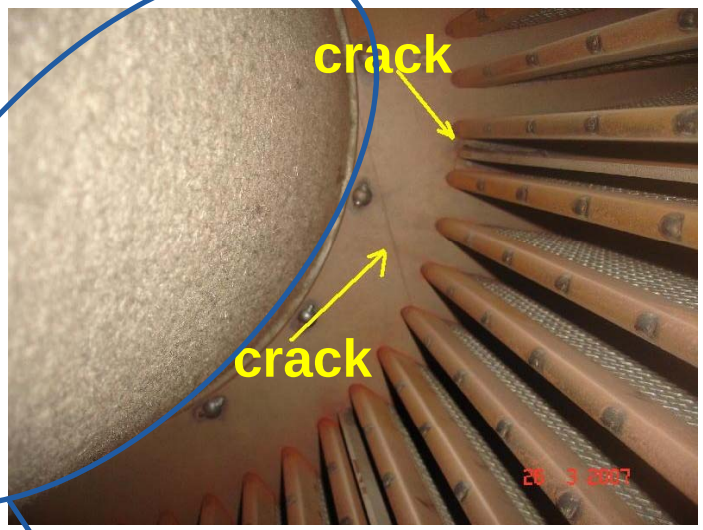


TCA Silencer with axially inserted damping plates

Inner section of silencer

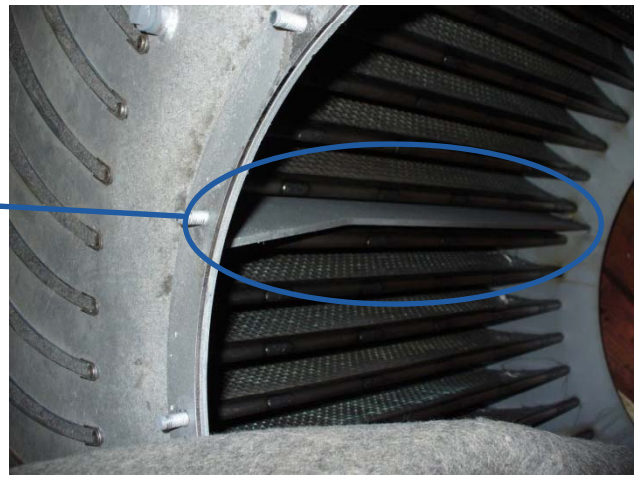
Inner section of silencer with washing nozzle

TCA
Silencer Improvement

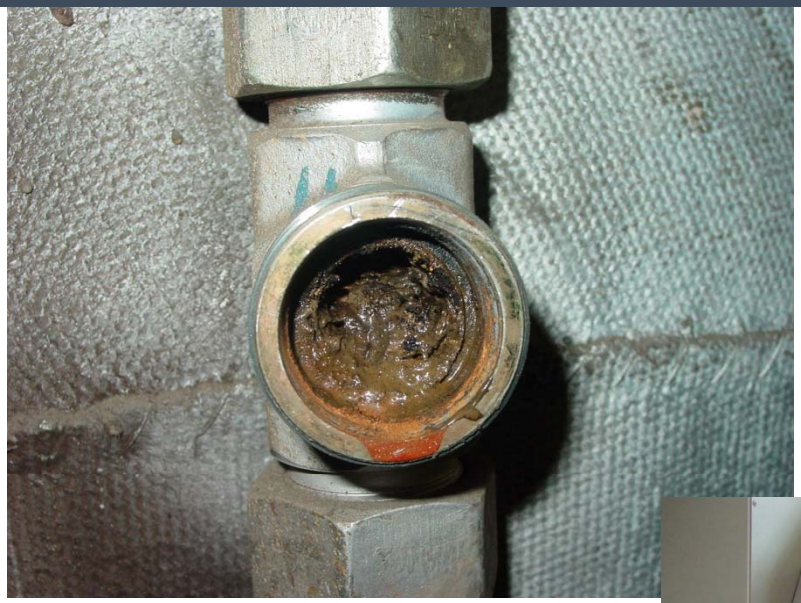


- High vibration level of gallery on particular engines:
  (9K90MC-C with 3xTCA77)
  (6S60MC and MC-C with 1xTCA77)
- Silencer design not stiff enough

- Inner cone removed
- Ribs strengthend
- New vibrational limits for low frequencies



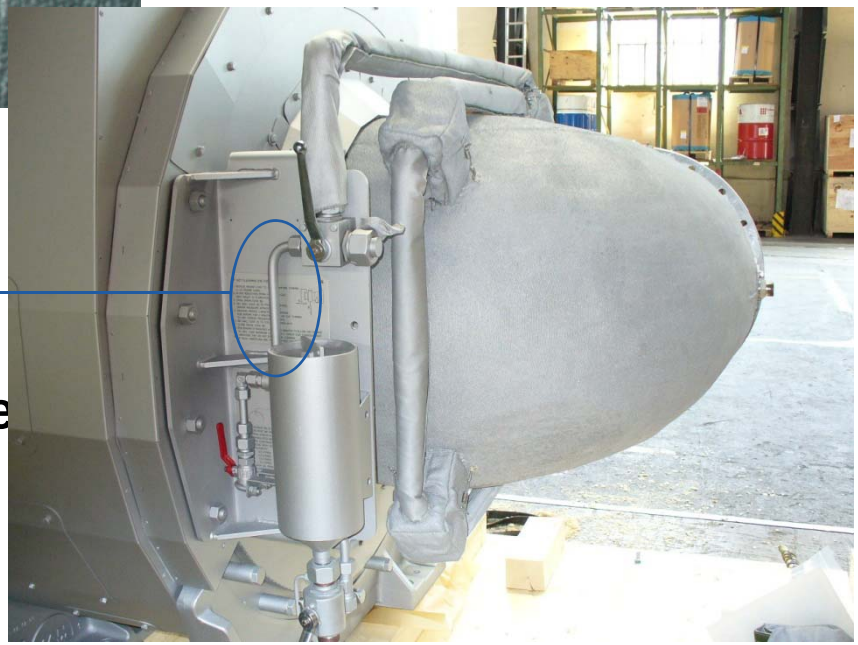
TCA
Turbine Cleaning Improvement



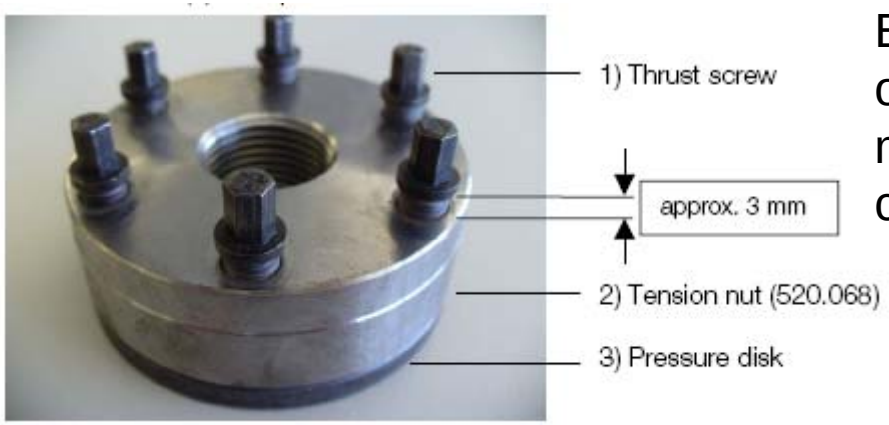
- **Blocked turbine wet cleaning**

Sealing air supply

- **Stainless steel pipes**
- **Stiffer support and more compact arrangement of the items**



TCA CUS 233 (04/07) length of screws in tension nut on TCA 66



Tension nut with pressure disk

Experience has shown that the thrust srews of the TCA 66 are a little short. Assembly faults might then cause t/c failure, if assembly is not carried precisely.

Provided that the thrust srews (1) are flush screwed in up to the pressure disk (3), the collar of the thrust screws should protrude approx. 3mm above the tension nut (2).

If during assembly the tension nut is incorrectly screwed onto the turbine rotor, it is possible that in a subsequent tensioning process the thrust srews (1) will rest their collar at the tension nut (2). The tension rad that serves to fix the compressor wheel on the turbine rotor will then not be sufficiently pretensioned. This may cause a rough running of the rotor or a bearing damage at the turbocharger during operation.

The tension nut has to be installed accurately according to the work card [500.43]. To ensure proper assembly turn tension nut a quater turn back only.

NA/S, NA/T (CUS 249 02/08)
Changed lube oil pressures

Introduction

Due to the long operating experience with NA-turbochargers
MAN Diesel was able to reconsider the lubrication oil pressures for T/C delivered after 1999.

Description

For a simplification of the oil pressure values on MAN B&W two-stroke engines the maximum oil pressure for NA/S and NA/T9 turbochargers was increased to 2.2 bar.

