Office for Product Safety & Standards

Guidance note for retail fuel dispensers and road tanker mounted meter measuring systems fitted with standard temperature accounting (STA) displays

Advice for retailers, manufacturers, Weights and Measures Inspectors and Approved Verifiers

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Contents

1 Background

Under the Weights and Measures Act 1985 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, such as the temperature of the:

(i) underground, overground or lorry mounted storage tank,
(ii) fuel,
(iii) and the measuring instrument itself.

The measuring instrument's maximum permissible errors provide an acceptable level of accuracy of the quantity of fuel being dispensed, whilst considering uncertainties of measurement, such as the temperature of the fuel being measured.

Whilst the regulations do not prescribe the temperature to which fuel is dispensed, some fuel dispensers do have the ability to correct the volume of the fuel dispensed while considering temperature variables by incorporating the fuels known density and cubical thermal expansion coefficient, so providing a consistent measure irrespective of the influence of temperature fluctuations. The process of this conversion is known as "standard temperature accounting" to 15 ˚C often abbreviated to "STA".

Identification of STA dispensers and tanker delivery systems

Where fuel dispensers and tanker delivery systems are fitted with STA software, a sign will be clearly visible on the display on the instrument stating "@15˚C".

When a delivery is made and STA software is enabled, the consumer will receive a receipt, recording the fuel temperature, volume and @15˚C.

Note that STA function can be enabled and disabled but should only be changed once over the period of one year.

How STA function works

Where the STA function is not available or fitted but not enabled, the quantity of fuel delivered to the consumer will be delivered at ambient temperature. Over the course of a year both the fuel temperature and operating conditions will fluctuate. Whilst this will lead to the consumer receiving the stated quantity (within maximum permissible limits), the quantity of fuel delivered will vary slightly over the course of a year with a fraction more energy in colder weather, or a fraction less energy in warmer weather.

Where the STA function on dispensers and tanker delivery systems is fitted and enabled, the consumer will receive a consistent quantity throughout the year, as the STA software takes into account the temperature fluctuations of both the fuel and the operating conditions by correcting the quantity dispensed to 15˚C.

2 Advice for retail forecourt operators and fuel oil delivery companies

The instruments used may incorporate standard temperature accounting, STA, such that the volume display is converted to 15°C. The instruments must have completed conformity assessment and bear the correct markings. Older equipment must bear the prescribed stamp as passed as fit for use for trade.

If a dispenser display or tanker delivery system ticket is marked as STA enabled (e.g. @ 15°C) then the function must be switched on.

The STA function should remain on for at least a minimum period of 12 months.

The function must *never* be switched on in winter and off in summer to gain a commercial advantage from seasonal changes in fuel temperature. This would be considered by Trading Standards as an unfair practice, which could lead to an offence.

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 clearly shown on the dispenser in relation to its status.

3 Advice for instrument manufacturers

Manufacturers must ensure that the Module B Type Examination Certificate (issued under the Measuring Instruments Regulations 2016) for their instrument includes STA functionality within the certificate, including any supplementary sealing arrangements / tamper evident stickers to prevent tampering.

Older equipment passed for use for trade under previous Weights and Measures legislation can only be modified to incorporate STA if it is permitted under its pattern approval or is retrofitted in accordance with the latest version of WM1006 '*Guidance on the retrofitting of Automatic Temperature Compensation, ATC, devices on nationally approved fuel dispensers*'.

Any instruments that have STA applied and enabled must be suitably and conspicuously marked as delivering litres adjusted to 15 °C close to the volume display with '*@15°C'*.

4 Inspection advice for Weights and Measures Inspectors (WMIs)

An instrument which incorporates standard temperature accounting, must be clearly marked close to the display (or on the printed delivery ticket) that the volume is being corrected to 15°C.

Where there is a clear display to the consumer that the volume is being corrected to 15°C, then the STA function must be enabled.

The instrument should conform to the type examination certificate and feature the temperature conversion device as set out within the certificate. Check the 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.

