Eastern Petroleum Supplies Ltd,
New House Farm,
Maldon Road,
Steeple,
Essex,
CM0 7RR, UK

Master Meter Maintenance Manual

Tel + 44 (0) 1621 773292
Fax + 44 (0) 1621 772353
E-Mail sales@easternsupplies.co.uk
Web Site Address: www.easternsupplies.co.uk

Eastern Petroleum Supplies Ltd, New House Farm, Maldon Road, Steeple, Essex, CM0 7RR, UK
Tel + 44 (0) 1621 773292 Fax + 44 (0) 1621 772353 E-Mail sales@easternsupplies.co.uk
Web Site Address: www.easternsupplies.co.uk

Eastern Petroleum Supplies Ltd, New House Farm, Maldon Road, Steeple, Essex, CM0 7RR, UK
Tel + 44 (0) 1621 773292 Fax + 44 (0) 1621 772353 E-Mail sales@easternsupplies.co.uk
Web Site Address: www.easternsupplies.co.uk

Contents

1 Introduction	3
1.1 Warranty	3
1.2 Introduction	3
1.3 Description	3
2 Installation	4
2.1 Principles of operation	4
2.2 Precautions	4
2.3 Installation	5
2.3.1 Aircraft Refueller	5
2.3.2 Dispenser and Hydrant Systems	5
2.3.3 Gantry, Pipeline and Bunkering Meters	5
2.3.4 Road Delivery Tankers	6
2.4 Preset Meters	6
3 Test procedure	7
3.1 Calculation of Results	7
3.1.1 Calculation with temperature compensation	8
3.2 Calibration curve (example)	9
4 Maintenance	10
4.1 Preservation after use	10
4.2 Check Proving of Master Meter	10

Products maybe updated without condition of advanced notice.
We do not undertake liability for use the dates that are modified

Eastern Petroleum Supplies Ltd, New House Farm, Maldon Road, Steeple, Essex, CM0 7RR, UK
Tel + 44 (0) 1621 773292 Fax + 44 (0) 1621 772353 E-Mail sales@easternsupplies.co.uk
Web Site Address: www.easternsupplies.co.uk

Eastern Petroleum Supplies Ltd, New House Farm, Maldon Road, Steeple, Essex, CM0 7RR, UK
Tel + 44 (0) 1621 773292 Fax + 44 (0) 1621 772353 E-Mail sales@easternsupplies.co.uk
Web Site Address: www.easternsupplies.co.uk

1 Introduction

1.1 Warranty

Each device comes with a 1-year warranty, starting from the delivering date.
Such warranty of good operating of the equipments includes our efforts of repairing or replacing, in the shortest time, the parts that fail for defective manufacturing or material during the warranty period, without rights to any refund for damages or other expenses. If a device is going to be transferred in our laboratory for repair, the delivery expenses is at the customer's expense. For any inspection of our qualified personnel related to what stated above, the labour is at our expenses, while the board, lodging and travel expenses are in charge at the customer.
The components furnished and installed, but not produced, by us are covered by the guarantee released by the respective producers.
The warranty ceases if non-original spare parts are used; the warranty ceases too for an improper use or if the operational limits of the device are exceeded.

1.2 Introduction

1. Still now a usual way of proving positive displacement meters is by means of proving tanks, specially designed and built tanks of known capacity. These methods, when carefully conducted by skilled operators, can be accurate, but they lay themselves open to many errors. They are also slow and the equipment is cumbersome.

2. The Master Meter system has been designed to simplify the whole procedure of checking the accuracy of a meter. In many applications this can be done with the meter under test in its normal operating position, and the equipment is easily transportable.

Care is necessary in the use of a Master Meter, but provided the instructions in this manual are followed strictly, the whole operation is very quick and simple.

3. It cannot be emphasized too strongly that with modern meters, repeatability is such, that it should be possible to carry out a number of runs at the same speed and obtain consistent results. On occasion these may be varied by outside influences such as temperature, but the point of this note is to recommend that, if there is a variation in the results of repeated runs at the same speed, all conditions of test and method of operation should be examined very carefully before assuming that the fault lies in the meter under test.

4. No meter, including a Master Meter, is accurate, throughout its speed range, but provided it is consistent, and the variation is known, at any given speed of reading of the Master Meter may be corrected by the application of a factor.
   By using the electronic counter with the linearization of the error curve, the Master Meter error is very near to zero. For the purpose of this manual (+) plus indicates that the reading of the meter under test is greater than the reading of the master meter and (-) minus indicates that the reading of the meter under test is smaller than the reading of the master meter.

