Department for
Business, Energy
& Industrial Strategy

Office for Product
Safety & Standards

GUIDANCE NOTE FOR RETAIL FUEL DISPENSERS (PETROL PUMPS) AND ROAD TANKER MOUNTED METER MEASURING SYSTEMS FITTED WITH STANDARD TEMPERATURE ACCOUNTING (STA) DISPLAYS:

ADVICE FOR RETAILERS, MANUFACTURERS, LOCAL AUTHORITY TRADING STANDARDS OFFICERS AND APPROVED VERIFIERS

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Contents

1 Background

Under the Weights and Measures Act 1985 (and the Units of Measurement Directive transposed by the Units of Measurement Regulations 1986 (SI 1986/1082) as amended), the litre is expressed as a dimensional quantity and is equal to 1 cubic decimetre. The quantity is not defined at any specified temperature. The temperature of the liquid fuel dispensed can vary due to the influence of various factors, for example the temperature of the underground or lorry mounted storage tanks, the temperature of the fuel delivered from the refineries, and the temperature of the equipment itself. The legal tolerances for the equipment (the maximum permissible errors) have been agreed at national, European, and International levels. The magnitude of tolerance is chosen to provide an acceptable level of accuracy while providing a similarly acceptable allowance for the uncertainties of the measurement being made (which can include the temperature of the fuel being measured).

For environmental, health and safety and business reasons, the Retail Petroleum industry is obliged to monitor the quantity of fuel in the delivery chain to maintain accurate stock control and to check for potentially damaging leaks in storage tanks. The changes in volume due to the fuel being measured at different temperatures could be addressed by standardising the measured volume at a fixed temperature i.e. 15 °C and taking readings of temperature of the delivered fuel, in tank and at the meter. However, whilst it is not the intention to introduce regulations to prescribe such temperature readings, metrology law permits the use of equipment that corrects physically dispensed volume to a set temperature volume reading. In the petroleum industry a litre at 15 °C is referred to as a “standard litre” and the process of converting the volume in litres at a given temperature is known as “standard temperature accounting” often abbreviated to “STA”. Currently, most fuel metering systems deliver a litre of fuel by volume with no reference to temperature.

Will the consumer lose out by using equipment which has the STA function enabled?

With equipment that does not have the STA function or does not have the STA function enabled (i.e. traditional) there will be a variation in total energy content depending on whether the temperature of the fuel is greater or less than 15 °C. The variation in energy content is dependent upon the change in temperature and the density of the fuel. In any case the dispensed volume must still meet the legal tolerances.

The volume displayed on equipment that has the STA function enabled is converted to a reference temperature of 15 °C. The temperature converted volume of fuel dispensed must meet the legal tolerances.

2 Advice for retail forecourt operators and fuel oil delivery companies

Equipment may incorporate standard temperature accounting, STA, such that the volume display is converted to 15 °C. This type of display on equipment is legal although it is important to note that it is NOT mandatory under UK legislation – it is optional.

However, equipment that is verified with the STA function enabled should remain STA enabled throughout the whole year to avoid consistently favouring either the seller or the buyer, even if the equipment has been appropriately re-verified. Alternatively if the STA function is disabled then it should remain STA disabled for the same reason. Switching the STA function ‘on and off’ throughout the year to gain a commercial advantage from seasonal changes in fuel temperature is considered by Trading Standards to be an offence under consumer and business protection legislation.

On a retail forecourt, there is no legal metrological requirement that would prevent STA from being enabled on one dispenser and not on another, providing that the correct markings are shown on the dispenser.

3 Advice for equipment manufacturers

Approval of equipment incorporating a display with STA is permitted under current legislation which implements the Measuring Instruments Directive 2014/32/EU as implemented by 'The Measuring Instruments Regulations' SI 2016/1153. For equipment approved under previous Weights and Measures legislation, it is possible that a modification to incorporate STA can be made subject to conditions detailed in WM1006 'Guidance on the retrofitting of Automatic Temperature Compensation, ATC, devices on nationally approved fuel dispensers'. All STA equipment must be suitably marked as delivering STA litres.