Test the accuracy of the STA converted volume by following the testing procedure given in the Annex A of this document. The corrected volume should fall within the maximum permissible errors set out within the legislation.

5 Re-qualification advice for WMIs and Approved Verifiers

The instrument should conform to the type examination certificate.

Test the accuracy of the STA converted volume by following the testing procedure given in the Annex A of this document.

The corrected volume should fall within the maximum permissible errors set out within the legislation.

Ensure all supplementary sealing arrangements are in place, as set out in the certificate, before applying the re-qualification mark to the instrument.

If the consumer display / delivery ticket states that the volume is being corrected to 15°C, then check the STA function is enabled.

6 Frequently asked questions

- **How will I recognise an STA enabled fuel dispenser?**

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

- **Can calibration and re-qualification be conducted at the same time?**

The instrument should be calibrated appropriately and the STA enabled before the requalification testing begins. STA should not be disabled/enabled within a 12-month period.

- **Can all types of capacity measure be used to test STA forecourt instrument?**

All working standard capacity measures can be used, including both carbon fibre and metal. Metal capacity measures may require additional calculation as set out within appendix B.

- **Will the STA instrument remain correct if the type of fuel in a storage tank is changed?**

If the fuel dispensed from a forecourt dispenser is changed, then the STA calculation will be incorrect and require reconfiguration with the correct parameters for the new fuel. This will trigger a re-qualification.

On a road tanker mounted meter measuring system, the system will include the STA correction parameters for all fuels that will be dispensed from it. If a brand-new fuel is introduced to the tanker (that has not been carried before) then the density data within the instrument should be reconfigured triggering a re-qualification. STA should not be disabled/enabled within a 12-month period.

- **Can a site operate dispensers without enabling the STA?**

After a 12-month period, if the site no longer wishes to use STA and requests that it is disabled, then any related marking / labelling (Litres at 15°C or similar) should be removed from the display, before the dispenser undergoes re-qualification.

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 corrected 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 can be used for inspections and re-qualifications only.

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 data is included for domestic fuels kerosene and gas oil.

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

2. Equipment needed

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

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

3. Test method

a. Wet and drain the measure.
b. Deliver the set volume of fuel into the measure at the required flowrate.
c. Note the measure reading.
d. Insert the thermometer in the measure 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 and record the temperature of the fuel in the measure.
g. Correct the measure reading to volume at 15 °C using formula in Appendix A.
h. Compare with the fuel dispenser indication of litres at 15 °C. Is the result within the maximum permissible errors for the class of instrument?
i. If result is within 10ml of the maximum limit of error, and a metal measure was used, then apply the additional calculation in Appendix B.
j. Round results to the nearest 10ml (two decimal places for litres).
k. Is the adjusted result within the maximum permissible errors for the class of instrument?

4. Temperature conversion data

Appendix A contains Temperature Conversion Multipliers which are based on fuel density data issued by DESNZ within Table 1.

Table 1: Density values of different fuel types

Density figures have been provided by UKPIA from data gathered throughout 2021 and issued by DESNZ Oil and Gas Statistics.	Average Density to 4 significant figures, at 15°C.	Density kg/m^3	Coefficients of cubical thermal expansion (β) L/°C
Petrol – Super	0.7391	739.1	0.00123
Petrol – Standard	0.7301	730.1	0.00125
Kerosene – Aviation Turbine	0.7987	798.7	0.00093
Kerosene – Marked	0.8005	800.5	0.00093
Diesel – Gas Oil & Marine	0.8448	844.8	0.00084
Diesel – Automotive (sulphur free)	0.8359	835.9	0.00085

NOTE: *These values should continue to be used until this guidance is updated by the Office for Product Safety and Standards.*

Annex B: Testing procedure for road tanker mounted meter measuring systems

1. For new systems undergoing conformity assessment. 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 shall be made to the Reference Meter reading, for tests with temperature correction switched on, using one of the following methods with the test sheet provided in Appendix C.