New design

The new lube oil pressure requirements are as follows:

Normal operation pressure	1.3 – 2.2 bar
Normal operation temperature	40 – 70 °C
Alarm pressure	1.0 – 1.3 bar
Slow down pressure	0.8 – 1.0 bar
Shut down pressure	below 0.8 bar
Pre-lubrication pressure	0.6 – 2.2 bar for 10 – 30 minutes
Post lubrication	Not necessary due to built-in tank

NR 12/S (CUS 244 10/07)
Splash oil cooling (I)

Introduction

Splash oil cooling (already introduced on larger NR/S) stops coking
of lube oil on turbine side in case of high operating temperatures in combination with condition and quality of the lube oil.
Spalsh oil cooling is now also introduced into NR 12/S series.

Description

Lube oil is splashed into the upper area of the sealing cover (517.017) and distributed by means of a borehole in the bearing casing (517.001). The oil runs down into the lube oil drain via a U-shaped annular groove in the sealing cover. By this the surface temperature of the cover is reduced and oil coking is stopped.

NR 12/S (CUS 244 10/07)
Splash oil cooling (II)

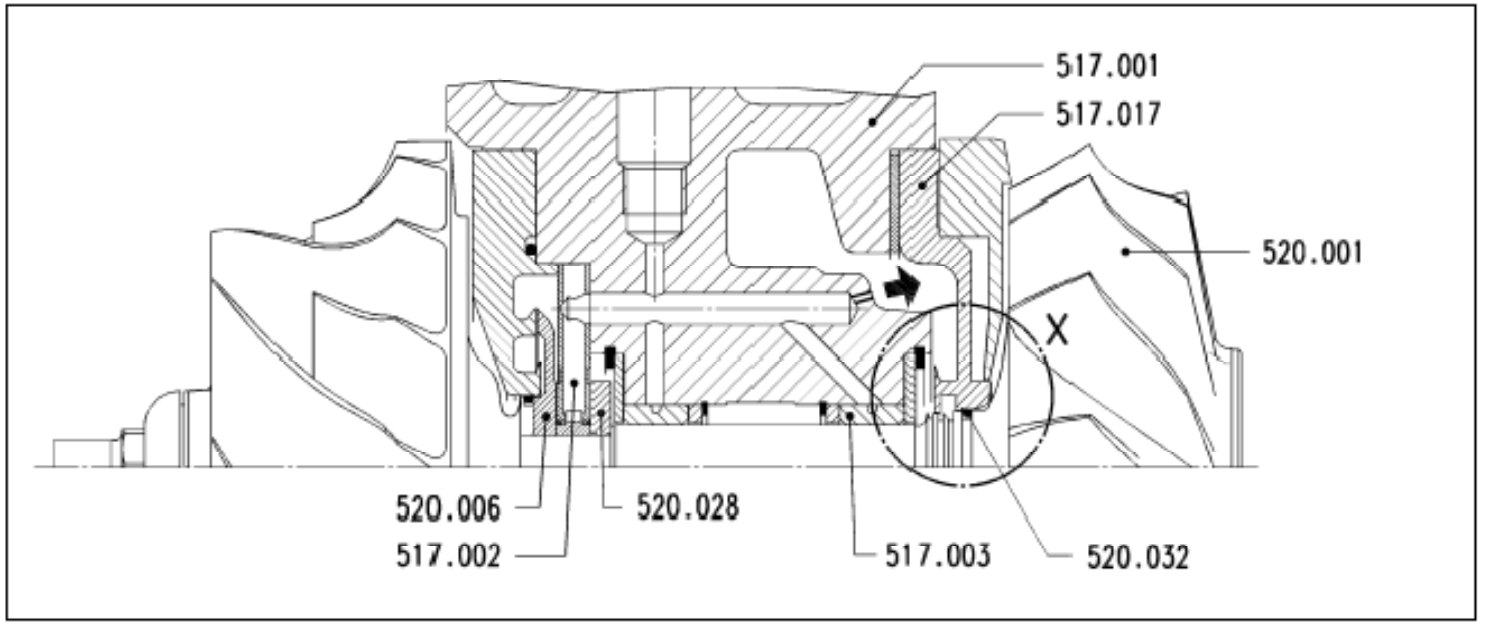


Figure 1. Cartridge with splash oil cooling and modified bearing

The turbine rotor (520.001) and the sealing cover have been modified in this area (detail X) so that the lube oil is hindered from escaping between piston ring (520.032) and sealing cover (517.017) in each operating condition.
NR 12/S T/Cs can now be pre- or post-lubricated with full oil pressure of max. 2.2 bar. A good post-lubrication after engine stops cools the t/c's casings, thus preventing the oil coke building in the piston ring area. Additionally the bearings are cooled and varnishing of especially the turbine side bearing bushes can be prevented. This increases the service life of the bushes consequently.

NR 12/S (CUS 244 10/07)
Modification of bearing (I)

Description

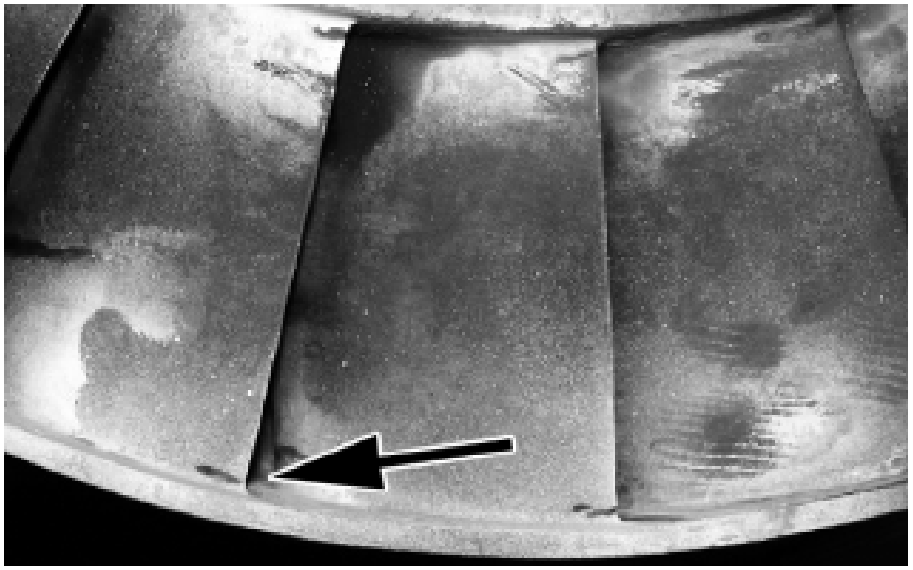
The introducing of splash oil cooling required further modifications on the locating bearing (517.002). So the splash ring (520.006) and the thrust ring (520.028) were revised.

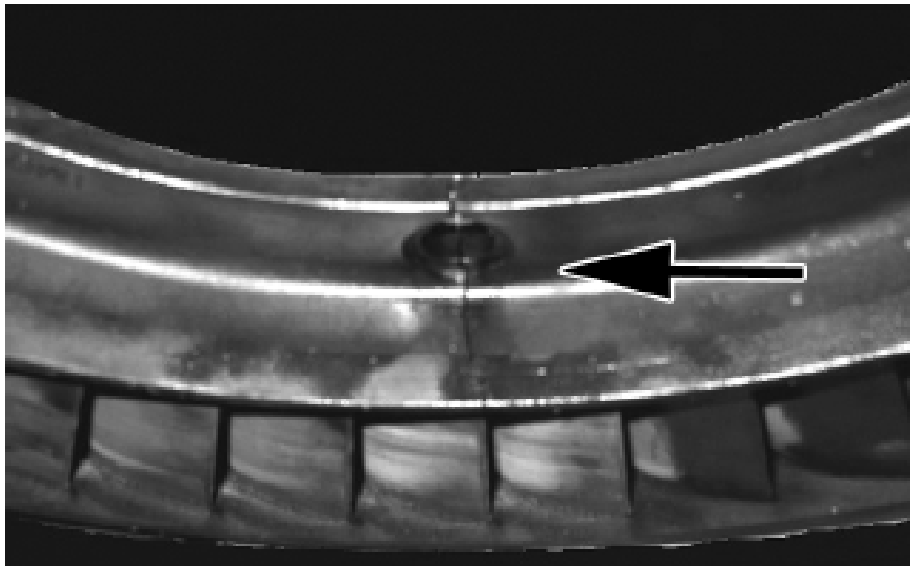
Caution!

Please pay attention that a splash ring and a thrust ring of the latest design is installed when fitting a new locating bearing. Otherwise a bearing damage is risked.

Please check and, if necessary, adjust the lube oil pressure of 1.3 – 2.2 bar before turbocharger after installation of the new components.
Independent of splash oil cooling, future spare part orders will exclusively be delivered with new locating bearing including a new splash ring and a new thrust ring.
The rotor and the sealing cover are only available in the revised version.