4 Inspection advice for trading standards officers (TSOs)

For equipment having a display which incorporates standard temperature accounting, it must first be approved. Normally this will be done via a type or design examination. During this process the temperature conversion device of the equipment will be checked and approved. Therefore there is no need for this device to be checked again during inspections. The equipment should of course conform to type and have the temperature conversion device as approved at type or design examination. You should also check that any software version is either approved in the certificate, such as for a retrofitted device, or is an approved standard configurable feature in a dispenser's software, from a certain version onwards.

One way to test the accuracy of the STA converted volume is to follow the testing procedure given in the Annex of this document.

5 Verification advice for TSOs and approved verifiers

The testing method outlined in section 4 above is suitable for inspection purposes because the testing error is small in relation to the legal tolerances allowed for equipment in-service. For verification purposes, the legal tolerances are sufficiently similar to allow the same method to be used. TSOs and Approved Verifiers are of course free to use an alternative testing method provided it is suitable for the purpose and has a sufficiently small error in relation the legal tolerances for verification.

6 Frequently asked questions

• How will I recognise an STA fuel dispenser?

The legend on the faceplate for the volume indicator will be ‘Litres at 15 °C’ or something similar.

• Can calibration and verification be carried out at the same time?

Bearing in mind that verification of STA equipment should be carried out with the STA facility active it may not be possible on all makes/types of equipment to verify on the basis of the calibration tests. Where calibration has to be carried out with the STA facility disabled then further tests will need to be carried out with the STA enabled for verification purposes.

• Can all types of contents measures be used to test STA forecourt equipment?

All measures can normally be used although some will be better suited and not involve further calculations to establish the result. It is advisable to check with the equipment providers about the suitability of their measures for testing STA dispensers and how the measures would be used in practice.

• Will the STA equipment remain correct if the type of fuel in a storage tank is changed?

If the fuel dispensed from a forecourt dispenser is changed to one with a different density then the STA calculation will be incorrect e.g. petrol to diesel. The STA equipment should be reconfigured with the correct parameters for the new fuel and re-verified (re-qualified) as the change will have affected both the accuracy and function of the measuring system. It would normally be expected that access to reconfigure the equipment for a different fuel is sealed.

On a road tanker mounted meter measuring system, the initial verification should have included the STA correction parameters for all fuels that will be dispensed. If a new fuel is to be carried and metered, the STA equipment should be reconfigured with the correct parameters for the new fuel and re-verified (re-qualified) as the change will have affected both the accuracy and function of the measuring system.

Annex A

Testing procedure for forecourt dispensers

1. Introduction

This document offers guidance on a simple method of testing fuel dispensers with temperature conversion devices which display volume at 15 °C, and uses existing capacity measures which have been calibrated at 20 °C. Other methods may be devised which are equally satisfactory. This method is for verification, re-verification and field inspection; not for type evaluation.

This guidance does not contain sufficient detail to be used as an operator instruction.

The same principle can be applied to larger deliveries of fuel and some data is included in Appendix A for kerosene and gas oil.

This guidance does not address Health and Safety matters which need to be considered before any work is carried out.

2. Equipment

Working standards of capacity (2 L, 5 L, 10 L, and 20 L as necessary)

Metal and epoxy composite contents measure	NMO Specification 7321
Integrated measure	NWML Specification 7323
Measures with a calibrated neck or measurement tube are easier to use for this application rather than ‘strike’ measures	
Thermometer	Accuracy ± 0.2 °C

3. Test method

a. Wet and drain the measure.
b. Deliver the fuel into the measure at the required flowrate.
c. Note the measure reading.
d. Insert the thermometer so that it is supported near the centre of the liquid.
e. Note the fuel dispenser indication of litres at 15 °C.
f. When stable, read the temperature of the fuel in the measure.

g. Correct the measure reading to volume at 15 °C using Appendix A and compare with the fuel dispenser indication of litres at 15 °C. If the result is near the limit of allowable error, carry out a further correction for the measuring can using Appendix B.
h. The reading should be corrected for the thermal expansion of any metal measuring can using Appendix B

An alternative test method could be to determine the temperature of the dispensed fuel and then to calculate what the displayed volume at 15 °C would be for the nominal capacity of that measure with that fuel at that particular temperature.