Eastern Petroleum Supplies Ltd, New House Farm, Maldon Road, Steeple, Essex, CM0 7RR, UK
Tel + 44 (0) 1621 773292 Fax + 44 (0) 1621 772353 E-Mail sales@easternsupplies.co.uk
Web Site Address: www.easternsupplies.co.uk

1.3 Description

The Master Meter consists of a standard series P.D. Meter (mounted in a Carry Frame, mobile trolley, Road Going Trailer or Skid Base). The direction of flow through the meter is indicated by arrows on the meter manifold. It must be emphasized that the Master Meter, although robust, is a precision instrument and must be properly handled and treated to ensure that it maintains its accuracy.

2 Installation

2.1 Principles of operation

There are four main principles to be observed:

1. Conditions of product, line pressure, rate of flow and temperature must be as near as possible the same as those prevailing in the normal service of the meter under test.
2. The same quantity of test product must pass through both meters.
3. Special care must be taken that neither air nor vapour passes through either meter.
4. As far as possible all conditions must be the same at the end of a proving run as they were at the beginning.

- In general, the performance of all meters varies, with changes in their operating conditions. Trials on these Master Meter have established its characteristics under various conditions of speed, product and pressure, and these are given in the form of factors with each Master Meter. Tests should be made in conditions as near as possible the same as those in which the meter under test is normally used, as the characteristics of other meters under varying condition may not be known.

2.2 Precautions

- The Master Meter must be drained of the product which was left in it for storage, before commencing any test.
- The most common source of error in metering and meter proving is the presence of air or vapour. This may be present in one or more of five forms:
- Air trapped in the meter or connecting pipe-work.
- Air drawn into the system through, for example, a leaking gland on a pump.
- Entrained air in the product.
- Formation of a vortex or cavitations in the product supply.
- Breaking of the product due to sudden drop of pressure caused by change of diameter in the pipe, or restriction of a valve for instance.
- Care must be taken to avoid high points in the pipe-work or hoses as these may easily trap air. Sharp bends are equally undesirable. The whole system must be very Thoroughly purged of air. This is best done by circulating the product. The control valve must be opened very slowly because, if air is present, there is a danger that the meters may race, with consequent damage. Circulating the product also has the advantage of stabilizing the temperature. If the return line is connected to the tank from which the pump is sucking, as would be probable in the case of a refueller, care must be taken to ensure that the discharge is drowned

otherwise the product will become aerated. • It is essential to use a strainer between the pump and the upstream meter, the mesh of the strainer depending on the product.

- Because it is essential that the whole system shall remain full of product at all times, the flow must be controlled downstream of both meters. If this is not done, the velocity of the product will cause it to continue to flow through the meters after the control valve is shut.
  This will give false readings.
- The Master Meter is normally used with two flexible hoses. Even the stiffest flexible hose suffers from dilatation to some extent when pressurized. For this and other reasons it is essential that pressure and other conditions at the end of a proving run should be as nearly as possible the same as they were at the beginning.
- The flow should be available without fluctuations or pulsations

2.3 Installation

2.3.1 Aircraft Refueller

- It is probable that no test rig will be required, the vehicle's own pump, strainer, air separator and hoses being sufficient. The refueller must contain sufficient product to ensure that there is no danger of the pump drain a vortex.
- Connect one of the vehicle's discharge hoses to the Master Meter input hose. Using another hose, connect the Master Meter discharge hose to the refueller fill point. If it is necessary to discharge over the top, take care that the end of the discharge hose is drowned. A control valve must be provided downstream of the Master Meter.

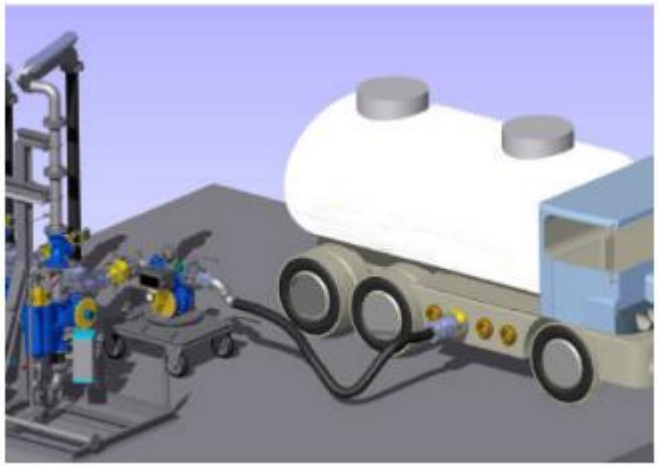
2.3.2 Dispenser and Hydrant Systems

- No pump other that that feeding the hydrant system is required, and the dispenser's strainer and air separator can be used. A large container is necessary in which to discharge the product used during proving and for this a refueller or bridging vehicle will probably be most convenient.
- Some hydrant schemes already incorporate a meter proving off-take close to the tank farm with a return line direct to the tanks.
- Connect the dispenser's discharge hose to the Master Meter input hose. Using another hose, connect the Master Meter discharge hose via the control valve to discharge container.

