Kasey Howe
WGMSC 2024

TURBINE METERS

Honeywell

Honeywell Gas Meters

A. Positive Displacement

1. Diaphragm

Honeywell

Honeywell Gas Meters

A. Positive Displacement
    1. Diaphragm
    2. Rotary

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Honeywell Gas Meters

A. Positive Displacement
    1. Diaphragm
    2. Rotary
B. Inferential
    3. Turbine

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Honeywell Gas Meters

A. Positive Displacement
    1. Diaphragm
    2. Rotary
B. Inferential
    3. Turbine
    4. Ultrasonic

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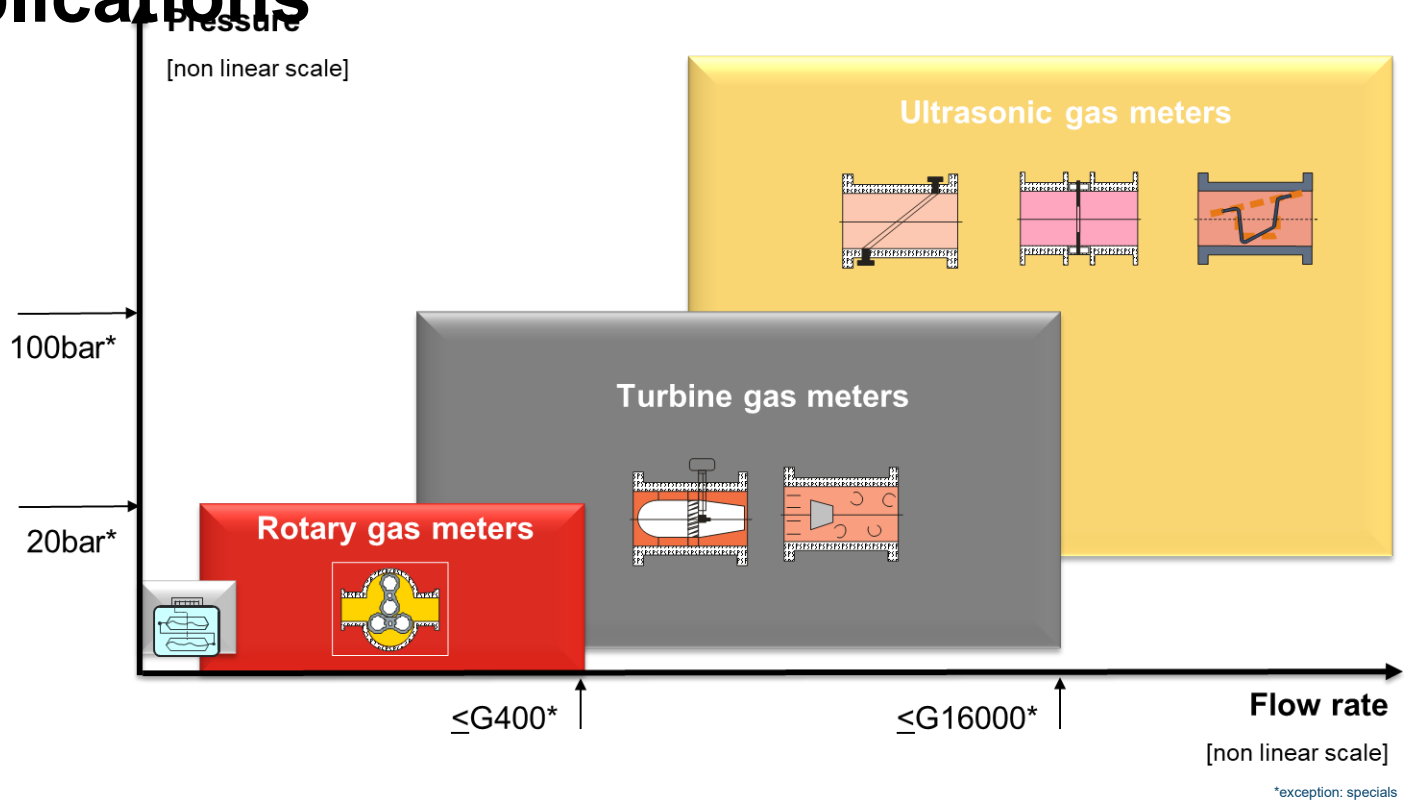
Metering technologies for different applications



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Turbine Meters

GT, GTS, GTX and AccuTest Turbine Gas Meters

Technical Bulletin

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Elster® Turbine Gas Meters

- Two types:
  - **TRZ2** (DN50/2” to DN150/6”)
  - **SM-RI-X** (DN200/8” to DN600/24”)
- Volumetric Gas Meters approved for custody transfer metering by European Notified Bodies PTB and NMI in accordance with MID
- Extensive Portfolio ranging from DN50 (2”) to DN600 (24”)
- Wide pressure range from atmospheric pressure up to 100 bar

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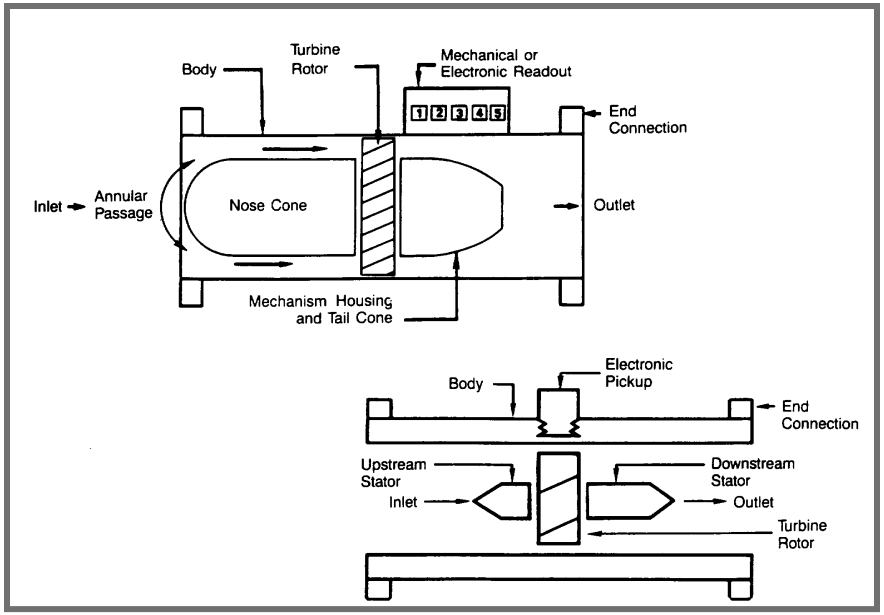
Principle of Operation

Velocity Meter

The faster the gas flows through the meter, the faster the rotor turns.



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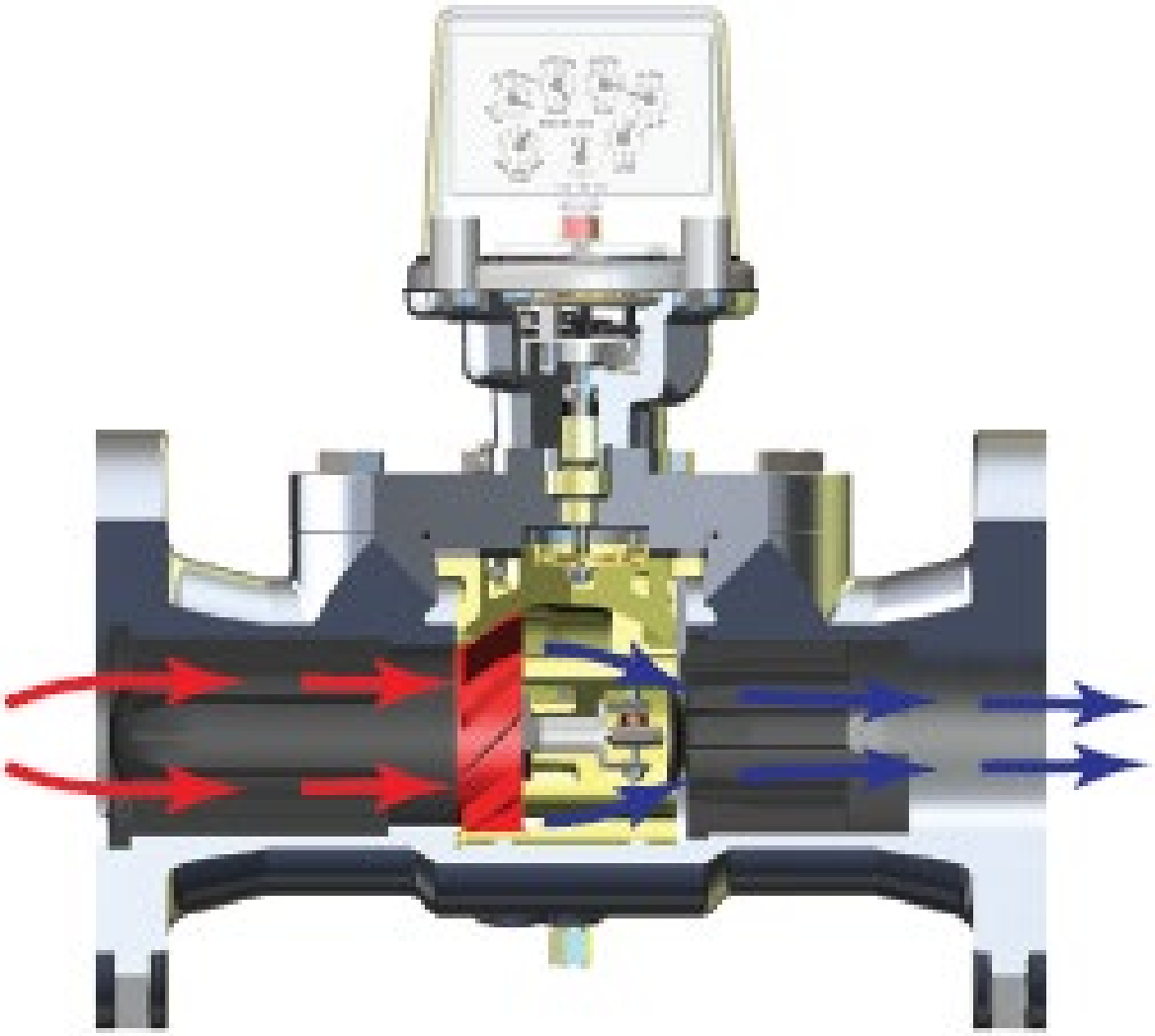
Principle of Operation