This calculated figure could then be used as the nominal capacity 'reference point' on that occasion with that fuel.

Appendix A gives an example of these test methods.

4. Temperature conversion data

Appendix A is a table of Temperature Conversion Multipliers which is based on the Petroleum Measurement Tables; as issued by the ASTM, API and IP which have been adopted by ISO 91-1 and OIML R 63; and fuel density data issued by BEIS. For other products and temperatures outside of the range covered by Appendix A the Petroleum Measurement Tables should be used in combination with fuel density data issued by BEIS or direct density measurement.

Density figures have been provided by UKPIA from data gathered throughout 2017 for use in 2018 and issued by BEIS Oil and Gas Statistics.	Average Density to 4 significant figures, at 15 °C.	Density kg/m^3
Petrol - Unleaded Super	**0.7359**	**735.9**
Petrol - Unleaded Premium	**0.7301**	**730.1**
Kerosene - Aviation Turbine	**0.7984**	**798.4**
Marked Kerosene	**0.8011**	**801.1**
Gas Oil & Marine Diesel	**0.8542**	**854.2**
Automotive Diesel (sulphur free)	**0.8377**	**837.7**

These figures are issued annually by BEIS, normally in December.

The Office for Product Safety and Standards will update this guidance when necessary.

Temperature of the fuel is the most significant factor and has a much greater effect than the expected density changes and the temperature effect on the measuring can. For example, the following changes cause the following change in volume:

Change	Size of Change	Volume effect on 20L
Temperature of fuel	2 °C	48 mL
Temperature of measure	2 °C	1.9 mL
Fuel density	2 kg/m^3	1 mL

5. Temperature correction of measuring can

Appendix B details the change in volume for the temperature of the measuring can where the measure has been calibrated at 20 °C. This is small compared to the temperature effect on the fuel. It can also be shown that the temperature of the fuel is much more significant than the temperature of the material of the test measure and that the two will fairly quickly stabilise near the fuel temperature.

Note: The tolerance on the test measure calibration is 1 mL / Litre. Therefore a 20 L measure has a calibration maximum permissible error of + 20 mL.

Example:

A 20 L stainless steel measuring can, calibrated at 20 °C, is used to measure fuel at 12 °C. Assuming the can and fuel have stabilised at 12 °C (T °C), the measuring can has shrunk and will appear to contain more than if it were at 20 °C.

From Appendix B the change in volume for T °C = 12 is -7.7 mL

If the measure appeared to contain exactly 20 L the corrected volume is:

20,000 mL - 7.7 mL = 19,992.3 mL

Tip:

A 20 L stainless steel measuring can will change approximately 1 mL for 1 °C change from its calibration temperature of 20 °C.

If its temperature is LESS than 20 °C – SUBRACT 1 mL for each degree C under 20 °C from the apparent quantity in the measuring can.

If its temperature is MORE than 20 °C – ADD 1 mL for each degree C over 20 °C to the apparent quantity in the measuring can.

Other sizes will change proportionately e.g. a 10 L stainless steel measuring can will change approximately 0.5 mL for 1 °C change from its calibration temperature of 20 °C.

Annex B

Testing procedure for road tanker mounted meter measuring systems

1. The recommended methodology for testing a temperature compensating system is to test the system for accuracy when not temperature compensating, then to switch on the compensating mode and conduct a further two test runs on each fuel to ensure the quantity delivered is correctly converted. For this method, test runs of 1000 litres will simplify the mathematics.

2. Temperature correction calculations may be made to the Reference Meter reading, and the test sheet provided as Appendix C may be used.

   The Temperature Conversion Multipliers from Appendix A may be used, and the corrected reference meter reading directly entered in the test sheet (Appendix C) in the box ‘Ref. Meter reading compensated to 15 °C.