2.3.3 Gantry, Pipeline and Bunkering Meters

- When a Master Meter is used to test meters installed in conjunction with bulk vehicle overhead filling equipment (e.g. bulk vehicle filling gantries fitted with articulated loading arms) it should be connected via a suitable "T" piece at the base of the loading arm. It is essential that the system incorporating the meter under test and the Master Meter shall be maintained at the same operating pressure as the bulk vehicle filling line under normal operating conditions. In gantries for Bottom Loading(Fig.1), hose to Master Meter has to be connected to the API coupling at the end of the loading arm. Gantry meters are normally of the preset type, and this may entail fitting the check valve assembly downstream of the Master Meter

Eastern Petroleum Supplies Ltd, New House Farm, Maldon Road, Steeple, Essex, CM0 7RR, UK
Tel + 44 (0) 1621 773292 Fax + 44 (0) 1621 772353 E-Mail sales@easternsupplies.co.uk
Web Site Address: www.easternsupplies.co.uk



2.3.4 Road Delivery Tankers

- Much the same applies in this case. In those tankers which normally discharge by gravity, no air separator is necessary provided that the product is allowed to settle.
  Again, a container at a suitable level will be required. Care must be taken to avoid drawing a vortex in the tanker.

ATTENTION: Standby Meters not installed and any meter which cannot be proved in its operating position

Here a simple test rig is necessary. The first requirement is a supply of fuel under pressure. For this it may be possible to arrange an off-take from the normal service of an installation, or it may be necessary to provide a special pump for meter proving. This pump, preferably centrifugal, should have a capacity sufficient to prove the meter up to its maximum rated capacity provided that this is within the maximum rated capacity of the Master Meter, which must not be exceeded.
If it is possible to use a pump on the existing installation it is probable that similar arrangements can be made for a strainer and an air separator, otherwise these two items should also be incorporated in the test rig. Control must be made for the discharge of the test product.
If an existing pump is used, it is most important that the normal working of the installation shall have no effect on the Master Meter test rig. It is essential that there shall be two valve separation throughout between the test rig circuit and the normal installation pipe-work.

2.4 Preset Meters

If the meter under test is fitted with a preset, it is advisable to test it in two stages:

(1) If necessary adjust the preset mechanism to give a precise cut off so that the meter counter indicates exactly the preset quantity. The calibration of the meter under test should in no circumstances be adjusted during this operation.

(2) Install the Master Meter with a valve downstream of it to control the flow. Preset a quantity larger than the test run and proceed as for a normal meter. Some presets incorporate a two stage shut-off valve, with a reduction of speed before the final closure. It is important that the preset quantity should be sufficient to ensure that the test run is Complete before the first stage shut-off comes into operation. Now check the calibration in accordance with a normal test procedure .

Eastern Petroleum Supplies Ltd, New House Farm, Maldon Road, Steeple, Essex, CM0 7RR, UK
Tel + 44 (0) 1621 773292 Fax + 44 (0) 1621 772353 E-Mail sales@easternsupplies.co.uk
Web Site Address: www.easternsupplies.co.uk

It is only possible to test the calibration of these meters by comparing the totalizer reading with the reading of the Master Meter. The throughput necessary to do this will depend upon the accuracy with which the totalizer can be read and upon the accuracy of the test Required, e.g. if the totalizer can only be read to within 1 litre and the result is required to be within 0-1‰ it will be necessary to run 1000 litres. The total throughput divided by the number of individual deliveries will give the quantity of each delivery. From this the accuracy of each delivery can be determined.