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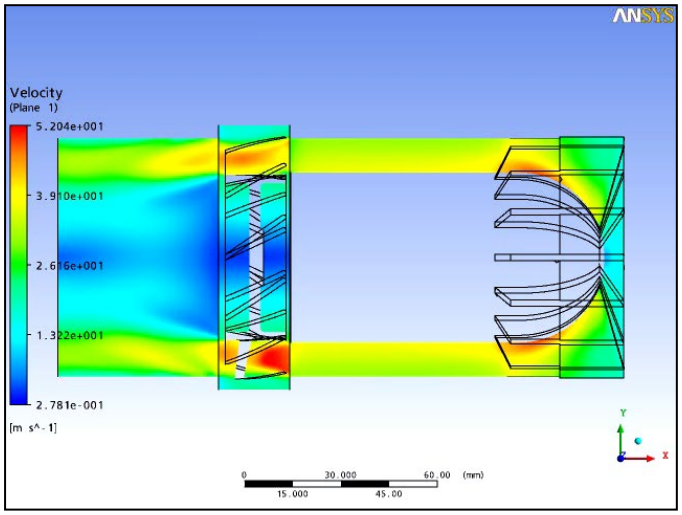
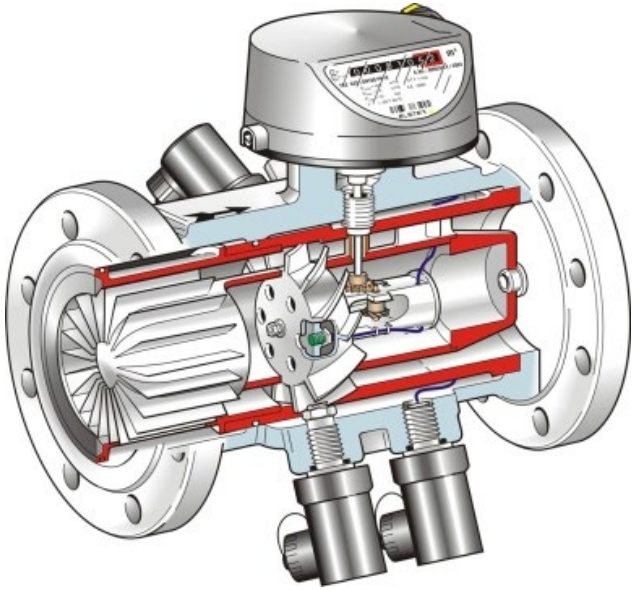
Turbine Gas Meters – Metering Principle





- **Flow guide / flow conditioner**
  - Reduces flow disturbances
  - Increases gas velocity due to constriction of cross section
- **Rotor**
  - mounted axially
  - Blades have certain angle
  - Rotation speed is proportional to the gas velocity / flow rate
- **Gearbox**
  - Rotor rotations are transmitted through the gearbox, reducing the number of revolutions to the index
  - A magnetic coupling transmits the rotations from the pressurized part to the unpressurized index head
- **Meter index**
  - Mechanical counter showing the volume which has passed

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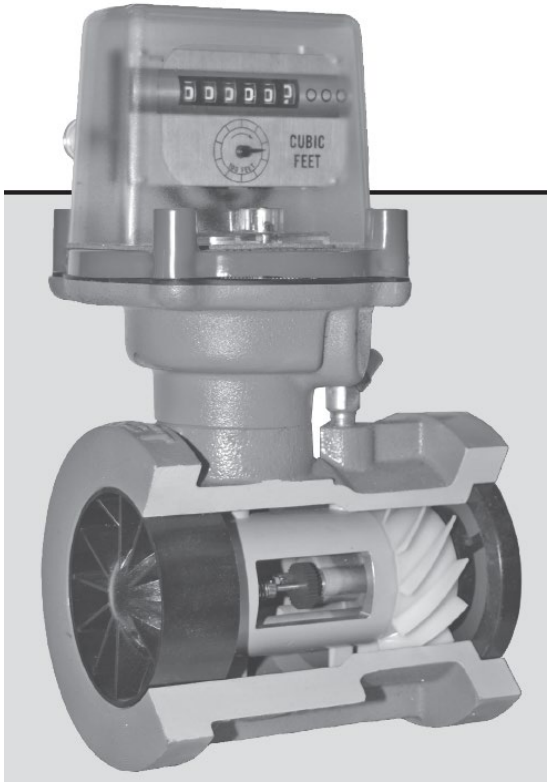
Types of Turbine Meters

A. GT Turbine (Downstream Rotor)

1. 3” GT



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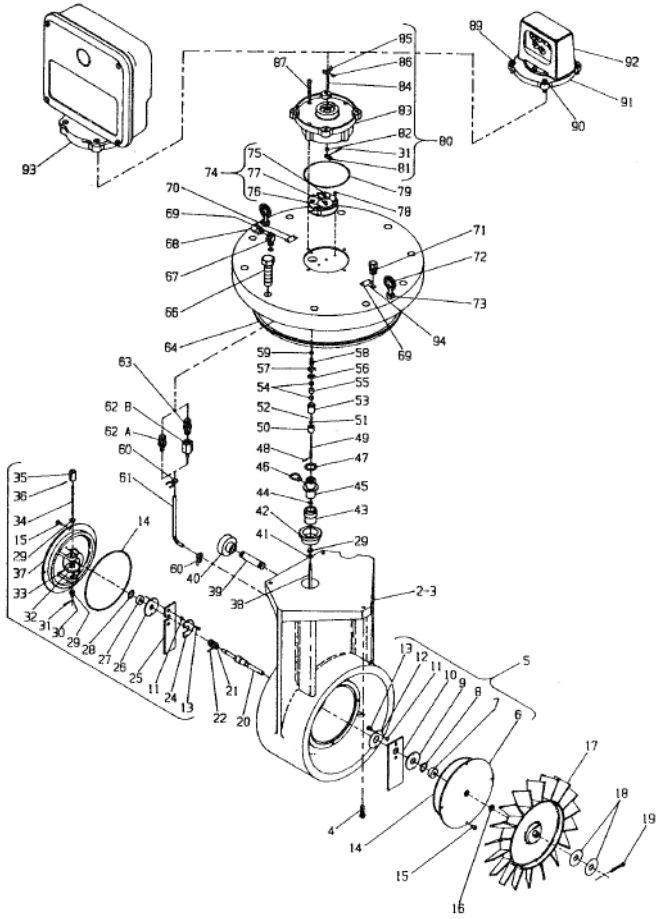
Types of Turbine Meters

A. GT Turbine (Downstream Rotor)

1. 3” GT
2. 12” GT



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Types of Turbine Meters

A. GT Turbine (Downstream Rotor)
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B. GTS Turbine (Upstream Rotor)
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   4. 6” GTS
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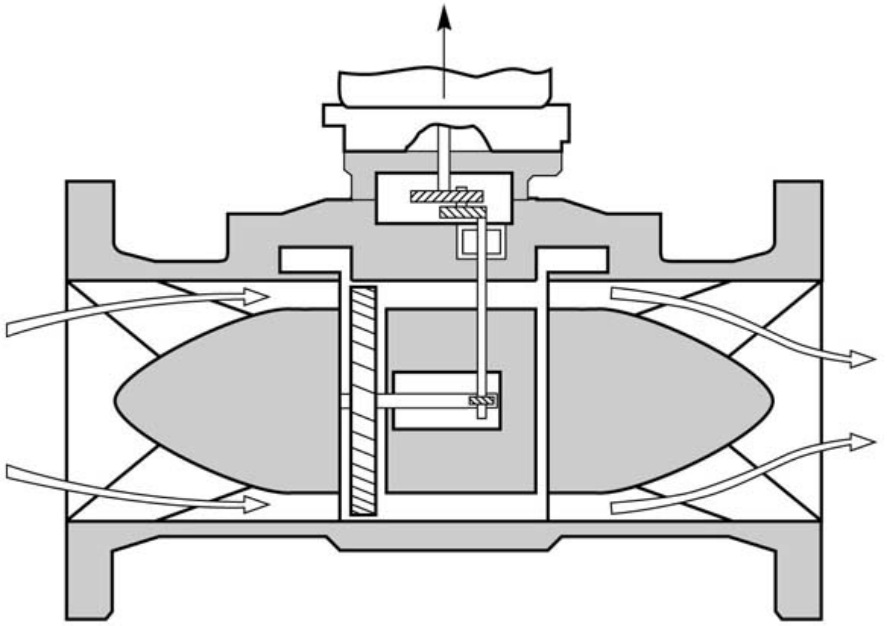

