



TS Series  
V Assy.  
Anodized Aluminum,  
Mechanical Drive

Manual FPPMSV02, Rev. 2010-12

# Installation, Operation & Parts Manual



Flow meter P/No.: TS \_\_\_\_\_

Flow meter S/No.: \_\_\_\_\_

The flow meter shipped under this general manual, has specifically:

**MODEL**

- TS10A
- TS15A
- TS20A
- TS30A

**ACCESSORIES**

- none
- Strainer, standard
- Strainer, High Capacity
- Air Eliminator
- Backpressure Valve
- Air Check Valve
- Preset Valve/Linkage

**REGISTER\***

- none
- Register (7887 or 7886)
- with 10:1 pulser
- with 100:1 pulser
- Printer (7888)
- Preset Counter (7889)
- with Micro Switch kit

\* Register manuals published by Veeder-Root

**Internals:**

- Rotors: PPS/carbon  LV  HT  HV  
 PPS/Teflon  LV  HT  HV
- Seals :  Viton  Teflon



Tuthill Transfer Systems,  
8825 Aviation Drive,  
Fort Wayne, IN 46809, USA  
www.tuthill.com

Tel: 260-747-9060 Fax: 800-866-4861  
FPPWebInquiries@tuthill.com

## INDEX

	Section . Page
FPP Meters and Principle of Operation .....	1 . 3
Material Specifications, Capacity & derating on high viscosity liquids .....	1 . 4
Part No. and Assy No. break-down .....	1 . 6-7
Safety Instructions .....	1 . 8
Installation, Start-Up & Operation Procedures .....	1 . 8-9
Reversing Direction of Flow .....	1 . 10
Flow meter Calibration & Re-Calibration .....	1 . 11-12
Servicing the Flow Meter .....	1 . 13-15
Troubleshooting the Flow Meter .....	1 . 17
Flange kits .....	1 . 16
Parts List, models TS10A, TS15A, TS20A & TS30A .....	1 . 18
Exploded View .....	1 . 19
Torque & Tools chart .....	1 . 20
Warranty .....	1 . 20
Strainers .....	2 . 1
Parts List, standard Strainer (2" & 3") .....	2 . 2
Parts List, High Capacity Strainer (2" & 3") .....	2 . 3
Air Eliminator, incl. Parts List .....	2 . 4-5
Backpressure Valve, incl. Parts List .....	2 . 6
Air Check Valve, incl. Parts List .....	2 . 7

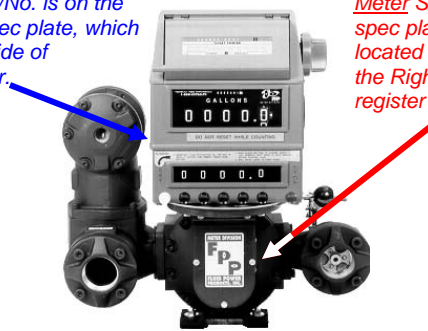
Name of Distributor who supplied this flow meter: \_\_\_\_\_

Phone number for Distributor Service Department: \_\_\_\_\_

### Serial No.

This flow meter is the subject of a continuing improvement program. To ensure correct supply of replacement parts, every parts inquiry must include the Serial No. from the original flow meter assembly.

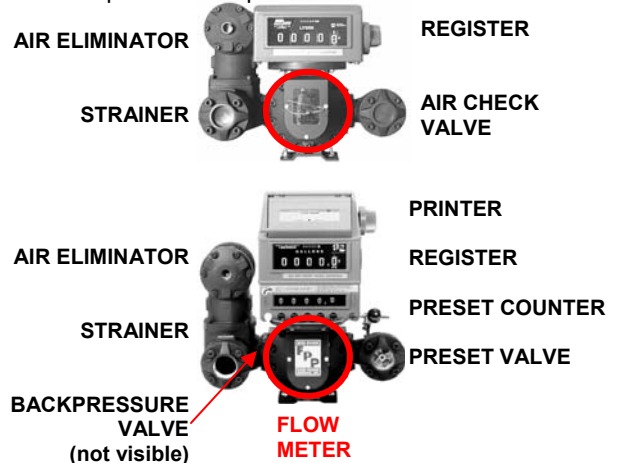
*Register S/No. is on the register spec plate, which is on the side of the register.*



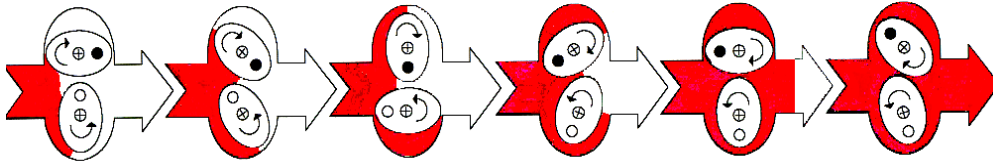
*Meter S/No. is on the spec plate, which is located on the side of the Right Angle Drive register adaptor.*

### Terminology

The possible components in this flow meter are:



## TS Series, Principle of Operation



- Only 2 moving parts.
- Patented 'Waveform' oval gears = sustained accuracy with a minimum of maintenance.
- No metal-to-metal contact in measuring chamber or in bearings.
- The lowest differential pressure values amongst rotary PD meters.

**=> Lower Cost of Ownership!**

### About FPP Meters

We thank you for purchasing an **FPP Meter** for liquid measurement service. **FPP Meters**, formerly Fluid Power Products, is now a trade name of Tuthill Transfer Systems. FPP was established in 1980. Since its inception, the company has been dedicated to manufacturing cost-effective, high performance flow metering devices for petroleum, industrial, commercial and municipal service.

Our facilities include computerized order entry and inventory control, so that you are assured of accurate and prompt deliveries. Furthermore, our production personnel ensure that each order, regardless of size, receives individual attention.

Constant attention to new product development and production design, our high standards of manufacture and final testing are the reasons why **FPP Meters** meet your most demanding requirements. With the 'Waveform' oval gear (2003 patent) meter accuracy is better than ever before.

Our meters are used in batching, blending, process control and to dispense fluids in liquid handling facilities throughout the World. Service includes gasohol blends, bio-diesel and special formulation racing fuels.

### Principle of Operation

Positive Displacement meters have a measuring chamber, where inlet & outlet are separated by rotors, a rotating element or sliding vanes. As the liquid passes through the flow meter, it causes the rotors/element/vanes to turn, which forms the basis for volumetric measurement.

The **Oval Gear** metering principle is based on two elliptical (oval) gears, which turn on center on two horizontal shafts inside a measuring chamber formed by two overlapping cylinders. The oval gears have meshing teeth along their entire circumference, ensuring that the gears will maintain correct position in relation to each other at all times, without the use of timing gears.

The volume being transferred from the inlet to the outlet side (= volume measured), forms between the oval gear and the side of the measuring chamber, alternately in the upper and the lower half of the measuring chamber.



In a full 360° rotation of the gears, four such known volumes are released to the downstream side of the flow meter.

With precision machining and close internal tolerances, the slippage is minimal for superior linearity (accuracy) over a broad turn-down ratio. Oval gear meters are largely unaffected by changes in liquid viscosity (see page 1.8).

The TS Series meter is designed to provide:

**V●● Assy:** Drive to a mechanical register (*this manual*).

**E & F●● Assy:** Electric pulse signal to an electronic register installed on the flow meter.

**S & W●● Assy:** Electric pulse signal to a remote electronic register.

In the two electronic versions, the flow meter is 100% glandless with static O-ring seals only. A pulser (pulse pick-up) detects the movement of internal magnets, to generate the signal to the electronic register. Several types of pulse signal are available to ensure signal compatibility with all electronic registers.

### Fluid Compatibility

**FPP Meter** flow meters are available in anodized aluminum and stainless steel, with a variety of rotor types, and seal & bearing materials, to ensure compatibility with a broad range of liquids and operating conditions. If in doubt about compatibility with a specific fluid or the operating conditions, please refer to **FPP210 (Liquid Compatibility list)** or **FPP200 (FPP Technical Manual)**. If those publication do not provide a clear answer, please consult with your authorized FPP Meter distributor, or Customer Care at the factory.

While most refined petroleum products can be handled with the same flow meter, some require different rotors and/or seals. **Do not change service liquid, without consulting with your authorized FPP Meter distributor.**

### Model Nominal Capacity

<b>TS10A</b>	<b>40 GPM</b>	<b>150 lpm</b>
<b>TS15A</b>	<b>60 GPM</b>	<b>230 lpm</b>
<b>TS20A</b>	<b>150 GPM</b>	<b>570 lpm</b>
<b>TS30A</b>	<b>200 GPM</b>	<b>760 lpm</b>

Normal turn-down is 10:1.

Operation in excess of nominal capacity will cause excessive wear or premature failure.

Meters can be calibrated for use below 10%, if the flow rate is steady or viscosity > 50 cSt.



## TS Series, Anodized Aluminum - Specifications for V●● assemblies

**Materials**

- Case : Anodized aluminum
- Rotors : PPS with carbon bearings, } See cover for
- (oval gears) Teflon™ bearings optional. } rotor & seal
- Posts : HC303SS } materials in
- Seals : Viton™ standard, } this meter.
- Teflon™ optional.

