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ENGINEERING MANUAL

682 SERIES PISTON FLOW METER

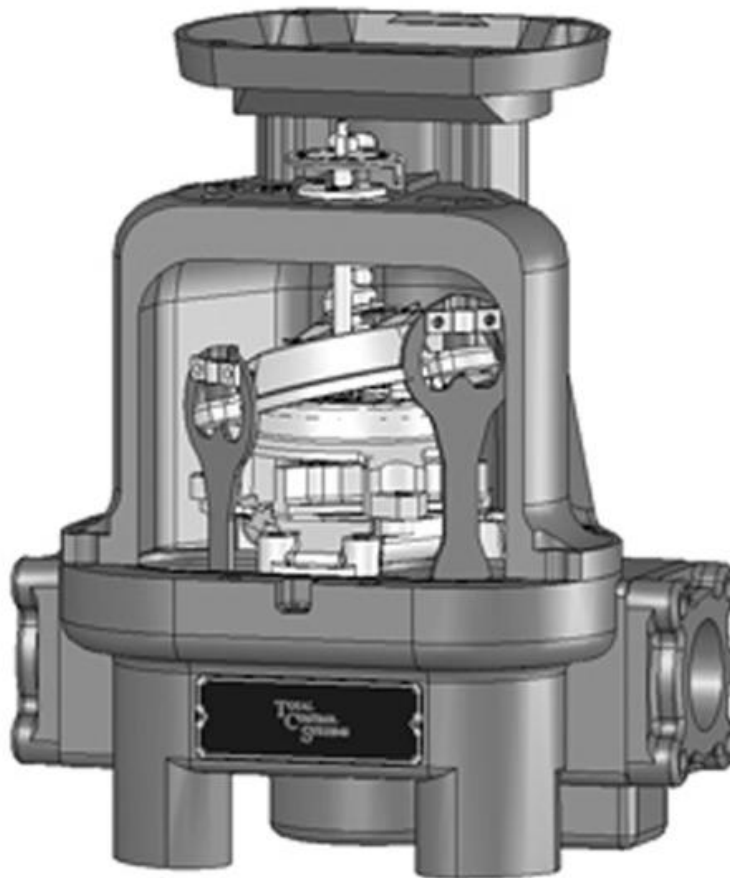


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QUOTE & PURCHASE SPECIFICATIONS

There are many advantages available only to Total Control Systems meters, such as performance, installation, operating, and maintenance. In order to assure you of receiving a Total Control Systems meter, we suggest that the following statements, along with a TCS model number and description be included when issuing quote and purchase specifications.

“Flow Meter shall be of positive displacement design having reciprocating piston motion, with in-line flange connections.”

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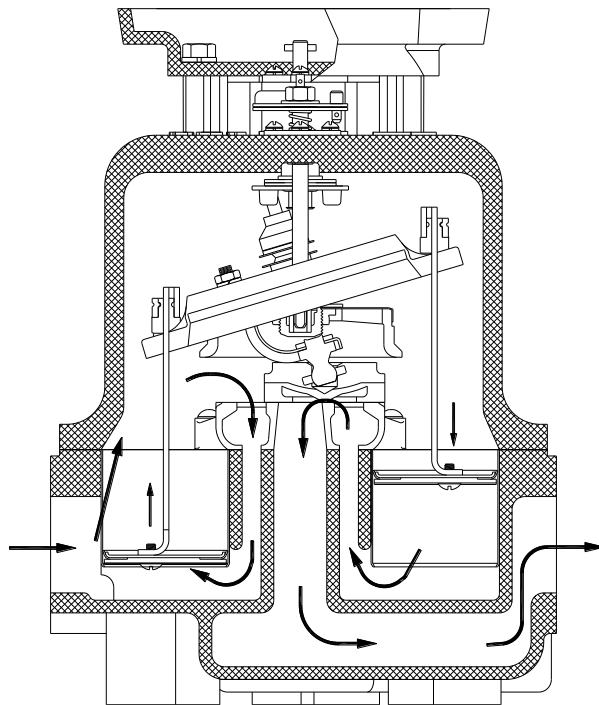
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METER DESIGN

The 682 meter is a true Positive Displacement Meter, with the inlet and outlet on the same horizontal plain (straight in - straight out). Within the meter, three plungers are fitted within their respective cylindrical measuring chambers. The plungers are joined to a wobble plate, which has a shaft extending from its upper surface. The wobble plate features a valve pivot on the underside of the plate. The valve pivot drives a sliding valve from cylinder opening to cylinder opening as product flows, controlling the sequence of events.

The wobble plate shaft is always held at an inclined position by the center gear post. This allows the plate to tilt from side to side but it is prevented from rotating by four guide pins on the pivot bracket assembly.

As product enters the meter, it initially flows into the meter chamber located in the upper meter housing. As the sliding valve travels around the meter chamber, it alternately opens and closes the inlet and outlet of each measuring cylinder in turn. The sliding valve starts in position with one measuring cylinder open to the downstream flow. The plunger for the corresponding cylinder is in the upper position with the cylinder below open to the outlet. With the upper housing full of product at line pressure, the differential pressure between the inlet and outlet will force the plunger to the bottom of the cylinder, expelling the product in the measuring cylinder to the meter outlet. As this occurs, another plunger is forced from the down position to the upper position. As this happens, the sliding valve moves to open the inlet of this cylinder. As the plunger moves upward, it draws product into the bottom of the measuring cylinder through the open port in the meter chamber. Once this plunger reaches the upper position, the cycle will repeat, so long as product continues to enter the meter. If product flow stops, pressure in the meter equalizes and motion stops. Thus the meter only operates when product is flowing.



METER TYPE CLASSIFICATION

SP STANDARD PETROLEUM

For metering refined petroleum products such as Gasoline, Fuel Oils, Diesel, Bio-Diesel, Kerosene, Motor Oils, etc.

SPA STANDARD PETROLEUM (AVIATION)

For metering refined petroleum products such as Aviation Gasoline, Jet Fuels, Gasoline, Fuel Oils, Diesel, Bio-Diesel, Kerosene, Motor Oils, etc.

SPD STANDARD PETROLEUM (DUCTILE IRON)

For metering alternative fuels such as Natural Gasoline, Ethanol, Methanol, Bio-Diesel, Aviation Gasoline, Fuel Oils, Diesel, Motor Oils, etc.

AF ALL FERROUS

For metering Pesticides, Nitrogen Solutions, Fertilizer, Chlorinated Solvents, Paints, Inks, Alcohols, Adhesives, Motor Oils, Molasses, Corn Syrup, Liquid Sugars, etc.

SS STAINLESS STEEL

For metering the same liquids as the SP, SPA, SPD, IP, IC and AF flow meters, but includes food processing and special handling fluids such as Nitric, Phosphorus and Glacial Acetic Acids, Anti-Icing Fluids, Vinegar, Fruit Juices, etc.

METER OPERATING SPECIFICATIONS

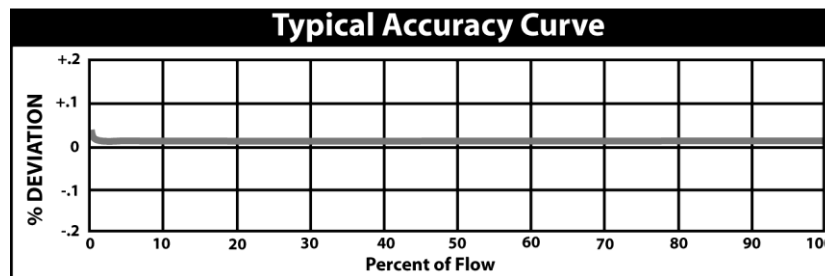
Type	Reciprocating 3 Piston Positive Displacement
Connections	1-1/2" NPT Flange Connection Standard 1" and 2" NPT, BSP, Slip Weld or ANSI Flange Connections Optional
Flow Rate	Minimum: 0.2 GPM (0.76 LPM) Maximum: 50 GPM (189 LPM)
Working Pressure	150 PSI maximum (10.5 Bar)
Working Temperature	-20°F to 160°F (-28.9°C to 71°C)
Units of Measure	1/10 th U.S. Gallons Standard Litres, Pounds, Quarts, Imperial Gallons Optional Others available upon request.

METER SELECTION FACTORS

WEIGHTS & MEASURES

Before any meter can be specified, knowledge of each application is required. If the liquid is to be sold through a metered delivery, domestic or international certification from a governing body may be required. Total Control Systems strictly adheres to all domestic and international metrology conformance regulations for the custody transfer of fluids. For questions regarding weights and measures approvals or other issues, please consult factory.

ACCURACY



The 682 meter's accuracy (percent of error over or under the zero – error level) remains within design parameters (+/- 0.1%) over its minimum rated flow range to its maximum rated flow range for custody transfer meter requirements. This percentage meets or exceeds the Wholesale and Vehicle accuracy requirements for accurate custody transfer of product, as specified in the National Institute of Standards and Technology (NIST) Handbook 44.

PRODUCT CHARACTERISTICS

A) Material Compatibility

Consult the Total Control Systems CHEMICAL COMPATIBILITY charts on pages 21 to 33 of this manual to find the suitable materials and meter type for the product to be measured. Products incompatible with meter materials will potentially pose harm to personnel, reduce the accuracy and operational life of the meter and contaminate the liquid and could

B). Flow Rate

The minimum and maximum system rate of flow must be determined for the selection of flow meter. The flow rate of the system is dependent upon the product viscosity; the desired meter configuration, the pump capabilities of the system and the plumbing configuration.

C) Pressure

Consult the specified maximum working pressure of the meter under flow meter type and pressure rating. All meters meet the European Pressure Equipment Directive (PED) No. 97/23/EC. Failure to adhere to the maximum allowable pressure may potentially cause a seal leak or casting rupture.

D) Temperature

The operating temperature has a great effect on the meter seals. Temperature also has a relationship to the operating pressure as it relates to the flow meter castings. It will be necessary to reduce the maximum rated working pressure as the operating temperature increases. Any metering system operating over 180F (82 C) will require at least a one (1) foot registration extension to protect the registration devices. Increase in temperature may increase the corrosion rate of some products.

1) Seal Temperature Rating

Viton	-31F to 400F	-35C to 204C
Simriz	-40F to 450F	-10C to 230C
Teflon	-20F to 500F	-30C to 260C

2) Pressure rating at elevated temperatures.

Temperature	Reduced Maximum Operating Pressure
150 F	150 PSI
200 F	100 PSI
250 F	75 PSI
300 F	50 PSI

E) Lubricity

The lubricity or non-lubricity of the product will be a major factor in determining the operational life of the meter. Products with lubrication will reduce friction between two metal surfaces and help dissipate heat. Products with no lubrication may potentially reduce the life of seals and bearings.

F) Suspensions & Suspended Solids

Products with high percentages (5%) of suspensions or suspended solids, or any hard solids, such as sand, are not recommended for the 682 series meter. Products with a low percentage of soft suspensions or suspended solids (<5%) may be metered at a reduced flow rate. It is recommended that the flow be reduced by 20% from the flow rate for a similar product without suspensions or suspended solids.

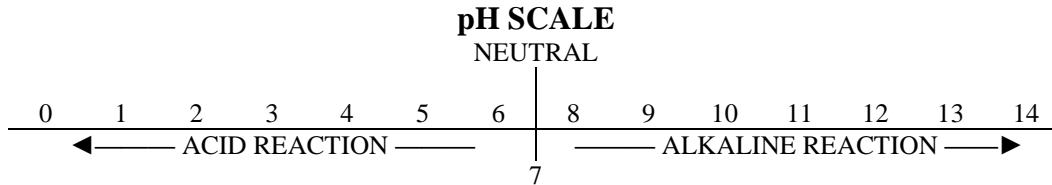
G) Foreign Materials

Products that are to be measured may have foreign materials present. The inlet side of any positive displacement meter should be equipped with a strainer to protect the meter and accessories from damage in the system. The strainer should be suitable for 1-1/2" or 2" piping with an appropriate screen mesh size. A minimum of 40-mesh screen is recommended for petroleum service.

H) pH

The resistance of any metal to the effects of high or low PH is difficult to calculate because of the varying concentrations and corrosiveness of fluids, particularly blended products. At right is a generalized recommendation for pH resistance for metals used in the Series 682 meter. For specific application, consult the factory.

<u>Material</u>	<u>Recommended pH Range</u>
Aluminum	5 – 8
Ductile Iron	5.5 – 11
Ni-Resist	5.5 – 14
Stainless Steel	0 – 14



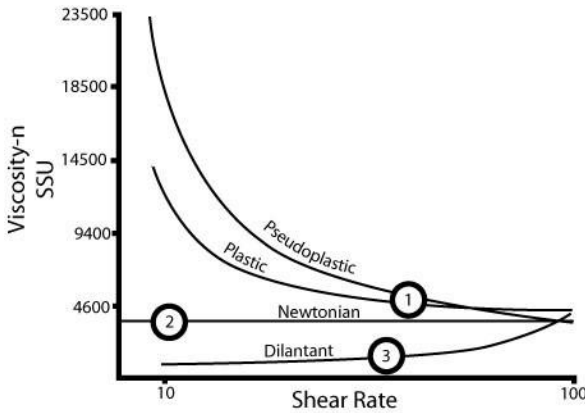
I) Viscosity

Viscosity is the property of a fluid that is a measure of its resistance to flow. Among the earliest to express this quantitatively was Sir Isaac Newton. He reasoned that the viscosity of a liquid was proportional to its shear stress (or resistance to shear). In other terms, viscosity is basically constant with shear and flow rate. Liquids that behave in this manner are referred to as “Newtonian” liquids. Petroleum fluids, water and similar chemicals are categorized as Newtonian liquids.

Other types of fluids are grouped into a general category called “Non-Newtonian”. Among the fluid types that are categorized as non-Newtonian are dilatants, plastic, pseudoplastic and thixotropic liquids. Non-Newtonian liquids are characterized by viscosity that changes with the rate of shear as compared to the Newtonian fluids where viscosity is essentially a constant. As a consequence, the performance of a fluid through a flow meter is much more predictable for Newtonian fluids than for Non-Newtonian liquids.