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C. AccuTest Turbine (2 Independent Rotors)
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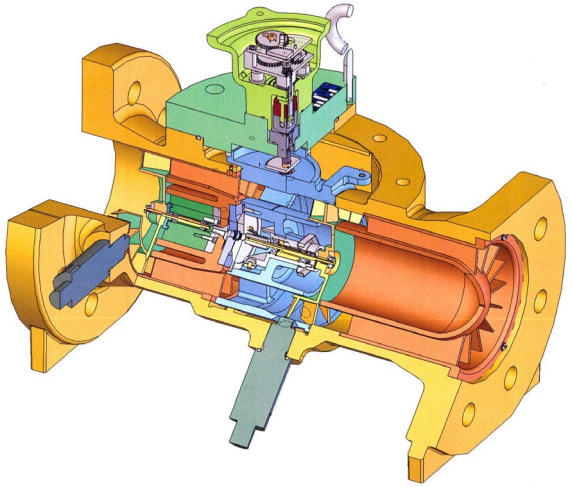

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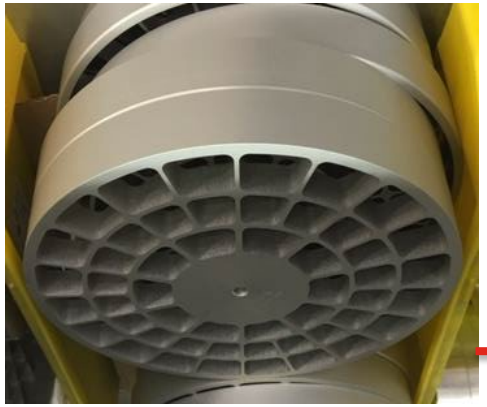
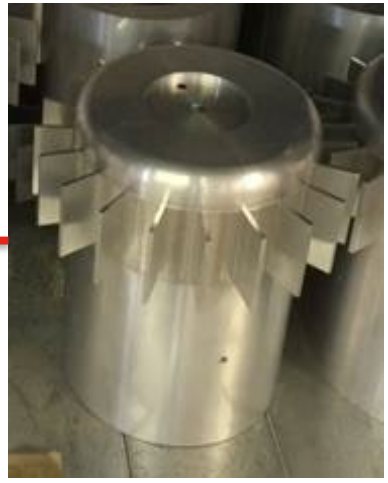
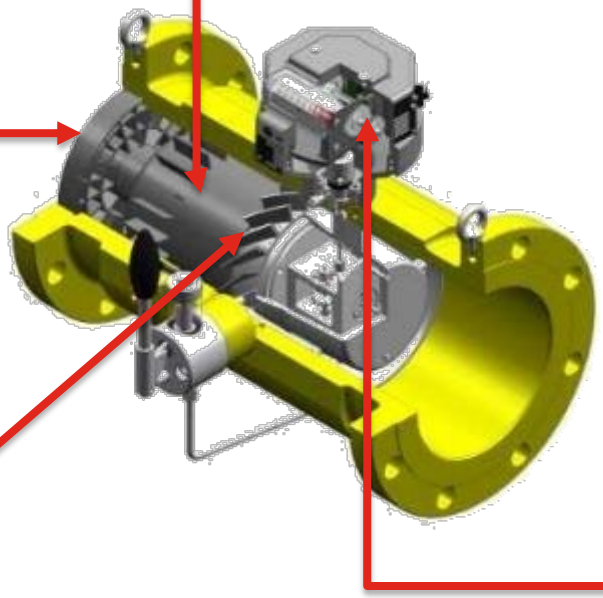
TRZ2 and SM-RI-X

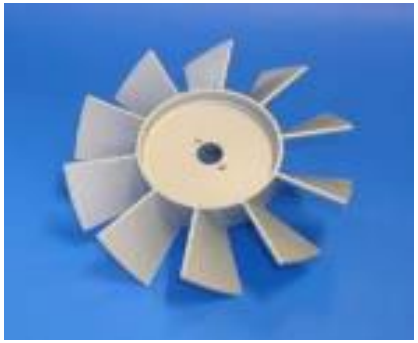


Flow conditioner



Flow straightener





Turbine Rotor

Index Head MI-2

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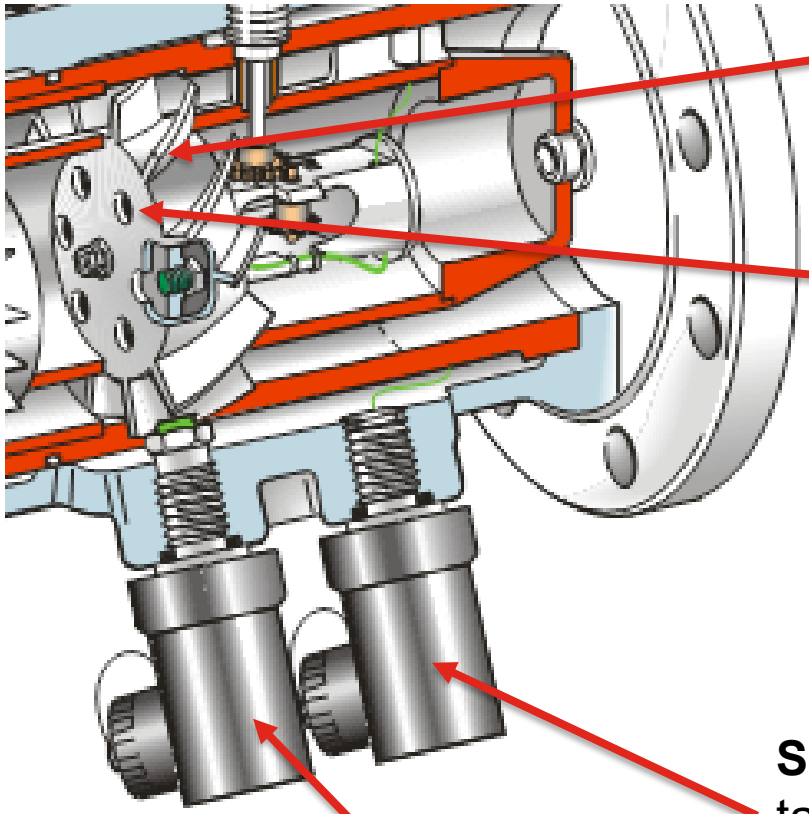
High Frequency Outputs TRZ2



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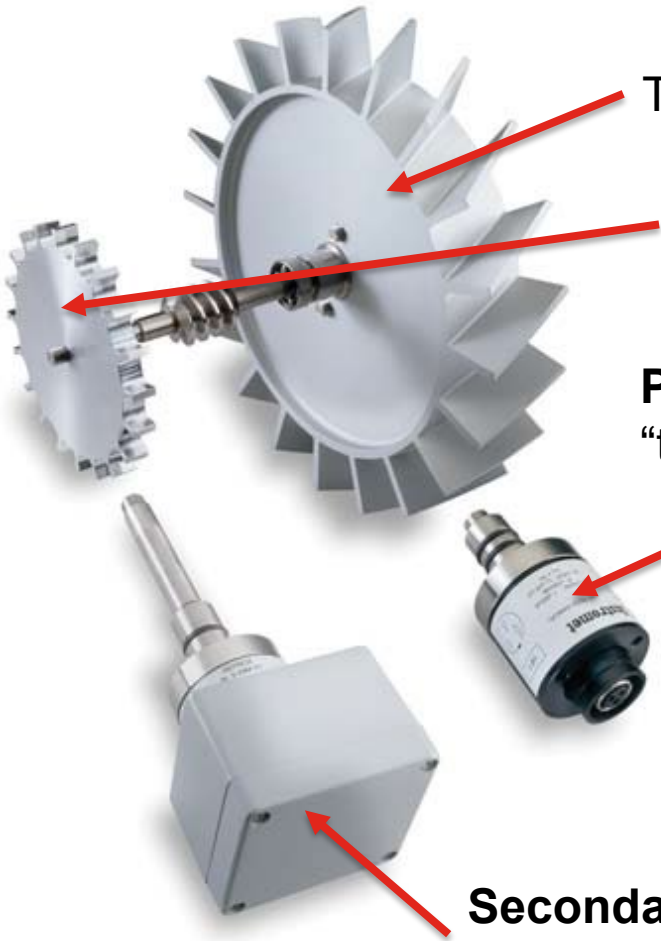
High Frequency Outputs SM-RI-X

Diameter	Meter size	$Q_{min} - Q_{max}$ [m³/h]	HF [Hz at Q_{max}]
DN 200 8"	G 650	50 – 1000	770
	G 1000	80 – 1600	1180
	G 1600	130 – 2500	1060
DN 250 10"	G 1000	80 – 1600	825
	G 1600	130 – 2500	1320
	G 2500	200 – 4000	1200
DN 300 12"	G 1600	130 – 2500	810
	G 2500	200 – 4000	1270
	G 4000	320 – 6500	1175
DN 400 16"	G 2500	200 – 4000	660
	G 4000	320 – 6500	1055
	G 6500	500 – 10000	890
DN 500 20"	G 4000	320 – 6500	530
	G 6500	500 – 10000	865
	G 10000	800 – 16000	770
DN 600 24"	G 6500	500 – 10000	470
	G 10000	800 – 16000	720
	G 16000	1300 – 25000	650