**Connections**

- Bolted companion flanges with NPT or BSP port;
- Optional: Anodized aluminum welding flanges
- Carbon steel welding flanges
- Carbon steel 150# RF ANSI adaptors

- Pressure Rating at 100°F (38°C) with 3:1 Safety Factor**
- Meter/Strainer :** 150 PSI/100°F = 10.3 BAR/40°C
- Air Elim/Valves:** 150 PSI/100°F = 10.3 BAR/40°C

**Temperature Rating**

- V assy :** -40°F to +180°F = -40°C to +80°C
- Use HT or HV rotors if temp. can exceed 120°F = 50°F

**Meter Performance**

When field calibrated on actual liquid of service

**Linearity**

- Over 5:1 turn-down from max. capacity : ±0.175%
- Over 10:1 turn-down from max. capacity : ±0.30%
- Over 30:1 turn-down from max. capacity : ±0.5%

**Repeatability**

0.05% or better under constant conditions

**Nominal Capacity**

- ◇ With LV rotors on 1-300 cP viscosity:
- ◇ With HV rotors on 5-1000 cP viscosity:

	<b>GPM</b>	<b>LPM</b>	<b>m<sup>3</sup>/h</b>
<b>TS10A</b>	40	150	9
<b>TS15A</b>	60	230	14
<b>TS20A**</b>	150	570	34
<b>TS30A**</b>	200	760	45

\*\* = On low viscosity lubricating liquids, **intermittent** use to 125% of capacity is permitted.

**Viscosity**

- ◇ With LV rotors 100% capacity to 1,500 SSU/300 cP.
- ◇ With HV rotors 100% capacity to 5,000 SSU/1,000 cP.
- ◇ With HV rotors, the flow meter may be used to 1,500,000 SSU/350,000 cP at reduced flow rates (see meter viscosity/coefficient table in next column).

**Opt. Pulsers on mechanical register**

	<b>10:1 pulser</b>	<b>100:1 pulser</b>
1/10 gallon register	10 PPG	100 PPG
Whole gallon register	1 PPG	10 PPG
1/10 liter register	10 ppl	100 ppl
Whole liter register	1 ppl	10 ppl
Dekaliter register	0.1 ppl	1 ppl

**Flow Meter nominal capacity:**

- Normal operating range is with 10:1 turn-down from model nominal capacity.
- On low viscosity liquids, best performance (linearity/service life) is between 50% and 85% of model nominal capacity.
- On **diesel fuel**, TS20A & TS30A models with **mechanical register only** may be operated to 125% of nominal capacity in **intermittent service** (this does NOT apply to models with preset and/or printer).  
Intermittent service = < 6 hours/day,  
and deliveries not to exceed 15-20 minutes.
- On **higher viscosity liquids**, **model nominal capacity is reduced** as per tables below.

**Flow Meter Coefficient**

Liquid Viscosity		Carbon brgs.			Teflon brgs.			Rotor Code TYPE
		B	L	I	C	M	J	
SSU	cSt	LV	HT	HV	LV	HT	HV	
32	1	1.00	1.00	1.00	1.00	1.00	1.00	
60	10	1.00	1.00	1.00	1.00	1.00	1.00	
240	50	1.00	1.00	1.00	1.00	1.00	1.00	
465	100	1.00	1.00	1.00	1.00	1.00	1.00	
925	200	1.00	1.00	1.00	0.90	0.90	1.00	
1,415	300	0.86	0.86	1.00	0.73	0.73	0.98	
1,890	400	0.77	0.77	1.00	0.62	0.62	0.96	
2,360	500	0.71	0.71	1.00	0.57	0.57	0.94	
2,830	600	0.66	0.66	1.00	0.53	0.53	0.92	
3,300	700	0.63	0.63	1.00	0.50	0.50	0.90	
3,775	800	0.60	0.60	1.00	0.48	0.48	0.85	
4,250	900	0.56	0.56	1.00	0.45	0.45	0.80	
4,720	1,000	0.54	0.54	1.00	0.43	0.43	0.75	
9,440	2,000		0.35	0.77		0.28	0.65	
14,150	3,000		0.28	0.65		0.22	0.55	
18,875	4,000		0.24	0.58		0.19	0.46	
23,600	5,000		0.19	0.53		0.15	0.42	
28,325	6,000		0.16	0.49		0.13	0.39	
33,050	7,000		0.14	0.47		0.11	0.37	
37,750	8,000		0.12	0.44		0.09	0.35	
42,475	9,000		0.10	0.42		0.08	0.34	
47,200	10,000			0.41			0.32	
94,400	20,000			0.30			0.24	
141,600	30,000			0.24			0.19	
188,800	40,000			0.20			0.16	
236,000	50,000			0.18			0.14	
283,200	60,000			0.17			0.13	
330,400	70,000			0.14			0.11	
377,600	80,000			0.13			0.10	
424,800	90,000			0.12			0.10	
472,000	100,000			0.11			0.09	
944,000	200,000			0.08			0.06	
1,416,000	300,000			0.07			0.05	
1,888,000	400,000			0.06			0.05	
2,360,000	500,000			0.06			0.04	
2,832,000	600,000			0.06			0.04	
3,304,000	700,000			0.05			0.04	
3,776,000	800,000			0.05			0.04	
4,248,000	900,000			0.05			0.04	
4,720,000	1,000,000			0.05			0.04	

**This page is intentionally left blank**

## Flow Meter Part No.

### Flow Meter Part No.

Most flow meter assemblies can be fully defined with a 10 position Part Number. Only when non-standard options are selected (pulser, seals, non-standard rotors or strainer basket), does it become necessary to extend the Part No.:

Position 1-5 = **Model No.** Capacity & Materials

Position 6-8 = **Assy. No.** Register & Accessories, refer to table on page 1.7.

Position 9-17 = **Variables** See codes below.

# TS Series

## MECHANICAL, 2010 P/No. overview

MODEL No.					ASSY No.			FLANGES	CALIBR.	ROTORS	PULSER	SEALS	STRAINER	Mesh size			
T	S	2	0	A	V	-	-			C	M						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

*If all STANDARD selections, these identifiers are not filled in.*

**Flanges**

- A NPT companion flanges
- B BSP companion flanges
- C 150# RF ANSI adaptors, **CS**
- F AA welding flanges
- H CS welding flanges

**Calibration for mechanical register**

- T 1/10 gallon, *not on TS30*
- G Whole gallon, *not on TS10 or TS15*
- Y 1/10 liter, *TS10 only*
- L Whole liter, *not on TS10*
- D Dekaliter, *not on TS10 or TS15*
- U 1/10 Imp gallon, *not on TS30*
- I Whole Imp gallon, *not on TS10 or TS15*

**Rotor/Bearing materials & Rotor type**

- B PPS/carbon, **LV** Standard = '**GREEN**' price in price lists.
- L PPS/carbon, **HT** Std for **HT** service ('**YELLOW**' in p/l)
- I PPS/carbon, **HV** Std for **HV** service ('**BLUE**' in p/l)
- C PPS/Teflon, **LV**
- M PPS/Teflon, **HT**
- J PPS/Teflon, **HV**

**Pulser on Register**

- X none (standard)
- D 10:1 dry reed
- S 100:1 solid state

**Seal Material**

- A Viton,
- B Teflon,

**Strainer TYPE**

- S Std. Strainer (*blank if 40 mesh*)
- H Hi Cap strainer




**Strainer BASKET**

- 4 40 mesh, std/LV & HT rotors
- 2 20 mesh, std/HV rotors
- 8 80 mesh, optional (3" only)
- 0 100 mesh, optional (2" only)

Area Shaded YELLOW = non-std => Longer Lead Time!

**Flow Meter Assy No. = Register & Accessory combination**

**Assy Nos. / Mechanical Meters**

<b>WITHOUT preset valve/linkage</b>					+ BACKPRESSURE VALVE <b>OR</b> + AIR CHECK VALVE	<b>Issued August, 2009</b>
		METER	+ STRAINER	ELIMINATOR		
<b>CAL</b>	With calibrator & RAD adaptor for register, but no ratio gear plate or register (distributor to add)	V03	V21	V22	V27 BPV	Without register
					V23 ACV	
<b>VR1</b>	With Calibrator, RAD Adaptor, Ratio Gear Plate & Register	V04	V05	V06	V28 BPV	7887
					V25 ACV	
<b>VR2</b>	Same + Zero Start Ticket Printer,	V07	V08	V09	V29 BPV	7887 & 7888
					V26 ACV	
<b>VR3</b>	Same + Preset Counter/Micro Switch assy	V35	V36	V37	V31 BPV	7887, 7889 & 7856
					V38 ACV	
<b>VR4</b>	Same + Zero Start Ticket Printer, Preset Counter/Micro Switch assy	V39	V40	V41	V32 BPV	7887, 7888, 7889 & 7856
					V42 ACV	

**with mechanical preset valve/linkage**

if LV rotors, LV valve (1-50 cSt) } If liquid viscosity is in 50-300 cSt range, either the distributor or the installer must remove set screw from valve piston prior to start-up.  
 if HT rotors, LV valve (1-50 cSt) }  
 if HV rotors, LV valve (50-300 cSt)

<b>VR3</b>	With Calibrator, RAD adaptor, Ratio Gear Plate, 2-stg Preset Counter & Register	V11	V12	V13	V43 BPV	7887 & 7889
					V30 ACV	
<b>VR4</b>	Same + Micro Switch kit on preset counter	V51	V52	V53	V44 BPV	7887, 7889 & 7856
					V54 ACV	
<b>VR4</b>	With Calibrator, RAD adaptor, Ratio Gear Plate, 2-stg Preset Counter, Register & Zero Start Ticket Printer	V15	V16	V17	V45 BPV	7887, 7888 & 7889
					V34 ACV	
<b>VR4</b>	Same + Micro Switch kit on preset counter	V55	V56	V57	V46 BPV	7887, 7888, 7889 & 7856
					V58 ACV	

## Installation, Start-Up & Operation

### SAFETY INSTRUCTIONS

Make sure that all necessary safety precautions have been taken, including proper clothing, personal safety equipment and fire safety equipment if required.

Before Start-Up of the Flow Meter, **make certain** that:

1. The meter is properly mounted, secured and piped.
2. All connections are tight.
3. All bleed and drain valves are closed.
4. Do NOT smoke near meter, or use meter near an open flame, when metering flammable liquids. Fire or Explosion could result.
5. This meter is not intended for use on liquids, which require 3A Sanitary equipment for human consumption. It may be used on edible liquids, which do not spoil easily, such as vegetable oils, liquid sweeteners & similar.