3. The coefficient of cubical thermal expansion of the reference meter is believed to be in the order of 0.00002 litre /°C at most. This would make a difference in any calculations of 0.02 litres /°C for a test run of 1000 litres, and may be considered to be sufficiently small to be ignored.

Appendix A

Temperature compensation multipliers[1]

Use the multiplier in the table below to convert fuel at the temperature listed in the left column to volume at 15 °C

Example:

a) A measuring can contains 20.15 L of Unleaded Premium and its temperature is 11 °C. From the table below for 11 °C the multiplier in the Unleaded Premium column is 1.0050. The equivalent volume at 15 °C is:

20.15 L x 1.0050 = 20.25075 L at 15 °C

A temperature compensated fuel dispenser which delivered the 20.15 L into the measure should indicate 20.25 L at 15 °C subject to indicator limitations and allowable errors and appropriate rounding.

b) An alternative methodology could be to calculate from the table that the equivalent volume at 15 °C for 20.00 L of Unleaded Premium at 11 °C is:

20.00 L x 1.0050 = 20.1 L at 15 °C

Thus, if the measuring can contained 20.00 L at 11 °C, the temperature compensated fuel dispenser should indicate 20.1 L at 15 °C.

This value of 20.1 L can then be used as a reference point so that:-

If 20.15 L of Unleaded Premium was delivered at 11 °C:

0.15 L at 11 °C corrects to 0.15 x 1.0050 = 0.15075 at 15 °C

The temperature compensated fuel dispenser should therefore indicate:

20.1 + 0.15075 = 20.25075 L at 15 °C.

This alternative methodology could be used to determine the value of the excess and deficiency tolerance band on a 20 L delivery at 11 °C as it would be indicated by the temperature compensated fuel dispenser at 15 °C

Again, this is subject to indicator limitations, allowable errors and appropriate rounding.

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[1] The temperature correction factors are based on information subject to copyright from the API Manual of Petroleum Measurement Standards Chapter 11. API, ASTM, and EI (was IP) rights are acknowledged.

Temp °C	Unleaded super	Unleaded premium	Aviation Turbine kerosene	Marked Kerosene	Gas Oil & Marine Diesel	Automotive Diesel
0	1.0184	1.0187	1.0139	1.0138	1.0123	1.0127
0.2	1.0182	1.0184	1.0137	1.0137	1.0122	1.0125
0.4	1.0179	1.0182	1.0136	1.0135	1.0120	1.0123
0.6	1.0177	1.0179	1.0134	1.0133	1.0118	1.0122
0.8	1.0175	1.0177	1.0132	1.0131	1.0117	1.0120
1	1.0172	1.0174	1.0130	1.0129	1.0115	1.0118
1.2	1.0170	1.0172	1.0128	1.0127	1.0114	1.0116
1.4	1.0167	1.0169	1.0126	1.0126	1.0112	1.0115
1.6	1.0165	1.0167	1.0125	1.0124	1.0110	1.0113
1.8	1.0162	1.0164	1.0123	1.0122	1.0109	1.0111
2	1.0160	1.0162	1.0121	1.0120	1.0107	1.0110
2.2	1.0157	1.0159	1.0119	1.0118	1.0105	1.0108
2.4	1.0155	1.0157	1.0117	1.0116	1.0104	1.0106
2.6	1.0153	1.0154	1.0115	1.0114	1.0102	1.0105
2.8	1.0150	1.0152	1.0113	1.0113	1.0100	1.0103
3	1.0148	1.0149	1.0112	1.0111	1.0099	1.0101
3.2	1.0145	1.0147	1.0110	1.0109	1.0097	1.0100
3.4	1.0143	1.0144	1.0108	1.0107	1.0095	1.0098
3.6	1.0140	1.0142	1.0106	1.0105	1.0094	1.0096
3.8	1.0138	1.0139	1.0104	1.0103	1.0092	1.0095
4	1.0135	1.0137	1.0102	1.0102	1.0091	1.0093
4.2	1.0133	1.0135	1.0100	1.0100	1.0089	1.0091
4.4	1.0130	1.0132	1.0099	1.0098	1.0087	1.0090
4.6	1.0128	1.0130	1.0097	1.0096	1.0086	1.0088
4.8	1.0126	1.0127	1.0095	1.0094	1.0084	1.0086
5	1.0123	1.0125	1.0093	1.0092	1.0082	1.0085
5.2	1.0121	1.0122	1.0091	1.0091	1.0081	1.0083
5.4	1.0118	1.0120	1.0089	1.0089	1.0079	1.0081
5.6	1.0116	1.0117	1.0087	1.0087	1.0077	1.0079
5.8	1.0113	1.0115	1.0086	1.0085	1.0076	1.0078
6	1.0111	1.0112	1.0084	1.0083	1.0074	1.0076