The Master Meter is obviously not really suitable for testing repeating preset meters where the amount of each delivery is so small as to make the operation a lengthy and tedious process

3 Test procedure

Drain the Master Meter, install it and throughly purge the whole system of air by circulating the product. It may be necessary to run several hundred liters for this purpose. Check carefully for leaks between the two meters. Now proceed as follows:

1- Stop the flow by shutting the control valve downstream of the meters but allow pumping to continue to maintain pressure.
2- Zeroize both meter counters. Check that there is no creep on the counters.
3- Open the control valve until the desired rate of flow is shown on the Master Meter rate of flow indicator or on the Digital Readout
4- Read and note pressure during each run.
5- Run EXACTLY 1000 litres as shown on the counter of the meter under test, leaving the pump running to maintain line pressure. Check that there is no creep on the counters.
6- Read the Master Meter counter, or if fitted, the units drum assembly to estimate to a smaller part of a unit.(or read on the Digital Readout)

NOTES :- It is essential that the required rate of flow be reached as soon as possible and be maintained for as long as possible. Towards the end of the run, reduce the flow rate smoothly so as to get a precise shut-off. It is advisable to do runs in units of 100 as this makes the calculations of the results easier. The longer the run the more accurate will be resultant reading.

3.1 Calculation of Results

Show two examples in which two meters are tested by two different Master Meters under different conditions of product.
(a)Correct Master Meter reading by the Master Meter error for the speed of the run. This gives the correct Master Meter reading.

Speed of run	1000 l/min	Master Meter A	Master Meter B
Master Meter error	1000 l/min	+0.045%	-0.010%
		A	B
Master Meter reading		1001.32	999.32
Correction		- 0.45	+ 0.10
Corrected Master Meter reading		1000.87	999.42

(b) The Meter error (E) as a percentage is calculated:

Eastern Petroleum Supplies Ltd, New House Farm, Maldon Road, Steeple, Essex, CM0 7RR, UK
Tel + 44 (0) 1621 773292 Fax + 44 (0) 1621 772353 E-Mail sales@easternsupplies.co.uk
Web Site Address: www.easternsupplies.co.uk

$$E\% = \frac{Vi - Vo}{Vo} \times 100$$

with:
Vo = Master Meter reading
Vi = Meter under test readin(c) The meter errors of our example are:

A

$$E(A) = \frac{1000 - 1000{,}87}{1000{,}87} \times 100 = -0{,}087\%$$

B

$$E(A) = \frac{1000 - 999{,}42}{999{,}42} \times 100 = -0{,}087\%$$

3.1.1 Calculation with temperature compensation

Example:

Master Meter
Fluid : Diesel
Speed of run : 1200litri/min
Density at (15°C) : 850 Kg/m3
Master Meter error(Error M/M %): 0,1%

Meter under test:
Reading(Vp): 10000litri
Temperature: 18°C
Correction of volume: to get coeff. from a ASTM table=0.9975
Compensation reading at 15°C(Vp15): Vp * coeff. comp. = 10000litri * 0,9975=9975litri

Master Meter
Reading(Vo): 9998litri
Temperature: 19°C
Correction of volume: to get coeff. from a ASTM table=0.9967
Compensation reading at 15°C(Vo15): Vp * coeff. comp. = 9998litri * 0,9967=9965litri