NA 48/S/T-57/T/T9 (CUS 237 10/07)
Cracks in nozzle ring



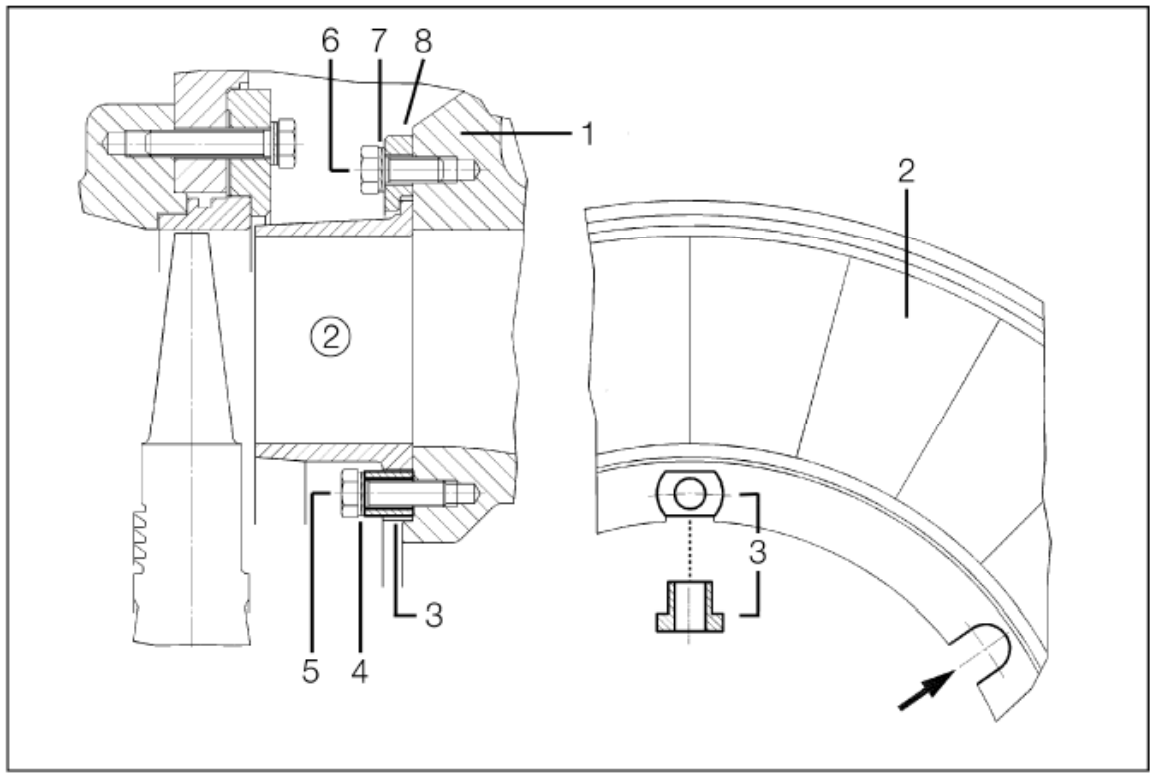


During scheduled maintenance work on NA turbochargers in the past, our MAN Diesel PrimeServ service personnel have occasionally detected the formation of cracks at the vanes (inlet side and outlet side of the vane) and at the bolt holes of cast nozzle rings.

Only nozzle rings for the following turbocharger types are affected:
NA48/S, NA48/T, NA57/T and NA57/T9

Investigations carried out by MAN Diesel showed that the cracks had been caused by the rigid fastening of the nozzle rings in the gas-admission casings. The gas-admission casing had not been able to adequately absorb the expansion of the nozzle ring as a result of high exhaust-gas temperatures.

NA 48/S/T-57/T/T9 (CUS 237 10/07)
Cracks in nozzle ring

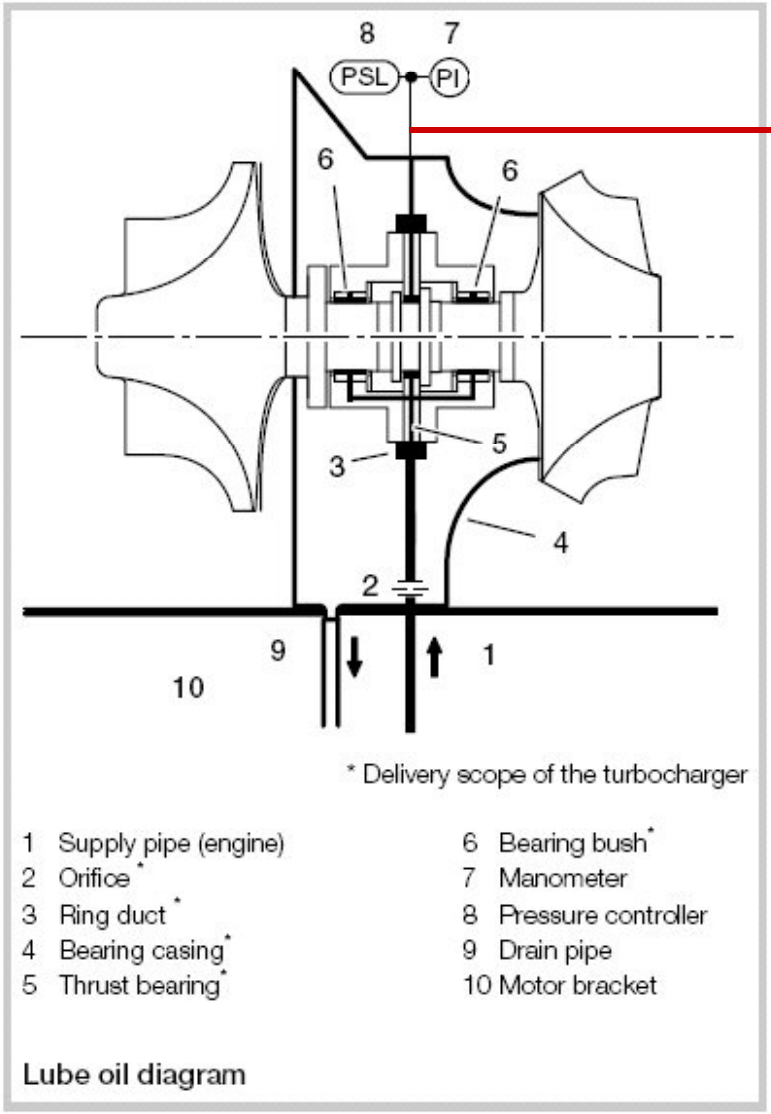


TCA nozzle ring modification similar to NA

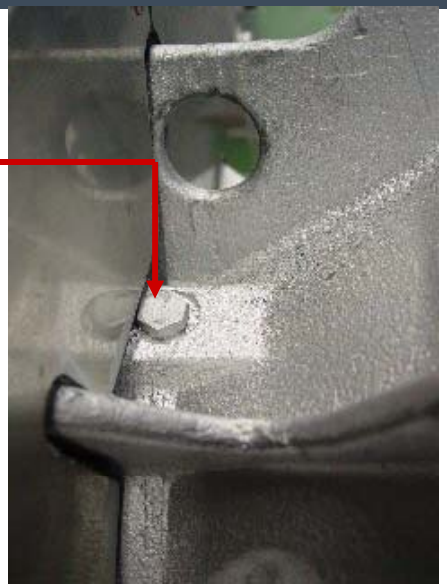
1 Gas-admission casing
2 Nozzle ring
3 Sleeve
4 Lock washer pair
5 Hexagon bolt
6 Hexagon bolt
7 Lock washer pair
8 Clamping ring

MAN Diesel points out that none of these cases of damage gave cause for concern with regard to the reliable operation of the turbochargers.
Nevertheless, MAN Diesel recommends its customers to check and, if necessary, replace the nozzle ring during the next scheduled turbocharger maintenance. The new nozzle rings can be mounted in the gas-admission casing without further modifications.
In case of replacement orders, MAN Diesel will automatically deliver this latest design of nozzle ring with the associated fastening materials.

TCR:
The lube oil system



Lube oil diagram



Function of the Lube Oil System

Lubrication and cooling of the highly stressed bearing points in the exhaust gas turbocharger is effected through a lube oil system which is integrated in the bearing casing of the turbocharger.

The lube oil is conducted from the lube oil system (Lube oil diagram, see Page 4-2) of the engine via the supply pipe (**1**) to the lube oil system of the turbocharger. The orifice (**2**) mounted in the oil supply reduces the oil pressure to the required value. The lube oil is conducted to the radial and axial lubrication gaps of the turbocharger via the ring duct (**3**) and the bores in the bearings. A connection for the manometer (**7**) and/or the pressure controller (**8**) for controlling/monitoring of the lube oil pressure is located on the top of the bearing casing (**4**).
The oil flows back into the engine's lube oil system via the drain pipe (**9**).

Oil Pressures

Measuring Location	Limit Value in bar
Lube oil pressure during operation (40 - 75 °C)	1.3 - 2.2
Max. lube oil pressure in cold condition	< 6
Continuous pre-lubrication	0.3 - 0.6
Post lubrication, 10 to 30 minutes	0.3 - 0.6

Alarm Points	
Alarm	1.0
Direct load reduction of the engine (slow down)	0.8
Engine stop (shut down)	0.6

Pre-lubrication

Before starting the engine, the bearing points of the exhaust gas turbocharger must be pre-lubricated. This takes place automatically together with the pre-lubrication of the engine, as the lube oil system of the turbocharger is connected to the lube oil system of the engine. Depending on the engine system, pre-lubrication occurs directly before starting.

Pre-lubrication before starting:

Duration < 10 minutes with an oil pressure of 1.3 - 2.2 bar.