6.2	1.0108	1.0110	1.0082	1.0081	1.0072	1.0074
6.4	1.0106	1.0107	1.0080	1.0079	1.0071	1.0073
6.6	1.0103	1.0105	1.0078	1.0078	1.0069	1.0071
6.8	1.0101	1.0102	1.0076	1.0076	1.0068	1.0069
7	1.0099	1.0100	1.0074	1.0074	1.0066	1.0068
7.2	1.0096	1.0097	1.0073	1.0072	1.0064	1.0066
7.4	1.0094	1.0095	1.0071	1.0070	1.0063	1.0064
7.6	1.0091	1.0092	1.0069	1.0068	1.0061	1.0063
7.8	1.0089	1.0090	1.0067	1.0067	1.0059	1.0061
8	1.0086	1.0087	1.0065	1.0065	1.0058	1.0059
8.2	1.0084	1.0085	1.0063	1.0063	1.0056	1.0058
8.4	1.0081	1.0082	1.0061	1.0061	1.0054	1.0056
8.6	1.0079	1.0080	1.0060	1.0059	1.0053	1.0054
8.8	1.0076	1.0077	1.0058	1.0057	1.0051	1.0052
9	1.0074	1.0075	1.0056	1.0055	1.0049	1.0051
9.2	1.0072	1.0072	1.0054	1.0054	1.0048	1.0049
9.4	1.0069	1.0070	1.0052	1.0052	1.0046	1.0047
9.6	1.0067	1.0067	1.0050	1.0050	1.0045	1.0046
9.8	1.0064	1.0065	1.0048	1.0048	1.0043	1.0044
10	1.0062	1.0062	1.0047	1.0046	1.0041	1.0042
10.2	1.0059	1.0060	1.0045	1.0044	1.0040	1.0041
10.4	1.0057	1.0057	1.0043	1.0043	1.0038	1.0039
10.6	1.0054	1.0055	1.0041	1.0041	1.0036	1.0037
10.8	1.0052	1.0052	1.0039	1.0039	1.0035	1.0036
11	1.0049	1.0050	1.0037	1.0037	1.0033	1.0034
11.2	1.0047	1.0047	1.0035	1.0035	1.0031	1.0032
11.4	1.0044	1.0045	1.0034	1.0033	1.0030	1.0030
11.6	1.0042	1.0042	1.0032	1.0031	1.0028	1.0029
11.8	1.0040	1.0040	1.0030	1.0030	1.0026	1.0027
12	1.0037	1.0037	1.0028	1.0028	1.0025	1.0025
12.2	1.0035	1.0035	1.0026	1.0026	1.0023	1.0024
12.4	1.0032	1.0032	1.0024	1.0024	1.0021	1.0022
12.6	1.0030	1.0030	1.0022	1.0022	1.0020	1.0020