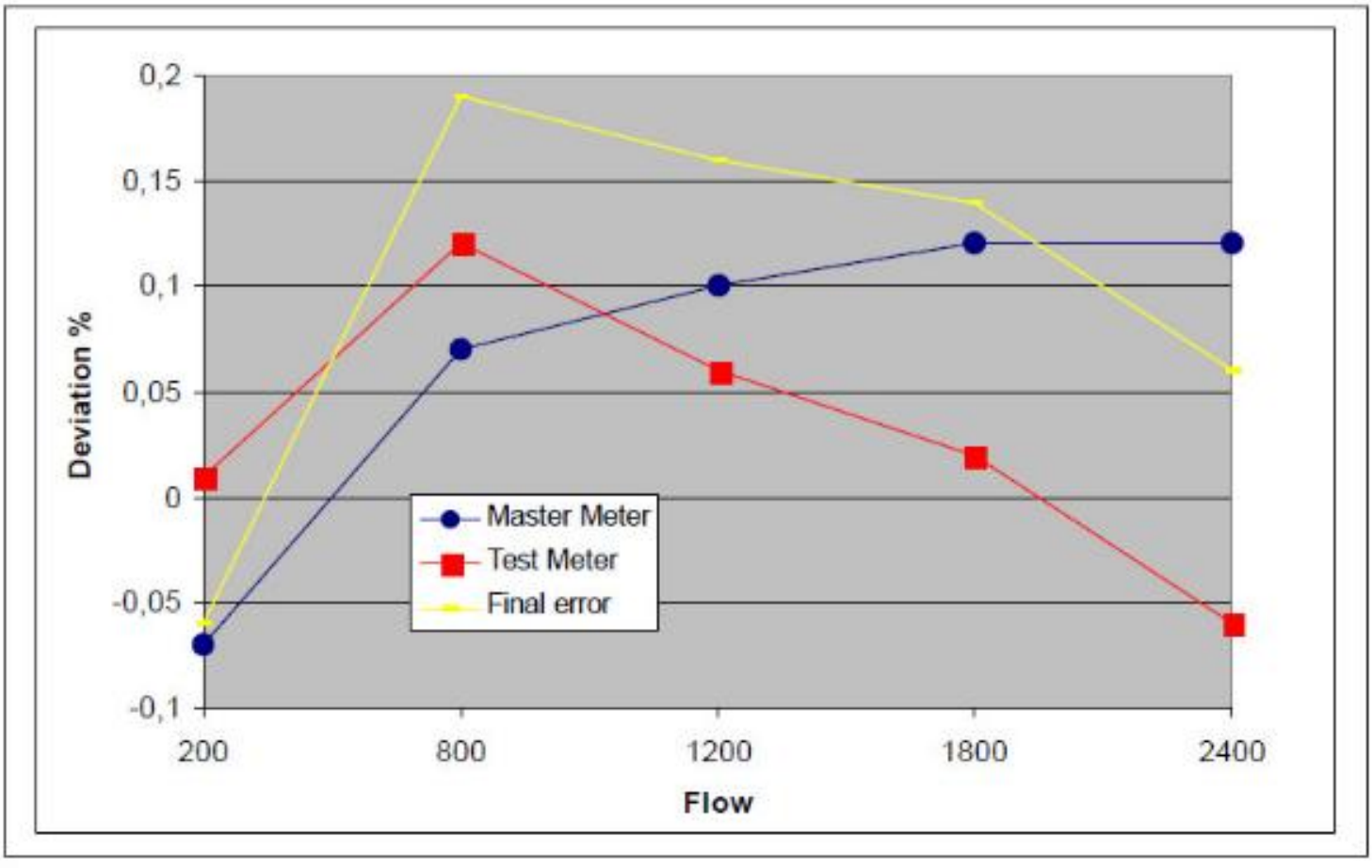
$$Error\% = \frac{Vp15 - Vo15}{Vo15} \times 100 = = (9975 - 9965) / (9965) * 100 = 0{,}1\%$$

Final error Test meter = Error % + Error M/M % = (0,1) + (0,1)% = 0,2

Eastern Petroleum Supplies Ltd, New House Farm, Maldon Road, Steeple, Essex, CM0 7RR, UK
Tel + 44 (0) 1621 773292 Fax + 44 (0) 1621 772353 E-Mail sales@easternsupplies.co.uk
Web Site Address: www.easternsupplies.co.uk

3.2 Calibration curve (example)

Flow	Deviation %		
	Master Meter	Test Meter	Final Error
200	-0,07	0,01	-0,06
800	0,07	0,12	0,19
1200	0,1	0,06	0,16
1800	0,12	0,02	0,14
2400	0,12	-0,06	0,06



Eastern Petroleum Supplies Ltd, New House Farm, Maldon Road, Steeple, Essex, CM0 7RR, UK
Tel + 44 (0) 1621 773292 Fax + 44 (0) 1621 772353 E-Mail sales@easternsupplies.co.uk
Web Site Address: www.easternsupplies.co.uk

4 Maintenance

4.1 Preservation after use

- This section deals with matter special to the Master Meter. For routine maintenance and overhaul of the meter, The P.D. Meter manual should be consulted. The most important matter requiring attention is the thorough cleanliness of the meter, and the prevention of any corrosion.
- After use the meter should be emptied. To this prepare drip trays and then disconnect the hoses from the proving rig, first having drained the entire system as much as possible.
  Now open the valve on the drain line hose in a suitable container and pump out all the product.
- If the meter has been used on a black oil, it should be thoroughly washed out with Kerosene.

Proceed as follows:
With the meter inverted support both inlet and outlet hoses at as high a level as possible. Insert a funnel in the inlet hose and gradually pour in Kerosene until it appears in the outlet hose. Now pump the meter out as before. Continue until all the proving product has been removed.

It is advisable that the meter capsule itself should be left full of clean kerosene when the Meter is not being used. This should be circulated by an hand pump once a month. To avoid contamination, care must be taken to drain this before starting a new test.

4.2 Check Proving of Master Meter

Experience has shown that even after many millions of litres have been passed, the accuracy and calibration factors of these meters do not vary appreciably. Nevertheless, as the Master Meter may have suffered mechanical damage or neglect it is essential that it should be check tested from time to time. Where convenient this may be carried out in the proving rig at the manufacturer's works or whenever is possible