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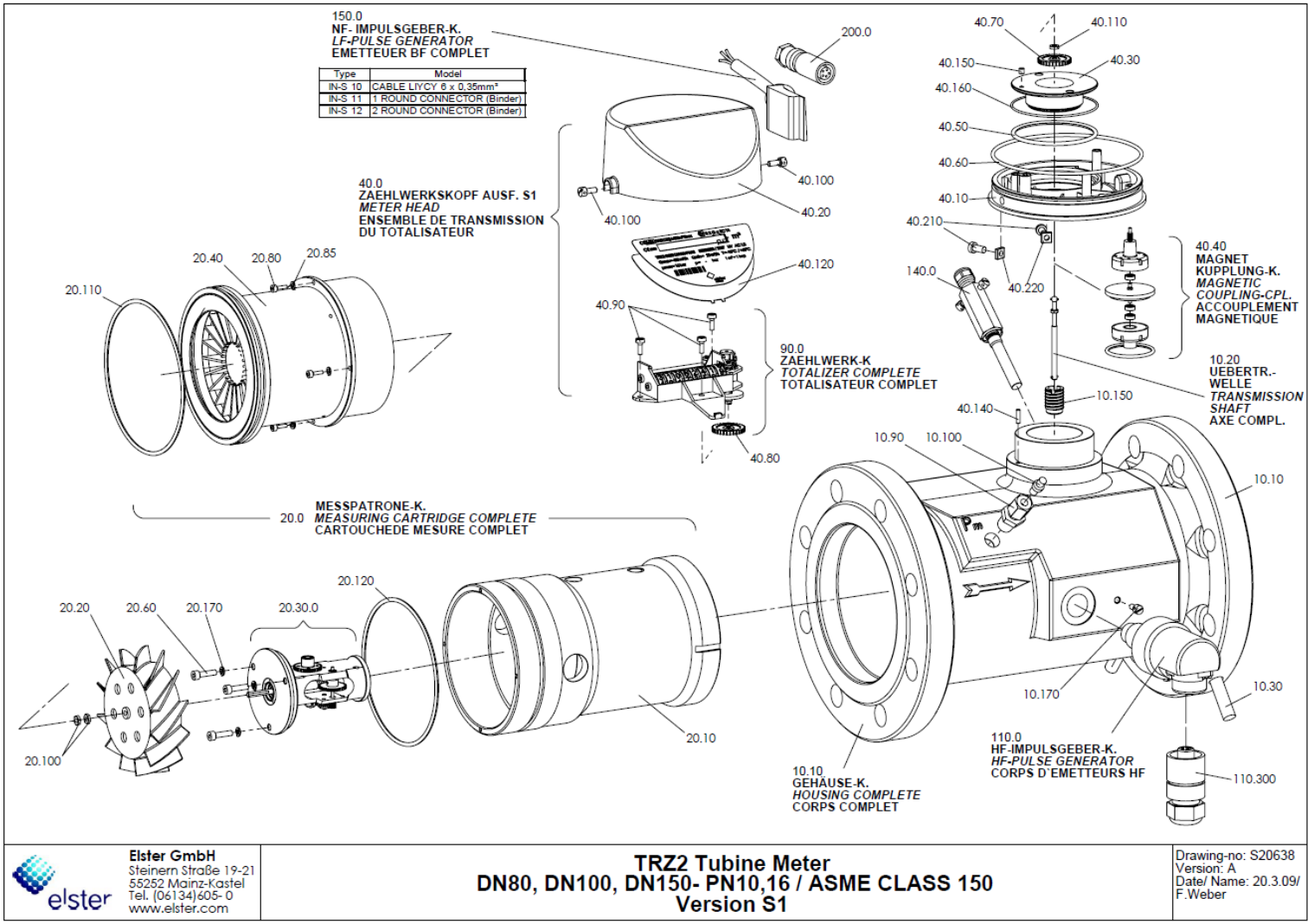

elster Elster GmbH Steinern Straße 19-21 55252 Mainz-Kastel Tel. (06134)605- 0 www.elster.com	**TRZ2 Tubine Meter** **DN80, DN100, DN150- PN10,16 / ASME CLASS 150** **Version S1**	Drawing-no: S20638 Version: A Date/ Name: 20.3.09/ F.Weber

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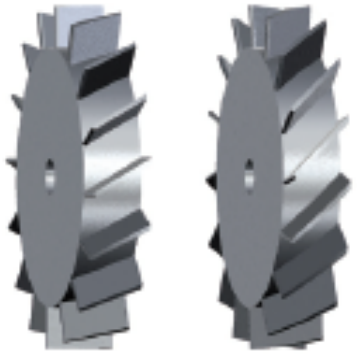
Rotor Options for Turbine Meters



Rotor Materials

Available in either plastic or metal (Metal must be used for high frequency RF pulser).

3"	4"	6"	8"	12"
45° Plastic	45° Plastic	45° Plastic	45° Plastic	45° Plastic
	45° Metal	45° Metal	45° Metal	
	30° Metal	30° Metal	30° Metal	

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American Turbine Meters

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American Turbine Meters

Features

- Flush type lubrication system with oil reservoir, flushes main bearings while meter is in operation.
- Aluminum rotors available for all pressure models and required for meters with high frequency pulse outputs.
- Common gear train for meter sizes (3”, 4”, 6” and 8”) reduces spare parts inventory.
- Inlet flow guide flow conditioners minimize the effects of flow disturbances in short coupled installations.

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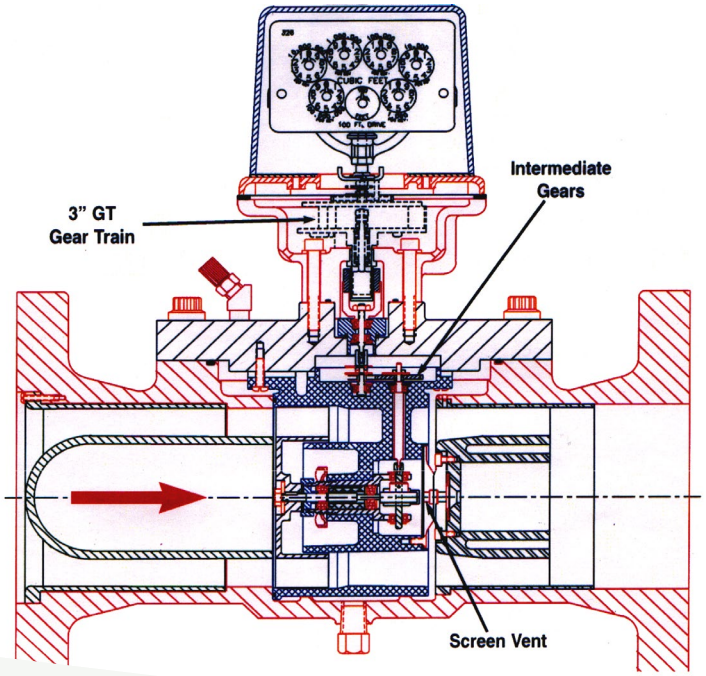

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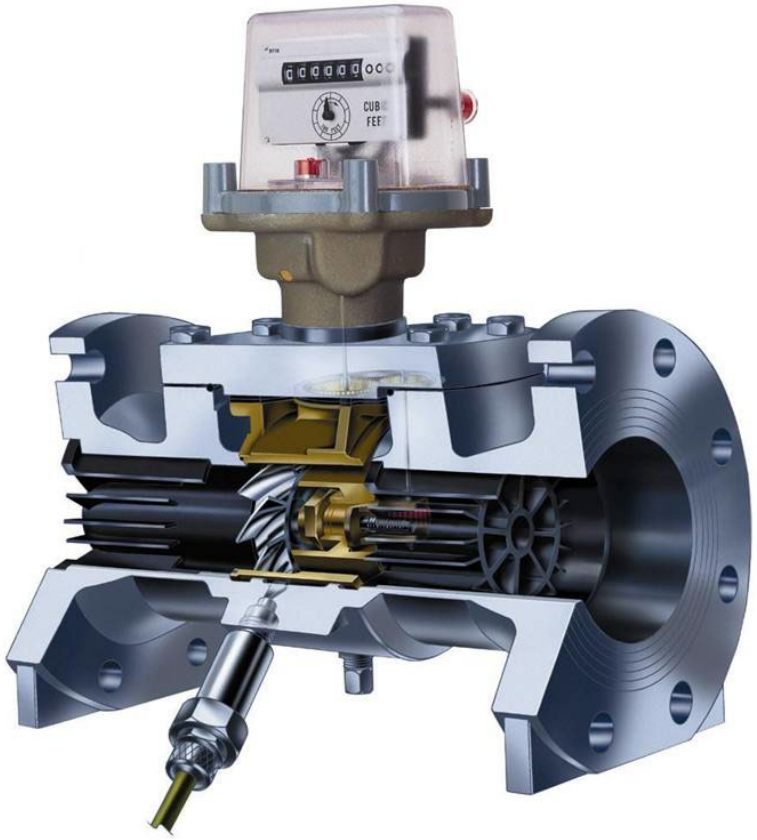
American Turbine Meters

Features

- Optional High frequency RF type pulser that measures the blade tip. Can be used to evaluate rotor condition.
- Interchangeable pre-calibrated measurement cartridges for easy field maintenance.
- Mechanical drive models for use with P&T correctors or electronic pulse output models to directly interface with flow computers.