**Install the Flow Meter and Accessories in compliance with all applicable Local, State & Federal Construction, Electrical and Safety Codes.**

### OPERATING TEMPERATURE

**TS Series V●● assemblies are rated for operation from -40°F/+180°F (-40°C/+80°C). However:**

- **They are not suitable for cryogenic service.**
- **When operating temperature exceeds +120°F (+50°C), pressure rating is reduced. Please refer to FPP Technical Manual for details.**

### OPERATING PRESSURE

Maximum **non-shock** Operating Pressure is:

Flow Meter/Strainer : 400 PSI (28 BAR)	}	at 100°F (= +38°C)
Air Eliminator/Valves: 150 PSI (10 BAR)		

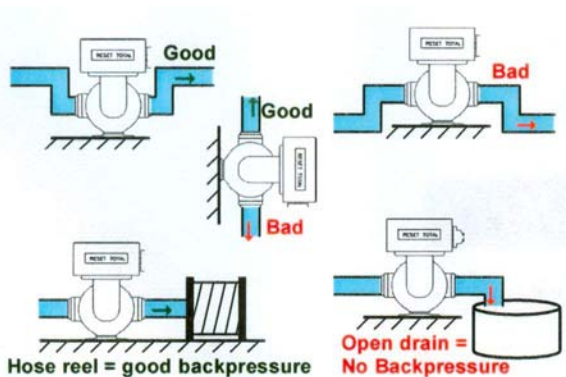
*The flow meter should never be operated in excess of this pressure. Care should be taken to eliminate thermal and hydraulic shock conditions, so that system pressure never exceeds Maximum Working Pressure rating.*

### Installation

- Positive Displacement meters are designed to operate full of liquid. The meter should be installed in a manner, so that it **remains full of liquid at all times**.

The flow meter is not designed to operate on air, but the design and materials of construction allow for operation on vapor *for short periods of time* without damage to the oval gears or flow meter internals.

- The **meter should always be supported** by bolting firmly to a solid platform or foundation. Never use the connecting pipe as the sole means of support.
- For most accurate measurement, the flow meter should operate with some backpressure (avoid delivering into an open vessel).
- The flow meter can operate with liquid going Left-to-Right, Right-to-Left or Vertical Up, but it must be installed with **rotor shafts in horizontal position** (= with vertical end covers). Failure to observe this will impact negatively on flow meter accuracy.



- **Hydraulic shock** can be harmful to flow meter and other system components. Consideration to eliminate hydraulic shock should be given in selection of pump and design of the piping system.
- Protective caps installed in flow meter flanges prior to shipment should remain in place until you are ready to install in the piping system.
- It is recommended that a **Strainer** be installed upstream of each flow meter, to prevent damage from foreign matter, such as welding slag, pipe scale or parts breaking off other equipment. If using an FPP right-angle strainer:
  - Inlet can be either from the front or the rear of the strainer (inlet flange & strainer basket cover have same bolt pattern, and can be reversed in the field).
  - Allow adequate space for removal of strainer basket cover, so strainer basket can be cleaned.
    - 10" for models TS10A, TS15A & TS20A.
    - 11" for model TS30A
  - If no fluid is specified, strainer basket comes standard with 40 mesh.

We also offer:

- 20 mesh for high viscosity liquids, such as heavy fuel oil, automotive lube oils, liquid sugars, molasses, etc.
- 100 mesh for gasoline, alcohol & solvent service.
- 200 mesh for LPG (Propane) service.
- Flush the system to remove all debris, scale and welding slag **prior to flow meter installation**. If this is not possible, temporarily remove rotors (oval gears), and reinstall after the system has been flushed.

Continued



- Apply pipe compound to male threads, to **install the two companion flanges**. Tighten to a position, that allows the meter to bolt to the companion flanges, free of pipe stress.
- When installing the flow meter, consider future maintenance of both flow meter and accessories. The meter can be serviced in place, provided block (isolation) valves are included, and adequate space allowed.
- Flow meters are designed to withstand a certain level of **vibrations**, such as might be experience on retail delivery tank trucks. If the flow meter will be used in a system with higher levels of vibration, it must be protected with:
  - Vibration isolating pad under the mounting pedestal.
  - Vibration isolators (flexible hose) on both inlet & outlet.
- In critical installations a **by-pass line is recommended**, so flow can continue while flow meter is being serviced.
- When an **Air Eliminator** is included in the flow meter assembly, the strainer/air eliminator must be in horizontal position, since the air eliminator operates on a gravity principle. A few drops of liquid may be expelled when the air eliminator vents, so vent ports should be piped back to storage or to a collection tank (sloping towards the tank).
- If an **Air Check Valve** is included in the flow meter assembly, a modified air eliminator is used. One of the air eliminator vents must be connected to the port on the air check valve, using pipe, tubing or a flexible hose.

This connection must be made in the field, as we do not know what would be a convenient/practical path for the connection. Similarly, we do not know whether local regulations or codes dictate materials to be used for this connection.

- **Thermal relief valves are recommended**, and should be installed whenever it is possible to block (isolate) the flow meter between two valves. The pressure rise in a closed system, from just a few degrees increase in temperature, can be many times normal working pressure.
- **Connections for calibration** should be provided during installation. An easy means for diverting flow into a calibration vessel (or master meter) should be considered.

The ideal installation incorporating all of these recommendations is shown at the bottom of the page.

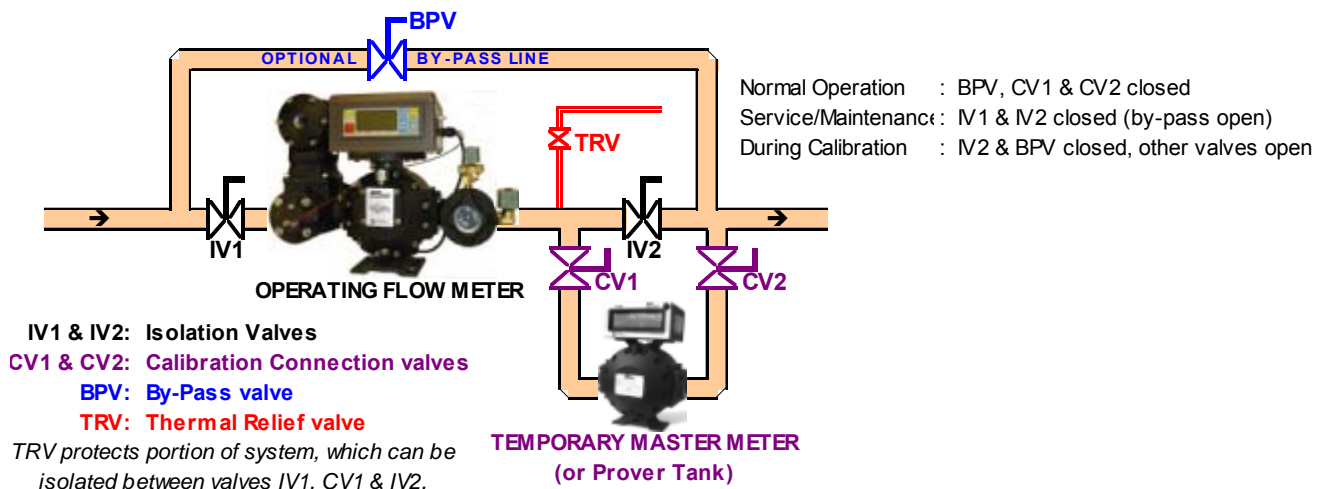
### Start-Up/Operation

**Very slowly fill the system with liquid**, to avoid operating the flow meter on air or vapor. This can be accomplished in the following manner:

1. Throttle the meter inlet valve, and allow the system to fill slowly by gravity.
2. Crack open the outlet valve. Start the pump, and then slowly crack open the inlet valve, filling the meter slowly before fully opening the inlet and outlet valves.

### In normal operations:

- **Avoid sudden changes in temperature.**
- **Avoid sudden changes in flow rate.**
- **Gradually increase or decrease the flow rate.**



## Changing Direction of Flow

TS Series flow meters can operate in either direction. Standard assembly, when facing the flow meter, has the flow going **Left-to-Right**, unless specified differently at time of the order. A label with the word **INLET** is placed on the inlet flange, as assembled at the factory.

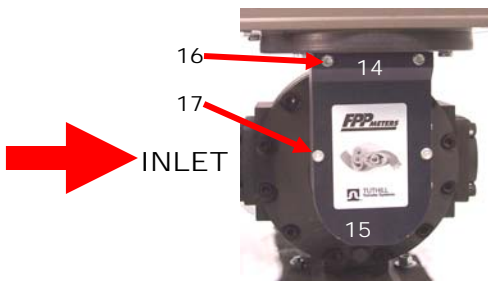
When the meter is first installed, check that the register is turning correctly when you start the flow. If it is not (or it is attempting to run backwards), check position of the face gear (11E) on the calibrator drive shaft (21A), and if necessary correct the position of the face gear versus the packing gland pinion (11D) as explained below.