Many of the more viscous liquids pumped through the 682 series rotary flow meter are plastic and pseudoplastic and as such are reduced in effective viscosity after being pre-sheared by the pump.

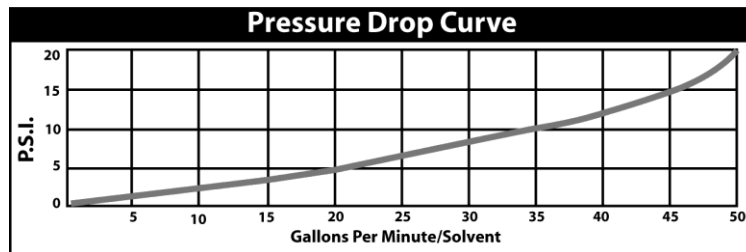
The diagram below shows how viscosity varies as a function of shear rate on various types of liquids. As noted, some fluids may not be suitable for metering with the 682 Series flow meter. See Section K Operating Limits for additional considerations concerning viscosity.



- 1) Thixotropic Liquids (Plastic and Pseudoplastic):
Viscosity decreases as shear rate increases. Typical liquids include gels, Latex paints, lotions, shortening, mayonnaise, printers ink, hand cleaner and yeast.
- 2) Newtonian Liquids:
Viscosity remains unchanged with shear.
- 3) Dilatant Liquids:
Viscosity increases as shear rate increases. Most liquids in this category are unsuitable with PD flow meters. Examples include clay, slurries and some confectionary bases.

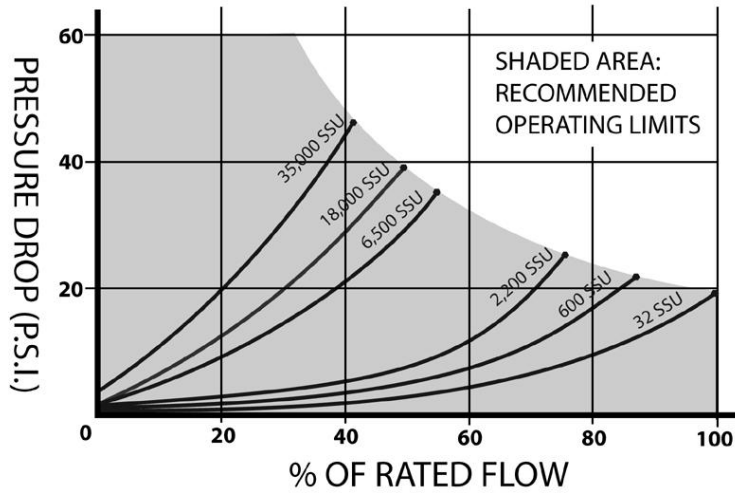
J) Pressure Loss

Pressure drop across a flow meter is the difference between of the inlet and outlet pressure of the flow meter while it is operating. As flow rate increases through the meter, the pressure drop will increase as shown in the chart below. When the metering system includes any accessories such as an air eliminator or a valve, each of these devices will add approximately 5 PSI to the overall pressure drop for the meter system.



K) Operating Limits

The viscosity of the product to be metered will have a direct impact on the flow rate at which the metering system can effectively operate. The following chart is a flow meter selection guide indicating the relationship between viscosity and flow rate. If the desired system flow rate and fluid viscosity fall outside the recommended operating limits, the flow rate must be reduced.



VISCOSITY CONVERSION (Specific Gravity = 1)

CPS Centipoise	SSU Saybolt Universal	CPS Centipoise	SSU Saybolt Universal	CPS Centipoise	SSU Saybolt Universal	CPS Centipoise	SSU Saybolt Universal
1	31	200	1,000	900	4,300	7,000	32,500
2	34	220	1,100	1,000	4,600	8,000	37,000
4	38	240	1,200	1,200	5,620	8,500	39,500
7	47	260	1,280	1,300	6,100	9,000	41,080
10	60	280	1,380	1,400	6,480	9,500	43,000
15	80	300	1,475	1,500	7,000	10,000	46,500
20	100	320	1,530	1,700	8,000	15,000	69,400
25	130	340	1,630	1,800	8,500	20,000	92,500
30	160	360	1,730	1,900	9,000	30,000	138,500
40	210	380	1,850	2,000	9,400	40,000	185,000
50	260	400	1,950	2,200	10,300	50,000	231,000
60	320	420	2,050	2,400	11,200	60,000	277,500
70	370	440	2,160	2,500	11,600	70,000	323,500
80	430	460	2,270	3,000	14,500	80,000	370,000
90	480	480	2,380	3,500	16,500	90,000	415,500
100	530	500	2,480	4,000	18,500	100,000	462,000
120	580	550	2,660	5,000	23,500	125,000	578,000
140	690	600	2,900	5,500	26,000	150,000	694,000
160	790	700	3,380	6,000	28,000	175,000	810,000
180	900	800	3,880	6,500	30,000	200,000	925,000

$$\text{Centistokes} = \frac{\text{Centipoise}}{\text{Specific Gravity}}$$

$$\text{Centipoise} = \text{Centistokes} \times \text{Specific Gravity}$$

SYSTEM DESIGN

Meter Selection

The flow meter must be carefully chosen using the information in the Meter Selection Factors section above. The meter must be selected based on the operating system and product characteristics. System variables include flow rate, temperature and pressure. The product characteristics include the material compatibility, lubricity, viscosity, suspensions, pH, and other factors. Failure to select the correct flow meter may result in serious injury, system failure or reduced system performance.

Air Elimination

In any system I which the supply tank may be completely drained or where multiple products manifold into one metering system, there is a risk of air being present in the fluid stream. The solution is an air or vapor eliminator located before the flow meter to vent the air or vapor from the system before it can be measured. Air or vapor elimination is required for all weights and measures regulatory approvals in custody transfer applications.

Control Valves

Safety and isolation valves should be used throughout the metering system. In any pumping system where there is one pump and multiple flow meters, a digital or hydro-mechanical Rate-of-Flow control valve must be used at each flow meter to prevent the meter from operating above its maximum flow rating.

Best Plumbing Configuration

- 1) Flow meter must have secure mounting to a riser stand or the foundation.
- 2) The inlet and outlet piping must be securely supported, in a manner that does not allow pipe stress on the flow meter. The meter must also be supported and must not hang from the pipe fittings.
- 3) System must be designed to keep the flow meter full of liquid at all times. Meter inlet and outlet should be lower than the associated system plumbing (in the SUMP POSITION).
- 4) System piping must be of at least 1-1/2" or larger throughout the entire metering system. This will allow for minimal pressure loss.
- 5) The pipe should be laid out as straight as possible to reduce pressure loss from flow restrictions.
- 6) It is not necessary for the air eliminator to be installed directly to the meter. It may be installed upstream from the meter. For effective operation of the air eliminator, it should be mounted between the meter and any valves, pipe tees or any other potential places where air may enter the system.
- 7) The metering system must include a means for calibration.

Protection From Debris

On new installations, care must be taken to protect the meter from damage during start-up. It is recommended that a strainer be installed upstream of the meter. Damage may result from the passage through the meter of dirt, sand, welding slag or spatter, thread cuttings, rust, etc.

It is recommended that a spool be constructed to be installed in place of the meter until the system is flushed. The spool is a flanged length of pipe equal in length to the meter and its attached accessories. The meter may be left in place if the plumbing can be temporarily bypassed around the meter to protect the meter from debris. Once the system has run “clean” for a period of time the meter may be reinstalled or temporary protective devices removed.

Thermal Expansion

Most liquids will expand and contract with temperature. In any system where there is a chance for liquid to be captured between closed valves without relief, there is a risk of thermal expansion. This condition can create dangerously high pressures within the system. For every one degree of temperature increase, there is a corresponding pressure increase of 126 PSI (8.69 BAR).

Care must be taken in designing the system where thermal shock may occur by implementing Pressure Relief Valves or Thermal Expansion Joints in the system design.

Hydraulic Shock (Water Hammer)

Hydraulic shock is a rise in pressure that occurs when an operating system has immediate change in direction of flow. This can be due to a sudden valve closure while the system is operating at a high flow rate. Hydraulic shock can damage any item in the way of the product flow such as the internal parts of the meter, valves, and pump. System design and improper operating procedures will increase the risk of this problem. The use of 2-stage preset control valves or surge suppressing bladders or risers will help reduce or eliminate this problem.

The shock pressure when a valve is closed quickly is computed as follows. The maximum recommended shock pressure is 6 PSI.

$$\text{Shock Pressure (PSI)} = 63 \times \text{Velocity (FPS)}$$

In order to eliminate hydraulic shock from sudden valve closure, the valve closure rate must be reduced. The time required to close the valve so that the line pressure will not exceed the normal pressure at zero flow is calculated as follows.

$$\text{Time (seconds)} = \frac{0.027 \times L \times V}{N - F}$$

- V = Velocity in Feet/Seconds
- L = Length of pipe before the valve in feet
- N = Line pressure at no flow
- F = Line pressure at full flow

Products that Dry/Congea/Crystallize

There are many liquids that crystallize, harden and/or solidify on contact with air or with an increase in temperature. A proper system design and a good understanding of the product being measured will help to avoid the possibility of air entering into the system and the product being affected.

Calibration

The meter shall be tested and calibrated with the product it is intended to measure when installed. Total Control Systems shall not be responsible for loss of product or any damages resulting from the end user's failure to test the meter to insure proper calibration. Every 682 Series meter is tested and calibrated at the factory to ensure that it may be calibrated in your system.

See pages 15 – 20 for instructions on how to calibrate the 682 Series meter.

It is the end user's responsibility to report this device to the local Weights and Measures officials for inspection prior to the meter being put to use.

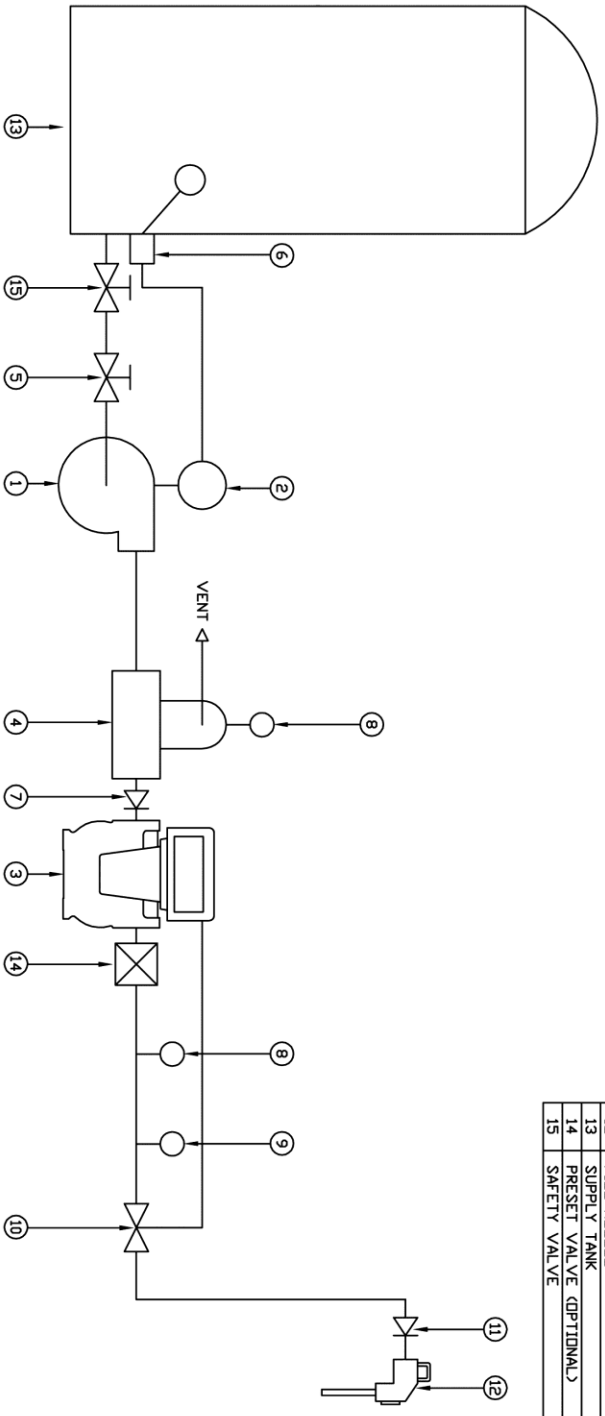
Refer to the Material Safety Data Sheet on pages 39 – 42 for information on the calibration fluid used in factory testing.