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- Models with extended capacity ratings can reduce the diameter on an entire meter run, resulting in substantial savings in piping, flanges, block valves, etc.
- Completely machined housings are upgradeable to Accutest model.
- Maintain 100 +/- 1% Accuracy over range from Qmax to Qmin

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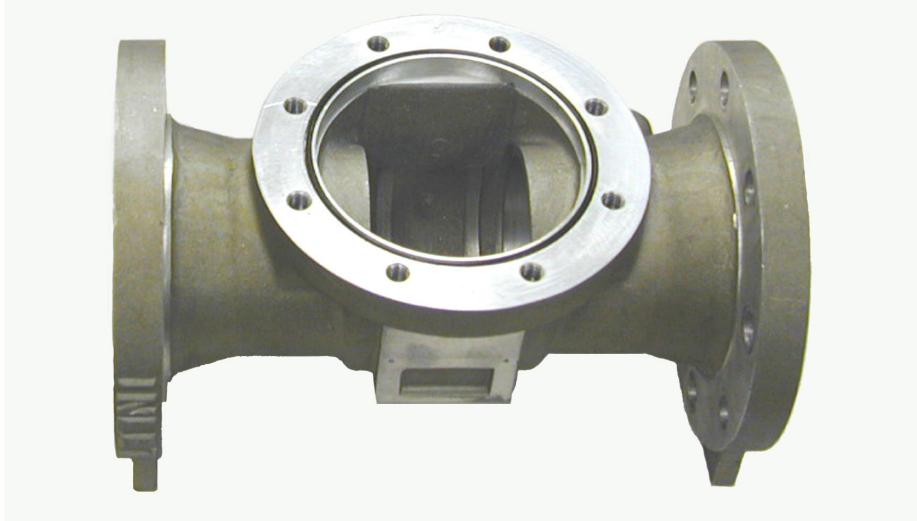

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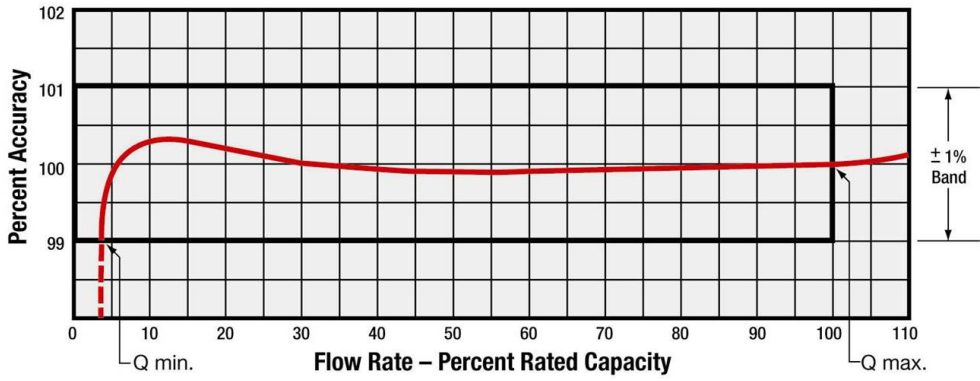

Typical Gas Turbine Meter, Accuracy Curve

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Types of HPS Turbine Meters

A. GT Turbine (Downstream Rotor)
   1. 3” GT
   2. 12” GT

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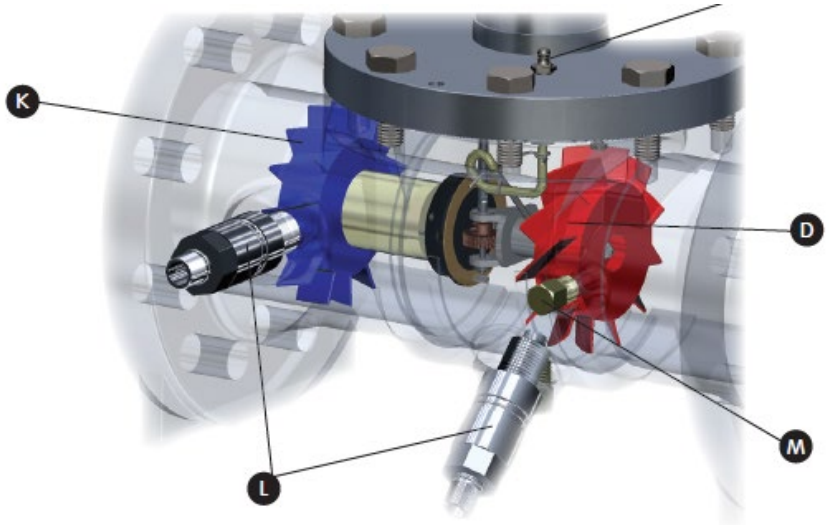

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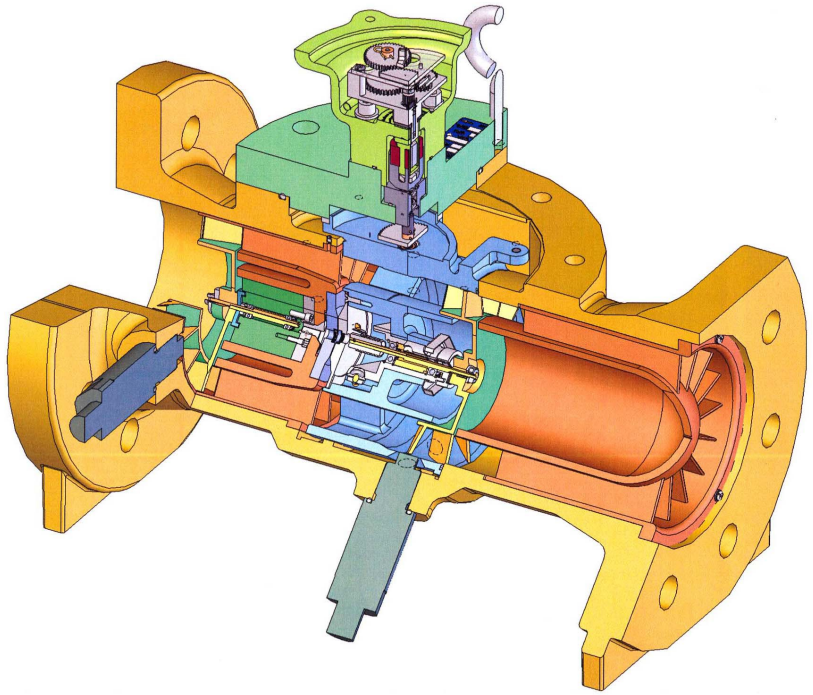
Reference Rotor

Accutest Turbine Meters

- Accutest meters have two independent cartridges installed in one housing.
- Same main cartridge as used in GTS meters, but with an additional independent reference cartridge installed in the outlet flow guide.
- Reference cartridge designed for long term accuracy and durability.
- High frequency RF style pulsers sense the blade tip passing.
- Only available with Aluminum rotors.
- Allows proving of the meter without any other metering equipment.
- Accutest transfer proving kit connects a laptop computer to the meter for instantaneous proving and diagnostics.



Accutest meter cutaway view

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Accutest Turbine Meters

- Mercury Accutest Corrector corrects for Temperature, Pressure and Meter Accuracy.
- Continuously monitors Accuracy by sensing the rotor frequency and calculating the accuracy.
- MUST BE AC POWERED.
- Can be set up to provides alarms for when meter accuracy falls outside user set limits.
- Can be set up to provide audit trails of configured outputs.
- Available in Mini-AT or 800 series housings. Uses standard Min-At components; Battery packs, pressure transducers, etc.

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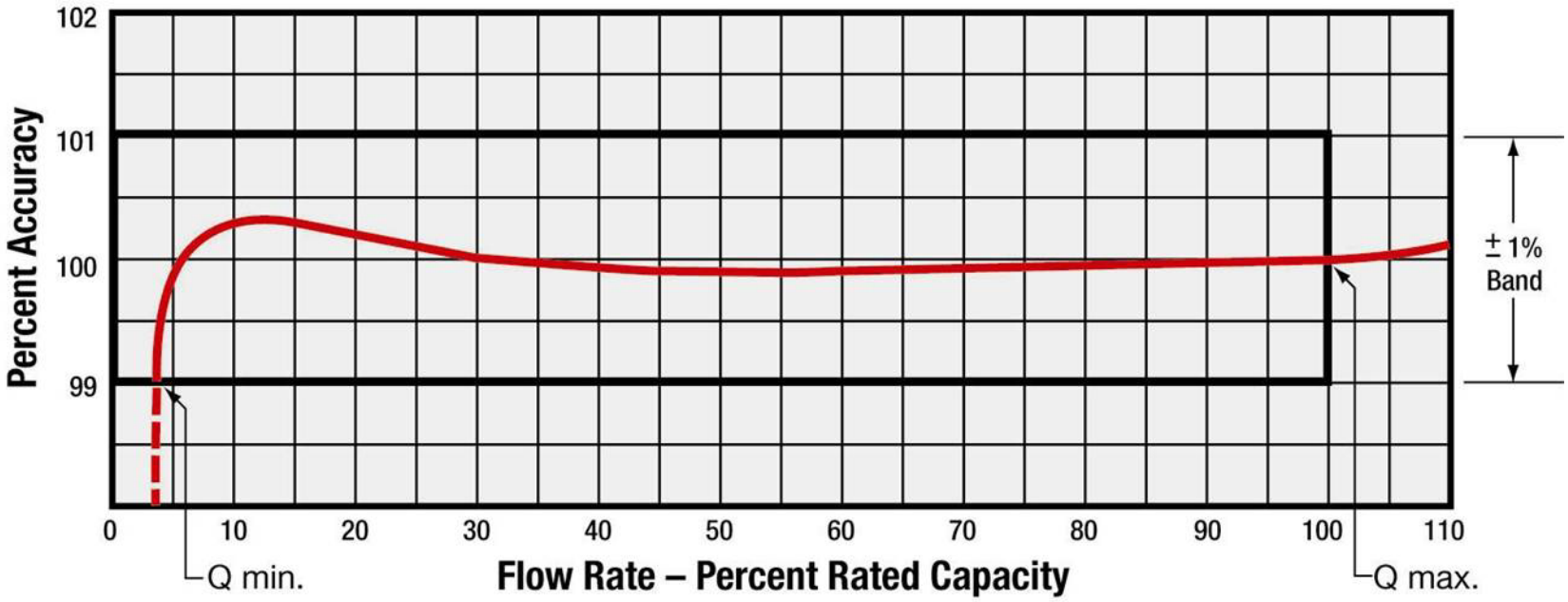
Typical meter performance



Typical Gas Turbine Meter, Accuracy Curve

- Rated rangeability over the +/- 1% band is the ratio of the maximum flow rate (Qmax) to the minimum flow rate (Qmin).
- Rangeability of a turbine meter becomes larger with increasing line pressure.