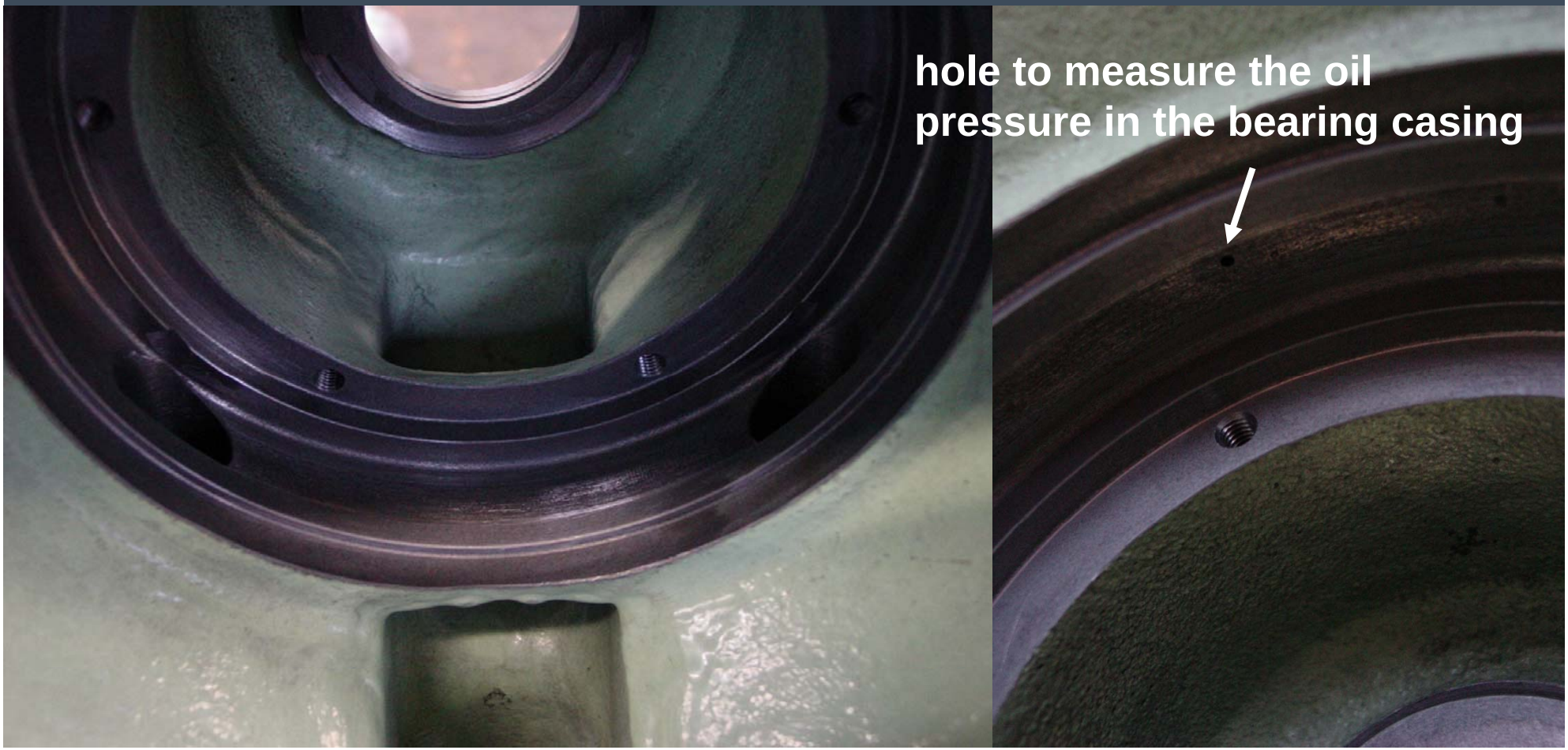
Continuous pre-lubrication:

With an oil pressure of 0.3 to 0.6 bar.

Post Lubrication

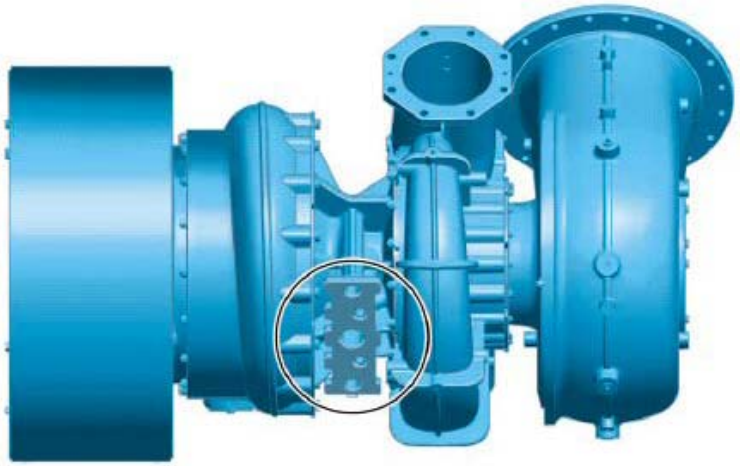
After an engine shut-down, the bearings of the turbocharger must be post lubricated for cooling purposes with a lube oil pressure of 0.3 to 0.6 bar (reference height: center axis of the exhaust gas turbocharger) for a period of 10 to 30 minutes.