Typical System Installations

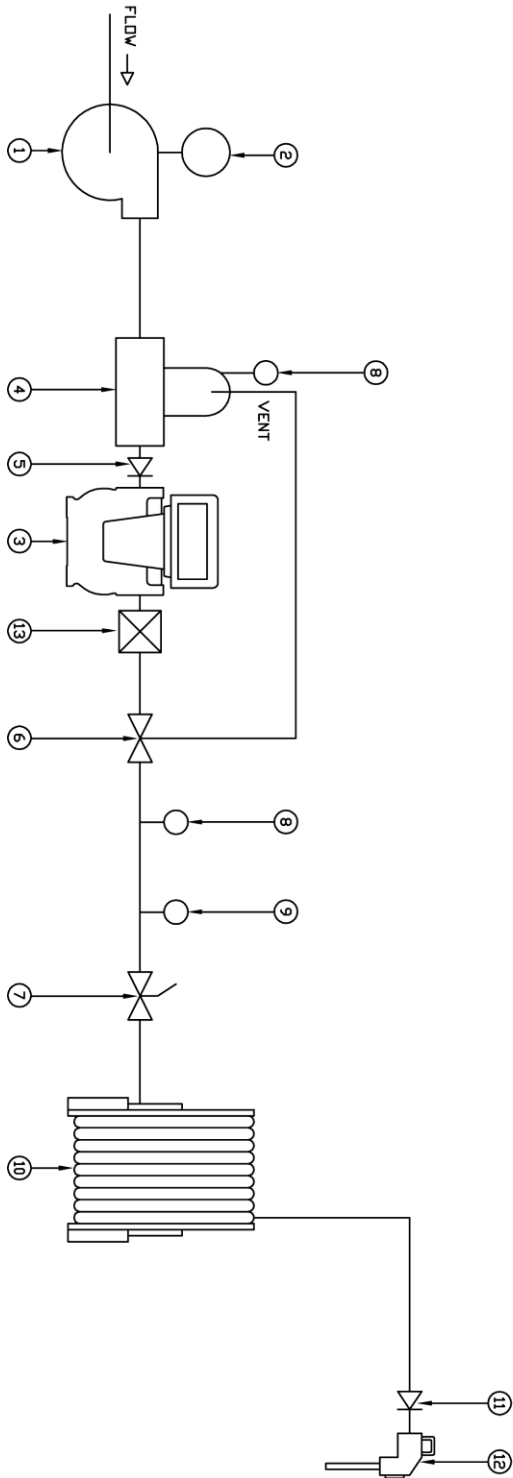
See pages 13 and 14 for diagrams of typical metering system designs. These diagrams are not definitive. Actual system requirements vary greatly from installation to installation. System design is the responsibility of the end user.

PARTS LIST

ITEM	DESCRIPTION
1	PUMP
2	PUMP MOTOR
3	FLOW METER W/ REGISTER
4	STRAINER/VAPOR ELIMINATOR
5	ISOLATION VALVE
6	LIQUID LEVEL CONTROL DEVICE (OPTIONAL)
7	CHECK VALVE
8	PRESSURE GAUGE (OPTIONAL)
9	TEMPERATURE GAUGE (OPTIONAL)
10	FLOW RATE CONTROL VALVE
11	CHECK VALVE
12	FILL NOZZLE
13	SUPPLY TANK
14	PRESET VALVE (OPTIONAL)
15	SAFETY VALVE



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 A DIVISION OF
 MURRAY EQUIPMENT, INC.
 BRUM-FILLING LIQUID-MEASURING SYSTEM
 DATE 08/16/06
 DRN. SEP
 REV. INC.
 DRAWING NUMBER TCS00111



PARTS LIST	
ITEM	DESCRIPTION
1	PUMP
2	PUMP MOTOR
3	FLOW METER W/ REGISTER
4	STRAINER/VAPOR ELIMINATOR
5	CHECK VALVE
6	AIR CHECK VALVE (OPTIONAL)
7	FLOW RATE CONTROL VALVE
8	PRESSURE GAUGE (OPTIONAL)
9	TEMPERATURE GAUGE (OPTIONAL)
10	HOSE REEL
11	CHECK VALVE
12	FILL NOZZLE
13	PRESET VALVE (OPTIONAL)

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FOR
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MOBILE LIQUID-MEASURING SYSTEM

DATE	08/16/06	DRAWING NUMBER	TC000112
DRAWN	SEP	REV.	
BY		REV.	
NO.		NO.	

METER CALIBRATION

The method of proving should be selected, and necessary provisions made, during the design stage of the installation. Of the most commonly used systems, portable provers have the advantage of more closely reproducing the condition under which the product is normally delivered.

Use Accurate Prover

A volumetric testing prover is a scientifically designed test measure, having proper drainage means built in, a calibration gauge glass neck, and protection against deformation (which causes volume changes). Scientifically designed provers are commercially available

No other sort of home-made or non-scientific prover such as a truck compartment, tank or drum should be used. A homemade prover will most likely prove to be unsatisfactory. The use of such a prover may cause expensive errors due to inaccurate meter calibration.

Even scientifically designed provers should be checked periodically for accuracy and care must be taken to ensure these provers are not damaged during use, transportation or storage. A dent in a prover will affect its measurement accuracy. Weights and Measures officials have been very cooperative in giving assistance to checking privately owned volumetric provers.

Recommended size of test measure:

The prover capacity should be equal to at least one minute's flow through the meter at its maximum rate.

A 50 Gallon prover would be required for a 682 Series meter operating at full flow rate.

Setting a Prover

The prover must be set level, using the levels provided on the prover, or using separate leveling means. This insures consistent results from test to test and when moving the prover from meter to meter.

Where to Test a Meter

The best place to test is in its normal operating position, as opposed to a separate test stand. In this way, the correctness of the installation and of the operational conditions will be verified by the test. Always test a meter with the same liquid it is to measure, because a difference in viscosity, temperature and system plumbing can have an affect on meter accuracy.

Discharge Line from Meter

Where a portable prover is used, the liquid should be discharged into the prover in the same manner as a normal delivery would be made. In cases where a special test connection must be used, the discharge line must be arranged to drain to the same point on each test to ensure repeatable test conditions. Any valves used to control the meter flow rate and the start and stop of the fluid flow must be located on the discharge side of the mter.

Wetting the Prover

The calibrated accuracy of a prover is determined on its wet measure capacity by its manufacturer, so the prover must be wetted prior to actual testing.

To wet the prover, follow this procedure. Reset the meter register to zero, and fill the prover to the zero or 100% marking of the scale. Disregard the meter reading. Drain the prover, and reset the register. The first meter reading is disregarded as there will be a slight difference between a wet and a dry prover fill.

After the prover has drained, allow the tank to drain for a set time. Thirty seconds is a typical drain time, with the count beginning as soon as the fluid empties or is dumped from the prover. It is important that whatever amount of time is selected, that this same interval be used for all tests to ensure repeatable test conditions. If a considerable period of time is to elapse between tests and the prover is emptied, then the prover must be re-wetted prior to subsequent testing. The re-wetting operation can be eliminated by allowing the prover to remain full until the next test is to be run.

Making the Tests

Once the prover is wetted, the accuracy tests can begin according to this procedure. Reset the register to zero, and run the required tests through the meter. Typically, a flow meter will be run at several flow rates. Do not exceed the maximum recommended rate of flow for the meter. The difference between the fluid volume as measured in the prover is compared to the reading of the register on the meter. An error calculation is made, expressed as a per cent. The per cent errors at each flow rate are compared to arrive at an overall error percentage. The overall error must fall within certain parameters. In addition, multiple tests at any given flow rate must be repeatable within a certain percentage.

Accuracy test and repeatability requirements vary from jurisdiction to jurisdiction. Consult your local weights and measures officials for guidance on the specific requirements for the area in which the installation is located.

Determining Test Results

Run the meter to deliver a volume of product that corresponds to the prover capacity. Read the volume of product on the calibrated plate on the neck of the prover. This reading will typically be in cubic inches. If so, the percentage error can be readily computed with the following information:

- (a) One gallon equals 231cu.in.
- (b) A 100-gallon prover holds 23,100cu.in. Thus, 23.1cu.in. represents 0.1% error.

The National Institute of Standards and Technology, in its NIST Handbook 44 specifies a tolerance of plus or minus the following:

METER TOLERANCE

Indication of Device	Tolerance		
	Acceptance Test	Maintenance Test	Special Test
Wholesale	0.20%	0.30%	0.50%
Vehicle	0.15%	0.30%	0.45%

Acceptance tolerances apply to new meters and repaired meters after reconditioning. Maintenance tolerances apply to meters retested after being in service. Special tolerances are applied at low flow rates and also for tests of the system air eliminator (See Product Depletion Test below).

Some US and most international jurisdictions have their own test requirements and tolerances. It is the responsibility of the end user to contact the proper local authorities and to ensure that the correct test requirements are applied.

Repeatability

NIST Handbook 44 requires that multiple tests conducted at approximately the same flow rate and draft size shall have test results that do not exceed 40% of the absolute value of the maintenance tolerance. Also, the results of each test must be within the applicable tolerance. So for a vehicle meter with a maintenance tolerance of 0.30%, all readings at one flow rate must be within 0.12% (40% of 0.30). All readings at this flow rate must also be within the + or – 0.30%.

Changing Meter Calibration

Refer to page 20 for the procedure to change meter calibration. Any change in the meter calibration adjustment will change the delivery in the same amount for all rates of flow. That is, the calibration curve retains its shape, but is shifted up or down on the y-axis of the graph.

If a meter test indicates satisfactory performance at one flow rate, but is shown to be unsatisfactory at a different flow rate and the overall accuracy is less than twice the required tolerance (2 times +/-0.30% for example), the meter can be adjusted to shift the curve up or down so that the entire error curve fits within the required limits. Small adjustments should be made so as to avoid overshifting the curve so the meter falls out of accuracy in the other direction.

If a meter test indicates satisfactory performance at one flow rate, but is shown to be unsatisfactory at a different flow rate and the overall accuracy is more than twice the required tolerance, changing the calibration will not remedy this condition. Shifting the curve will simply indicate an out of tolerance condition at a different flow rate. In this case, check the minimum flow rate and ensure that the testing is at or above the minimum recommended rate of flow for the meter. If the meter flow rate is within recommended limits, the meter likely requires cleaning or repairs.

Temperature Correction

If the conditions of testing are such that there will be a change of more than a few degrees in the temperature of the liquid between when it passes through the meter and when the prover is read, it will be advisable to make a temperature correction to the prover readings. To do this, it is necessary to install thermowells; to take readings of the temperature of the liquids in the meter and in the prover. Corrections to the indicated volume of both the prover and register readings can be made with National Standard API Tables.

Product Depletion (Split Compartment) Test

The purpose of a product depletion test is to verify the proper operation of air elimination in the event that the metered product storage tank is pumped dry. This test is necessary for meters that may drain a tank completely, such as a vehicle tank meter. Due to the nature of the testing which introduces air into the system, appropriate attire and protection is required. Testing should be conducted with caution.

Multiple-Compartment Test Procedure:

- 1) Begin the test from a compartment (ideally the largest compartment) containing an amount of fluid equal to or less than one-half the nominal capacity of the prover being used. Operate the meter at the normal full flow rate and note when the compartment is empty. There are several methods for determining that the compartment is empty. There may be a significant change in the sound of the pump. There may be visual evidence that the compartment has run dry. The meter register may stop entirely or may begin to register sporadically (pause, resume running, pause, run again, etc.)
- 2) If the meter stops for 10 seconds or more, proceed to step 3. If the meter indication fails to stop entirely for a period of 10 seconds, continue to operate the system for 3 minutes.
- 3) Close the valve from the empty compartment, and if top filling, close the nozzle or valve at the end of the delivery hose. Open the valve from another compartment containing the same product. Carefully open the valve at the end of the delivery hose to avoid product splashing out of the prover due to pockets of vapor or air. The test results may be invalid if product is splashed out of prover.
- 4) Continue the delivery of product at the normal full flow rate until the liquid level in the prover reaches the nominal capacity of the prover.
- 5) Close the delivery nozzle or valve. Stop the meter. Allow any foam to settle, then read the prover sight gauge as quickly as is practical.
- 6) Compare the meter indication with the actual delivered volume in the prover.
7. Calculate the meter error, apply Product Depletion test tolerance, and determine whether or not the meter error is acceptable. For NIST Handbook 44 applications, the Special Test tolerance is applied.

Single Compartment Test Procedure:

The test of single-compartment tanks is easier to accomplish if there is a quick-connect hose coupling between the compartment valve and the pump that supplies product to the meter. If the system does not have quick-connect couplings between the compartment and the meter, an additional source of sufficient product at the test site is required.

Without a quick-connect coupling:

- 1) Begin the test with the tank containing an amount of fuel equal to or less than one-half the nominal capacity of the prover being used. Operate the meter at the normal full flow rate and note when the tank is empty. There are several methods for determining that the tank is empty. There may be significant change in the sound of the pump. There may be visual evidence that the tank has run dry. The meter register may stop entirely or may begin to register sporadically (pause, resume running, pause, run again, etc.)
- 2) If the meter stops for 10 seconds or more, proceed to step 3. If the meter indication fails to stop entirely for a period of 10 seconds, continue to operate the system for 3 minutes.
- 3) Close the tank valve, and if top filling, close the nozzle or valve at the end of the delivery hose. Stop the pump and load sufficient product from the alternate source into the supply tank. Allow the product to stand in the compartment for a brief time to allow entrained vapor or air to escape. Carefully open the valve at the end of the delivery hose to avoid product splashing out of the prover due to pockets of vapor or air. The test results may be invalid if product is splashed out of prover.
- 4) Continue the delivery of product at the normal full flow rate until the liquid level in the prover reaches the nominal capacity of the prover.
- 5) Close the delivery nozzle or valve. Stop the meter. Allow any foam to settle, then read the prover sight gauge as quickly as is practical.
- 6) Compare the meter indication with the actual delivered volume in the prover.
- 7) Calculate the meter error, apply Product Depletion test tolerance, and determine whether or not the meter error is acceptable. For NIST Handbook 44 applications, the Special Test tolerance is applied.

Calibration Procedure

- 1) A valve or nozzle must be at the end of the delivery hose (at the prover).
- 2) Turn on the pump and purge the system of air. Leave the pump on.
- 3) Shut off the valve at the end of the delivery hose and let the system pressurize.
- 4) Wet the prover and empty it, letting it drip for 30 seconds.
- 5) Reset the register on the meter to "0".
- 6) Fill the prover to the line marked "0".
- 7) Record what the register reads. For a 5 Gallon prover, every 1/10 gallon difference between the register and the 5 gallons known to be in the prover equals a +/- 2% inaccuracy. For example, a reading of 4.9 gallons on the register, compared with a 5 gallon prover filled to the "0" line would indicate that the meter is giving away 2% of the product it meters.
- 8) Remove the seal wire and pin that secures the calibrator disc on top of the meter.
- 9) The top disc on the calibrator features a vertical tab with markings to indicate the direction adjustments are made. The tab is marked with a "plus" and a "minus" sign. This indicates "plus" product and "minus" product. By turning the disc in one direction or the other, product delivery will be increased or decreased. In the example above, the meter has over-delivered 2% (5 gallons passed through it in the test, but the meter only registered 4.9 gallons). In this example, the meter would be adjusted to the "minus" side.
- 10) A full revolution of the disc will change the calibration of the meter 3%. In the example above, the disc should be turned 2/3 of one revolution (2%) in the minus direction to end up with less product through the meter.
- 11) Empty the prover and let it drip for 30 seconds.
- 12) Run a second test and make a fine adjustment; and then another test to check your fine adjustment.
- 13) Replace the pin into the disc, and seal it with the seal wire.