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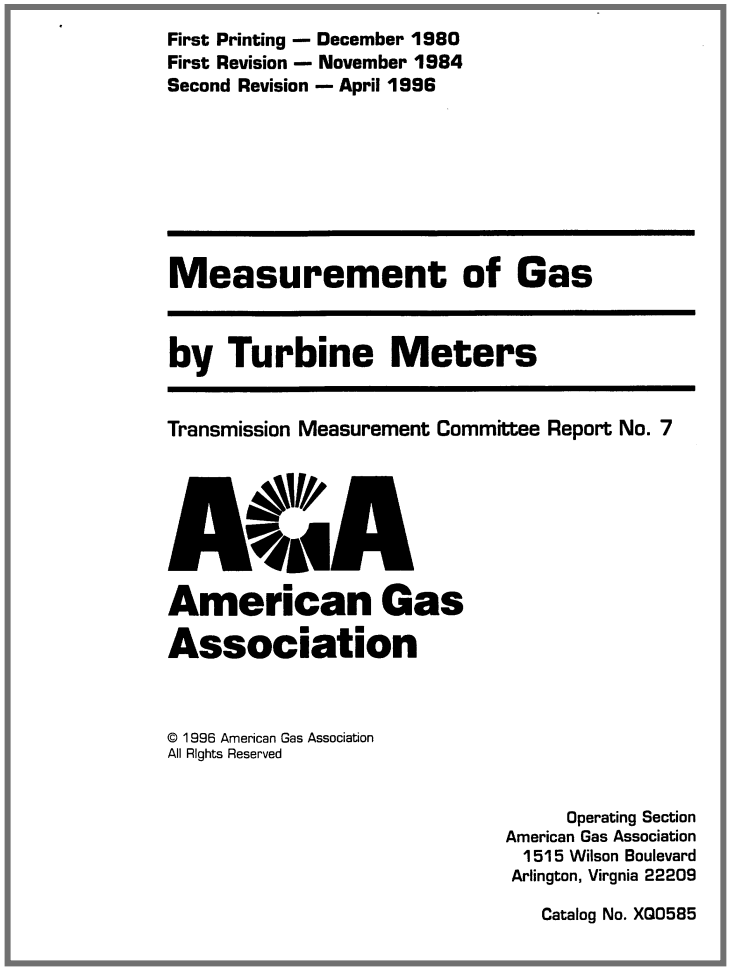
Standards

A.G.A. Report No. 7



First Printing — December 1980
First Revision — November 1984
Second Revision — April 1996

Measurement of Gas by Turbine Meters

Transmission Measurement Committee Report No. 7

American Gas Association

Operating Section
American Gas Association
1515 Wilson Boulevard
Arlington, Virginia 22209

Catalog No. XQ0585

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Installation Checklist

- Meter is sized properly for line pressure and load.
- Meter has been lubricated. Except permanently lubricated models.
- Installation is in accordance with AGA report #7 recommendations and/or company Standards.
- Inlet and outlet meter connections are concentric to the pipe flanges.
- Paper paint masks on the meter flanges have been removed.
- Gaskets do not protrude into the flow passageway.
- Filters, strainers and other associated equipment are provided where needed.
- Meter can be isolated and by passed if needed.
- Pressure blow down is properly sized and located downstream.
- Provisions are made for in-line testing.
- Pressure and/or Temperature taps are provided if required.
- No welding should be done with the cartridge in the housing.
- If Hydrostatic testing is done, using a spool piece is recommended.

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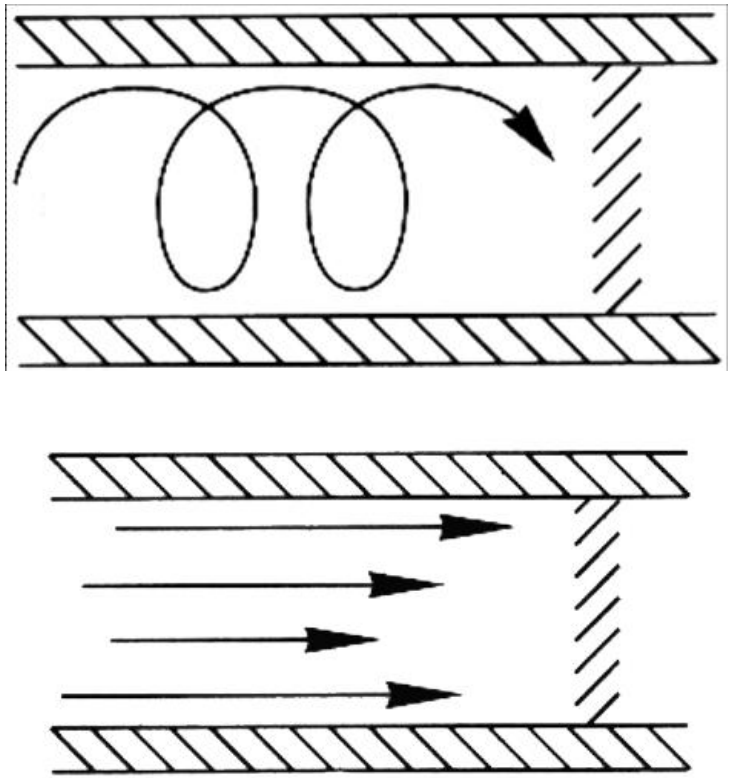
Factors that affect Accuracy

- External flow disturbances
  - Swirl –

    Turbulence stemming from gas “rolling” through the pipe.

    Can either increase or decrease accuracy depending on rotor angle and direction of swirl.
  - Jetting –

    The concentration of the gas stream into one section of the flow area. This results in a non uniform velocity profile entering the meter and can affect accuracy / volume readings.
  - Other factors
    - Piping
    - Straightening vanes
    - Fittings



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Factors that affect Accuracy

- Internal flow disturbances
  - Density and/or Pressure of the gas being measured.
  - Drag in bearings or on the rotor from dirt, contaminants or excessive oil, etc.
  - Binds in index drive and/or index
  - Blocked passages in the flow guides.
  - Damage or wear to the rotor blades.

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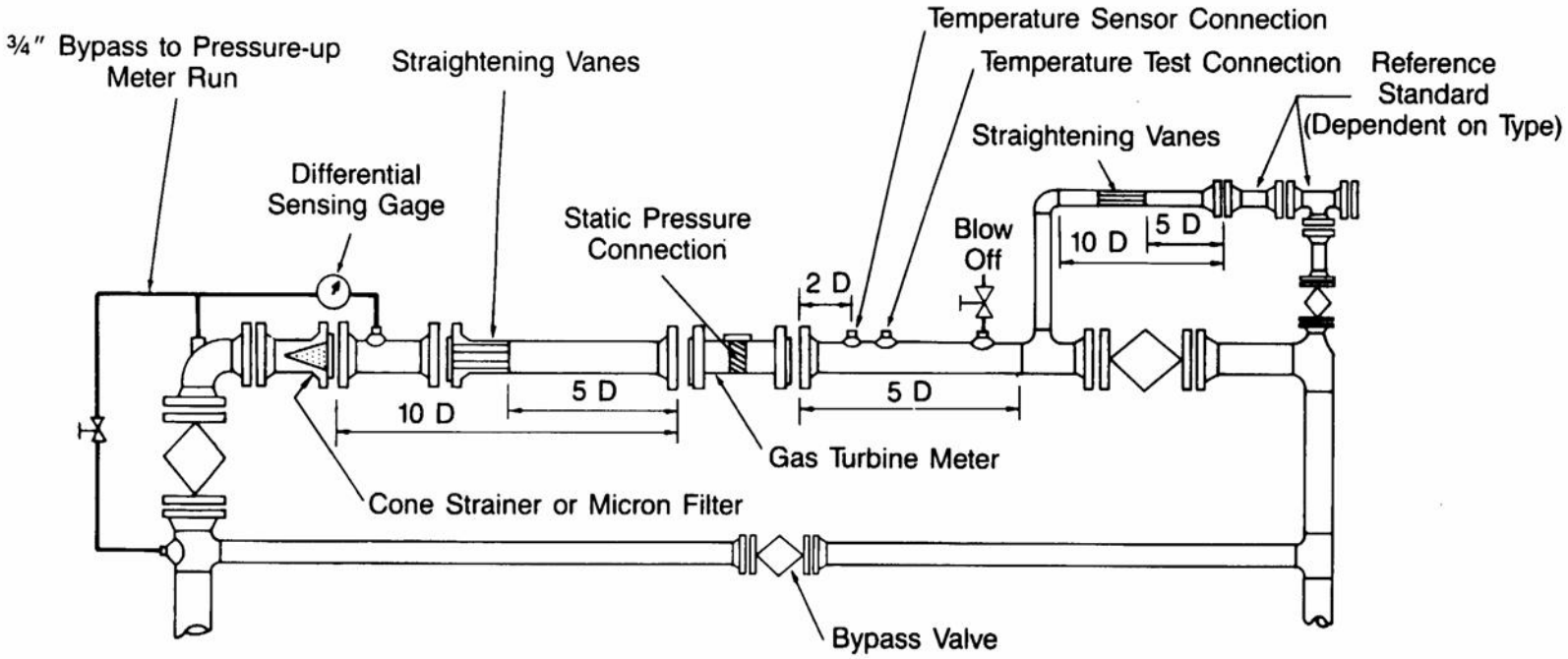
Typical installation



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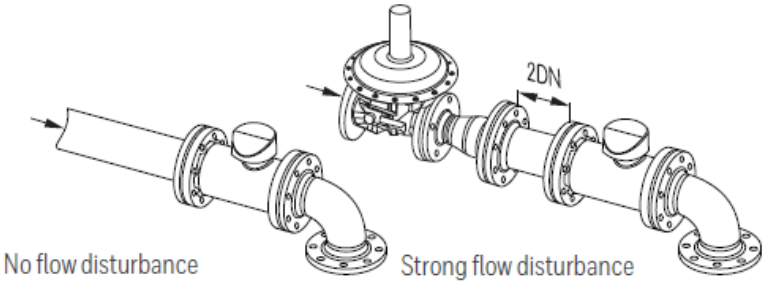
Installation of Turbine Meters

- Installation of turbine meters shall be in line with EN12261 requirements
- TRZ2 meters can be installed vertically or horizontally
- SM-RI-X meters shall be installed horizontally
- Inlet piping shall be a minimum of 2D independent of flow disturbances
- TRZ2 DN50/2” requires 5DN inlet piping
- The meter outlet must be in the same nominal size of the meter which can also be a bend.