**Left-to-Right** flow = Face gear **below** packing gland pinion

**Right-to-Left** flow = Face gear **above** packing gland pinion

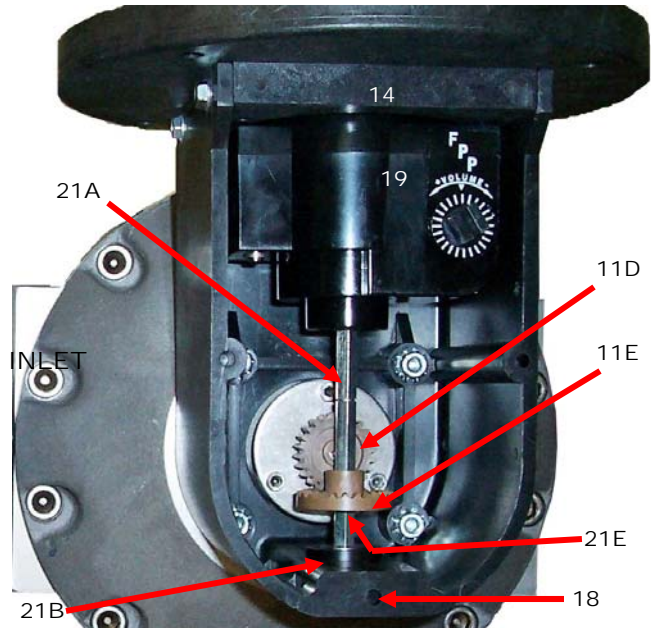
The direction of flow can be changed in the field. This requires the following steps:

- Any accessories (strainer and/or preset valve) attached to the flow meter must be moved to the opposite side.
  - **Strainer** inlet is standard from the front. When moving the strainer to Right-to-Left position, switch the inlet flange and strainer basket cover. If rear inlet is preferred, leave flange & basket cover as is, when moving the strainer.
- Standard outlet on **Preset Valve** or **Air Check Valve** is towards the front. When moving the valve to Right-to-Left position:
  - Air Check Valve: Rotate the valve 180°, then install tubing connecting air eliminator to the valve.
  - Preset Valve: Rotate the valve 180°. Disassemble the linkage, and re-assemble mirror image to original assy.

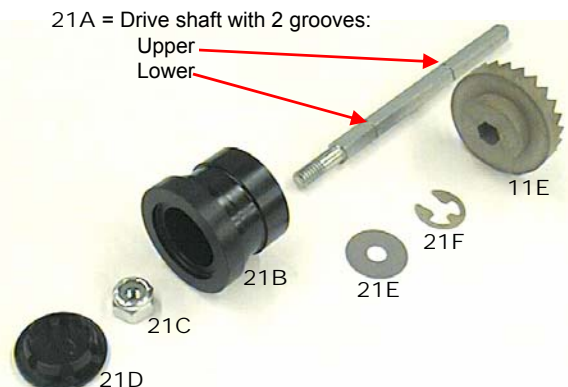


- Reverse the position of the face gear (11E) on the calibrator drive shaft (21A).
- First remove screws (16 & 17) to detach the dust cover (15) from the RAD (14 = Right Angle Drive) adaptor. Now refer to photo in next column.
- Notice position of the face gear (11E) on the calibrator drive shaft (21A) in relation to the packing gland pinion (11D).

Remove E-ring (21F) with a screwdriver or small pliers. As shown, the E-ring is installed **below** the face gear, where it is not visible in the photo.



- Now loosen the set screw (18) with a 3/32" Allen wrench, to release the calibrator drive shaft bushing (21B).
- Slide the calibrator drive shaft bushing (21B) out of the bottom of the RAD (14).
- Pull the calibrator drive shaft assembly out of the RAD.
- Remove the face gear (11E), and turn it 180°, so that the gear teeth are facing in the opposite direction from the original installation.
- Re-assemble the parts in reverse order.
  - Make sure that the calibrator drive shaft bushing flange (21B), is tight against the RAD (14).
  - Tighten the hex nut (21C)
  - Re-install the E-ring (21F) in the appropriate groove (in the above example, the E-ring now goes into groove above the pinion).
  - Inspect to make sure that there is slight backlash between the pinion gear (11D) and the face gear (11E). They must engage without binding or slipping.



## Calibration, Mechanical Flow Meters

### W&M Certifications:

<b>TS10A</b>	<b>US</b>
<b>TS15A</b>	<b>US &amp; Canada</b>
<b>TS20A</b>	<b>US, Canada, EU &amp; Australia</b>
<b>TS30A</b>	<b>US, Canada, EU &amp; Australia</b>

Certifications are liquid specific. Please refer to national certificates for liquid categories covered.

### Flow Meter Calibration at the Factory

All TS Series meters are accuracy tested prior to shipment. Data from accuracy testing is not supplied with flow meters, since results achieved on our test fluid do not apply to actual liquid of operation, unless the two liquids have identical viscosity characteristics.

When calibrated on a liquid with 1 cP viscosity, if the flow meter is not field recalibrated on actual liquid of service, we expect that the flow meter will be:

- Under by 1-2% on a liquid with 0.5 cP viscosity.
- Over by 0.35% to 0.6% on a liquid with 10 cP viscosity.
- Over by 0.7% to 1.2% on a liquid with 100 cP viscosity.

The accuracy curve will not shift significantly at higher viscosities, even if the actual operating liquid has viscosities up to 500,000 cP.

Accuracy curves of individual flow meters vary slightly. Such minor variations are corrected in the mechanical calibrator. In our calibration procedure, the meter calibrator is set for zero error, when operating at 95-100% of capacity on 1 cSt viscosity fluid.

### Flow Meter Calibration in The Field

Since we cannot test on actual fluid of operation, it is the responsibility of the buyer to field calibrate:

- In place of service
- On actual operating liquid.

This will minimize errors arising from:

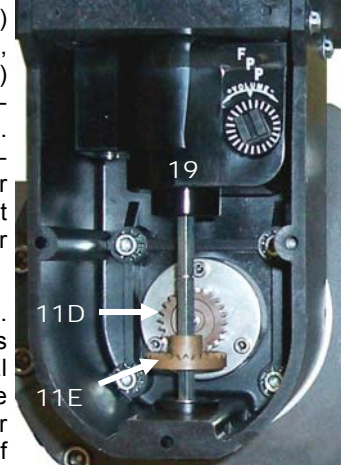
- A. Operation at a different flow rate.
- B. Operation on a fluid with different viscosity

It is recommended that written records be maintained on all flow meters. These records should include:

- Supplier and Service Department phone number.
- Date of installation.
- Details of maintenance performed.
- Date & result of each re-calibration, with % change made on flow meter calibrator assy.

Mechanical TS Series meters have a mechanical drive train directly from the rotors (oval gears) to the register. To convert rotor movement to volume reading on the register, this drive train includes 3 calibration components:

- Packing gland pinion (11D) can have 12 or 24 teeth, while the face gear (11E) always has 24 teeth, resulting in a 1:1 or 2:1 ratio. The appropriate ratio depends upon flow meter model size & specific unit of calibration selected for the register.
- Mechanical calibrator (19). This component makes minute adjustments to final calibration to compensate for individual flow meter characteristics, viscosity of fluid being metered, and flow meter wear factor.
- A ratio gear plate installed below the mechanical register. Gearing on this gear plate is specific to flow meter model & unit of calibration selected. Optimum ratio is between 0.5000 & 5.0000 for best service life.



The mechanical register is common to all flow meter models, so it is possible to move registers from one flow meter to another. **Do NOT move the ratio gear plate from one flow meter to another.**

### Frequency of Re-Calibration

- In installations subject to local Weights&Measures regulations, frequency of recalibration must conform to such regulations.
- If local authorities issue regulations for non-W&M flow meters, such regulations must be observed.
- If user is ISO9000 certified, user ISO standards will indicate frequency of re-calibration for instrumentation. Those standards should be observed.

When no regulations or standards apply, our recommendations are:

- A. Calibrate immediately after installation.
- B. Re-calibrate after 15-30 days.
- C. Re-calibrate after 180 days and again after 360 days.

After the run-in calibration (B) and follow-up calibrations (C), it is possible to evaluate degree of change under normal operating conditions. Based on values found, and total volume being metered under normal operating conditions, decide whether a 6, 12 or possibly 24 month schedule should be adopted.

## Flow Meter Calibration

### Procedures & Methods

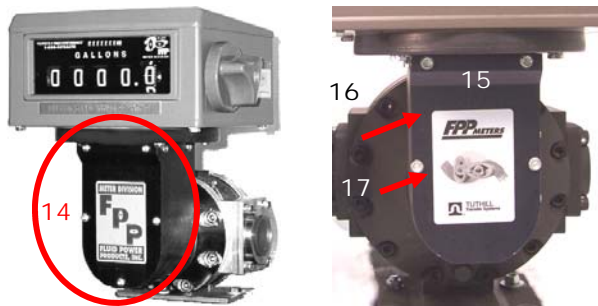
Flow meters used in systems where the flow rate can fluctuate, should be tested at minimum, intermediate & maximum flow rates. In non-W&M service, a flow meter always operating at a steady flow rate, can be tested at that flow only.

All tests should be repeated 3 times to confirm repeatability. All tests should be of at least 60 second duration, to minimize the effect of flow meter error during start-up and shut-down.

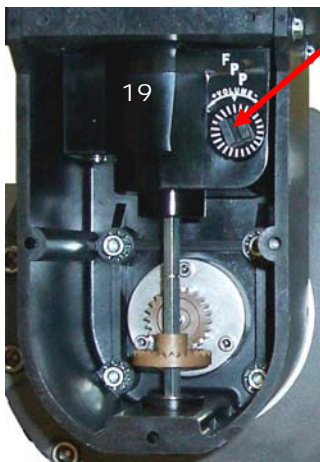
- After calibrating a known volume (X) into an accurate prover, through a master meter, or against a certified scale with adequate resolution, compare with register reading (Y) and calculate correction:

$$\frac{X - Y}{X} \times 100 = \% \text{ correction}$$

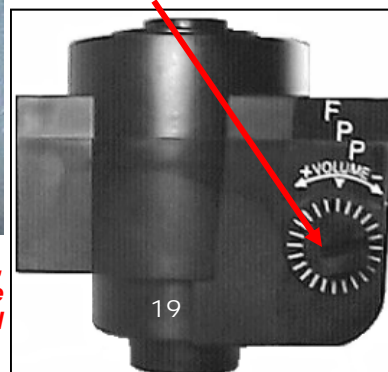
- When re-calibration has established that a correction is required, remove the dust cover (15) from the RAD (14 = right angle drive adaptor), by detaching screws (16 & 17).