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

   OR

   b. For the test methodology as described in 1 above for 1000 litres, the volume / temperature correction factor (CT) for insertion in the test sheet, can be taken to be the 'factor' γ (the coefficient of cubical thermal expansion) multiplied by 1000.

      Coefficients of cubical thermal expansion, γ (litres /ºC) for the usual 'bulk fuels' have been determined based on the data set out in Appendix A below as:

      Kerosene 0.00093 litre / °C

      Gas Oil 0.00084 litre / °C

      It can therefore be seen that for kerosene, the volume / temperature correction factor (CT) is 0.93 litres /°C, and for gas oil it is 0.84 litres /°C, for a test run of 1000 litres.
3. The coefficient of cubical thermal expansion of the reference meter is estimated at 0.00002 litre /°C at most. Thus, the effect on a run of 1000 litres would only be 0.02 litres /°C, which is sufficiently small to be ignored.

Appendix A: Temperature compensation multipliers[1]

Use the formula below, (multipliers for each fuel & temperature are overleaf):

Capacity Measurement recorded (L) x Temperature Multiplier = Corrected Measure @ 15°C (L)

Corrected Measure (L) – Instrument Volume Reading (L) = Error (L)

Example: Standard Petrol, 20 Litre delivery, Fuel Temp 18°C

20.04 L **x** 0.9962 **=** 19.963848 L (*Round to nearest 10ml*) so 19.96 L

19.96 L **–** 20.00 L **=** - 0.04 L *or* - 40 ml

MPE of 0.5% on 20 L delivery is +/- 100 ml

Error found is not within 10 ml of MPE, so Appendix B adjustment not necessary.

Alternative method for establishing the error:

Capacity Measure volume at 20°C x Temperature Multiplier = Capacity Measure volume at 15°C

Capacity Measurement recorded (L) - Capacity Measure volume at 20°C = Adjusted Error (L)

Capacity Measure at 15°C + Adjusted Error (L) = Corrected Measure @ 15°C (L)

Corrected Measure @ 15°C (L) – Instrument Volume Reading (L) = Error (L)

Example: Standard Petrol, 20 Litre delivery, Fuel Temp 18°C

Measurement corrected to 15°C

20.00 L **x** 0.9962 **=** 19.924 L (*Round to nearest 10ml*) thus 19.92 L

Adjusted error

20.04 L delivered at 18°C

20.04 L **–** 20.00 **=** 0.04 L

0.04 x 0.9962 = 0.039848 L (*Round to nearest 10ml*) = 0.04 L adjustment

Corrected measure @15°C (L)

19.92 L **+** 0.04 L = 19.96 L

Error (L)

19.96 L **–** 20.00 L **=** - 0.04 L *or* - 40 ml

MPE of 0.5% on 20 L delivery is +/- 100 ml

Error found is not within 10 ml of MPE, so Appendix B adjustment is not necessary.

[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.