12.8	1.0027	1.0027	1.0021	1.0020	1.0018	1.0019
13	1.0025	1.0025	1.0019	1.0019	1.0017	1.0017
13.2	1.0022	1.0023	1.0017	1.0017	1.0015	1.0015
13.4	1.0020	1.0020	1.0015	1.0015	1.0013	1.0014
13.6	1.0017	1.0018	1.0013	1.0013	1.0012	1.0012
13.8	1.0015	1.0015	1.0011	1.0011	1.0010	1.0010
14	1.0012	1.0013	1.0009	1.0009	1.0008	1.0008
14.2	1.0010	1.0010	1.0007	1.0007	1.0007	1.0007
14.4	1.0007	1.0008	1.0006	1.0006	1.0005	1.0005
14.6	1.0005	1.0005	1.0004	1.0004	1.0003	1.0003
14.8	1.0002	1.0003	1.0002	1.0002	1.0002	1.0002
15	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
15.2	0.9998	0.9997	0.9998	0.9998	0.9998	0.9998
15.4	0.9995	0.9995	0.9996	0.9996	0.9997	0.9997
15.6	0.9993	0.9992	0.9994	0.9994	0.9995	0.9995
15.8	0.9990	0.9990	0.9993	0.9993	0.9993	0.9993
16	0.9988	0.9987	0.9991	0.9991	0.9992	0.9992
16.2	0.9985	0.9985	0.9989	0.9989	0.9990	0.9990
16.4	0.9983	0.9982	0.9987	0.9987	0.9988	0.9988
16.6	0.9980	0.9980	0.9985	0.9985	0.9987	0.9986
16.8	0.9978	0.9977	0.9983	0.9983	0.9985	0.9985
17	0.9975	0.9975	0.9981	0.9981	0.9983	0.9983
17.2	0.9973	0.9972	0.9979	0.9980	0.9982	0.9981
17.4	0.9970	0.9970	0.9978	0.9978	0.9980	0.9980
17.6	0.9968	0.9967	0.9976	0.9976	0.9979	0.9978
17.8	0.9965	0.9965	0.9974	0.9974	0.9977	0.9976
18	0.9963	0.9962	0.9972	0.9972	0.9975	0.9975
18.2	0.9960	0.9960	0.9970	0.9970	0.9974	0.9973
18.4	0.9958	0.9957	0.9968	0.9968	0.9972	0.9971
18.6	0.9955	0.9955	0.9966	0.9967	0.9970	0.9969
18.8	0.9953	0.9952	0.9965	0.9965	0.9969	0.9968
19	0.9950	0.9950	0.9963	0.9963	0.9967	0.9966
19.2	0.9948	0.9947	0.9961	0.9961	0.9965	0.9964

19.4	0.9946	0.9945	0.9959	0.9959	0.9964	0.9963
19.6	0.9943	0.9942	0.9957	0.9957	0.9962	0.9961
19.8	0.9941	0.9940	0.9955	0.9955	0.9960	0.9959
20	0.9938	0.9937	0.9953	0.9954	0.9959	0.9958
20.2	0.9936	0.9935	0.9951	0.9952	0.9957	0.9956
20.4	0.9933	0.9932	0.9950	0.9950	0.9955	0.9954
20.6	0.9931	0.9930	0.9948	0.9948	0.9954	0.9952
20.8	0.9928	0.9927	0.9946	0.9946	0.9952	0.9951
21	0.9926	0.9925	0.9944	0.9944	0.9950	0.9949
21.2	0.9923	0.9922	0.9942	0.9942	0.9949	0.9947
21.4	0.9921	0.9920	0.9940	0.9941	0.9947	0.9946
21.6	0.9918	0.9917	0.9938	0.9939	0.9945	0.9944
21.8	0.9916	0.9915	0.9936	0.9937	0.9944	0.9942
22	0.9913	0.9912	0.9935	0.9935	0.9942	0.9941
22.2	0.9911	0.9910	0.9933	0.9933	0.9940	0.9939
22.4	0.9908	0.9907	0.9931	0.9931	0.9939	0.9937
22.6	0.9906	0.9905	0.9929	0.9929	0.9937	0.9935
22.8	0.9903	0.9902	0.9927	0.9928	0.9935	0.9934
23	0.9901	0.9900	0.9925	0.9926	0.9934	0.9932
23.2	0.9898	0.9897	0.9923	0.9924	0.9932	0.9930
23.4	0.9896	0.9895	0.9921	0.9922	0.9931	0.9929
23.6	0.9893	0.9892	0.9920	0.9920	0.9929	0.9927
23.8	0.9891	0.9890	0.9918	0.9918	0.9927	0.9925
24	0.9888	0.9887	0.9916	0.9916	0.9926	0.9924
24.2	0.9886	0.9885	0.9914	0.9915	0.9924	0.9922
24.4	0.9883	0.9882	0.9912	0.9913	0.9922	0.9920
24.6	0.9881	0.9879	0.9910	0.9911	0.9921	0.9918
24.8	0.9878	0.9877	0.9908	0.9909	0.9919	0.9917
25	0.9876	0.9874	0.9906	0.9907	0.9917	0.9915
25.2	0.9873	0.9872	0.9905	0.9905	0.9916	0.9913
25.4	0.9871	0.9869	0.9903	0.9903	0.9914	0.9912
25.6	0.9868	0.9867	0.9901	0.9902	0.9912	0.9910
25.8	0.9866	0.9864	0.9899	0.9900	0.9911	0.9908