NOTE:

- A) If your meter has a mechanical or electronic preset, it should be set high enough so that it doesn't affect the calibration process by stopping a test run prematurely
- B) Only a valve at the prover should be used to control the flow during calibration.

682 SERIES METER CONSTRUCTION

Type	Housing	Internal Hardware	Cups	Seal
SP	Anodized Aluminum	Iron & Stainless Steel	Glass Filled TFE	Viton®
SPA	Anodized Aluminum	Ni-Resist & Stainless Steel	Glass Filled TFE	Viton®
SPD	Ductile Iron	Iron & Stainless Steel	Glass Filled TFE	Viton® & Simriz®
AF	Ductile Iron	Iron & Stainless Steel	Glass Filled TFE	Viton® & Simriz®
SS	316 Stainless Steel	316 Stainless Steel	Glass Filled TFE	Viton® & Simriz®

*Simriz is a registered trademark of Freudenberg-NOK.
Teflon is a registered trademark of Dupont Dow Elastomers, L.L.C.
Viton is a registered trademark of E.I. Dupont de Nemours & Co*

QUICK COMPATIBILITY

Product	Aluminum	Ductile Iron	Stainless Steel	Ni-Resist	Ceramic	Viton	Simriz	Teflon
Acetone	■	■	■	■	■		■	■
Anhydrous Ammonia	■	■	■	■	■		■	■
Avgas	■	■	■	■	■	■	■	■
Bio-Diesel (B100)	■	■	■	■	■	■	■	■
Butane	■	■	■	■		■	■	■
Corn Syrup	■	■	■	■		■	■	■
Diesel Fuel	■	■	■	■	■	■	■	■
Epoxy	■	■	■	■			■	■
Ethanol	■	■	■	■	■	■	■	■
Fuel Oil	■	■	■	■	■	■	■	■
Gasoline	■	■	■	■	■	■	■	■
Glycerin	■	■	■	■	■	■	■	■
Jet Fuel	■	■	■	■	■	■	■	■
Kerosene	■	■	■	■	■	■	■	■
Latex	■		■			■	■	■
Methanol	■	■	■	■	■		■	■
Methyl Ethyl Ketone	■	■	■	■	■		■	■
Molasses	■	■	■	■	■	■	■	■
Naptha	■	■	■	■		■	■	■
Nitrogen Fertilizer	■	■	■	■	■	■	■	■
Nitric Acid (50%)			■		■		■	■
Paraffin	■	■	■	■		■	■	■
Potassium Carbonate		■	■	■		■	■	■
Rosins	■		■			■	■	■
Sodium Chloride			■			■	■	■
Stoddard Solvent	■	■	■	■	■	■	■	■
Tallow	■	■	■	■		■	■	■
Tetrachoroethylene		■	■	■	■	■	■	■
Urea			■		■	■	■	■
Varnish	■		■			■	■	■
Vegetable Oil	■	■	■	■	■	■	■	■
Water, Deionized			■		■	■	■	■
Xylene	■	■	■	■	■	■	■	■

COMPATIBILITY CHART

<i>SOLUTION</i>	<i>VISCOSITY SSU</i>	<i>SPECIFIC GRAVITY</i>	<i>SP</i>	<i>SPA</i>	<i>SPD</i>	<i>AF</i>	<i>SS</i>
0-14-0, N-P-K SOLUTION			U	U	U	E	E
10-10-10, N-P-K SOLUTION			U	U	U	E	E
10-34-0, N-P-K SOLUTION			U	U	U	F	E
11-37-0, N-P-K SOLUTION			U	U	U	E	E
14-7-7, N-P-K SOLUTION			U	U	U	E	E
16-4-4, N-P-K SOLUTION			U	U	U	E	E
20-0-36, N-P-K SOLUTION			U	U	U	E	E
20-10-5, N-P-K SOLUTION			U	U	U	E	E
20-8-8, N-P-K SOLUTION			U	U	U	E	E
3-10-10, N-P-K SOLUTION			U	U	U	E	E
3-10-30, N-P-K SOLUTION			U	U	U	E	E
3-18-18, N-P-K SOLUTION			U	U	U	E	E
3-9-12, N-P-K SOLUTION			U	U	U	G	E
3-9-9, N-P-K SOLUTION			U	U	U	G	E
4-12-12, N-P-K SOLUTION			U	U	U	E	E
4-12-8, N-P-K SOLUTION			U	U	U	G	E
5-15-15, N-P-K SOLUTION			U	U	U	E	E
5-8-12, N-P-K SOLUTION			U	U	U	E	E
6-18-6, N-P-K SOLUTION			U	U	U	E	E
7-12-6, N-P-K SOLUTION			U	U	U	E	E
9-18-9, N-P-K SOLUTION			U	U	U	E	E
AATREX®, HERBICIDE		1.19	U	U	U	E	E
ACETALDEHYDE		0.783	U	U	U	G	E
ACETATE		0.9	U	U	U	G	E
ACETIC ACID	30	1.05	U	U	U	U	G
ACETIC ANHYDRITE		1.09	U	U	U	U	E
ACETONE	30	0.8	U	U	U	G	E
ACETYL CHLORIDE		1.11	U	U	U	G	E
ACRYLIC ACID	40	1.05	U	U	U	G	E
ACRYLIC ADHESIVES			U	U	U	G	E
ACRYLIC EMULSION			U	U	U	G	E
ACRYLIC ESTER			U	U	U	G	E
ACRYLIC RESIN			U	U	U	G	E
ACRYLONITRILE	100	0.8	U	U	U	G	E
ADBLUE			U	U	F	F	E
ADHESIVES			U	U	U	G	G
AIR (LIQUID CRYOGENIC)			U	U	U	U	U
ALCOHOL			U	U	G	G	E
ALCOHOL, ALLYL		0.852	U	U	U	U	E
ALCOHOL, AMYL		0.817	U	U	G	G	E
ALCOHOL, BEER (NOT SANITARY)	32	1.01	U	U	U	U	G
ALCOHOL, BENZYL		1.04	U	U	G	G	E
ALCOHOL, BUTYL		0.8109	U	U	G	G	E
ALCOHOL, DENATURED			U	U	G	G	E
ALCOHOL, DIACETONE		0.94	U	U	G	G	E
ALCOHOL, ETHYL	30	0.816	U	G	E	G	E
ALCOHOL, ETHYLENE		1.115	U	F	E	G	E
ALCOHOL, ISOBUTYL		0.806	U	U	G	G	E
ALCOHOL, ISOPROPYL		0.7863	G	U	G	G	E
ALCOHOL, METHYL	30	0.79	U	U	E	G	E
ALCOHOL, POLYVINYL	5000 - 50000	1.31	U	U	G	G	E

E = Excellent / Recommended
G = Good / Minor Effect
F = Fair / Moderate Effect
U = Not Recommended

This chart is intended as a chemical resistance guide rather than an unconditional rating since many system characteristics influence rate of corrosion and operation of meter; such as solution, viscosity, concentration, temperature, lubricity, presence of solids, pressure and flow rate. Ratings apply to liquids and solutions of commercial purity. Ratings do not imply Weights & Measures or UL conformance. Ratings for food type materials do not imply FDA conformance. Information compiled is based on published data and research performed by Total Control Systems. Total Control Systems cannot warranty, expressed or implied, that the laboratory results would be obtained under actual operating conditions.

COMPATIBILITY CHART

<i>SOLUTION</i>	<i>VISCOSITY SSU</i>	<i>SPECIFIC GRAVITY</i>	<i>SP</i>	<i>SPA</i>	<i>SPD</i>	<i>AF</i>	<i>SS</i>
ALCOHOL, PROPYL		0.804	G	U	G	G	E
ALCOHOL, WHISKEY (<i>NOT SANITARY</i>)	150		U	U	U	U	E
ALCOHOL, WINE (<i>NOT SANITARY</i>)			U	U	U	U	E
ALKALI SOLUTION			U	U	U	G	E
ALKYD RESINS	50000		U	U	U	G	E
ALUMINUM CHLORIDE		2.44	U	U	U	U	U
ALUMINUM HYDROXIDE (10%)		2.42	U	U	U	U	E
ALUMINUM NITRATE			U	U	U	U	E
ALUMINUM SULFATE (50%, 125F)		2.71	U	U	U	U	F
AMINES			U	U	U	G	F
AMMONIA (32%)		0.99	U	U	U	G	E
AMMONIA, ANHYDROUS (NH ₃) (<i>USE TEFLON SEALS & COUNTER EXTENSION</i>)	30	0.70	U	U	U	U	U
AMMONIUM CARBONATE			U	U	U	G	E
AMMONIUM CHLORIDE	50	1.05	U	U	U	U	G
AMMONIUM HYDROXIDE	30	0.99	U	U	U	G	E
AMMONIUM NITRATE		1.73	U	U	U	F	E
AMMONIUM PHOSPHATE	50	1.62	U	U	U	U	F
AMMONIUM SULFATE		1.77	U	U	U	U	G
AMMONIUM SULFIDE			U	U	U	U	U
AMMONIUM SULFITE		1.41	U	U	U	U	U
AMYL ACETATE	30	0.88	U	U	U	G	G
ANILINE	40	1.02	U	U	U	G	E
ANIMAL FAT			U	U	U	G	E
ANITIFREEZE	88	1.10	E	E	E	E	E
ANTIMONY TRICHLORIDE			U	U	U	U	U
APPLE JUICE (<i>NOT SANITARY</i>)		1.06	U	U	U	U	E
AQUA AMMONIA			U	U	U	G	E
AQUA REGIA			U	U	U	U	U
AROMATIC SOLVENTS			U	U	E	E	E
ARSENIC ACID	50	2.0	U	U	U	U	G
ASPHALT (120F - 300F) (<i>USE HEAT EXTENSION & TRIM</i>)	2400 - 12000	1.1 - 1.5	U	U	U	G	E
ASPHALT EMULSION (75F) (<i>WATER BASED MAY CONTAIN CLAY</i>)	155 - 7000	1.0	U	U	U	G	E
AVIATION GASOLINE (AV GAS)	30	0.71	U	E	E	G	E
BACKDRAFT®, HERBICIDE			U	U	U	G	E
BARIUM HYDROXIDE		1.65	U	U	U	G	G
BARIUM NITRATE		3.24	U	U	U	F	E
BARIUM SULFATE			U	U	U	F	E
BARIUM SULFIDE		4.25	U	U	U	F	G
BARRICADE®, INSECTICIDE			U	U	U	E	E
BASAGRAN®, HERBICIDE			U	U	U	E	E
BEER	32	1.0	U	U	U	U	G
BEET SUGAR LIQUIDS			U	U	U	G	E
BENZALDEHYDE	40	1.05	U	U	U	G	E
BENZENE	31	0.90	U	U	U	G	G
BENZOIC ACID		1.27	U	U	U	U	G
BENZOL		1.04	U	U	U	G	G
BENZYL CHLORIDE		1.10	U	U	U	U	F
BICEP®, HERBICIDE			U	U	U	E	E
BIODIESEL FUEL (B100 @ 70F)	38	0.88	E	E	E	E	E

E = Excellent / Recommended
G = Good / Minor Effect
F = Fair / Moderate Effect
U = Not Recommended

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COMPATIBILITY CHART

<i>SOLUTION</i>	<i>VISCOSITY SSU</i>	<i>SPECIFIC GRAVITY</i>	<i>SP</i>	<i>SPA</i>	<i>SPD</i>	<i>AF</i>	<i>SS</i>
BIPHENYL		1.0	U	U	U	G	E
BLEACH SOLUTION			U	U	U	U	U
BORAX	50	1.73	U	U	U	U	G
BOUNDARY®, HERBICIDE			U	U	U	E	E
BRAVO®, FUNGICIDE			U	U	U	G	E
BRINE SOLUTION			U	U	U	F	G
BROADSTRIKE™, HERBICIDE			U	U	U	E	E
BROMINE		3.11	U	U	U	U	U
BUCTRIL®, HERBICIDE			U	U	U	E	E
BUTADIENE (USE VITON OR TEFLON SEALS)	50	0.62	U	U	U	F	E
BUTANE	30	0.60	U	U	U	U	U
BUTANOL	30	0.81	U	U	U	G	E
BUTYL ACETATE	30	0.88	U	U	U	G	E
BUTYL ACRYLATE	50	0.90	U	U	U	U	G
BUTYL CARBITOL		0.95	U	U	U	G	E
BUTYL CELLOSOLVE	50	0.90	U	U	U	G	E
BUTYL PHTHALATE		1.05	U	U	U	G	E
BUTYLENE		0.60	U	U	U	G	E
CALCIUM CHLORIDE	50	1.23	U	U	U	F	G
CALCIUM HYDROXIDE		2.34	U	U	U	G	E
CALCIUM HYPOCHLORITE			U	U	U	U	U
CANE SUGAR LIQUIDS	225 - 5000		U	U	U	G	G
CAMIX®, HERBICIDE			U	U	U	U	G
CARBITOL		0.95	U	U	U	G	G
CARBON DIOXIDE			U	U	U	U	U
CARBON TETRACHLORIDE	30	1.59	U	U	U	F	G
CARMEL (NOT SANITARY)	1950		U	U	U	U	E
CATTLE FEED			U	U	U	G	E
CAUSTIC POTASH			U	U	U	G	E
CAUSTIC SODA (50%, 125F)	150	1.53	U	U	U	G	G
CELLOSOLVE		0.90	U	U	U	G	E
CHLORACETIC ACID		1.58	U	U	U	U	U
CHLORIC ACID			U	U	U	U	U
CHLORINATED SOLVENTS			U	U	U	G	G
CHLORINE			U	U	U	U	U
CHLOROENZENE	30	1.10	U	U	U	G	E
CHLOROETHENE		0.91	U	U	U	G	E
CHLOROFORM		1.49	U	U	U	G	E
CHLOROPRENE		0.96	U	U	U	U	U
CHLOROSULPHONIC ACID		1.76	U	U	U	U	U
CHLOROTHENE			U	U	U	G	E
CHOCOLATE (NOT SANITARY)	50000 -100000		U	U	U	U	E
CHOLINE CHLORIDE			U	U	U	U	G
CHROMIC ACID		2.67	U	U	U	U	U
CHROMIUM SULFATE		1.70	U	U	U	U	G
CIDER (NOT SANITARY)			U	U	U	U	E
CITRIC ACID (30%, 75F)	50	1.54	U	U	U	U	E
CLARITY®, HERBICIDE			U	U	U	E	E
COAL TAR EMULSION	3000 - 8000	1.2	U	U	U	F	G
COBALT NITRATE (COBALTOUS)		1.88	U	U	U	U	G
COCOA BUTTER		0.86	U	U	U	F	E