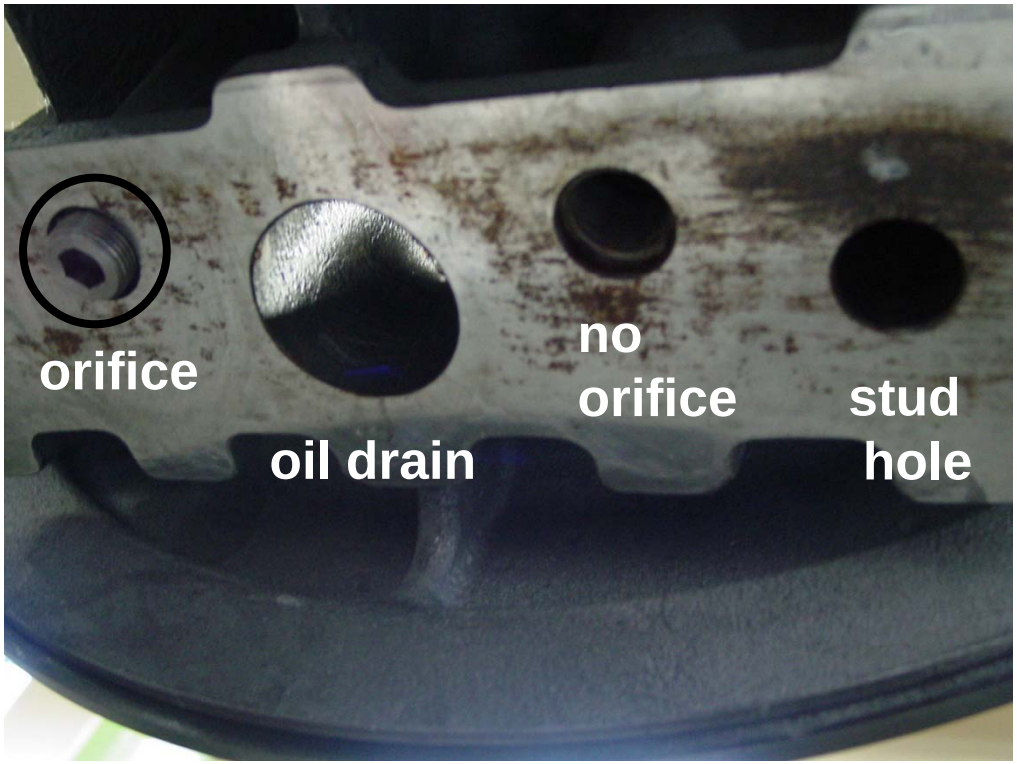
TCR:
Lubrification system

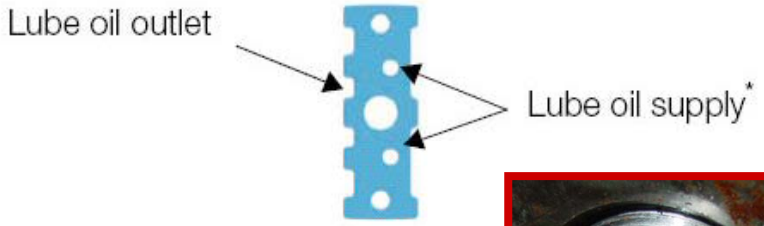


Oil supply bores, oil drain and ring channel in the bearing casing

TCR: Lube oil pressure adjusted with orifice







* Alternatively left or right

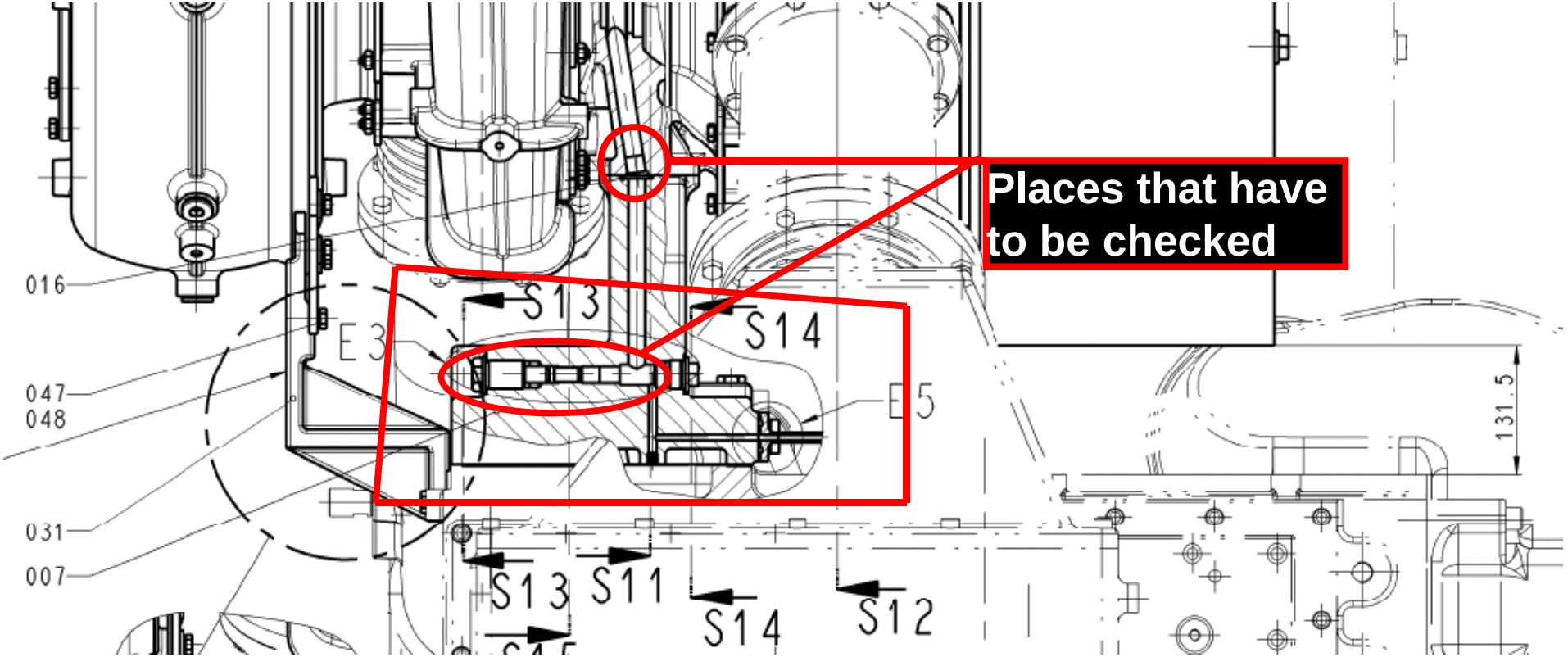
Lube oil connections

The location in the TC foot is definetly not the recommended location for the orifice. It is better to install the orifice in the TC bracket on engine side

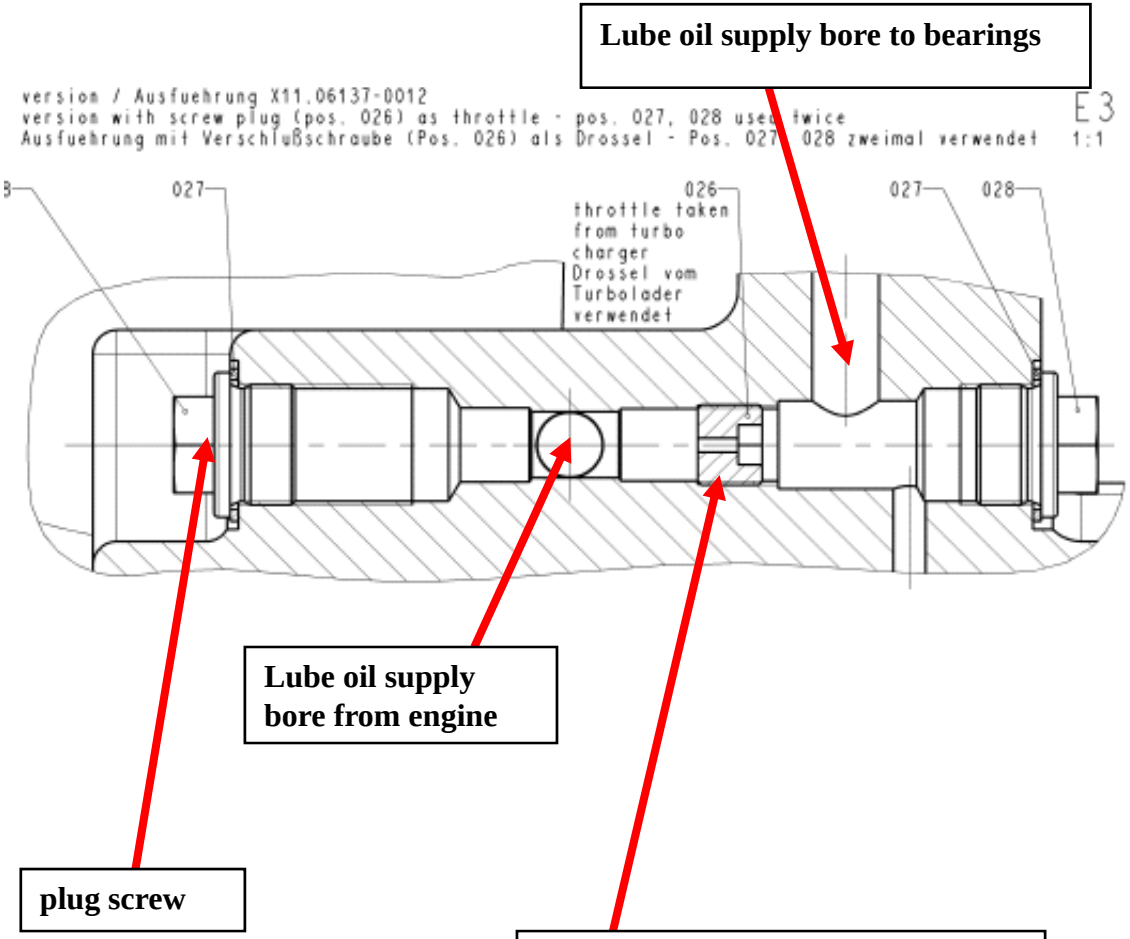
Note

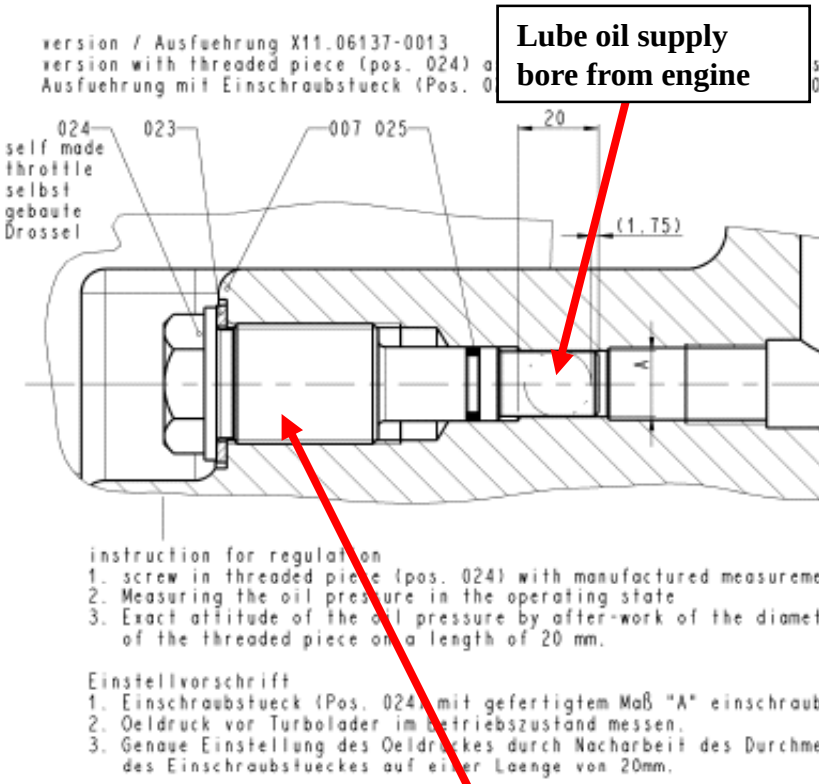
Ensure that only one orifice is mounted in the lube oil supply to the turbocharger.