This provides access to the calibrator assembly (19), which has a dial on the front, and is marked with directions for + and - Volume. Each graduation of this dial represents approx. 0.06% change



The dial has a **slot for a screw driver** in the center, so the setting can be changed. As you turn the center, you will hear two 'clicks' for each graduation mark. Each 'click' represents approximately 0.03% change in the setting.



**Do NOT change setting, unless re-calibration of the flow meter has established the need for correction.**

- When prover/master meter reading is **less than flow meter register reading**, **add percentage** calculated by turning the calibrator in the **+ volume direction**.
- When prover/master meter reading is **more than flow meter register reading**, **subtract percentage** calculated by turning the calibrator in the **- volume direction**.
- After correcting calibrator setting, circulate product through the flow meter for a few minutes. Then perform at least 3 more tests, to confirm flow meter accuracy & repeatability.

- If the flow meter does not repeat, it will likely require a new set of rotors (oval gears).

Before ordering new gears, inspect the measuring chamber for scratches or wear. If the measuring chamber is scratched or scored beyond what can be smoothed with emery paper, flow meter case should be replaced.

- Finally:
  - Re-seal the flow meter.
  - Enter date and % correction on the permanent flow meter record.

As long as degree of change is moderate, the flow meter is in good condition.

If there is a sudden significant jump in correction required, the rotors are likely about worn out. Rotor replacement should be considered now, rather than letting further wear cause rotors to start rubbing on flow meter housing.

## Servicing the Flow Meter

### ! SAFETY INSTRUCTIONS !

- **REMOVE ALL INTERNAL PRESSURE BEFORE OPENING THE FLOW METER.**
- **DRAIN & RINSE THE FLOW METER BEFORE SERVICING.**
- **IF IT IS NECESSARY TO TRANSPORT OR SHIP THE FLOW METER TO A DIFFERENT LOCATION FOR SERVICE, IT **MUST BE RINSED 3 TIMES** WITH A NEUTRAL FLUID PRIOR TO TRANSPORTATION/SHIPMENT.**

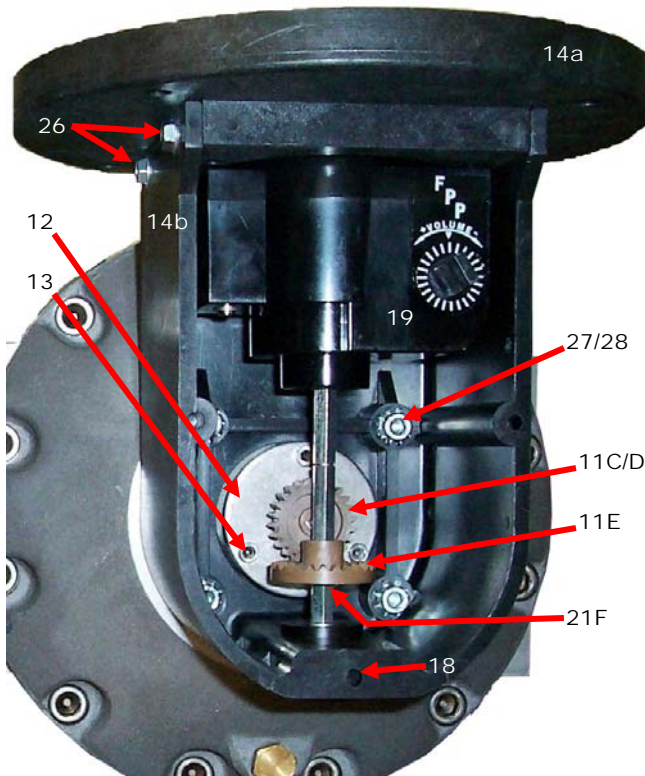
*Installation, Maintenance & Service must be performed by personnel:*

- A. Qualified to work on this type of equipment.*
- B. Familiar with all applicable local codes and ordinances covering the type of service, where the flow meter is used (gasoline, LPG, etc.).*

*Avoid pipe strain and stress when making flow meter repairs. The weight of piping and the flow meter should be supported independently. This means that the meter can be serviced without affecting piping alignment.*

*Avoid prying or exerting heavy pressure on precision parts, as this could affect the performance of the flow meter.*

*Assure that all machined parts are free of burrs and nicks. Stone all machined surfaces if necessary to remove burrs.*



*Always coat bolt threads with an anti-seize, or an appropriate lubricant to prevent thread damage, and to assure proper torque values are applied when reassembling.*

*If flow meter threads are damaged, repair using inserts.*

### **Servicing the Mechanical Drive Components**

Flow meter wear depends upon several variable factors (flow rate vs model capacity, lubricity of the liquid, total volume being metered annually and maintenance of mechanical register, preset and/or printer), so it is impossible to predict the expected life for each component.

There are 8 parts or components, which will require inspection and/or replacement at some point. In the order they are likely to occur, these are:

#### **Regular Maintenance (1-3 years)**

- A. Face Gear (11E) & Packing Gland Pinion (11D)
- B. Packing Gland O-ring (11B)

#### **Longer Term Wearing Components (2-5 years)**

- C. Calibrator Drive Shaft Assembly (21)
- D. Gear Plate, internal (4)

#### **Very Long Term Wearing Components (3-10 years)**

- E. Packing Gland (11)
- F. Oval Gears (2), or inspection of measuring chamber

#### **Longest Term Wearing Components (5-20 years)**

- G. Post Plate assembly (3)
- H. Calibrator Assembly (19)

Of these, only A, C & H can be performed without taking the pressure off the system and draining the flow meter. The remaining all require opening of flow meter interior.

The first step is to remove the dust cover (see pages 1.8-9) from the RAD (14 = Right Angle Drive adaptor).

#### **A. Face Gear (11E) & Packing Gland Pinion (11D)**

#### **C. Calibrator Drive Shaft Assembly (21)**

Always replace Face Gear & Packing Gland Pinion together. They can be ordered under a single P/No. (see page ...).

- Remove E-ring (21F) from the drive shaft assembly (21) with a screwdriver or small pliers.
- Loosen the set screw (18) with a 3/32" Allen wrench, to release the calibrator drive shaft bushing (21B).
- Slide the calibrator drive shaft bushing (21B) out of the bottom of the RAD (14), and pull the calibrator drive shaft assembly out of the RAD.
- Replace Face Gear (11E) on the calibrator drive shaft assembly.
- Remove E-ring (11C) from the packing gland (11) with a screwdriver or small pliers, and replace the Packing Gland Pinion (11D).
- Reassemble in reverse order.

## Servicing the Flow Meter

### B. Packing Gland O-ring (11B) E. Packing Gland Assembly (11)

**First relieve system pressure and drain the flow meter.**

Then follow instructions for above for removal of calibrator drive shaft assembly. Remove E-ring (11C) from the packing gland assembly, and pull off the pinion (11D).

- Remove three screws (13) from the packing gland retainer (12). Remove the retainer
- Packing Gland O-ring and/or Packing Gland assembly can now be replaced.

*When replacing the Packing Gland, the drive dog must be aligned with the slot in the gear on the gear plate.*

- Reassemble in reverse order.

### D. Gear Plate, Internal (4)

#### F. Oval Gears (2), or inspection of measuring chamber

The wearing parts in the Gear Plate assembly are the reduction gears. On a longer time scale, the bushing in the gear plate will wear out. The gear plate assembly can be rebuilt or replaced in one of 3 ways, with d.3 being what is most commonly required:

- d.1 Complete gear plate assembly
- d.2 Gear plate/bushing assembly only, re-using gears.
- d.3 Repair kit, with reduction gears & fasteners.

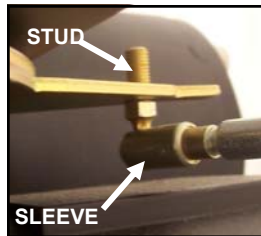
**First relieve system pressure and drain the flow meter.**

**Also, detach the mechanical register stack, to take the weight off of flow meter front cover.**

If the mechanical register stack includes a **preset counter**, detach the linkage from the trip ring (see top of next column) prior to taking the register stack off.

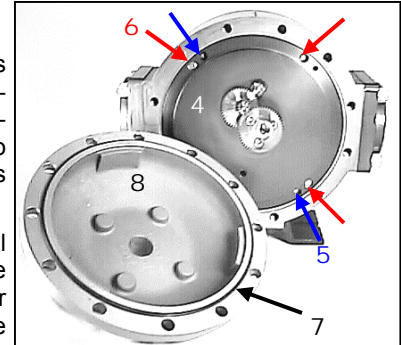


Register stack attaches to the RAD with 4 screws, 2 front and 2 rear.



Valve linkage connects to preset trip ring at the rear. Slide the sleeve towards the shaft to release the mounting stud.

- Remove dust cover & calibrator drive shaft as explained above.
- Remove 4 screws/washers (27/28) holding the RAD to the front cover (8).
- Remove the cover bolts (10) from the front cover (8), now remove the front cover from the flow meter and inspect the cover O-ring (7) for flaws. **Teflon fitted meters:** Always replace seals when opening the flow meter.



You now have access to the Gear Plate assembly (4). If rebuilding with repair kit, no further disassembly is required.

If replacing the oval gears, inspecting the measuring chamber or replacing the complete gear plate:

- Remove 4 screws (6) from the gear plate. The gear plate can now be pulled off dowel pins (5), **using a 5/16-8 x 1" jack bolt if necessary.**
- The gear plate assembly can now be rebuilt or replaced as required.
- Prior to removing the rotors (oval gears), use a soft pencil to make an alignment mark where the gears engage. This will make re-assembly easier.