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F = Fair / Moderate Effect
U = Not Recommended

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COMPATIBILITY CHART

<i>SOLUTION</i>	<i>VISCOSITY SSU</i>	<i>SPECIFIC GRAVITY</i>	<i>SP</i>	<i>SPA</i>	<i>SPD</i>	<i>AF</i>	<i>SS</i>
COMMAND®, HERBICIDE			U	U	U	E	E
COPPER CHLORIDE		3.38	U	U	U	U	U
COPPER CYANIDE			U	U	U	U	U
COPPER NITRATE	50	2.17	U	U	U	U	G
COPPER SULFATE	50	2.28	U	U	U	U	G
CORN EXTRACTIVE, FERMENTED	10000	1.20	U	U	U	G	E
CORN STARCH	150 - 1400	1.20	U	U	U	U	U
CORN SYRUP (<i>NOT SANITARY</i>)	5000 - 500000	1.35	U	U	U	G	E
CORNSWEET (<i>NOT SANITARY</i>)	740	1.35	U	U	U	G	E
COTTONQUICK®, DEFOLIANT			U	U	U	U	E
CRANBERRY JUICE (<i>NOT SANITARY</i>)			U	U	U	U	E
CREOSOTE (COAL TAR)	300	1.08	U	U	U	F	G
CRESYLIC ACID (CRESOL)			U	U	U	U	G
CROP OILS	100	1.04	G	G	E	E	E
CUMENE		0.86	U	U	U	G	E
CUTTING OILS			E	E	E	E	E
CYCLOHEXANE	50	0.78	U	U	U	G	E
CYCLOHEXANOL		0.94	U	U	U	G	E
CYCLOHEXANONE		0.94	U	U	U	G	G
CYCLONE® MAX, HERBICIDE			U	U	U	U	E
DEF®, DEFOLIANT			U	U	U	U	E
DEICING FLUID		1.15	G	G	G	G	G
DETERGENTS		1.20	U	U	U	G	E
DEXTROSE			U	U	U	U	E
DIAZINON, INSECTICIDE			U	U	U	E	E
DIBUTYL PHTHALATE			U	U	U	G	E
DICHLOROBENZENE		1.46	U	U	U	G	G
DICHLOROETHANE		1.26	U	U	U	G	G
DICHLOROPROPENE		1.23	U	U	U	G	E
DIESEL FUEL (LOW SULPHUR)	30 - 100	0.90	E	E	E	E	E
DIETHANOLAMINE		1.10	U	U	U	G	G
DIETHYL SULFATE		1.18	U	U	U	G	G
DIETHYLANILINE		0.96	U	U	U	G	E
DIETHYLBENZENE		0.865	U	U	U	G	G
DIETHYLENE GLYCOL		1.12	U	U	U	G	E
DIISOBUTYL KETONE		0.81	U	U	U	G	E
DIISOCYANATE			U	U	U	F	G
DIISOPROPYL KETONE			U	U	U	G	E
DIMETHYLAMINE		0.69	U	U	U	G	E
DIMETHYLFORMAMIDE		0.95	U	U	U	G	G
DIOCTYL PHTHALATE	320	0.99	U	U	U	G	G
DIPHENYL		1.0	U	U	U	G	G
DIPHENYL OXIDE		1.74	U	U	U	G	E
DIPROPYLENE GLYCOL		1.03	G	G	G	G	G
DIVINYLBENZENE		0.93	U	U	U	G	E
DOUBLEPLAY®, HERBICIDE			U	U	U	E	E
DOW THERM			E	E	E	E	E
DUAL®, HERBICIDE			U	U	U	E	E
DYE			U	U	U	U	E
EDTA			U	U	U	F	G
E-85		0.78	F	G	E	E	E

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COMPATIBILITY CHART

<i>SOLUTION</i>	<i>VISCOSITY SSU</i>	<i>SPECIFIC GRAVITY</i>	<i>SP</i>	<i>SPA</i>	<i>SPD</i>	<i>AF</i>	<i>SS</i>
EMULSION			G	G	G	G	E
ENAMEL			U	U	U	G	E
EPOXY	46500	1.15	U	U	U	G	G
EPOXY RESIN			U	U	U	G	G
EPTAM®, HERBICIDE			U	U	U	E	E
ETHANE		0.45	U	U	U	U	U
ETHANOL	30	0.79	U	G	E	E	E
ETHANOLAMINE		1.02	U	U	U	G	E
ETHER		0.69	U	U	U	G	G
ETHYL ACETATE	30	0.89	U	U	U	G	G
ETHYL ACRYLATE		0.92	U	U	U	U	E
ETHYL HEXANOIC ACID		0.91	U	U	U	U	G
ETHYLAMINE		0.69	U	U	U	F	G
ETHYLBENZENE		0.87	U	U	U	G	E
ETHYLENE CHLORIDE	30	1.26	U	U	U	G	E
ETHYLENE DIAMINE	30	0.90	U	U	U	G	E
ETHYLENE DIBROMIDE		2.17	U	U	U	U	E
ETHYLENE DICHLORIDE	30	1.26	U	U	U	G	E
ETHYLENE GLYCOL	100	1.12	E	E	E	E	E
ETHYLENE OXIDE	30	0.87	U	U	U	U	U
ETHYLENE VINYL ACETATE	7000		U	U	U	U	E
EXTREME®, HERBICIDE			U	U	U	G	E
FATTY ACIDS		0.84	U	U	U	F	E
FERRIC CHLORIDE		2.80	U	U	U	U	U
FERRIC HYDROXIDE		3.40	U	U	U	U	U
FERRIC NITRATE		1.68	U	U	U	U	G
FERRIC SULFATE	50	2.10	U	U	U	U	G
FERROUS CHLORIDE		1.93	U	U	U	U	U
FERROUS SULFATE		1.90	U	U	U	U	G
FINISH HARVEST AID			U	U	U	U	G
FLUORINE			U	U	U	U	U
FLUOSILIC ACID			U	U	U	U	U
FORMALDEHYDE	30	0.82	U	U	U	U	G
FORMIC ACID		1.22	U	U	U	U	F
FREEDOM®, HERBICIDE			U	U	U	E	E
FREON® 11	< 30	1.48	U	U	U	U	U
FREON® 12	< 30	1.31	U	U	U	U	U
FREON® 13			U	U	U	U	U
FREON® 14			U	U	U	U	U
FREON® 21 (USE TEFLON SEALS)	< 30	1.37	U	U	U	U	U
FREON® 22(USE TEFLON SEALS)	< 30	1.12	U	U	U	U	U
FREON® 31 (USE TEFLON SEALS)			U	U	U	U	U
FREON® 112 (USE TEFLON SEALS)	< 30	1.63	U	U	U	U	U
FREON® 113	< 30	1.57	U	U	U	U	U
FREON® 114	< 30	1.46	U	U	U	U	U
FREON® 114B2 (USE TEFLON SEALS)	< 30	2.16	U	U	U	U	U
FREON® 115	< 30	1.29	U	U	U	U	U
FREON® 134A (USE TEFLON SEALS)	< 30	1.21	U	U	U	U	U
FRONTIER®, HERBICIDE			U	U	U	E	E
FUEL OIL #1	34	0.85	E	E	E	E	E
FUEL OIL #2	36	0.87	E	E	E	E	E

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COMPATIBILITY CHART

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FUEL OIL #3		0.9	E	E	E	E	E
FUEL OIL #4	105	0.95	E	E	E	E	E
FUEL OIL #6	2000 – 10000	0.97	E	E	E	E	E
FULTIME®, HERBICIDE	1280	1.16	U	U	U	E	E
FURAN RESIN		0.94	U	U	U	G	E
FURFURAL	50	1.16	U	U	U	G	G
GALAXY®, HERBICIDE			U	U	U	E	E
GASOHOL	30	0.72	F	E	E	E	E
GASOLINE	33	0.75	E	E	E	E	E
GLUCOSE	50000	1.40	U	U	U	G	E
GLUE			U	U	U	G	E
GLYCERIN (GLYCEROL)	5000	1.26	G	G	E	G	E
GLYCOL	50 - 200	1.11	E	E	E	E	E
GLYCOL ESTER			U	G	G	G	E
GLYPHOMAX® PLUS, HERBICIDE			U	U	U	G	G
GRAMOXONE® EXTRA, HERBICIDE			U	U	U	U	E
GRAZON®, HERBICIDE			U	U	U	E	E
GREASE			E	E	E	E	E
GUARDSMAN®, HERBICIDE			U	U	U	E	E
HARNESSE®, HERBICIDE			U	U	U	E	E
HEPTANE	30	0.70	U	U	U	G	E
HEXANE	30	0.66	U	U	U	G	E
HYDROCARBON RESIN			U	U	U	G	E
HYDROCHLORIC ACID			U	U	U	U	U
HYDROGEN PEROXIDE			U	U	U	U	U
INK (CAN BE ABRASIVE)	500 - 50000	1.0 – 1.4	U	U	U	F	G
IODINE		4.98	U	U	U	U	U
ISOBUTYL ACETATE		0.87	U	U	U	G	E
ISOBUTYL KETONE			U	U	U	G	E
ISOCYANATE		1.20	U	U	U	G	E
ISOOCTANE		0.69	G	G	G	G	E
ISOPROPYL ACETATE	30	0.87	U	U	U	G	E
ISOPROPYL ETHER	30	0.72	U	U	U	G	E
JET FUEL	30	0.80	G	E	U	U	E
KEROSENE	34	0.81	E	E	E	E	E
KETCHUP (NOT SANITARY)			U	U	U	U	E
KETONES			U	U	U	G	E
LACQUER	100 - 100000	0.95	U	U	U	G	E
LACTIC ACID		1.20	U	U	U	U	G
LACTOL SPIRITS			G	G	G	G	E
LADDOK®, HERBICIDE			U	U	U	E	E
LANOLIN			U	U	U	G	E
LARD		0.95	U	U	U	G	E
LASSO®, HERBICIDE			U	U	U	E	E
LATEX (CONGEALS & SHEAR SENSITIVE)	15000		U	U	U	G	E
LATEX EMULSIONS (SHEAR SENSITIVE)	10000 - 100000		U	U	U	G	E
LEAD ACETATE		2.50	U	U	U	U	G
LEMON JUICE			U	U	U	U	E
LIBERTY®, HERBICIDE			U	U	U	E	E
LIGNUM SULFONATE	10000	1.20	G	G	G	G	E
LIME WATER		2.34	U	U	U	G	E

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COMPATIBILITY CHART

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LIQUID FEED (CAUSTIC)			U	U	U	U	E
LIQUID FEED (NEUTRAL)			U	U	U	G	E
LIQUIFIED NATURAL GAS (LNG)			U	U	U	U	U
LIQUIFIED PETROLEUM GAS (LPG)	30	0.50	U	U	U	U	U
LORSBAN® 4E, INSECTICIDE			U	U	U	E	E
LUMAX®, HERBICIDE			U	U	U	U	G
MAGNESIUM CHLORIDE		2.32	U	U	U	U	F
MAGNESIUM HYDROXIDE		2.36	U	U	U	G	E
MAGNESIUM NITRATE		1.46	U	U	U	U	G
MAGNESIUM SULFATE	50	1.68	U	U	U	F	G
MALATHION		1.23	U	U	U	E	E
MALEIC ACID		1.59	U	U	U	U	E
MALEIC ANHYDRIDE		1.30	U	U	U	U	G
MANEX®, FUNGICIDE			U	U	U	G	E
MARKSMAN®, HERBICIDE			U	U	U	E	E
MAYONNAISE (<i>NOT SANITARY</i>)	9400		U	U	U	U	E
METHANE			U	U	U	U	U
METHANOL	30	0.79	U	U	E	G	E
METHYL ACETATE		0.92	U	U	U	G	E
METHYL BROMIDE		1.73	U	U	U	F	G
METHYL CELLOSOLVE		0.97	U	U	U	G	E
METHYL CHLORIDE		0.92	U	U	U	U	G
METHYL CHLOROFORM		1.33	U	U	U	G	E
METHYL ETHYL KETONE (MEK)	30	0.82	U	U	U	G	E
METHYL ISOBUTYL KETONE	30	0.80	U	U	U	G	G
METHYL METHACRYLATE	30	0.95	U	U	U	F	E
METHYL PARATHION			U	U	U	E	E
METHYLENE CHLORIDE		0.92	U	U	U	U	G
METHYL-T-BUTYL ETHER (MTBE)	30	0.74	F	G	G	G	E
MICRO-NUTRIENTS (CAUSTIC)			U	U	E	U	E
MICRO-NUTRIENTS (NEUTRAL)			U	G	E	G	E
MINERAL SPIRITS			E	E	E	E	E
MOLASSES (CAUSTIC)	1000 - 100000	1.45	U	U	E	U	E
MOLASSES (NEUTRAL)	1000 - 100000	1.45	U	G	E	G	E
MONOCHLOROACETIC ACID			U	U	U	U	U
MONOCHLOROBENZENE		1.11	U	U	U	G	E
MONOETHANOLAMINE		0.69	U	U	U	G	E
MONOETHYLAMINE		0.69	U	U	U	G	E
MONOMERS			G	G	G	G	E
MURIATIC ACID			U	U	U	U	U
NAPHTHA	30	0.89	E	E	E	E	E
NAPHTHALENE		1.15	U	U	E	G	E
NAPHTHENIC ACID			U	U	U	F	E
NATURAL GASOLINE			U	F	E	E	E
NEOPENTYL GLYCOL		1.07	U	U	U	G	E
NICKEL AMMONIUM SULFATE			U	U	U	U	U
NICKEL CHLORIDE		3.55	U	U	U	U	G
NICKEL NITRATE		2.07	U	U	U	U	G
NICKEL SULFATE		2.0	U	U	U	U	G
NITRIC ACID			U	U	U	U	U
NITROBENZENE	30	1.20	U	U	U	G	E