Table 2: Multiplier values for different fuels at different temperatures

	Petrol		Kerosene		Diesel	
Temp °C	**Super**	**Standard** (E10)	**Aviation Turbine**	**Marked**	**Gas Oil & Marine**	**Automotive**
0	1.0183	1.0187	1.0139	1.0139	1.0125	1.0127
0.2	1.0181	1.0184	1.0137	1.0137	1.0123	1.0125
0.4	1.0178	1.0182	1.0136	1.0135	1.0122	1.0123
0.6	1.0176	1.0179	1.0134	1.0133	1.0120	1.0121
0.8	1.0173	1.0177	1.0132	1.0131	1.0118	1.0120
1	1.0171	1.0174	1.0130	1.0129	1.0117	1.0118
1.2	1.0169	1.0172	1.0128	1.0128	1.0115	1.0116
1.4	1.0166	1.0169	1.0126	1.0126	1.0114	1.0115
1.6	1.0164	1.0167	1.0124	1.0124	1.0112	1.0113
1.8	1.0161	1.0164	1.0123	1.0122	1.0110	1.0111
2	1.0159	1.0162	1.0121	1.0120	1.0109	1.0110
2.2	1.0156	1.0159	1.0119	1.0118	1.0107	1.0108
2.4	1.0154	1.0157	1.0117	1.0116	1.0105	1.0106
2.6	1.0152	1.0154	1.0115	1.0115	1.0104	1.0105
2.8	1.0149	1.0152	1.0113	1.0113	1.0102	1.0103
3	1.0147	1.0149	1.0111	1.0111	1.0100	1.0101
3.2	1.0144	1.0147	1.0110	1.0109	1.0099	1.0100
3.4	1.0142	1.0144	1.0108	1.0107	1.0097	1.0098
3.6	1.0139	1.0142	1.0106	1.0105	1.0095	1.0096
3.8	1.0137	1.0139	1.0104	1.0104	1.0094	1.0095
4	1.0135	1.0137	1.0102	1.0102	1.0092	1.0093
4.2	1.0132	1.0135	1.0100	1.0100	1.0090	1.0091
4.4	1.0130	1.0132	1.0098	1.0098	1.0089	1.0090
4.6	1.0127	1.0130	1.0097	1.0096	1.0087	1.0088
4.8	1.0125	1.0127	1.0095	1.0094	1.0085	1.0086
5	1.0122	1.0125	1.0093	1.0093	1.0084	1.0084
5.2	1.0120	1.0122	1.0091	1.0091	1.0082	1.0083
5.4	1.0117	1.0120	1.0089	1.0089	1.0080	1.0081
5.6	1.0115	1.0117	1.0087	1.0087	1.0079	1.0079

5.8	1.0113	1.0115	1.0086	1.0085	1.0077	1.0078
6	1.0110	1.0112	1.0084	1.0083	1.0075	1.0076
6.2	1.0108	1.0110	1.0082	1.0081	1.0074	1.0074
6.4	1.0105	1.0107	1.0080	1.0080	1.0072	1.0073
6.6	1.0103	1.0105	1.0078	1.0078	1.0070	1.0071
6.8	1.0100	1.0102	1.0076	1.0076	1.0069	1.0069
7	1.0098	1.0100	1.0074	1.0074	1.0067	1.0068
7.2	1.0095	1.0097	1.0073	1.0072	1.0065	1.0066
7.4	1.0093	1.0095	1.0071	1.0070	1.0064	1.0064
7.6	1.0091	1.0092	1.0069	1.0069	1.0062	1.0063
7.8	1.0088	1.0090	1.0067	1.0067	1.0060	1.0061
8	1.0086	1.0087	1.0065	1.0065	1.0059	1.0059
8.2	1.0083	1.0085	1.0063	1.0063	1.0057	1.0057
8.4	1.0081	1.0082	1.0061	1.0061	1.0055	1.0056
8.6	1.0078	1.0080	1.0060	1.0059	1.0054	1.0054
8.8	1.0076	1.0077	1.0058	1.0057	1.0052	1.0052
9	1.0074	1.0075	1.0056	1.0056	1.0050	1.0051
9.2	1.0071	1.0072	1.0054	1.0054	1.0049	1.0049
9.4	1.0069	1.0070	1.0052	1.0052	1.0047	1.0047
9.6	1.0066	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	1.0061	1.0062	1.0047	1.0046	1.0042	1.0042
10.2	1.0059	1.0060	1.0045	1.0044	1.0040	1.0041
10.4	1.0056	1.0057	1.0043	1.0043	1.0038	1.0039
10.6	1.0054	1.0055	1.0041	1.0041	1.0037	1.0037
10.8	1.0051	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	1.0032	1.0032
11.4	1.0044	1.0045	1.0034	1.0033	1.0030	1.0030
11.6	1.0042	1.0042	1.0032	1.0032	1.0028	1.0029
11.8	1.0039	1.0040	1.0030	1.0030	1.0027	1.0027
12	1.0037	1.0037	1.0028	1.0028	1.0025	1.0025
12.2	1.0034	1.0035	1.0026	1.0026	1.0023	1.0024
12.4	1.0032	1.0032	1.0024	1.0024	1.0022	1.0022