26	0.9864	0.9862	0.9897	0.9898	0.9909	0.9907
26.2	0.9861	0.9859	0.9895	0.9896	0.9907	0.9905
26.4	0.9859	0.9857	0.9893	0.9894	0.9906	0.9903
26.6	0.9856	0.9854	0.9891	0.9892	0.9904	0.9901
26.8	0.9854	0.9852	0.9890	0.9890	0.9902	0.9900
27	0.9851	0.9849	0.9888	0.9888	0.9901	0.9898
27.2	0.9849	0.9847	0.9886	0.9887	0.9899	0.9896
27.4	0.9846	0.9844	0.9884	0.9885	0.9897	0.9895
27.6	0.9844	0.9842	0.9882	0.9883	0.9896	0.9893
27.8	0.9841	0.9839	0.9880	0.9881	0.9894	0.9891
28	0.9839	0.9837	0.9878	0.9879	0.9892	0.9890
28.2	0.9836	0.9834	0.9876	0.9877	0.9891	0.9888
28.4	0.9834	0.9832	0.9875	0.9875	0.9889	0.9886
28.6	0.9831	0.9829	0.9873	0.9874	0.9887	0.9884
28.8	0.9829	0.9827	0.9871	0.9872	0.9886	0.9883
29	0.9826	0.9824	0.9869	0.9870	0.9884	0.9881
29.2	0.9824	0.9821	0.9867	0.9868	0.9882	0.9879
29.4	0.9821	0.9819	0.9865	0.9866	0.9881	0.9878
29.6	0.9819	0.9816	0.9863	0.9864	0.9879	0.9876
29.8	0.9816	0.9814	0.9861	0.9862	0.9877	0.9874
30	0.9814	0.9811	0.9860	0.9860	0.9876	0.9872
30.2	0.9811	0.9809	0.9858	0.9859	0.9874	0.9871
30.4	0.9809	0.9806	0.9856	0.9857	0.9872	0.9869
30.6	0.9806	0.9804	0.9854	0.9855	0.9871	0.9867
30.8	0.9804	0.9801	0.9852	0.9853	0.9869	0.9866
31	0.9801	0.9799	0.9850	0.9851	0.9867	0.9864
31.2	0.9799	0.9796	0.9848	0.9849	0.9866	0.9862
31.4	0.9796	0.9794	0.9846	0.9847	0.9864	0.9860
31.6	0.9794	0.9791	0.9844	0.9846	0.9862	0.9859
31.8	0.9791	0.9789	0.9843	0.9844	0.9861	0.9857
32	0.9789	0.9786	0.9841	0.9842	0.9859	0.9855

Appendix B

Correction for expansion of stainless steel fuel test can per degree C

Note - Cubical coefficient of expansion β[2] varies with actual construction material. This value from NMO Specification 7321 for stainless steel.