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COMPATIBILITY CHART

<i>SOLUTION</i>	<i>VISCOSITY SSU</i>	<i>SPECIFIC GRAVITY</i>	<i>SP</i>	<i>SPA</i>	<i>SPD</i>	<i>AF</i>	<i>SS</i>
NITROGEN FERTILIZER (28%, 30% & 32%)	50	0.82	U	U	U	G	E
NONYLPHENOL	160	1.10	U	U	U	U	G
OIL DISTILLATE			E	E	E	E	E
OIL, BUNKER 'C'	2000 - 10000	0.90	E	E	E	E	E
OIL, CASTOR	1500	0.96	E	E	E	E	E
OIL, CHINAWOOD	1425	0.94	E	E	E	E	E
OIL, COCONUT	148	0.93	G	G	F	F	E
OIL, COD LIVER	150	0.93	E	E	E	E	E
OIL, COOKING			G	G	G	G	E
OIL, CORN	150	0.93	G	G	G	G	E
OIL, COTTONSEED	176	0.93	E	E	E	E	E
OIL, CRUDE (SOUR)	56	0.83	U	U	G	G	E
OIL, CRUDE (SWEET)	110	0.86	G	G	G	G	E
OIL, FISH		0.93	G	G	G	G	E
OIL, FURNACE	37	1.1	G	G	G	G	E
OIL, HYDRAULIC			E	E	E	E	E
OIL, LINSEED	500 - 1000	0.95	G	G	G	G	E
OIL, LUBRICATION	200 - 4000	0.88 - 0.94	E	E	E	E	E
OIL, MINERAL	50	1.03	G	G	G	G	E
OIL, OLIVE	200	0.91	G	G	G	G	E
OIL, PALM	500	0.95	G	G	G	G	E
OIL, PEANUT	195	0.92	G	G	G	G	E
OIL, PEAR		0.88	U	U	G	G	E
OIL, PINE		0.94	G	G	G	G	E
OIL, RAPESEED	600	0.92	G	G	G	G	E
OIL, RED		0.90	U	U	G	G	E
OIL, RICUM		0.97	G	G	G	G	E
OIL, ROSIN	1500	1.08	G	G	E	E	E
OIL, SOYA	190	0.91	G	G	G	G	E
OIL, SOYBEAN	350	0.93	E	E	E	E	E
OIL, SUNFLOWER			G	G	G	G	E
OIL, TALL		0.98	U	U	G	G	E
OIL, TRANSFORMER			E	E	E	E	E
OIL, TUNG		0.94	G	G	G	G	E
OIL, VEGETABLE	50	0.95	G	G	G	G	E
OIL, WASTE (<i>CONSULT FACTORY</i>)			U	U	U	U	U
OLEUM SPIRITS		1.84	E	E	E	E	E
OPTILL®, HERBICIDE			U	U	U	E	E
ORANGE JUICE (<i>NOT SANITARY</i>)			U	U	U	U	E
ORTHO DICHLOROBENZENE	30	1.29	U	U	U	G	G
ORTHO XYLENE			U	U	U	G	G
OUTLOOK®, HERBICIDE			U	U	U	G	G
OXALIC ACID			U	U	U	U	U
OXYGEN (LIQUID CRYOGENIC)			U	U	U	U	U
PAINT LATEX ACETATE		0.84	U	U	U	G	E
PAINT LATEX ACRYLIC			U	U	U	G	E
PAINT LATEX VINYL			U	U	U	G	E
PAINT, ENAMEL			U	U	U	G	E
PAINT, LACQUER			U	U	U	G	E
PAINT, OIL BASE			U	U	U	G	E
PARAFFIN (<i>MAY BE HEATED UP TO 300F</i>)		0.90	U	U	U	G	E

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PARAPLEX	17000		U	U	U	G	E
PEANUT BUTTER	10000 - 100000	1.20	U	U	U	U	G
PENTACHLOROPHENOL			U	U	U	G	E
PENTANE	30	0.63	U	U	U	U	U
PERCHLOROETHYLENE	30	1.63	U	U	U	G	E
PETROLEUM ETHER		0.60	F	G	G	G	E
PHENOL		1.07	U	U	U	G	G
PHOSPHORIC ACID (0-85%, 125F)		1.83	U	U	U	U	G
PHOSPHOROUS CHLORIDE			U	U	U	U	U
PHOSPHOROUS TRICHLORIDE			U	U	U	U	U
PHTHALIC ACID		1.59	U	U	U	U	G
PHTHALIC ANHYDRIDE		1.53	U	U	U	U	E
PITCH			G	G	G	G	E
PLASTICIZER (AVOID AIR CONTACT)		1.12	G	G	G	G	E
POAST®, HERBICIDE			U	U	U	E	E
POLYESTER RESIN	150000		U	U	U	G	E
POLYETHYLENE		0.90	U	U	U	G	E
POLYMER	4600		U	U	U	U	G
POLYOL	1500 - 100000		U	U	U	G	E
POLYPHOSPHORIC ACID			U	U	U	U	E
POLYPROPYLENE		0.90	G	G	G	G	E
POLYPROPYLENE GLYCOL (TYPE 4)	4400	1.00	G	G	G	G	E
POLYURETHANE RESIN			U	U	U	G	G
POLYVINYL ACETATE (PVAC)		1.19	U	U	U	G	E
POLYVINYL CHLORIDE (SUSPENSIONS)			U	U	U	G	E
POTASH		2.43	U	U	U	F	G
POTASSIUM BROMIDE			U	U	U	U	G
POTASSIUM CARBONATE (POTASH)			U	U	U	F	G
POTASSIUM HYDRATE		2.04	U	U	U	F	G
POTASSIUM HYDROXIDE		1.52	U	U	U	F	G
POTASSIUM HYPOCHLORITE			U	U	U	U	U
POTASSIUM NITRATE		2.11	U	U	U	G	G
POTASSIUM PHOSPHATE			U	U	U	G	G
POTASSIUM SULFATE		2.66	U	U	U	G	G
POUNCE®, INSECTICIDE			U	U	U	E	E
PREP®, DEFOLIANT			U	U	U	U	E
PRIMEXTRA®, HERBICIDE			U	U	U	E	E
PRINCEP®, HERBICIDE			U	U	U	E	E
PRINTING INK			G	U	U	G	G
PRIST		1.02	U	U	U	U	E
PROPANE, LIQUID (LPG)	25	0.51	U	U	U	U	U
PROPYL ACETATE		0.89	U	U	U	G	G
PROPYLENE (USE VITON SEALS)	227	0.51	U	U	U	U	U
PROPYLENE GLYCOL	300	1.04	G	G	G	G	E
PROPYLENE OXIDE		0.83	U	U	U	U	E
PROWL®, HERBICIDE			U	U	U	E	E
PURSUIT® PLUS, HERBICIDE			U	U	U	E	E
RESIN, PHENOLIC			U	U	U	G	E
RESIN (CAUSTIC)			U	U	U	G	E
RESIN (NEUTRAL)			U	U	U	G	E
ROOFING TAR			U	U	U	G	E

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ROSIN		1.08	U	U	U	G	E
ROUNDUP®, HERBICIDE	31	1.01	U	U	U	E	E
RUBBER SOLVENT			U	U	U	G	E
SALICYLIC ACID		1.44	U	U	U	U	G
SALT BRINE			U	U	U	U	E
SHELLAC			F	G	G	G	E
SHELL-SOL			U	G	G	G	E
SILICONE FLUIDS			G	G	G	G	E
SILVER BROMIDE			U	U	U	U	U
SILVER NITRATE		4.33	U	U	U	U	G
SOAP SOLUTION			U	U	U	F	E
SODA ASH SOLUTION	50	1.55	U	U	U	G	E
SODIUM ACETATE		1.53	U	U	U	F	G
SODIUM ALUMINATE			U	U	U	G	E
SODIUM BICARBONATE (50%)		2.16	U	U	U	F	G
SODIUM BROMIDE		2.18	U	U	U	U	G
SODIUM CARBONATE		1.15	U	U	U	G	E
SODIUM CHLORATE			U	U	U	U	G
SODIUM CHLORIDE	30	2.17	U	U	U	G	G
SODIUM CHROMATE	60	2.72	U	U	U	G	G
SODIUM DICHROMATE		2.52	U	U	U	U	G
SODIUM FLOURIDE		2.56	U	U	U	U	U
SODIUM HYDROXIDE (50%, 125F)	150	1.53	U	U	U	G	G
SODIUM HYPOCHLORITE			U	U	U	U	U
SODIUM METAPHOSPHATE			U	U	U	G	E
SODIUM NITRATE		1.36	U	U	U	G	E
SODIUM PHOSPHATE		1.62	U	U	U	G	G
SODIUM SILICATE (AVOID AIR CONTACT)		1.56	U	U	U	G	E
SODIUM SULFATE		1.46	U	U	U	U	G
SODIUM SULFIDE		1.86	U	U	U	U	G
SODIUM SULFITE			U	U	U	U	G
SODIUM THIOSULFATE		1.23	U	U	U	U	E
SODIUM XYLENE SULFONATE			U	U	U	U	G
SONALAN®, HERBICIDE			U	U	U	E	E
STANNIC CHLORIDE		2.28	U	U	U	U	U
STARCH	100 - 100000	1.50	U	U	U	E	E
STARFIRE®, HERBICIDE			U	U	U	U	E
STEAM CONDENSATE			U	U	U	U	U
STEARIC ACID		0.84	U	U	U	U	E
STODDARD SOLVENT	30	0.78	E	E	E	E	E
STYRENE		0.90	E	E	E	E	E
SUGAR		1.69	U	U	U	G	E
SULFONIC ACID			U	U	U	F	E
SULFUR DIOXIDE			U	U	U	U	G
SULFURIC ACID (0-10% & 90-100%, 125F)	200	1.84	U	U	U	U	G
SULFURIC ACID, FUMING			U	U	U	U	U
SULFUROUS ACID	50	1.03	U	U	U	U	G
SULPHITE LIQUOR	530	1.30	U	U	U	U	G
SUPER BOLL®, DEFOLIANT			U	U	U	U	E
SURFACTANT			U	U	U	E	E
SURPASS®, HERBICIDE			U	U	U	E	E

E = Excellent / Recommended
G = Good / Minor Effect
F = Fair / Moderate Effect
U = Not Recommended

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COMPATIBILITY CHART

<i>SOLUTION</i>	<i>VISCOSITY SSU</i>	<i>SPECIFIC GRAVITY</i>	<i>SP</i>	<i>SPA</i>	<i>SPD</i>	<i>AF</i>	<i>SS</i>
TALLOW		0.86	U	U	U	G	E
TANNIC ACID		1.70	U	U	U	F	G
TAR			G	U	U	G	E
TELONE®, FUMIGANTS		1.21	U	U	U	U	G
TETRA ETHYL LEAD		1.63	U	U	E	E	E
TETRA METHYL LEAD		1.60	U	U	E	E	E
TETRACHLOROETHYLENE		1.59	U	U	U	G	E
TETRAHYDROFURAN	< 30	0.89	U	U	U	G	E
THERMA SEAL			U	U	U	U	U
THIONYL CHLORIDE			U	U	U	U	U
TITANIUM DIOXIDE (ABRASIVE)			U	U	U	U	U
TITANIUM TETRACHLORIDE			U	U	U	U	U
TOLUENE	30	0.87	U	U	U	E	E
TOLUENE DIISOCYANATE	100 - 500	1.22	U	U	U	G	E
TOLUOL		0.87	U	U	U	E	E
TOMATO PUREE (NON SANITARY)			U	U	U	U	G
TOPNOTCH™, HERBICIDE			U	U	U	E	E
TOUCHDOWN®, HERBICIDE			U	U	U	F	E
TOXEPHENE		1.66	U	U	U	U	G
TRANSMISSION FLUID	185	0.87	E	E	E	E	E
TREFLAN, HERBICIDE			U	U	U	E	E
TRIBUTYL PHOSPHATE		0.98	U	U	U	G	E
TRICHLOROACETIC ACID			U	U	U	U	U
TRICHLOROENZENE		1.46	U	U	U	G	G
TRICHLOROETHANE	30	1.22	U	U	U	G	E
TRICHLOROETHYLENE	30	1.44	U	U	U	G	E
TRICRESYL PHOSPHATE		1.16	U	U	U	U	E
TRIETHANOLAMINE	30	1.13	U	U	U	G	E
TRIETHYLAMINE		0.73	U	U	U	G	G
TRIETHYLENE GLYCOL	250	1.13	U	U	U	G	E
TRIFLURALIN			U	U	U	G	E
TRIMETHYLPENTANE		0.69	U	U	U	U	U
TRISODIUM PHOSPHATE		1.62	U	U	U	G	G
TURPENTINE	50	0.87	E	E	E	E	E
UREA		1.34	U	U	U	G	E
URETHANE FOAM			U	U	U	G	G
URETHANE RESIN			U	U	U	G	E
VAPAM®, FUMIGANT	25		U	U	U	G	E
VARNISH	8000	0.90	G	G	G	G	E
VAR SOL	32	0.80	G	G	G	G	E
VEGETABLE SHORTENING	150 - 1500	0.91	U	U	U	F	E
VINEGAR		1.04	U	U	U	U	E
VINYL ACETATE	30	0.93	U	U	U	G	E
VINYL CHLORIDE		0.92	U	U	U	G	E
VINYL TOLUENE		0.89	U	U	U	G	E
WARRIOR®, INSECTICIDE			U	U	U	E	E
WATER, ACID MINE			U	U	U	U	G
WATER, BOILER FEED			U	U	U	U	U
WATER, BRACKISH			U	U	U	U	G
WATER, CITY	8	1.0	U	U	U	U	G
WATER, DEIONIZED	8	1.0	U	U	U	U	G