TCR: Orifice in the engine foot (Holeby design)



TCR: Orifice in the engine foot (Holeby design)





Lube oil supply bore to bearings

Lube oil supply bore from engine

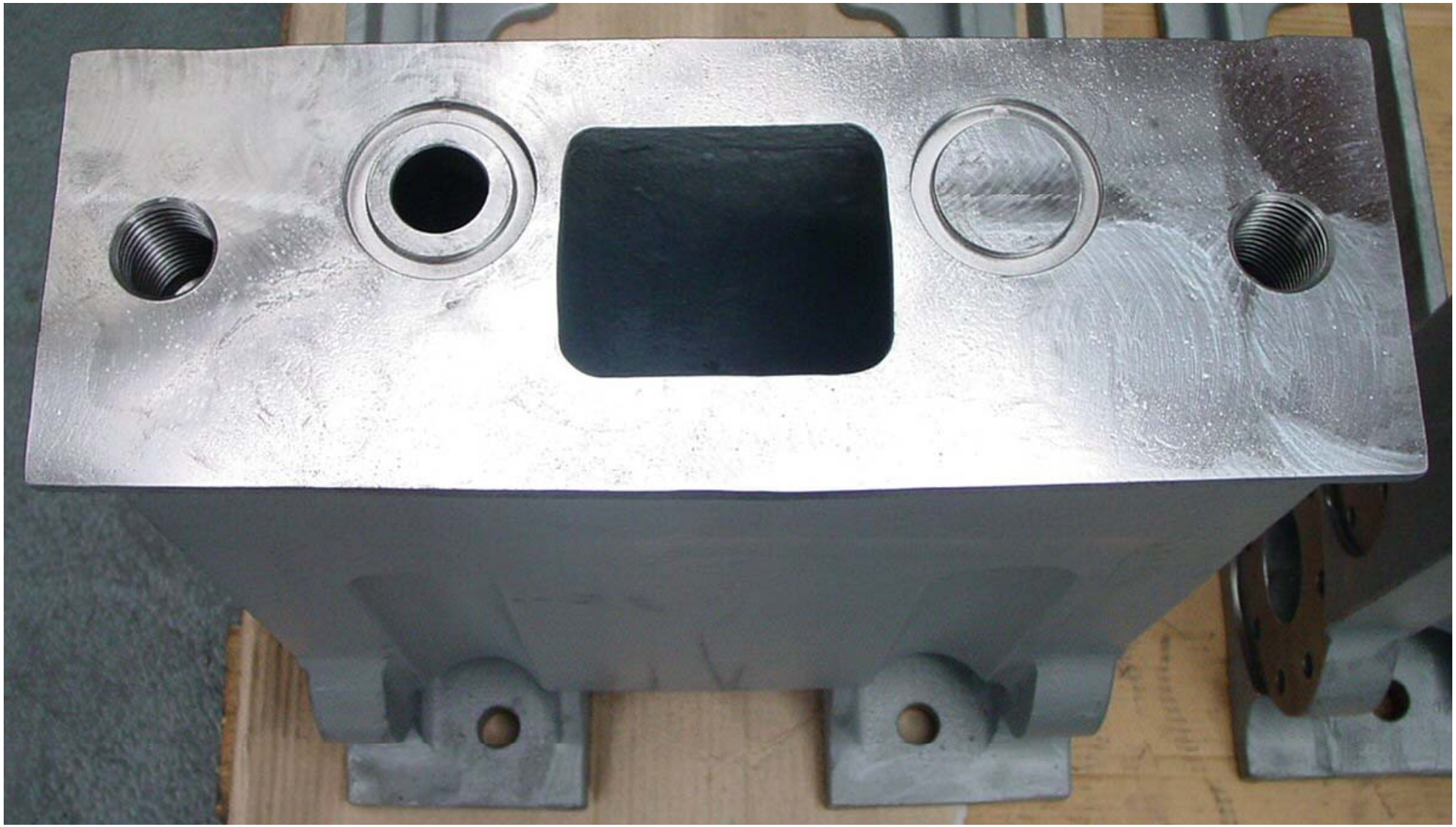
plug screw

Orifice delivered by MAN, normally it is delivered loose and the bore in the middle is pre adjusted according to turbocharger

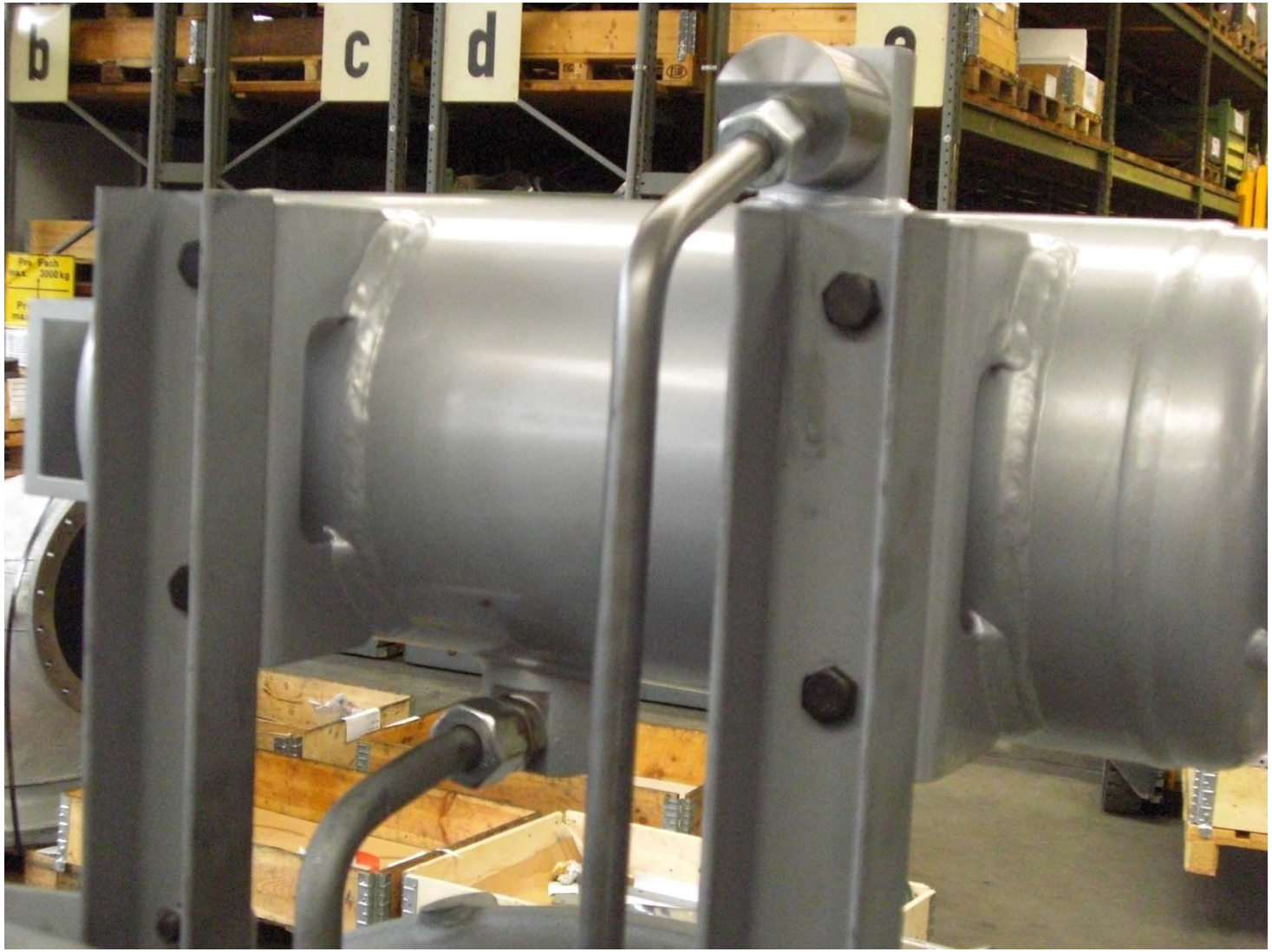
Lube oil supply bore from engine

Orifice supplied by MAN Holeby (Denmark), adjusted due to grinding at the diameter at the front end of the plug screw