The oval gears can now be inspected or replaced as required. When placing the oval gears back on the posts, make sure that they are aligned and spin freely on the posts. If they are not aligned correctly, they will disengage.

- The measuring chamber can now be inspected. Remove any deposits using a fine emery cloth or wire brush. Be careful to remove any particulate material, which can cause the meter to jam.

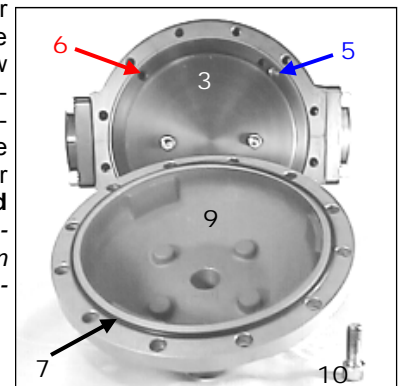
A minor scratch in chamber surface can be carefully smoothed out, but be careful not to cause scoring or to change the dimensions. If the measuring chamber shows signs of scoring from rotors rubbing, it should be replaced.

- Re-assemble in reverse order.

### G. Post Plate assembly (3)

**First relieve system pressure and drain the flow meter.**

- Remove the cover bolts (10) from the rear cover (9), now remove the rear cover from the flow meter and inspect the cover O-ring (7) for flaws. **Teflon fitted meters:** Always replace seals when opening the flow meter.



## Servicing the Flow Meter

- Remove 4 screws (6) from the post plate (3). The post plate assembly can now be pulled off dowel pins (5), **using a 5/16-8 x 1" jack bolt if necessary.**

The posts are expected to last through several sets of rotors. When the posts show signs of wear, or if they have been bent due to hydraulic shock, the complete postplate assembly must be replaced.

- \* If hydraulic shock is suspected, the cause should be identified and eliminated.
- \* If the posts show uneven wear (bearings cutting grooves into the post), the differential pressure across the flow meter is too high, due to a combination of excessive flow rate & viscosity. Solutions are:
  1. Reduce the flow rate.
  2. Increase the temperature to reduce the viscosity.
  3. Use a larger flow meter.

- Re-assemble in reverse order.

### H. Calibrator Assembly (19)

The calibrator assembly is a mechanical device, which will wear out eventually. Calibrator wear can be accelerated by failure to clean and lubricate the components in the mechanical register stack (refer to separate manuals). If flow meter re-calibration gives erratic results (non-repeating), it is likely that the calibrator is worn out.

To replace the calibrator:

- Remove dust cover, drive shaft assembly and register stack, as explained under **A** and **D**.
- Remove 2 screws (20) holding the Calibrator Assembly to the Veeder-Root register flange (14B), using a Phillips screwdriver.
- Re-assemble in reverse order.

For optional flow meter accessories:

- Strainer**
- Air Eliminator**
- Backpressure Valve**
- Air Check Valve**

*Pls see Section 2*

For optional control valves:

- Mechanical Preset Valve**
- 1-Stg solenoid operated Valve**
- 2-Stg solenoid operated Valve**

*Pls see separate Tuthill manual*

For mechanical register stack:

- Register**
- 10:1 pulser**
- 100:1 pulser**
- Preset Counter**
- Micro Switch kit**
- Ticket Printer**

*Pls see separate Veeder-Root manuals*

## Flange Kits & Parts for Flanges

Tuthill TS Series flow meters come standard with bolted companion flanges, with either NPT or BSP threaded ports. Other options are welding flanges (aluminum or steel), and 150# RF ANSI adaptors (steel).

Since meter (square) & accessory (round) flanges differ, a

new flange is required when adding to or deleting accessories from an existing flow meter. When adding accessories to TS10A & TS15A models, an adaptor might be required.

Single flange kits & adaptors, and relevant seals & screws, are identified below.

		<u>Flow Meter Inlet/Outlet Flange</u>	<u>Strainer or Valve Adaptor</u>	<u>Standard Strainer Inlet Flange</u>	<u>High Cap. Strainer Inlet Flange</u>	<u>Air Check &amp; Preset Vlv Outlet Flg</u>	<u>Electronic Preset Valve Outlet Flange</u>
<b>TS10A, OS</b> 1"	NPT/Viton	FK1100-1	FK1209	FK1104-1	na	na	FK1106-S1
	BSP/Viton	FK1101-1	same	FK1105-1	na	na	FK1107-S1
	ANSI/Viton	FK5100-1	same	FK5104-1	na	na	FK5106-S1
	Viton O-ring	SL1122	SL1122	SL1334	na	na	SL7500
	NPT/Teflon	FK2100-1	FK1209-T	FK2104-1	na	na	na
	BSP/Teflon	FK2101-1	same	FK2105-1	na	na	na
	ANSI/Teflon	FK5101-1	same	FK5105-1	na	na	na
	Teflon O-ring	SL2122	SL2122	SL2334	na	na	na
	Flange screw	FS2950	FS0920	FS2960	na	na	1123413
<b>TS10A, NS</b> 1"	NPT/Viton	FK1110-1	na	na	na	na	na
	BSP/Viton	FK1111-1	na	na	na	na	na
	Viton O-ring	SL1223					
	NPT/Teflon	FK2110-1	na	na	na	na	na
	BSP/Teflon	FK2111-1	na	na	na	na	na
	Teflon O-ring Flange screw	SL2223 FS2950					
<b>TS15A</b> 1½"	NPT/Viton	FK1160-1	FK1215 <sup>2</sup>	FK1154-1	na	FK1156-1	FK1156-S1
	BSP/Viton	FK1161-1	same	FK1155-1	na	FK1157-1	FK1157-S1
	ANSI/Viton	FK5160-1	same	FK5154-1	na	FK5156-1	FK5156-S1
	Viton O-ring	SL1233	SL1233	SL1334	na	SL7500	SL7500
	NPT/Teflon	FK2160-1	FK1215-T <sup>2</sup>	FK2154-1	na	FK2156-1	na
	BSP/Teflon	FK2161-1	same	FK2155-1	na	FK2157-1	na
	ANSI/Teflon	FK5161-1	same	FK5155-1	na	FK5157-1	na
	Teflon O-ring	SL2233	SL2233	SL2334	na	SL2500	na
	Flange screw/stud Flange washer Flange nut	FS9902 FS5008 na	FS5201 FS5203 FS5202	FS2960	na na na	FS2960	1123413
<b>TS20A</b> 2"	NPT/Viton	FK1200-1	na	FK1204-1	FK1204HC-1	FK1106-1	FK1106-S1
	BSP/Viton	FK1201-1	na	FK1205-1	FK1205HC-1	FK1107-1	FK1107-S1
	ANSI/Viton	FK5200-1	na	FK5204-1	FK5204HC-1	FK5106-1	FK5106-S1
	Viton O-ring	SL1233	na	SL1334	SL1350	SL7500	SL7500
	NPT/Teflon	FK2200-1	na	FK2204-1	FK2204HC-1	FK2106-1	na
	BSP/Teflon	FK2201-1	na	FK2205-1	FK2205HC-1	FK2107-1	na
	ANSI/Teflon	FK5201-1	na	FK5205-1	FK5205HC-1	FK5107-1	na
	Teflon O-ring	SL2233	na	SL2334	SL2350	SL2500	na
	Flange screw	FS2950	na	FS2960	FS2965	FS2960	1123413
<b>TS30A</b> 3"	NPT/Viton	FK1300-1	na	FK1304-1	FK1304-1	FK1106-1	FK1106-S1
	BSP/Viton	FK1301-1	na	FK1305-1	FK1305-1	FK1107-1	FK1107-S1
	ANSI/Viton	FK5300-1	na	FK5304-1	FK5304-1	FK5106-1	FK5106-S1
	Viton O-ring	SL1240	na	SL1350	SL1350	SL7501	SL7501
	NPT/Teflon	FK2300-1	na	FK2304-1	FK2304-1	FK2106-1	na
	BSP/Teflon	FK2301-1	na	FK2305-1	FK2305-1	FK2107-1	na
	ANSI/Teflon	FK5301-1	na	FK5305-1	FK5305-1	FK5107-1	na
	Teflon O-ring	SL2240	na	SL2350	SL2350	SL2503	na
	Flange screw	FS1951	na	FS2965	FS2965	FS2965	FS5210

NOTES: 1 = Used for both strainer & air check valve when assembled to TS10A model.  
2 = Used for strainer only when assembled to TS15A model (valves fit directly to meter body).



## Troubleshooting the Flow Meter

**Prior to opening or disassembly of any flow meter, all internal pressure must be relieved and all liquid must be drained. This must be done in accordance with applicable company and local codes & ordinances.**

**Make sure that all necessary safety precautions have been taken, including proper clothing, personal safety equipment and fire safety equipment if required.**

### No Flow

- Blocked strainer basket. Clean the basket.
- Faulty or non-functioning pump. Repair pump.
- Valve stuck in closed position. Check and repair valves.
- Flow meter 'frozen' due to build-up of chemical salts (or frozen water) inside the measuring chamber. Clean the flow meter (see **D & F** on page 1.12), and inspect for damage.
- Meter jammed on a particle, that has passed through a damaged strainer basket. Remove particle (see **D & F** on page 1.12) and replace rotors if necessary. Replace strainer basket, see page 2.1).

### Reduced Flow Rate

- Strainer basket partially blocked. Clean the basket (see page 2.1).
- Pump not functioning correctly. Repair pump.
- Valve stuck in partially closed position. Check valves and repair.
- Meter rotors (oval gears) partially 'salted' with chemical deposits, slowing the movement. Clean the meter (see **D & F** on page 1.12).