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G = Good / Minor Effect
F = Fair / Moderate Effect
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COMPATIBILITY CHART

SOLUTION	VISCOSITY SSU	SPECIFIC GRAVITY	SP	SPA	SPD	AF	SS
WATER, DEMINERALIZED		1.0	U	U	U	U	G
WATER, DISTILLED			U	U	U	U	G
WATER, FRESH		1.0	U	U	U	U	G
WATER, HARD			U	U	U	U	G
WATER, METHANOL			U	U	G	U	G
WATER, OILY			U	U	G	U	G
WATER, POTABLE			U	U	U	U	G
WATER, SALT			U	U	U	U	G
WATER, SEA		1.0	U	U	U	U	G
WATER, SOFT			U	U	U	U	G
WATER, TAP			U	U	U	U	G
WAX			G	G	G	G	G
WEEDMASTER®, HERBICIDE			U	U	U	E	E
WHEY			U	U	U	U	E
WHISKEY (NOT SANITARY)	150		U	U	U	U	E
WINE (NOT SANITARY)	30	0.96	U	U	U	U	E
WINDSHEILD WASHER FLUID			U	U	U	U	E
WOOD PRESERVATIVE			U	U	U	G	E
XYLENE	30	0.86	U	U	U	G	E
ZINC CHLORIDE			U	U	U	U	U
ZINC NITRATE		1.96	U	U	U	U	G
ZINC SULFATE		1.96	U	U	U	U	G

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APPROXIMATE WEIGHT

Pounds (Kilograms)		Flow Meter	Register Counter	Preset Counter	Ticket Printer	Mechanical Preset Valve	Electronic Preset Valve	Air Eliminator (Inline)	Air Eliminator & Strainer	Air Eliminator/ High Volume Strainer	Strainer & Cover	Air Check Valve
682- 15	SP	32 (14.5)	12 (5.4)	10 (4.5)	12 (5.4)	7 (3.2)	13 (5.9)	-	12 (5.5)	-	-	-
	SPA	32 (14.5)	12 (5.4)	10 (4.5)	12 (5.4)	7 (3.2)	13 (5.9)	-	12 (5.5)	-	-	-
	SPD	57 (26.0)	12 (5.4)	10 (4.5)	12 (5.4)	16 (7.3)	-	-	27 (12.2)	-	-	-
	AF	57 (26.0)	12 (5.4)	10 (4.5)	12 (5.4)	16 (7.3)	-	-	27 (12.2)	-	-	-
	SS	86 (39.0)	12 (5.4)	10 (4.5)	12 (5.4)	24 (10.9)	-	65 (29.5)	-	-	-	-

E = Excellent / Recommended
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F = Fair / Moderate Effect
U = Not Recommended

This chart is intended as a chemical resistance guide rather than an unconditional rating since many system characteristics influence rate of corrosion and operation of meter; such as solution, viscosity, concentration, temperature, lubricity, presence of solids, pressure and flow rate. Ratings apply to liquids and solutions of commercial purity. Ratings do not imply Weights & Measures or UL conformance. Ratings for food type materials do not imply FDA conformance. Information compiled is based on published data and research performed by Total Control Systems. Total Control Systems cannot warranty, expressed or implied, that the laboratory results would be obtained under actual operating conditions.

METRIC CONVERSION GUIDE

U.S. System to Metric System

Metric System to U.S. Systems

	If You Know	To Find	Multiply By	If You Know	To Find	Multiply By
Length: Base unit is the <i>Meter</i>	mil inch foot yard mile	millimeter millimeter meter meter kilometer	0.0254 25.4 0.3048 0.9144 1.6093	millimeter millimeter meter meter kilometer	mil inch foot yard mile	39.37 0.0394 3.2808 1.0936 0.6214
Area: Base unit is the <i>Square Meter (m²)</i>	inch ² foot ² foot ² yard ² mile ²	centimeter ² centimeter ² meter ² meter ² kilometer ²	6.4516 929.03 0.0929 0.8361 2.590	centimeter ² centimeter ² meter ² meter ² kilometer ²	inch ² foot ² foot ² yard ² mile ²	0.155 0.0011 10.7639 1.1960 0.3861
Mass: Base unit is the <i>Kilogram (kg)</i>	ounce (advp.) Pound Pound short ton (US)	gram kilogram metric ton metric ton	28.3495 0.4536 0.00045 0.9072	gram kilogram metric ton metric ton	ounce (advp.) pound pound short ton (US)	0.03527 2.2046 2204.6 1.1023
Volume/Capacity: Base unit is the <i>Cubic Meter (m³)</i>	inch ³ fluid ounce quart (liquid) gallon (US) gallon (US) gallon (US) gallon (UK) gallon (UK) gallon (UK) foot ³ yard ³ in ³ /lb ft ³ /lb	centimeter ³ centimeter ³ liter liter meter ³ gallon (UK) liter meter ³ meter ³ meter ³ meter ³ m ³ /kg m ³ /kg	16.3871 29.5735 0.9464 3.7854 0.0038 0.8327 4.456 0.00457 0.0283 0.7646 0.000036 0.0624	centimeter ³ centimeter ³ liter liter meter ³ gallon (UK) liter meter ³ meter ³ meter ³ meter ³ m ³ /kg m ³ /kg	inch ³ fluid ounce quart (liquid) gallon (US) gallon (US) gallon (US) gallon (UK) gallon (UK) gallon (UK) foot ³ yard ³ in ³ /lb ft ³ /lb	0.061 0.0338 1.0567 0.2642 264.17 1.20095 0.21997 219.97 35.3147 1.3079 27.680 16.018
Density: Base unit is the <i>Cubic Meter (m³)</i>	lb/ft ³ lb/in ³ lb/gal (US)	kg/m ³ g/cm ³ kg/m ³	16.0185 27.68 119.8264	kg/m ³ g/cm ³ kg/m ³	lb/ft ³ lb/in ³ lb/gal (US)	0.0624 0.03613 0.008345
Pressure: Base unit is the <i>Pascal (P)</i>	Psi Psi in Hg (60°F) in H ₂ O (60°F)	kPa bar kPa kPa	6.8948 0.0689 3.377 0.2488	kPa bar kPa kPa	psi psi in Hg (60°F) in H ₂ O (60°F)	0.145 14.51 0.2961 4.0193
Temperature: Base unit is the <i>Kelvin (K)</i>	in/(in * °F) °F °F	m/(m * °C) °C K	1.8 (°F - 32)/1.8 (°F + 459.67)/1.8	m/(m * °C) °C K	in/(in * °F) °F °F	0.556 1.8°C + 32 1.8k - 459.67
Velocity: Base unit is the <i>Meter per Second (m/s)</i>	in/min ft/s mi/hr	cm/s m/s km/hr	0.0423 0.3048 1.6093	cm/s m/s km/hr	in/min ft/s mi/hr	23.6220 3.2808 0.6214

STRAINER SCREEN SIZE

ASTM Mesh	Size Opening (inches)	Micron Opening
20	0.0331	841
40	0.0165	420
80	0.0070	177
100	0.0059	149
200	0.0029	74

682 ROTARY FLOW METER

Size	Pulse Transmitter	Meter A (Pulse Transmitter mounted to register)		Meter D (Pulse Transmitter mounted in place of register)	
		1/10 th Register	1/1 Register	Direct Meter Mount	
682-15	1:1 Reed Contact	1 pulse/unit	0.1 pulse/unit	N/A	
	10:1 Reed Contact	10 pulses/unit	1 pulse/unit	N/A	
	100:1 Solid State	100 pulses/unit	10 pulses/unit	400 Pulses per US Gallon	105.7 Pulses per Liter

METER A Standard meter assembly with Veeder Root mechanical registration.
 METER B Standard meter assembly less the Veeder Root mechanical registration.
 METER C Meter assembly ready to receive electronic register.
 METER D Direct drive meter assembly with 100:1 pulse transmitter.

GEAR PLATE INFORMATION

TCS STANDARD GEAR PLATES	Units	Registration	Type	Shafts	Ratio:1	Inverse Ratio	Rotation	Verification Test	Tenths Reading	Whole Reading	Gears
V/R 310450-708	US Gallons	1/10		Single	4.000	0.250	CCW	Rotate LEFT 4 times	1.0	10.0	33-66-33-66
V/R 324823-704	US Gallons – Preset	1/10		Double	4.000	0.250	CCW	Rotate LEFT 4 times	1.0	10.0	33-66-33-66
V/R 310450-743	Liters	1/10		Single	1.057	0.946	CCW	Rotate LEFT 4 times	3.8	37.8	38-58-52-36
V/R 324823-207	Liters – Preset	1/10	-	Double	1.057	0.946	CCW	Rotate LEFT 4 times	3.8	37.8	36-40-38
V/R 310450-702	US Gallons	1/100	-	Single	0.400	2.500	CCW	Rotate LEFT 4 times	10.0	100.0	55-44-66-33
V/R 310450-753	11# per US Gallon	1/10	-	Single	0.364	2.750	CCW	Rotate LEFT 4 times	11.0	110.0	43-33-59-28
V/R 310450-754	11# per US Gallon	Whole	-	Single	3.636	0.275	CCW	Rotate LEFT 4 times	1.1	11.0	33-60-33-66
V/R 7.75LBGP	7.75# per US Gallon	1/10	-	Single	0.516	1.937	CCW	Rotate LEFT 4 times	7.7	77.5	28-52-29-80
V/R 326253-600	US Gallons	Whole	-	Single	40.000	0.025	CCW	Rotate LEFT 4 times	0.1	1.0	32-76-19-80-19-34-76
V/R 324823-508	US Gallons – Preset	Whole	-	Double	40.000	0.025	CCW	Rotate LEFT 4 times	0.1	1.0	32-76-19-80-19-34-76
V/R 310450-767	Imperial Gallons	1/10	-	Single	4.804	0.208	CCW	Rotate LEFT 4 times	0.8	8.3	28-60-29-65
V/R 326253-505	Liters	Whole	-	Single	10.567	0.095	CCW	Rotate LEFT 4 times	0.4	3.8	28-57-29-72-33-29-69
V/R 324823-511	Liters – Preset	Whole	-	Double	10.567	0.095	CCW	Rotate LEFT 4 times	0.4	3.8	28-57-29-72-33-29-69
V/R 326253-209	Quarts	1/10	-	Single	1.000	1.000	CCW	Rotate LEFT 4 times	4.0	40.0	42-42-42
V/R 326253-503	Quarts	Whole	-	Single	10.000	0.100	CCW	Rotate LEFT 4 times	0.4	4.0	30-60-30-75-33-32-66
V/R 324823-100	Quarts U/D	1/10	-	Double	1.000	1.000	CCW	Rotate LEFT 4 times	4.0	40.0	42-42-42

GLOSSARY

Acceptance Test: An original test of a new device under carefully controlled conditions and with expert operators, to determine that the device will comply with the accuracy requirements for Weights and Measures approval to be used as a resale device.

Accessories (Auxiliary Equipment): Items used with a measuring device to facilitate the collection and use of information obtained from it (register, pulse output device). Also, items furnished to improve or control meter performance (strainers, air eliminators, valves)

Accumulative: A term applied to indicating elements or recording elements to describe the fact that they are not resettable to a zero indication in normal use.

Accuracy: Freedom from error, usually expressed in percentage.

Accuracy Curve: A graph or plotted curve showing the performance characteristics of a measuring device. The information plotted is the amount of error at the rates of flow between the minimum and maximum rated capacity of the device.

Adjustor: A ratio changing device which is used to obtain agreement between the indicated and/or recorded volume and the actual volume measured. The ratio may be either continuously variable or variable in increments.

Air Eliminator (also Air Release or Vapor Eliminator): A device installed upstream of the measuring device to avoid measuring air or vapor. Air or vapor measured with liquid will result in registering a volume larger than the liquid volume.

Air Separator: A device of the air eliminator type designed to include the capability of separating air or vapor intimately mixed with the liquid. It may include one or more air eliminator mechanisms and usually incorporates a greater volume or other means for achieving separation.

Air (Vapor) Control System: An arrangement of various elements intended to assist the air eliminator – or air separator – by stopping or reducing flow of liquid when air or vapor is detected. These devices may have various trade names.

Ambient Temperature: Literally, this is the temperature of the surroundings. It is usually used to denote the temperature of the atmosphere in a given location at a specific time.

Analog Device: A device in which the indicated quantity is a constantly changing amount, which indicates directly the amount being measured. An example is the pointer on a clock or a continuous motion type indicator. In reading this for the delivered quantity, it may be necessary to estimate the fractional units.

Back Pressure Valve: A device intended to maintain a desired minimum upstream pressure.

Bubble Point: The conditions of temperature and pressure under which a liquid will begin to form vapor.

Calibration: The procedure of setting or bringing a meter or a prover into agreement with an established standard.

Check Valve (Non-return Valve): A device designed to prevent a reversal of flow of liquid.

Clingage: The liquid film that adheres to the inside surface of a container after it has been emptied.