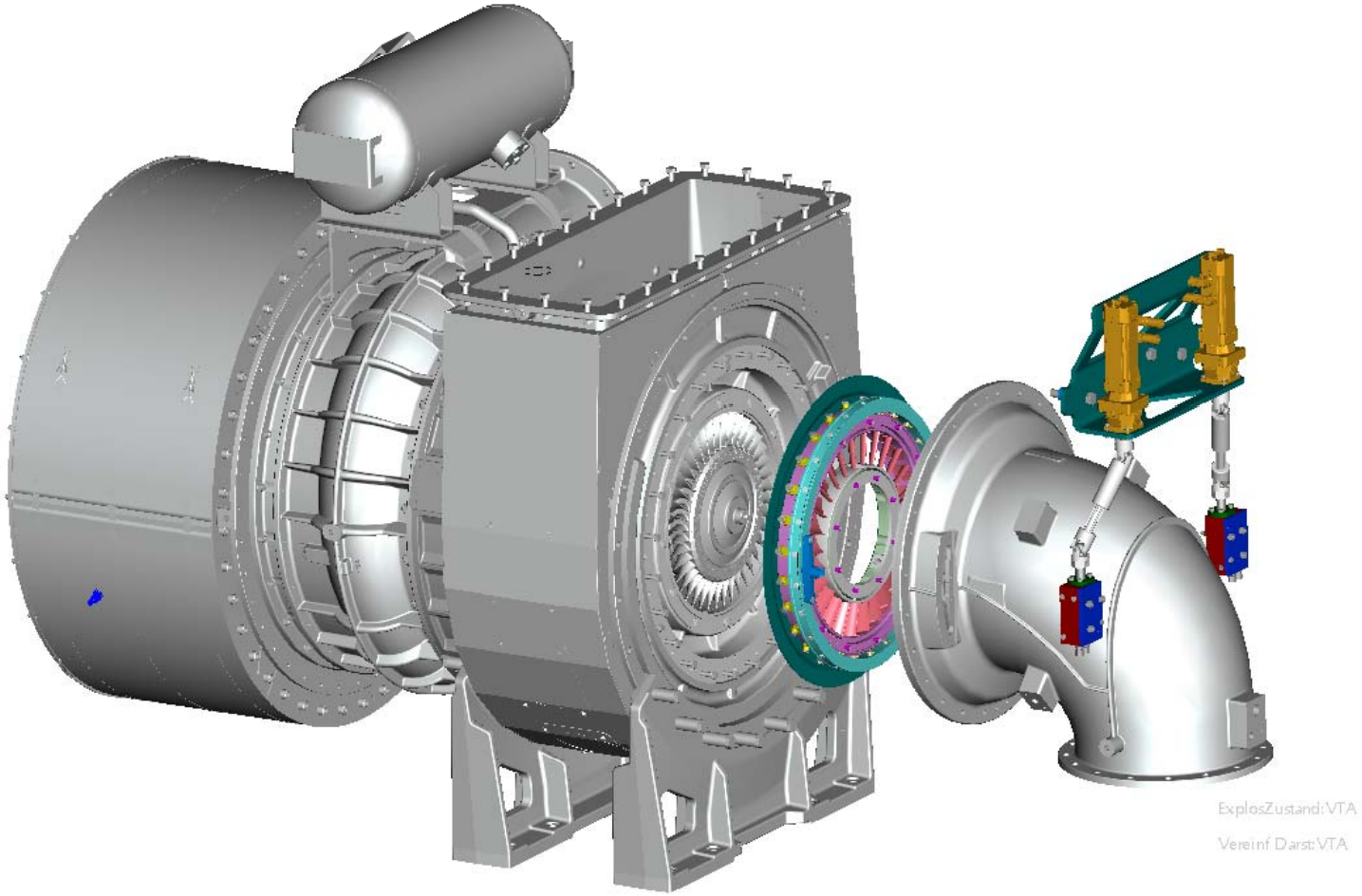
TCR:
Engine foot with O-ring grooves



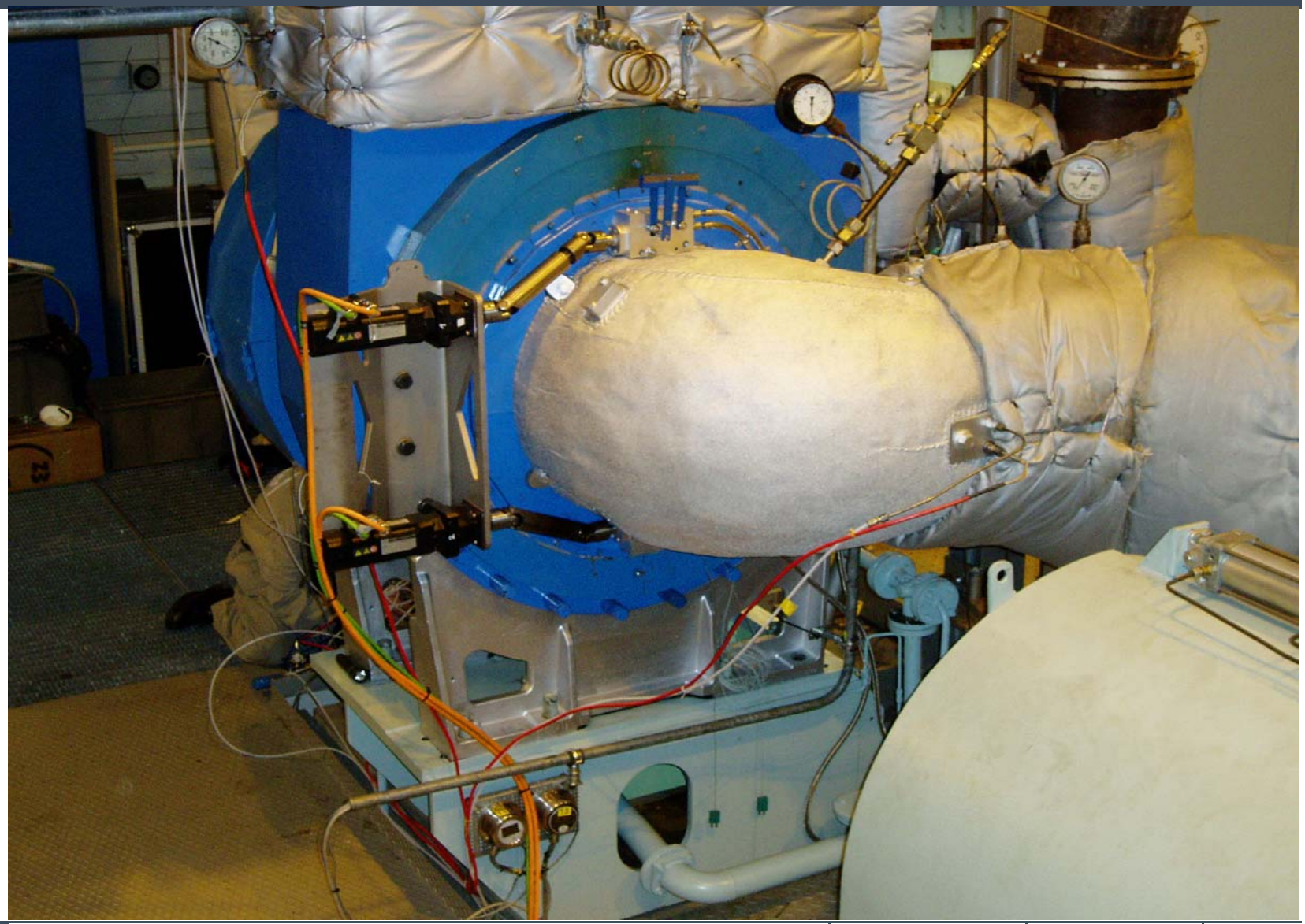
TCR 22-20:
New Gravity Postlubrication Tank (venting included)



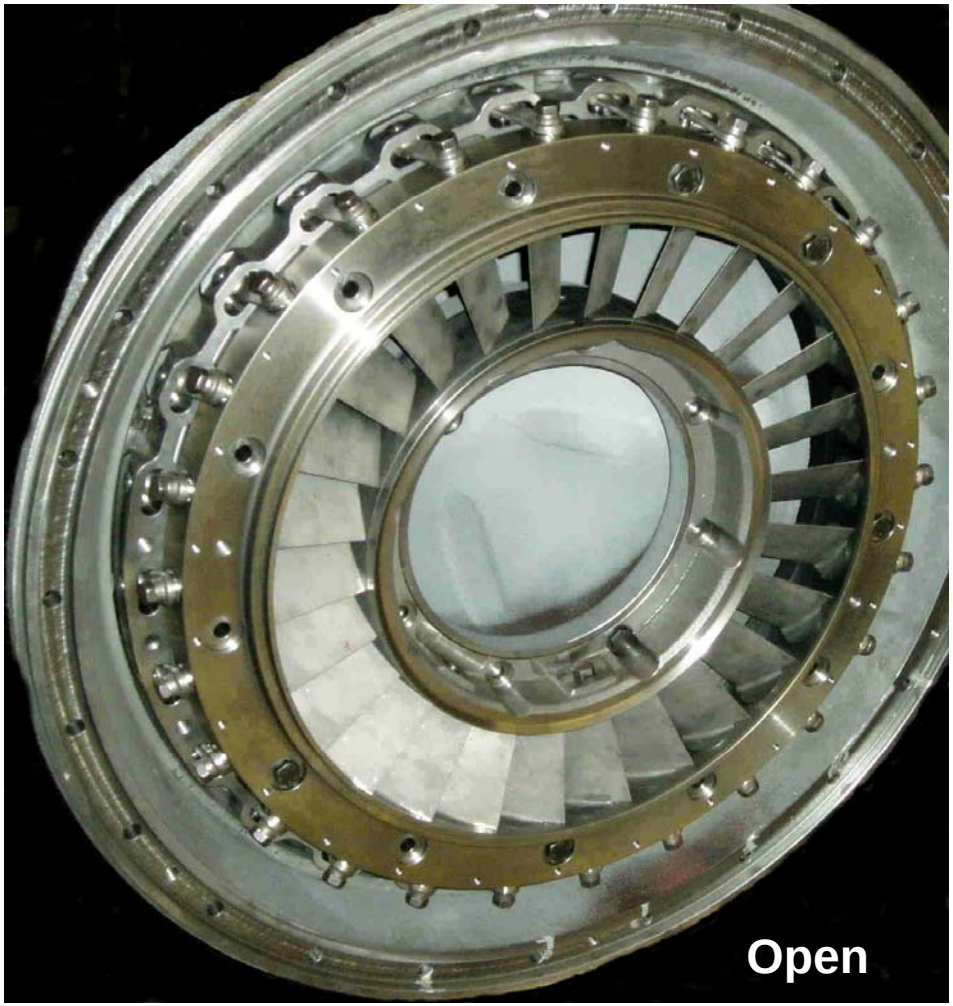
TCA Superior Performance
Variable Turbine Area (VTA)