Stainless Steel					
T°C[3]	**β**	**2 Litre**	**5 Litre**	**10 Litre**	**20 litre**
		Correction in mL			
0	0.000048	-1.9	-4.8	-9.6	-19.2
1	0.000048	-1.8	-4.6	-9.1	-18.2
2	0.000048	-1.7	-4.3	-8.6	-17.3
3	0.000048	-1.6	-4.1	-8.2	-16.3
4	0.000048	-1.5	-3.8	-7.7	-15.4
5	0.000048	-1.4	-3.6	-7.2	-14.4
6	0.000048	-1.3	-3.4	-6.7	-13.4
7	0.000048	-1.2	-3.1	-6.2	-12.5
8	0.000048	-1.2	-2.9	-5.8	-11.5
9	0.000048	-1.1	-2.6	-5.3	-10.6
10	0.000048	-1.0	-2.4	-4.8	-9.6
11	0.000048	-0.9	-2.2	-4.3	-8.6
12	0.000048	-0.8	-1.9	-3.8	-7.7
13	0.000048	-0.7	-1.7	-3.4	-6.7
14	0.000048	-0.6	-1.4	-2.9	-5.8
15	0.000048	-0.5	-1.2	-2.4	-4.8
16	0.000048	-0.4	-1.0	-1.9	-3.8

[2] The expected symbol for the coefficient of cubic expansion per °C is *'γ'*. In this case *'β'* is used to align with the OIML R 117-2 2014 *Dynamic measuring systems for liquids other than water. Part 2: Metrological controls and performance tests*.

[3] T°C is temperature of fuel and measuring can

17	0.000048	-0.3	-0.7	-1.4	-2.9
18	0.000048	-0.2	-0.5	-1.0	-1.9
19	0.000048	-0.1	-0.2	-0.5	-1.0
20	0.000048	0.0	0.0	0.0	0.0
21	0.000048	0.1	0.2	0.5	1.0
22	0.000048	0.2	0.5	1.0	1.9
23	0.000048	0.3	0.7	1.4	2.9
24	0.000048	0.4	1.0	1.9	3.8
25	0.000048	0.5	1.2	2.4	4.8
26	0.000048	0.6	1.4	2.9	5.8
27	0.000048	0.7	1.7	3.4	6.7
28	0.000048	0.8	1.9	3.8	7.7
29	0.000048	0.9	2.2	4.3	8.6
30	0.000048	1.0	2.4	4.8	9.6
31	0.000048	1.1	2.6	5.3	10.6
32	0.000048	1.2	2.9	5.8	11.5

Carbon fibre epoxy composite has a very low coefficient of expansion, of the order of $1x10^{6}$, and will therefore cause changes of less than 1 mL for the expected range of temperatures. The temperature effect on the test measure can therefore be ignored for carbon fibre measures.

Appendix C

Test sheet for road tanker mounted meter measuring systems

			INSERT FUEL TYPE						
	Temp. of fuel	Reference Meter	Temp. difference from 15°C	Ref. Meter reading compensated to 15°C	Ref. Meter error Correction Factor	Ref. Meter Corrected Reading at 15°C	Meter Under Test Reading	Error	%age Error
	(T)	(RM)	(ΔT)	CR15	(CF)	(CR)	(MUT)	(E)	
	°C	Litres	°C	Litres		Litres	Litres	Litres	%
Test			(15 – T)			(CR15 + (CR15 x CF))		(CR-MUT)	(E/CR) x100
Maximum Flow rate - Wet line									
			INSERT FUEL TYPE						
Maximum Flow rate - Wet line									

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GUIDANCE NOTE FOR RETAIL FUEL DISPENSERS (PETROL PUMPS) AND ROAD TANKER MOUNTED METER MEASURING SYSTEMS FITTED WITH STANDARD TEMPERATURE ACCOUNTING (STA) DISPLAYS:

ADVICE FOR RETAILERS, MANUFACTURERS, LOCAL AUTHORITY TRADING STANDARDS OFFICERS AND APPROVED VERIFIERS

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