12.6	1.0029	1.0030	1.0022	1.0022	1.0020	1.0020
12.8	1.0027	1.0027	1.0020	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	0.9971	0.9970	0.9978	0.9978	0.9980	0.9980
17.6	0.9968	0.9967	0.9976	0.9976	0.9978	0.9978
17.8	0.9966	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	0.9961	0.9960	0.9970	0.9970	0.9973	0.9973
18.4	0.9958	0.9957	0.9968	0.9968	0.9972	0.9971
18.6	0.9956	0.9955	0.9966	0.9967	0.9970	0.9969
18.8	0.9953	0.9952	0.9965	0.9965	0.9968	0.9968
19	0.9951	0.9950	0.9963	0.9963	0.9966	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	0.9963	0.9963
19.6	0.9943	0.9942	0.9957	0.9957	0.9961	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	0.9958	0.9958
20.2	0.9936	0.9935	0.9951	0.9952	0.9956	0.9956
20.4	0.9934	0.9932	0.9950	0.9950	0.9955	0.9954
20.6	0.9931	0.9930	0.9948	0.9948	0.9953	0.9953
20.8	0.9929	0.9927	0.9946	0.9946	0.9951	0.9951
21	0.9926	0.9925	0.9944	0.9944	0.9950	0.9949
21.2	0.9924	0.9922	0.9942	0.9942	0.9948	0.9947
21.4	0.9921	0.9920	0.9940	0.9941	0.9946	0.9946
21.6	0.9919	0.9917	0.9938	0.9939	0.9945	0.9944
21.8	0.9916	0.9915	0.9937	0.9937	0.9943	0.9942
22	0.9914	0.9912	0.9935	0.9935	0.9941	0.9941
22.2	0.9911	0.9910	0.9933	0.9933	0.9940	0.9939
22.4	0.9909	0.9907	0.9931	0.9931	0.9938	0.9937
22.6	0.9906	0.9905	0.9929	0.9929	0.9936	0.9936
22.8	0.9904	0.9902	0.9927	0.9927	0.9935	0.9934
23	0.9901	0.9900	0.9925	0.9926	0.9933	0.9932
23.2	0.9899	0.9897	0.9923	0.9924	0.9931	0.9930
23.4	0.9897	0.9895	0.9922	0.9922	0.9930	0.9929
23.6	0.9894	0.9892	0.9920	0.9920	0.9928	0.9927
23.8	0.9892	0.9890	0.9918	0.9918	0.9926	0.9925
24	0.9889	0.9887	0.9916	0.9916	0.9924	0.9924
24.2	0.9887	0.9885	0.9914	0.9914	0.9923	0.9922
24.4	0.9884	0.9882	0.9912	0.9913	0.9921	0.9920
24.6	0.9882	0.9879	0.9910	0.9911	0.9919	0.9919
24.8	0.9879	0.9877	0.9908	0.9909	0.9918	0.9917
25	0.9877	0.9874	0.9907	0.9907	0.9916	0.9915
25.2	0.9874	0.9872	0.9905	0.9905	0.9914	0.9913
25.4	0.9872	0.9869	0.9903	0.9903	0.9913	0.9912
25.6	0.9869	0.9867	0.9901	0.9901	0.9911	0.9910
25.8	0.9867	0.9864	0.9899	0.9900	0.9909	0.9908
26	0.9864	0.9862	0.9897	0.9898	0.9908	0.9907