TCA Superior Performance
TCA55 with VTA on burner rigg

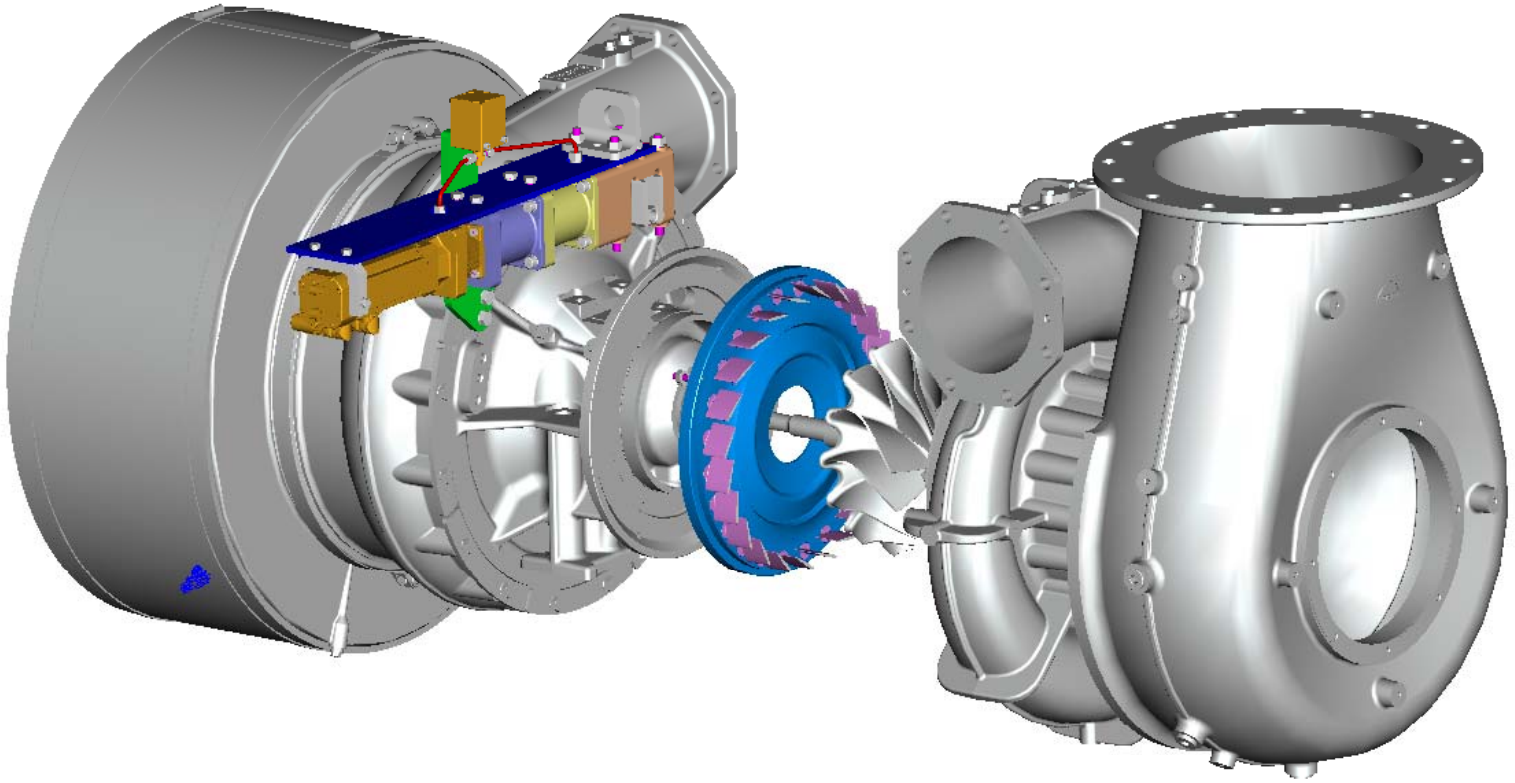


TCA Superior Performance
Variable Turbine Area (VTA)

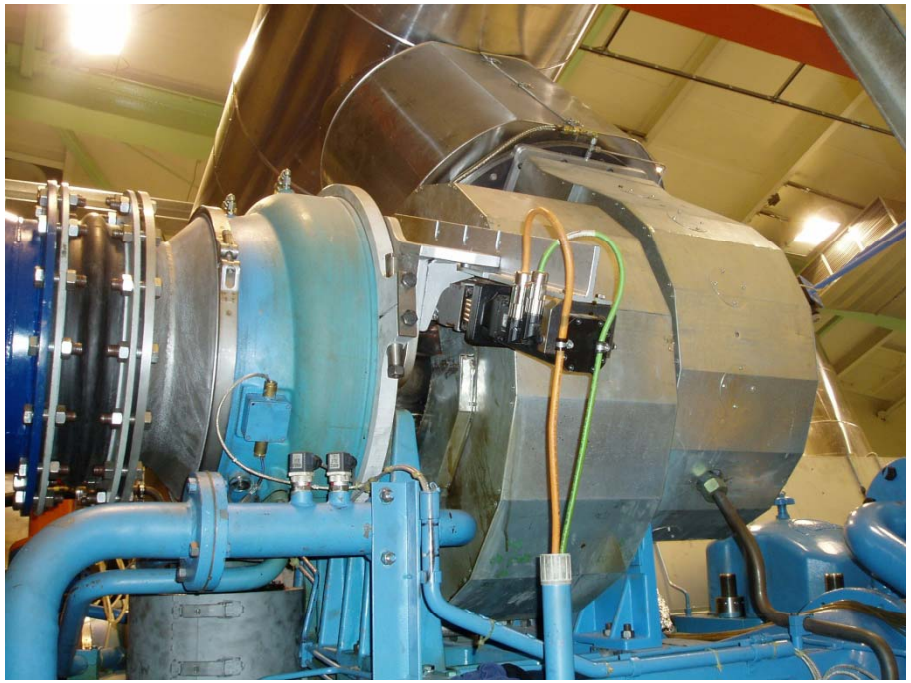


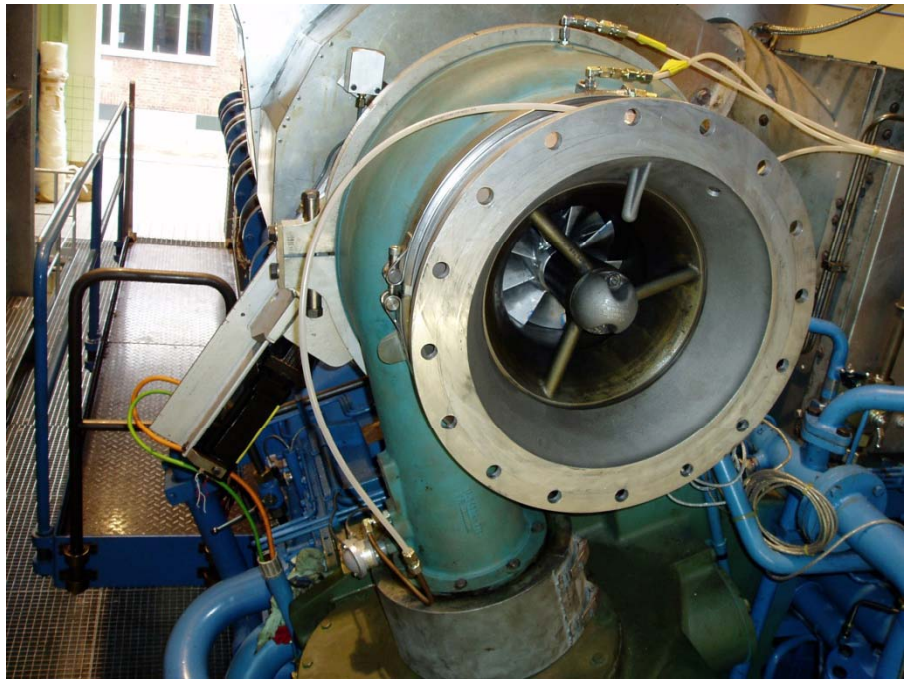
TCA Superior Performance
TCA55 with VTA on 4T50ME-X

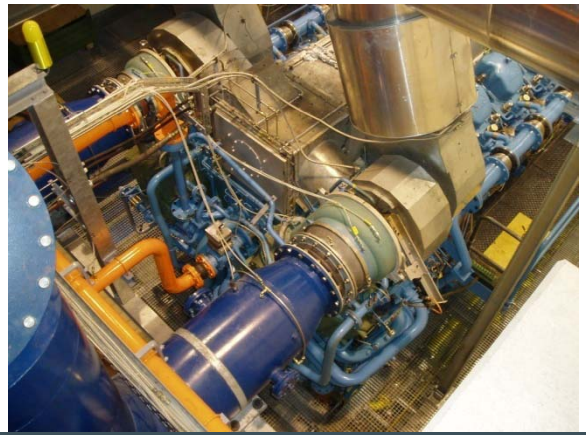
TCR Superior Performance
TCR with VTA



VTA on NR 29/S mounted on 12V 32/40 engine at MD-A power house







TCR Superior Performance
TCR Nozzle Ring With VTA