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Maintenance and Repair

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Commissioning of turbine meters

- **Step 1 (Visual check)**
  - Check meter for damage, broken seals, wrongly installed accessories
- **Step 2 (Lubrication of bearings)**
  - With permanent lubricated bearings / without oil pump go to Step 3
  - Meters with oil pump: fill supply tank with oil and operate the oil pump
- **Step 3 (Putting the meter into operation)**
  - Make sure a coarse filter is installed upstream during first gas flow.
  - Slowly open valves upstream of the meter to fill the metering system with gas until the operating pressure is reached.
  - The pressure must not increase with a rate higher than 350mbar per s, this means e.g. reaching 10 bar should take approx. 30 seconds.
  - Conduct a tightness test of the meter to find possible leaks, especially around the flange connections, HF-sensors and other accessories.
- **Step 4 (Fiscal commissioning)**
  - Fiscal commissioning process is mostly subject to local laws and must be followed strictly. Please consult with local authorities for details.

Disclaimer: This short check-list is only a guideline and does not replace the manual which must be followed for detailed instructions of meter commissioning.

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Maintenance and Lubrication

- Turbine Gas Meters operated with natural gas and equipped with a manual oil pump should be lubricated once every 3 – 4 months.
- In case of harsh operating conditions e.g. running constantly close to Q_{max} or measuring contaminated gases the lubrication cycle should be reduced to every 1 – 2 months.
- Always protect the pump against ingress of water by making sure the oil supply tank is firmly closed.
- During refilling of the oil supply tank guarantee that no air or water enters the system as this can cause severe damage to the turbine meter.
- No further regular maintenance is needed for turbine gas meters if operating within specification.

Disclaimer: This short check-list is only a guideline and does not replace the manual which must be followed for detailed instructions of meter maintenance.

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Maintenance and Repair

- Meter should be lubricated on a regular, scheduled period, with the recommended oil (NOT grease).
- Filters/strainers should be checked for differential and/or pressure drop.
- Before disassembly, make sure the meter is depressurized.
- Check the interior of the meter including seal tape (old GT), flow guides, rotor vanes for damage and remove any liquids or debris.
- Check the cartridge flow passages and rotor for damage.
- Conduct a spin test in a draft free area. Perform 3 tests and average the results. Make sure to block the back side of the cartridge to prevent air flowing on the rotor and affecting the spin time.
- Never lubricate a cartridge prior to performing a spin test. Any lubrication should be performed after spin testing.

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Spin testing

- Spin Testing detects changes in friction of the bearings that may affect meter accuracy.
- This affect of increased friction on meter accuracy is most evident at low flow rates (less than 20% max capacity) and at operating pressures less than 100 psi.
- Spin testing identifies any changes in friction of all the moving parts.
- Some common causes of increased friction are:
  - Bearing running dry or picking up dirt.
  - Wear to bearings.
  - Physical damage.
  - Foreign matter in running clearances.

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Field Minimum Spin times

- An acceptable spin test only indicates the meter is within tolerable limits but does not assure accuracy at line operating conditions
- Minimum Spin times are listed in table. These values indicate a meter with acceptable friction levels indicating acceptable accuracy.
- If a low spin test time is encountered, lubricate the bearings, and spin the rotor several times to distribute the new oil, then repeat the spin test.

Field Minimum Spin Times (in Seconds) @ 60°F (15.5°C)

GTS Cartridge less index					
	3”	4”	6”	8”	12” LP/HP
45-degree plastic rotor (all pressures)	NA	52	68	148	NA
45-degree metal rotor (all pressures)	NA	68	138	204	NA
30-degree metal rotor (all pressures)	NA	66	118	177	NA
GT Cartridge less index					
	3”	4”	6”	8”	12” LP/HP
45-degree plastic rotor (all pressures)	48	28	45	80	88/66

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Spin time reduction at colder temperatures

- The table shows the expected reduction in spin times at colder temperatures.
- Spin testing at temperatures below 20° F is not recommended.
- Reductions are due to increased viscosity of the oil and can not be distinguished from wear or damage to the cartridge.

Ambient Meter/Air Temperature ^{0}F / ^{0}C	Reduction In Minimum Spin Time
50^{0}F / 10^{0}C	2%
40^{0}F / 4.8^{0}C	5%
30^{0}F / (-)1.2^{0}C	10%
20^{0}F / (-)6.5^{0}C	15%

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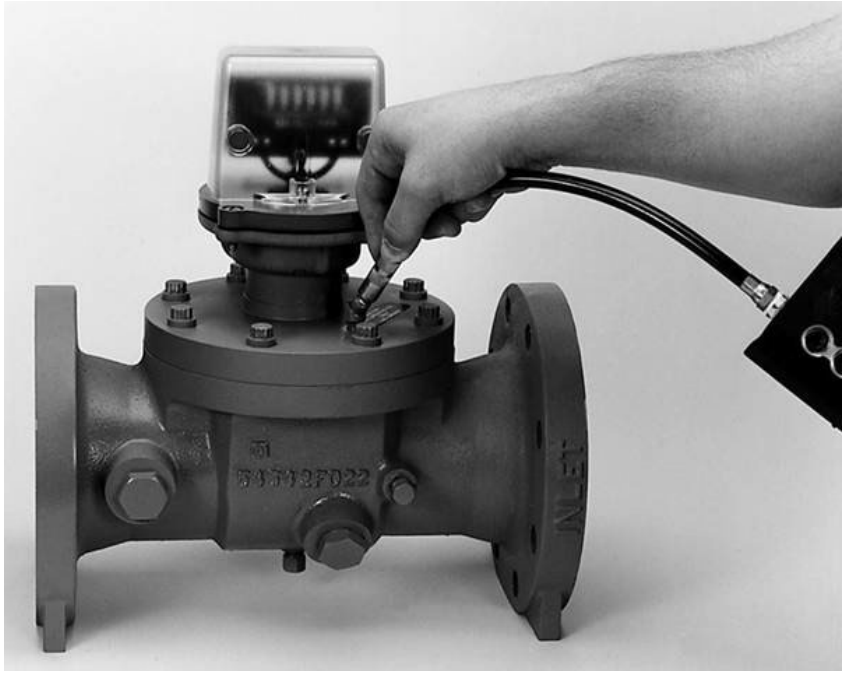
Lubrication

- Add oil at installation: Unit is shipped dry. Never grease the cartridge.
- Gas turbine meters require a high grade, low viscosity oil for long service and stable accuracy.
- Suitable lubrication oil alternatives are:

  Chemlube 201 or Nye 200
- AMCO design of lubricating system has an oil reservoir that slowly seeps oil to the bearings keeping them flushed of contaminates.
- External oil fitting has a check valve allowing the meter to be lubricated while in use.



High pressure lubrication gun

on GTS meter

Honeywell

Lubrication

- The amount of oil and the frequency of lubrication depends on several factors, including:
  - Condition (quality) of the gas.
  - Pressure and flow rate of gas.
- The exact time interval and amount of oil to be used is up to the customer to determine.
- Honeywell suggests the following as an initial starting point:
  - 6cc every 3 months for clean gas.
  - For a 6” 45 degree meter operating a 50% capacity, 24 hrs/day, that works out to around 6,000,000 cf per cc oil.
- If the meter has good spin times and the meter looks clean, then it may be possible to reduce the frequency of inspection.
- If the meter is dirty and has crud and oily residue in it, you may want to increase the frequency an/or increase the amount of oil added each time.
- Each customer may also have values specified in their operations manual that need to be followed.

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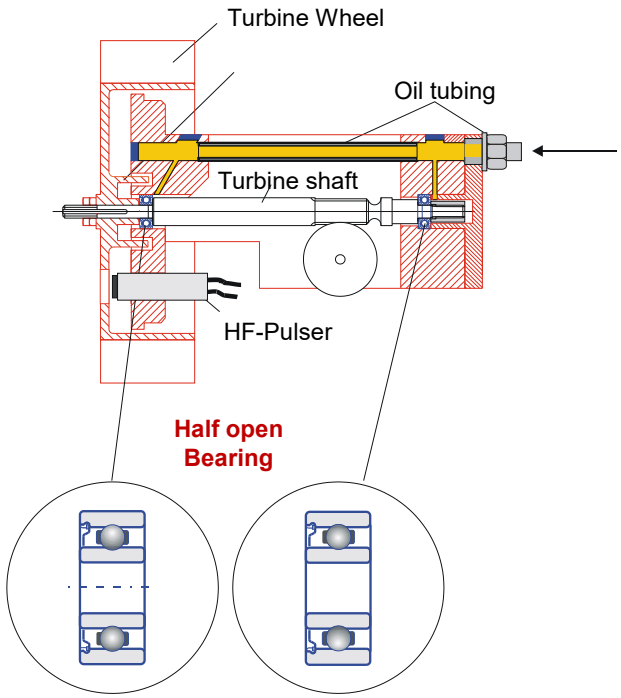
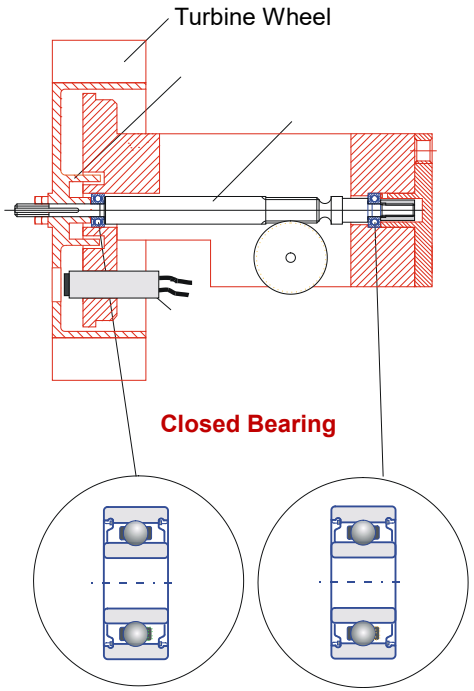
LUBRICATION (TRZ)