Coefficient of Expansion: A number usually expressed as a decimal that indicates the change of volume per unit of volume per degree of temperature change.

Counter (Register): A device which indicates a quantity related to the volume measured by the meter.

Delivery, Over – Delivery, Under: The terms, over-delivery and under-delivery, are commonly used to indicate the kind of measuring error that is indicated. Over delivery is the same as Under registration. Under delivery is the same as Over registration.

Density, Relative: The relative density (t_1/t_2) of a solid liquid substance is defined as the ratio of the mass of a given volume of the substance at a temperature t_1 to the mass of an equal volume of pure water at a temperature t_2 (this term replaces the normal term “specific gravity”).

Differential Pressure Valve: A device designed to maintain the total pressure in a system at a desired pressure higher than the vapor pressure of the liquid when being metered.

Digital Device: A device in which the indication of the measured quantity changes by finite increments, which may be units, fractions, or decimals.

Digital Signal: Transmitted information that takes the form of a series of individual distinct signals. These are commonly called pulses.

Drainage Time: The drainage time for test measures and provers shall be 10 seconds for a capacity of 10 gallons or less, and 30 seconds for capacities exceeding 10 gallons. This is necessary to achieve uniform clingage film for repeatable test conditions.

Error: The difference between the indicated value and the true value.

Flow Limiting Device (Flow Control): A device installed in the system to prevent the rate of flow through the meter from exceeding the desired maximum flow rate.

Flow Meter: Commonly used to describe a liquid measuring device that indicates the rate of flow in terms of velocity or as units of volume per unit of time.

Flow Range: The minimum and maximum flow rates established by the manufacturer to provide the maximum meter performance and accuracy with long life. If exceeded, accuracy or meter life may be adversely affected.

Flow Rate (Rate of Flow): The rate of flow of liquid expressed in volume or mass units per unit of time.

Gravity, Specific: See Density, Relative.

Laminar Flow: Liquid flow in which the liquid elements travel along relatively straight parallel paths.

Low Vapor Pressure Liquid: A liquid, which at atmospheric pressure and temperature can be maintained in an open system without boiling.

Maintenance Tolerance: A meter accuracy test made at the maximum discharge rate that may be anticipated under the conditions of installation after the initial acceptance testing has been successfully completed.

Master Meter: A meter used as a reference for testing other working meters.

Meniscus: The curved surface at the top of a liquid column.

Non-Return Valve (Check Valve): A device designed to prevent a reversal of flow.

Normal Test: A test made at the maximum discharge rate that may be anticipated under the conditions of installation. (If equipped with an automatic temperature compensator, the meter should be tested with the temperature compensator deactivated.) Any additional test conducted at flow rates down to and including one-half of the sum of the maximum discharge flow rate and the rated minimum discharge flow rate shall be considered normal tests.

Positive Displacement Meter: A meter in which the primary sensing element separates the liquid into measured segments of known volume providing a shaft motion or other signal that can be used for indicating the volume delivered.

Preset Device: An indicating device that can be preset for a desired quantity and which will stop the flow automatically, or provide an output signal when the preselected quantity of liquid has been metered or “delivered”.

Pressure Loss (also Pressure Drop, Loss of Head, Differential Pressure): The difference in pressure between the inlet and outlet of a device while operating.

Prover (Proving Tank): Volumetric Type. A closed or open vessel designed especially for accurate determination of the volume of a liquid delivered into or out of it during a meter run. The volume of liquid is either observed from the liquid level in a gage proving glass or known from previous calibration of a fixed-volume vessel. The volume is greater than ten gallons. See Test Measure.

Recording Element: A device designed to print the volume metered on a ticket, slip, tape, or card.

Reference Standard: A volumetric measure that has been verified to “contain” or to “deliver” a known volume. It is used for establishing the volume of field and working standards.

Register (Counter): A device, which indicates the quantity measured by the meter.

Registration, Over – Registration, Under: The terms, over-registration and under-registration, are commonly used to indicate the kind of measuring error that is experienced. Over-registration indicates the counter is registering a greater volume than is delivered by the meter, and under-registration indicates that the meter is delivering more than is registered on the counter. Over registration is the same as under delivery. Under registration is the same as over delivery.

Repeatability: A measure of the deviation as a series of test results from their mean value, all determinations being carried out under identical conditions.

Special Test: Any test other than a “Normal” test. A special test is defined as a test “to develop the operating characteristics of a liquid measuring device and any special elements and accessories attached to or associated with the device. Special test of a measuring system shall be made at a minimum discharge rate of 20% of the marked maximum discharge rate or at the minimum discharge rate marked on the device, whichever is less.

Split Compartment Test (also Product Depletion Test): A test applied to a truck mounted metering system, which simulates the conditions encountered in actual operation when one truck compartment is emptied during a delivering and the delivery is completed from another compartment.

Strainer (Filter): A device equipped with a porous medium or wire mesh element to prevent particles of foreign material from passing through a meter.

Test Measure: Vessels designed especially for the precision measurement of liquid having verified capacities of 1, 5, or 10 gallons. These are usually certified for accuracy of measurement by the National Bureau of Standards.

Tolerance: The amount of error that will be allowed. It is a plus or minus value.

Torque Load: The rotary power that a meter must provide in order to drive accessory equipment such as counters, printers, etc.

True Value: The theoretically correct amount. In every day use it is represented by the Standard being used for comparison.

Vapor Eliminator (Vapor Release): A device installed upstream of the measuring device to avoid measuring air and/or vapor.

MATERIAL SAFETY DATA SHEET

24 HOUR EMERGENCY ASSISTANCE
(260) 833-3173

GENERAL MSDS ASSISTANCE
(260) 484-0301

CODE: RPS

HAZARD RATING> LEAST-0 SLIGHT-1 MODERATE-2 HIGH-3 EXTREME-4

DR LUBRICANTS, INC.
4611 NEWAYGO ROAD, SUITE D
FORT WAYNE, IN 46808

DATE: 01/21/06
TELEPHONE: (260) 484-0301

SECTION I - PRODUCT IDENTIFICATION

PRODUCT: **RP 1039**

SECTION II - COMPOSITION AND HAZARDOUS INFORMATION*

CHEMICAL NAME	CAS NUMBER	WT. PERCENT IS LESS THAN	OCCUPATIONAL EXPOSURE LIMITS (TLV-TWA) (TLV-STEL)
PETROLEUM HYDROCARBON	64741-65-7	90.0	100MG/M3
PETROLEUM HYDROCARBON	64742-53-6	10.0	5MG/M3

*ITEMS NOT SHOWN ARE NOT LISTED IN THE OSHA - T.S.C.A. HAZARDOUS CHEMICALS LISTING.

SECTION III - PHYSICAL DATA

BOILING RANGE:	NA	VAPOR DENSITY:	NA
ODOR:	PETROLEUM ODOR	EVAPORATION RATE:	NA
APPEARANCE	AMBER LIQUID	SOLUBILITY:	INSOLUBLE
VOLATILE BY WEIGHT:	NA	PRODUCT DENSITY:	0.790
VOLATILE BY VOLUME:	NA		

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLAMMABILITY CLASSIFICATION:	COMBUSTIBLE	FLASH POINT: 150 F (CLEVELAND OPEN CUP)	LEL:NA UEL:NA
DOT:	COMBUSTIBLE LIQUID		
EXTINGUISHING MEDIA:	CARBON DIOXIDE, DRY CHEMICAL, FOAM		

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

UNUSUAL FIRE AND EXPLOSION HAZARDS : DO NOT DIRECT A SOLID STREAM OF WATER ONTO BURNING PRODUCT. THIS MAY CAUSE SPREADING AND INCREASE THE FIRES INTENSITY. COMBUSTION MAY PRODUCE: OXIDES OF CARBON, AND INCOMPLETELY BURNED HYDROCARBONS IN THE FORM OF FUMES AND SMOKE.

SPECIAL FIREFIGHTING PROCEDURES: WEAR A SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE.

SECTION V - HEALTH HAZARD DATA

EFFECTS OF OVER EXPOSURE: MAY CAUSE MILD EYE IRRITATION AND REDNESS. PROLONGED OR REPEATED EXPOSURE TO THE SKIN MAY RESULT IN LOSS OF NATURAL OILS ACCOMPANIED BY DRYNESS, CRACKING AND DERMATITIS. INGESTION MAY RESULT IN NAUSEA, DIARRHEA AND GASTRO INTESTINAL IRRITATION. OVEREXPOSURE TO MIST MAY CAUSE UPPER RESPIRATORY TRACT IRRITATION AND DIFFICULTY BREATHING.

MEDICAL CONDITIONS PRONE TO AGGRAVATION BY EXPOSURE: NONE KNOWN.

PRIMARY ROUTE(S) OF ENTRY: DERMAL INHALATION INGESTION.

EMERGENCY AND FIRST AID PROCEDURES: IN CASE OF EYE CONTACT, IMMEDIATELY FLUSH EYES WITH CLEAN WATER FOR AT LEAST 15 MINUTES. IF EYE IRRITATION PERSISTS, CONTACT A PHYSICIAN. IN CASE OF SKIN CONTACT, REMOVE ANY CONTAMINATED CLOTHING AND RINSE SKIN THOROUGHLY WITH WATER FOR AT LEAST 15 MINUTES. IF SKIN IRRITATION PERSISTS, CONTACT A PHYSICIAN. IN CASE OF OVEREXPOSURE TO MIST, REMOVE VICTIM TO FRESH AIR: IF BREATHING IS DIFFICULT ADMINISTER OXYGEN: AND CONTACT A PHYSICIAN IMMEDIATELY. IF PRODUCT IS INGESTED DO NOT INDUCE VOMITING: CONTACT A PHYSICIAN.

SECTION VI - REACTIVITY DATA

STABILITY: THIS PRODUCT IS STABLE UNDER NORMAL STORAGE CONDITIONS.

HAZARDOUS POLYMERIZATION: WILL NOT OCCUR UNDER NORMAL CONDITIONS.

HAZARDOUS DECOMPOSITION PRODUCTS: THERMAL DECOMPOSITION MAY RESULT IN THE FORMATION OF: OXIDES OF CARBON, AND INCOMPLETELY BURNED HYDROCARBONS IN THE FORM OF FUMES AND SMOKE.

CONDITIONS TO AVOID: AVOID CONTACT WITH OPEN FLAME, STORE IN ROOM TEMPERATURE AREA.

INCOMPATIBILITY: AVOID CONTACT WITH STRONG OXIDIZING AND REDUCING AGENTS AND STRONG ALKLI.

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SECTION VII - SPILL OR LEAK PROCEDURES

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STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: FOR SMALL SPILLS: SOAK UP SPILL WITH ABSORBENT MATERIAL. FOR LARGE SPILLS: DIKE SPILL AND PUMP INTO DRUMS FOR PROPER DISPOSAL.

WASTE DISPOSAL METHOD: DISPOSE OF IN ACCORDANCE WITH ALL LOCAL STATE AND FEDERAL REGULATIONS.

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SECTION VIII - SAFE HANDLING AND USE INFORMATION

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RESPIRATORY PROTECTION: NORMALLY NOT REQUIRED, HOWEVER, WHEN THE TLV IS EXCEEDED WEAR THE APPROPRIATE MSHA/NIOSH APPROVED RESPIRATOR.

VENTILATION: PROVIDE ADEQUATE VENTILATION (SUCH AS MECHANICAL OR LOCAL) TO ASSURE TLV IS NOT EXCEEDED.

PROTECTIVE GLOVES: NORMALLY NOT REQUIRED, HOWEVER, IF HANDS ARE FREQUENTLY IN FLUID WEAR OIL AND CHEMICAL IMPERVIOUS GLOVES.

EYE PROTECTION: SAFETY GLASSES REQUIRED FOR NORMAL USAGE, WEAR CHEMICAL GOGGLES WHEN EXCESSIVE SPLASHING MAY OCCUR.

OTHER PROTECTIVE EQUIPMENT: NORMALLY NOT REQUIRED, HOWEVER, WHERE REPEATED CONTACT OCCURS, WEAR IMPERVIOUS CLOTHING AND BOOTS.

HYGIENIC PRACTICES: FOLLOW STANDARD INDUSTRIAL HYGIENE PRACTICES. LAUNDRY ANY CONTAMINATED CLOTHING BEFORE RE-USE.

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SECTION IX - SPECIAL PRECAUTIONS

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PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE: DO NOT STORE IN THE PRESENCE OF HEAT, SPARKS, FLAME OR ANY OTHER SOURCES OF IGNITION. STORE AWAY FROM STRONG OXIDIZING AGENTS. EMPTY DRUMS MAY CONTAIN PRODUCT RESIDUES. ALL SAFETY PRECAUTIONS TAKEN WHEN HANDLING THIS PRODUCT SHOULD ALSO BE TAKEN WHEN HANDLING EMPTY DRUMS AND CONTAINERS.

OTHER PRECAUTIONS: NONE

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SECTION X - HMIS/NFPA RATINGS

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HMIS:HEALTH:1	FLAMMABILITY:2	REACTIVITY:0	PERSONAL PROTECTION:C
NFPA:HEALTH:1	FLAMMABILITY:2	REACTIVITY:0	SPECIFIC HAZARD:

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SECTION XI - OTHER REGULATORY INFORMATION

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DOT HAZARDOUS: NATURAL DESCRIPTION:

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THE INFORMATION CONTAINED HEREIN IS, TO THE BEST OF OUR KNOWLEDGE AND BELIEF, ACCURATE. HOWEVER, SINCE THE CONDITIONS OF HANDLING AND USE ARE BEYOND OUR CONTROL, WE MAKE NO GUARANTEE OF RESULTS, AND ASSUME NO LIABILITY FOR DAMAGES INCURRED BY USE OF THIS MATERIAL. IT IS THE RESPONSIBILITY OF THE USER TO COMPLY WITH ALL APPLICABLE FEDERAL, STATE AND LOCAL LAWS AND REGULATIONS.

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