### Product Flows, but the register does not record

- Check packing gland pinion (11D) & face gear (11E).
  - If disengaged, re-assemble the drive shaft assembly correctly.
  - If worn, replace pinion & face gear **as a set**.
- If the calibrator drive shaft turns, the problem is either in the calibrator assembly (19) or in the mechanical register.
  - Remove the calibrator assembly (see H on page 1.13). Insert the drive shaft and turn by hand. If it turns smoothly without binding, the problem is in the register.
  - Refer to Veeder-Root register manual & parts list.
- If the calibrator drive shaft does not turn, the problem is either in the packing gland or in reduction gears on the bearing plate.
- Check the connections between the pulser and the electronic register.
- Check pulser output. Replace pulser (or SCL) if needed.
- If product is flowing, and the flow meter is generating a pulse signal, the problem is in the electronic register. Please refer to the manual for the electronic register.

### Product Flows, register does not record correctly

If the **error factor is constant**, the flow meter is fine. The likely cause is either:

- Incorrect K Factor in the electronic register. Re-calibrate the meter and correct the K Factor.
- A constant problem with air getting into the system. Review system design and control valves.

If the **error is random**, the likely cause is either:

- Poor cable connections (insulation not trimmed, or stray strands getting close to incorrect contacts). This can be either on the scaler board or where pulse signal is connected to the register. Inspect and correct connections as necessary.
- Valve leaking, allowing a portion of the system to drain. Check & repair valves.
- An intermittent problem with air in the system, combined with inadequate air elimination. Review system design and control valves.
- Interference from other electrical equipment nearby., possibly combined with sub-standard cables.

### Broken Rotors (Oval Gears = #2)

- System started on air/vapors. Replace rotors and inspect meter case (#1) for damage; repair/replace as necessary. Slowly fill the system with liquid before starting the pump. Gradually increase flow rate to full capacity.
- Rotors jammed on a foreign particle (welding slag, part broken off other equipment, etc.). Replace rotors and inspect meter case (#1) for damage; repair/replace as necessary. Add a strainer in front of the flow meter. Slowly fill the system with liquid before starting the pump. Gradually increase flow rate to full capacity.

### Breaking Teeth on Rotors (Oval Gears = #2)

#### Breaking Teeth/shaft on Reduction Gears (#4D/F/G)

These are signs of **hydraulic shock conditions** in the system. Common sources:

- Starting or stopping flow too rapidly. Replace damaged components and **correct operational practices**.
- Pump by-pass not adjusted properly. Re-adjust as necessary.
- Open connection to another portion of the system with higher flow rates. Close connection prior to use.

### Leakage from End Covers

The seals (and possibly end covers) have been damaged due to excessive pressure. There are two possible sources:

- Starting or stopping flow too rapidly. Replace damaged components and **correct operational practices**.
- The flow meter is in a system, where it can be isolated between two valves. Add a Thermal Relief Valve to bleed off excess pressure when the temperature rises.

## Parts List

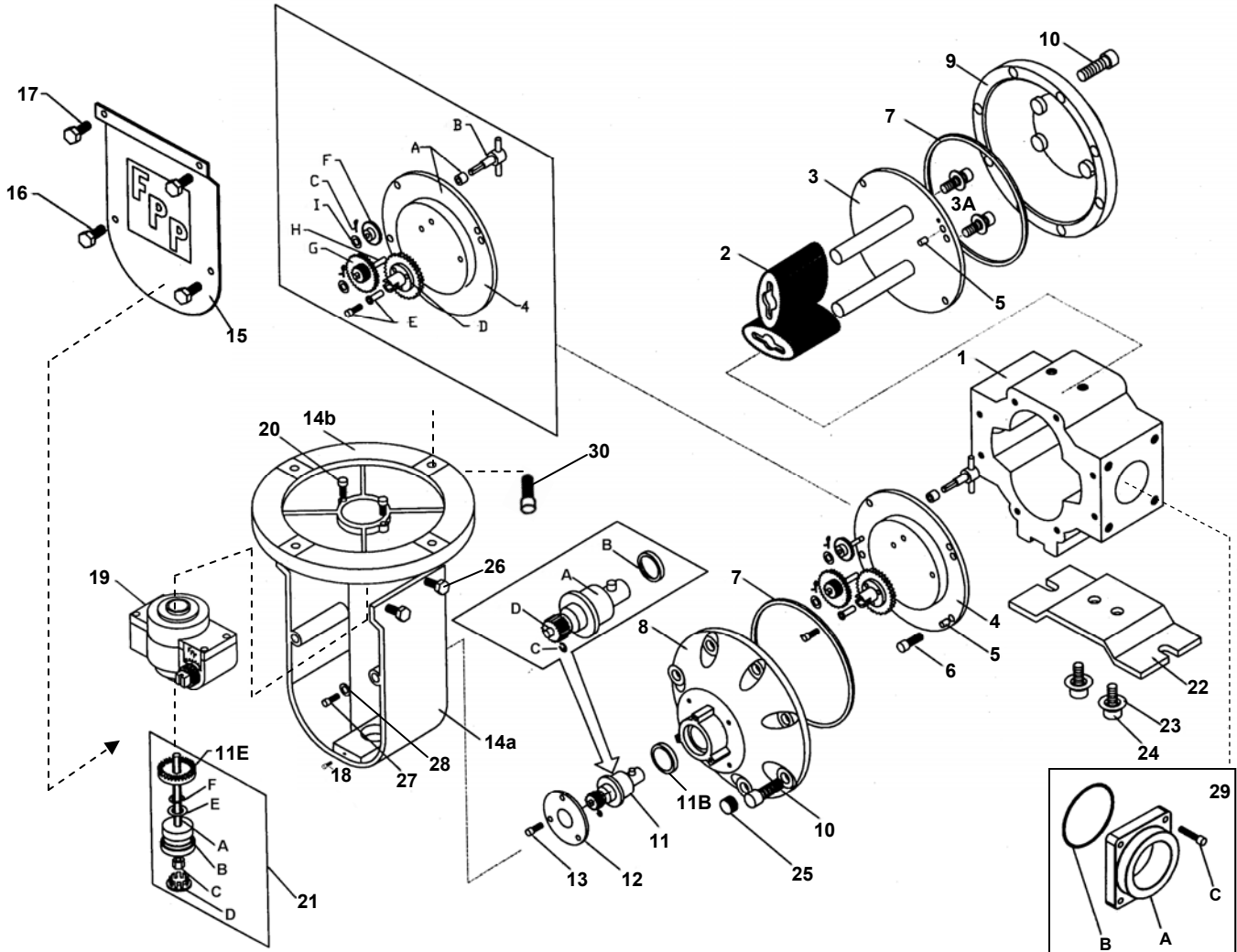
ITEM	DESCRIPTION	TS10A, OS		TS10A, NS		TS15A		TS20A		TS30A		
		QTY	P/No.	QTY	P/No.	QTY	P/No.	QTY	P/No.	QTY	P/No.	
1	Meter Body Depth across body:	1	MB2560 1.47" (37 mm)	1	MB2565 1.97" (50 mm)	1	MB2575 3.46" (88 mm)	1	MB2395 3.46" (88 mm)	1	MB5201-1 4.96" (126 mm)	
2	Gear Set, PPS/carbon, LV Opt. PPS/carbon, HT PPS/carbon, HV PPS/Teflon, LV PPS/Teflon, HT PPS/Teflon, HV	1	GS560RC GS560RC-MV GS560RC-HV GS560RT GS560RT-MV GS560RT-HV	1	GS10RC GS10RC-MV GS10RC-HV GS10RT GS10RT-MV GS10RT-HV	1	GS15RC GS15RC-MV GS15RC-HV GS15RT GS15RT-MV GS15RT-HV	1	GSTS2HRC GSTS2HRC-MV GSTS2HRC-HV GSTS2HRT GSTS2HRT-MV GSTS2HRT-HV	1	GS5201RC GS5201RC-MV GS5201RC-HV GS5201RT GS5201RT-MV GS5201RT-HV	***
3	Post Plate assy.	1	CP25521	1	CP25801	1	CP25802	1	CP2396-2	1	CP23961	***
4	Gear Plate assy., internal	1	CP25532	1	CP25532	1	CP25532	1	CP23162	1	CP23172	***
4a	Gear plate with bushing		CP25531		CP25531		CP25531		CP23161		CP23171	
4b-l	Repair kit, replacement of combination gear set		RKCP1		RKCP1		RKCP1		RKCP2		RKCP2	**
5	Dowel pin	4	MS902118-8	4	MS902118-8	4	MS902118-8	4	MS902118-8	4	MS902118-8	
6	Screw, for post/gear plates	8	FS9661	8	FS9661	8	FS9661	8	FS9661	8	FS9661	
7	O-ring, cover, Viton™ Opt. Teflon™	2	SL1157 SL2157	2	SL1157 SL2157	2	SL1157 SL2157	2	SL1167 SL2167	2	SL1167 SL2167	*
8	Front cover	1	CP2550	1	CP2550	1	CP2550	1	CP2398	1	CP2398	
9	Rear cover	1	CP2551	1	CP2551	1	CP2551	1	CP2397	1	CP2397	
10	Cover screws	16	FS2900	16	FS2900	16	FS2900	24	FS2928	24	FS2928	
11	Packing gland, AA/Viton Opt. SS/Teflon	1	RK2001 RK8002	1	RK2001 RK8002	1	RK2001 RK8002	1	RK2003 RK80031	1	RK2003 RK80031	**
11b	O-ring, Viton Opt. Teflon		SL1212 SL2212		SL1212 SL2212		SL1212 SL2212		SL1212 SL2212		SL1212 SL2212	*
11cde + 21f	For 1/10 gallon Whole gallon 1/10 liter Whole liter Whole dekaliter		GS2001 na GS2002 (std) GS2001 (opt) na		GS2001 na GS2002 (std) GS2001 (opt) na		GS2002 na na GS2001 na		GS2002 (std) na GS2002 (std) GS2001 (opt)		na GS2002 na GS2002 (std) GS2001 (opt)	*
12	Retainer, packing gland	1	MP9061	1	MP9061	1	MP9061	1	MP9061	1	MP9061	
13	Screws, PG retainer	3	FS9515	3	FS9515	3	FS9515	3	FS9515	3	FS9515	
14	RAD (right angle drive)	1	RD15911	1	RD15911	1	RD15911	1	RD15911	1	RD15911	
15	RAD dust cover	1	MP2505	1	MP2505	1	MP2505	1	MP2505	1	MP2505	
16	Screws, w seal wire hole	2	FS59121	2	FS59121	2	FS59121	2	FS59121	2	FS59121	
17	Screws, plain	2	FS5912	2	FS5912	2	FS5912	2	FS5912	2	FS5912	
18	Set screw for drive shaft	1	FS9652	1	FS9652	1	FS9652	1	FS9652	1	FS9652	
19	Calibrator assy.	1	CA6000	1	CA6000	1	CA6000	1	CA6000	1	CA6000	***
20	Screws, calibrator to RAD	2	FS2501	2	FS2501	2	FS2501	2	FS2501	2	FS2501	
21	Drive shaft assy, (A-F)	1	RD15912	1	RD15912	1	RD15912	1	RD15912	1	RD15912	**
22	Meter pedestal	1	MP2528		na		na	1	MP2526	1	MP2529	
23	Split lock washers		na		na		na		na		na	
24	Screws, for pedestal	2	FS9923		na		na	2	FS9923	2	FS9923	
25	Drain plug	2	MS4019	2	MS4019	2	MS4019	2	MS4019	2	MS4019	
26	Screws, RAD, w seal hole	2	FS59121	2	FS59121	2	FS59121	2	FS59121	2	FS59121	
	Screws, RAD, plain	2	FS5912	2	FS5912	2	FS5912	2	FS5912	2	FS5912	
27	Screws, RAD to cover	4	FS2800	4	FS2800	4	FS2800	4	FS2800	2	FS2800	
28	Lock washer, 1/4"	4	FS3602	4	FS3602	4	FS3602	4	FS3602	4	FS3602	
29	Flange or adaptor assy.		See pg. 1.14		See pg. 1.14		See pg. 1.14		See pg. 1.14		See pg. 1.14	
30	Register mounting bolt	4	FS0856	4	FS0856	4	FS0856	4	FS0856	4	FS0856	