DN 80 - DN 150

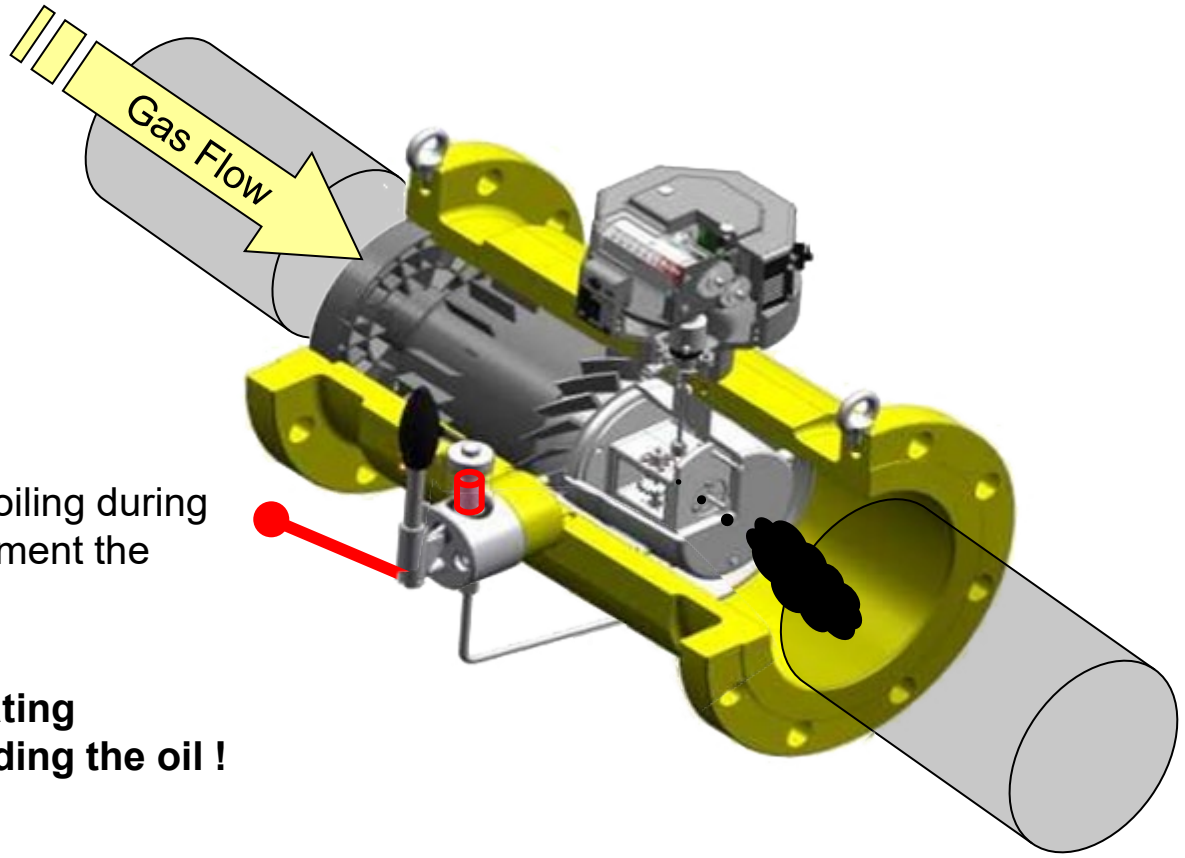


DN 50 - DN 150, Maintenance Free



Honeywell

OIL LUBRICATION BALL BEARINGS



Meet deadlines for oiling during operation and document the activity!

Observe the operating instructions regarding the oil !

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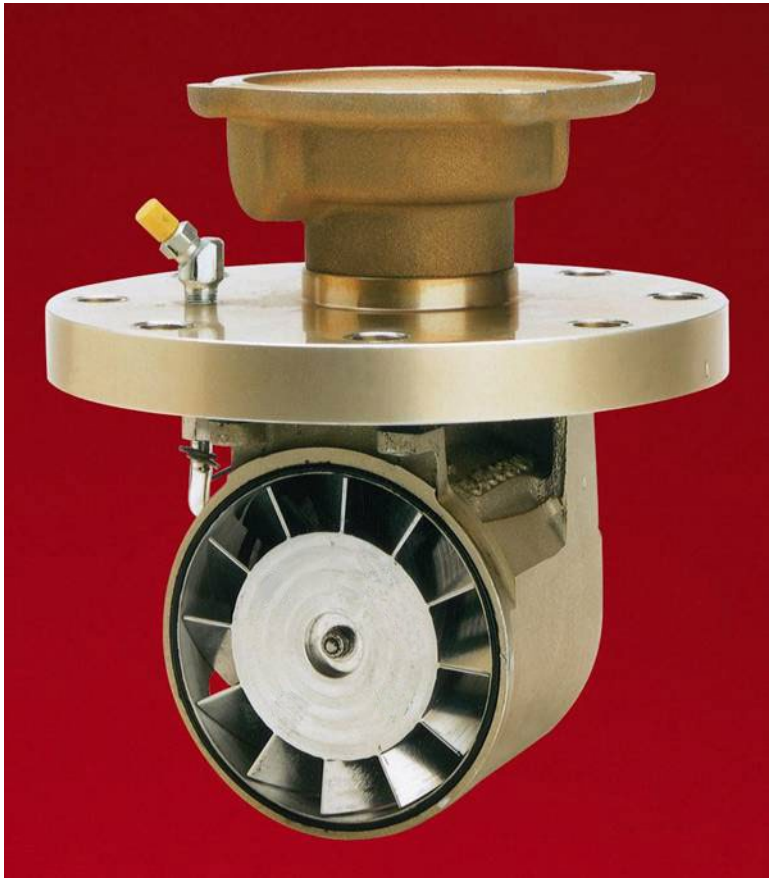
Test Curves

- Low Pressure
  - 350 cubic foot Bell Prover
  - Large Sonic Nozzle provers
  - 5 point accuracy curve standard
- High Pressure
  - Pressures up to 1480 PSIG Master turbine meters or sonic nozzles used as reference
  - 6 point accuracy curve standard
  - All facilities are available for recertification of existing meters.

Pre-calibrated replacement cartridges

- New replacement cartridges are available in all sizes and pressures.
  - 4”, 6” and 8” have 45P, 45M and 30M rotor choices.
  - All pressures available.
    175, 720 and 1440 psi.
    (275 psi - 12”)

- Tested at atmospheric and elevated pressures if so desired.

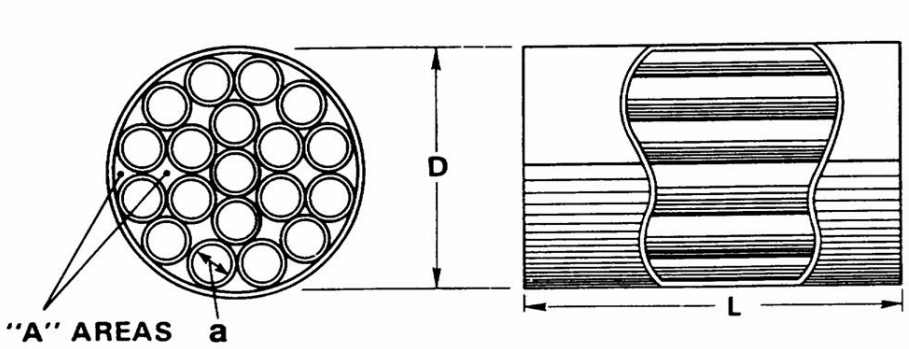


GTS main cartridge

Honeywell

Installation Accessories

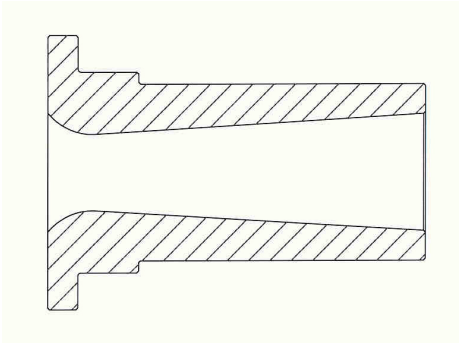
Straightening vanes



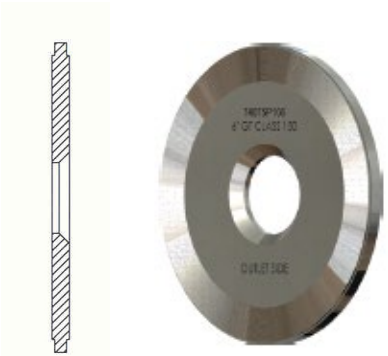
Straightening Vane tube bundle

Flow limiting nozzles/orifices

- Orifices may lose up to 50% pressure.
- Nozzles may only lose 20% of pressure .



Nozzle



Orifice Plate

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Installation/Maintenance Accessories

Lubrication guns

- Low pressure (up to 500 psi)
- High pressure (up to 1000 psi) versions.

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