26.2	0.9862	0.9859	0.9895	0.9896	0.9906	0.9905
26.4	0.9859	0.9857	0.9893	0.9894	0.9904	0.9903
26.6	0.9857	0.9854	0.9892	0.9892	0.9903	0.9901
26.8	0.9855	0.9852	0.9890	0.9890	0.9901	0.9900
27	0.9852	0.9849	0.9888	0.9888	0.9899	0.9898
27.2	0.9850	0.9847	0.9886	0.9886	0.9898	0.9896
27.4	0.9847	0.9844	0.9884	0.9885	0.9896	0.9895
27.6	0.9845	0.9842	0.9882	0.9883	0.9894	0.9893
27.8	0.9842	0.9839	0.9880	0.9881	0.9892	0.9891
28	0.9840	0.9837	0.9878	0.9879	0.9891	0.9890
28.2	0.9837	0.9834	0.9877	0.9877	0.9889	0.9888
28.4	0.9835	0.9832	0.9875	0.9875	0.9887	0.9886
28.6	0.9832	0.9829	0.9873	0.9873	0.9886	0.9884
28.8	0.9830	0.9827	0.9871	0.9871	0.9884	0.9883
29	0.9827	0.9824	0.9869	0.9870	0.9882	0.9881
29.2	0.9825	0.9821	0.9867	0.9868	0.9881	0.9879
29.4	0.9822	0.9819	0.9865	0.9866	0.9879	0.9878
29.6	0.9820	0.9816	0.9863	0.9864	0.9877	0.9876
29.8	0.9817	0.9814	0.9862	0.9862	0.9876	0.9874
30	0.9815	0.9811	0.9860	0.9860	0.9874	0.9873
30.2	0.9812	0.9809	0.9858	0.9858	0.9872	0.9871
30.4	0.9810	0.9806	0.9856	0.9857	0.9871	0.9869
30.6	0.9807	0.9804	0.9854	0.9855	0.9869	0.9867
30.8	0.9805	0.9801	0.9852	0.9853	0.9867	0.9866
31	0.9802	0.9799	0.9850	0.9851	0.9865	0.9864
31.2	0.9800	0.9796	0.9848	0.9849	0.9864	0.9862
31.4	0.9797	0.9794	0.9846	0.9847	0.9862	0.9861
31.6	0.9795	0.9791	0.9845	0.9845	0.9860	0.9859
31.8	0.9792	0.9789	0.9843	0.9843	0.9859	0.9857
32	0.9790	0.9786	0.9841	0.9842	0.9857	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 is for stainless steel. Where the measure is calibrated at 20°C and this calculation converts it to 15°C, allowing for the expansion and contraction of the stainless steel can.

TIP:

If the error found using Appendix A is within maximum permissible errors by at least 10 ml, then there is no need to correct for expansion of the metal measure.

The smallest unit on dispenser instrument display is 10 ml, so due to rounding, you should only use this expansion correction where temperatures are lower than 15 °C or higher than 25°C.

The formula to use is:

Calibrated measure volume @20°C (L) + Temperature correction = Adjusted Measure (L)

Example of 20 L stainless steel measure at 1°C

20.00 L + (-0.0182) =19.9818 L (*Round to nearest 10ml*) so 19.98 L

-20 ml

Example for 20L Stainless Steel Measure at 15°C

20.00 L + (-0.0048 L (-4.8 ml) = 19.9981 L (*Round to nearest 10ml*) so 20.00 L

0 ml

Example of 20 L stainless steel at 28°C

20.00 + (0.0077) = 20.0077 L (*Round to nearest 10ml*) so 20.01 L

+10 ml

Table 3: Correction volumes for different volume stainless steel measures

T°C[1]	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

[1] T°C is temperature of fuel and measure.

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
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

NOTE: 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 Reading	Fuel Multiplier Value	Ref. Meter reading compen-sated to 15°C	Ref. Meter error Correction Factor	Ref. Meter Corrected Reading at 15°C	Meter Under Test Reading	Error	%age Error
	T	RM	FM	CR15	CF	CR	MUT	E	
	°C	Litres		*(RM x FM)* Litres		(CR15 x CF) + CR15 Litres	Litres	(CR-MUT) Litres	(E/CR) x100 %
Maximum Flow rate – Wet line									
Minimum Flow rate – Wet line									

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