Time frame for replacement of regular maintenance items and long term consumables (rotors, packing gland & calibrator) varies a great deal. Factors include user maintenance schedule, fluid lubricity, flow rate versus model capacity, intermittent versus continuous duty & total volume. In heavy duty service, rotors may last from 2-5 years, while in lighter duty service, they may last from 10-20 years or more.

\* = Indicates recommended Spare Parts (regular maintenance items).

\*\* = Indicates suggested Spare Parts (longer time frame, but should be on hand if meter is in a location where service is not readily available).

\*\*\* = Indicates very long term wearing component (should be on hand if meter is in a location where service is not readily available).



**#4 = Gear Plate assembly (internal)**

Can be replaced complete, or as two sub-assemblies (the individual parts are not sold separately, as they must be replaced as a set):

- Gear plate with bushing (4A)
- Rebuild kit (items 4B-4I)

**#29 = Companion Flanges**

Companion flange assemblies (A+B+C) vary, depending on whether the flange attaches to:

- Flow meter body
- Inlet strainer
- Preset valve or air check valve on flow meter outlet.

A complete list of companion flange assemblies, seals and screws is found on page 1.16

**#11 = Packing Gland**

The **packing gland ratio** (D = 12 or 24 tooth pinion) depends upon flow meter model, and unit of calibration selected on the mechanical register. A list of packing gland ratios can be found in **FPP Technical Manual** (see list of ratio gear plates).

- Pinion/Face Gear (11D/E) can be replaced separately:
  - GS2001 2:1, metal/PPS
  - GS2002 1:1, PPS/PPS (standard)
  - GS2003 1:1, metal/PPS (*for tank truck service*)
- The packing gland is replaced as a kit under the P/No. shown in the parts list, which includes both GS2001 & GS2002.

**#21 = Calibrator Drive Shaft assy.**

This assembly is replaced as a kit containing all components (A-F). Except for the E-ring (F) and face gear (11E), parts are not sold separately.



## Tools & Torque Chart

ITEM	DESCRIPTION	TS10A	TS15A	TS20A	TS30A
6	Post/Bearing plate screw <b>Tool</b>	5/32" Allen	5/32" Allen	5/32" Allen	5/32" Allen
	<b>Torque specification</b>	10/32 19.2 in-lbs	10/32 19.2 in-lbs	10/32 19.2 in-lbs	10/32 19.2 in-lbs
10	Cover screw <b>Tool</b>	1/4" Allen	1/4" Allen	5/16" Allen	5/16" Allen
	<b>Torque specification</b>	5/16-18 80 in-lbs	5/16-18 80 in-lbs	3/8-16 143 in-lbs	3/8-16 143 in-lbs
13	Packing gland retainer screw <b>Tool</b>	Impact Battery Tool	Impact Battery Tool	Impact Battery Tool	Impact Battery Tool
	<b>Torque specification</b>	8/32 10.8 in-lbs	8/32 10.8 in-lbs	8/32 10.8 in-lbs	8/32 10.8 in-lbs
16	Dust cover screws <b>Tool</b>	Impact Battery Tool	Impact Battery Tool	Impact Battery Tool	Impact Battery Tool
	<b>Torque specification</b>	10/14 10.8 in-lbs	10/14 10.8 in-lbs	10/14 10.8 in-lbs	10/14 10.8 in-lbs
17	Calibrator bushing set screw <b>Tool</b>	3/32 Allen Tool	3/32 Allen Tool	3/32 Allen Tool	3/32 Allen Tool
	<b>Torque specification</b>	10/32 19.2 in-lbs	10/32 19.2 in-lbs	10/32 19.2 in-lbs	10/32 19.2 in-lbs
18	Calibrator mounting screw <b>Tool</b>	Impact Battery Tool	Impact Battery Tool	Impact Battery Tool	Impact Battery Tool
	<b>Torque specification</b>	Sheet Metal Screw s	Sheet Metal Screw s	Sheet Metal Screw s	Sheet Metal Screw s
24	Pedestal screw <b>Tool</b>	Built-in pedestal	Built-in pedestal	Impact Battery Tool	Impact Battery Tool
	<b>Torque specification</b>	N/A	N/A	3/8-16 143 in-lbs	3/8-16 143 in-lbs
25	Cover drain plug <b>Tool</b>	1/4" Allen	1/4" Allen	1/4" Allen	1/4" Allen
	<b>Torque specification</b>	Hand tight	Hand tight	Hand tight	Hand tight
26	RAD housing/flange screw <b>Tool</b>	Impact Battery Tool	Impact Battery Tool	Impact Battery Tool	Impact Battery Tool
	<b>Torque specification</b>	Sheet Metal Screw s	Sheet Metal Screw s	Sheet Metal Screw s	Sheet Metal Screw s
27	RAD to meter cover screw <b>Tool</b>	Impact Battery Tool	Impact Battery Tool	Impact Battery Tool	Impact Battery Tool
	<b>Torque specification</b>	1/4-20 45.6 in-lbs	1/4-20 45.6 in-lbs	1/4-20 45.6 in-lbs	1/4-20 45.6 in-lbs
30	Companion flange screw <b>Tool</b>	5/16" Allen	1/4" Allen	5/16" Allen	
	<b>Torque specification</b>	3/8-16 143 in-lbs	5/16-18 80 in-lbs	3/8-16 143 in-lbs	

Note: All torque specification are Reference guide listed from the Fastenal Technical Guide.

## Warranty

Tuthill Transfer Systems ("Manufacturer") warrants to each buyer of its FPP Meters products (the "Buyer") for a period of 12 months from date of invoice or sales receipt, but in no event more than 18 months from date of manufacture, that goods of its manufacture ("Goods") will be free from defects of material and workmanship. Manufacturer's sole obligation under the foregoing warranties will be limited to either, at Manufacturer's option, replacing or repairing defective Goods (subject to limitations hereinafter provided) or refunding the purchase price for such Goods theretofore paid by the Buyer, and Buyer's exclusive remedy for breach of any such warranties will be enforcement of such obligations of Manufacturer. If Manufacturer so requests the return of the Goods, the Goods will be redelivered to Manufacturer in accordance with Manufacturer's instructions F.O.B. Factory. The remedies contained herein shall constitute the sole recourse of the Buyer against Manufacturer for breach of warranty. IN NO EVENT SHALL MANUFACTURER'S LIABILITY ON ANY

CLAIM FOR DAMAGES ARISING OUT OF THE MANUFACTURE SALE, DELIVERY OR USE OF THE GOODS EXCEED THE PURCHASE PRICE OF THE GOODS. The foregoing warranties will not extend to Goods subjected to misuse, neglect, accident or improper installation or maintenance, or which have been altered or repaired by anyone other than Manufacturer or its authorized representative. THE FOREGOING WARRANTIES ARE EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES OF MERCHANTABILITY, FITNESS FOR PURPOSE OF ANY OTHER TYPE, WHETHER EXPRESS OR IMPLIED. No person may vary the foregoing warranties and remedies except in writing signed by a duly authorized officer of Manufacturer. Warranties or remedies that differ from the foregoing shall not otherwise be binding on Manufacturer. The Buyer's acceptance of delivery of the Goods constitutes acceptance of the foregoing warranties and remedies, and all conditions and limitations thereof.

**Tuthill Transfer Systems (TTS) warranty does not extend to damage due to corrosion, salt deposits or separation of chemicals - whether occurring during periods of operation or storage.**

**Components added after shipment from TTS, such as hose, nozzles & similar, are the responsibility of the distributor or contractor selling the installation.**