Standard Temperature Accounting: 15° or not 15°?

We dispense the myths, with the help of The Government's National Measurement Office (NMO)

Standard Temperature Accounting (STA) introduces a correction whereby fuel is sold according to what its volume would be at a temperature of 15 degrees Celsius.

In the forecourt industry, the term for equipment used to address this issue is **Automatic Temperature Compensation (ATC).**

The article below is taken solely from the guidance document offered by the NMO, and uses STA as its reference term.

What is a litre?

The litre is equal to 1 cubic decimetre, but the quantity is not defined at any specified temperature. The temperature of liquid fuel dispensed can vary due to the influence of various factors; e.g-temperature of the tanks, of the fuel delivered or of the equipment itself. The legal tolerances for the equipment (the maximum permissible errors) have been agreed at national, European, and International levels, to provide an acceptable level of accuracy.

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

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National Measurement Office

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 and it is important to note that it is NOT mandatory under UK legislation - it is optional.

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?

With equipment that does not have the STA function (or function enabled) there will be a variation in total energy content depending on whether the temperature of the fuel is greater or less than 15 °C, and is dependent on 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 corrected to a reference temperature of 15 °C. The temperature corrected volume of fuel dispensed must meet the legal tolerances and the legend on the faceplate for the volume indicator will be 'Litres at 15 °C' or something similar.

STA equipment enabled all year

Whether equipment is verified with the STA function enabled or not, it should remain as such throughout the whole year.

Switching the STA function 'on and off' throughout the year to gain a commercial advantage from seasonal changes in fuel temperature is 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, and consistency is maintained.

Advice for equipment supply & maintenance

Approval of equipment incorporating a display with STA is permitted under current legislation, which implements the Measuring Instruments Directive.
For equipment approved under previous Weights and Measures legislation, it is possible to approve a modification to incorporate STA, providing the existing certificate of approval has not expired.
All STA equipment must be suitably marked as delivering STA litres.

All equipment having a display, incorporating STA, must be approved by Trading Standards Officers. For further advice on how to obtain approval, please contact the type examination team at NMO.

Verification of STA equipment should be carried out with the STA facility active. It may not be possible on all 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.

All measures can normally be used to test STA forecourt equipment although it is advisable to check with the equipment providers regarding suitability.

If the fuel dispensed from a dispenser is changed to one with a different density then the STA calculation will be incorrect and the equipment reconfigured.

continued on p26

Testing Procedure for Forecourt Dispensers

1. Introduction

Here is 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 approval, and is not 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 the table below for kerosene and gas oil.

2. Equipment

Working standards of capacity (2 L, 5 L, 10 L, and 20 L as necessary)
Metal contents measure NWML 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

Utilising the conversion rates in the table right

a. Wet and drain the measure.

b. Deliver the fuel into the measure at the required flow-rate.

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 Table A and compare with the fuel dispenser indication of litres at 15 °C.

h. If using a metal measure and the result is near the limit of allowable error, carry out a further correction for the measure – see **nmo.gov.uk**

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.

4. Temperature Conversion Data

Here 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 data issued by DECC.

For other products and temperatures outside of the range covered by this Petroleum Measurement Tables should be used in combination with fuel density data issued by DECC or direct density measurement.

Temperature Compensation Multipliers

The table below is an excerpt of the multiplier used to convert fuel at the temperature listed in the left column to volume at 15 °C.

For a full copy of the table see below

Example:

a. A measuring can contains 20.15 L of Sulphur Free Diesel and its temperature is 11 °C. From the table below for 11 °C the multiplier in the Sulphur Free Diesel column is 1.0034.

The equivalent volume at 15 °C is:

20.15 L x 1.0034 = 20.21851 L at 15 °C

A temperature compensated fuel dispenser which delivered the 20.15 L into the measure should indicate 20.21851 L at 15 °C subject to indicator limitations, 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 Sulphur Free Diesel at 11 °C is:

20.00 L x 1.0034 = 20.068 L at 15 °C

Thus, if the measuring can contained 20.00 L at 11 °C, the temperature compensated fuel dispenser should indicate 20.068 L at 15 °C.

This value of 20.068 L can then be used as a reference point so that:-

If 20.15 L of Sulphur Free Diesel was delivered at 11 °C;

0.15 L at 11 °C corrects to 0.15 x 1.0034 = 0.15051 at 15 °C

The temperature compensated fuel dispenser should therefore indicate:

20.068 + 0.15051 = 20.21851 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.

temp °C	Petrol		Diesel	GAS OIL	Kerosene	
	Super	Premium	Sulphur Free	Gas Oil & Marine Diesel	Marked	Aviation Turbine
0	1.0184	1.0186	1.0126	1.0124	1.0139	1.0139
0.2	1.0182	1.0184	1.0125	1.0122	1.0137	1.0138
0.4	1.0180	1.0182	1.0123	1.0120	1.0135	1.0136
0.6	1.0177	1.0179	1.0121	1.0119	1.0133	1.0134
0.8	1.0175	1.0177	1.0120	1.0117	1.0131	1.0132
1	1.0172	1.0174	1.0118	1.0115	1.0130	1.0130
10	1.0062	1.0062	1.0042	1.0041	1.0046	1.0047
11	1.0049	1.0050	1.0034	1.0033	1.0037	1.0037
12	1.0037	1.0037	1.0025	1.0025	1.0028	1.0028

continued on p28

continued from page 26

Testing Procedure for Forecourt Dispensers

Density figures have been provided by UKPIA from data gathered throughout 2013 for use in 2014 and issued by DECC Oil and Gas division.		Density kg/m³
Petrol -	Unleaded Super	**735.6**
	Unleaded Premium	**730.2**
Kerosene -	Aviation Turbine	**798.1**
	Marked	**800.0**
Automotive diesel -	Sulphur free	**839.0**
Gas Oil & Marine Diesel		**853.1**

These figures are issued annually by DECC, normally in December. NMO 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 and that the two will fairly quickly stabilise near the fuel temperature. 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/m³	1 mL

A 20 L stainless steel measuring can will change approximately 1 mL for 1 °C change from its calibration temperature of 20 °C. Other sizes will change proportionately. A table from NMO is available for Correction for Expansion of Stainless Steel Fuel Test Can per degree C.

The National Measurement Office (NMO) ensures fair and accurate measurements are available and used for transactions regulated by law.

The above article is taken solely from the NMO guidance on STA, April 2014.

For further details or for the complete conversion charts please visit; **www.gov.uk/nmo** and the documents are found.at; **https://www.gov.uk/government/publications/standard-temperature-accounting-weights-and-measures**

ATC Advice from the PEIMF

Phil Monger, The PEIMF's Technical Officer, offers his comments and advice on ATC

The History

Contrary to common belief, it has been legally possible to install temperature corrected dispensers for as long as I can remember. The obstacles have always been in the past, the lack of available equipment and absence of any suitable guidance. So what brought about the changes we see today?

In 1997 the Petrol Retailers Association submitted a report to the Minister for Trade and Industry, which provided the evidence of significant losses experienced by fuel retailers, particularly with respect to those sites supplied from terminals with a history of supplying fuel at high temperatures. A subsequent Government sponsored investigation led to the publication of a report in 1999 by the National Engineering Laboratory entitled 'Temperature Compensation of Liquid Fuel". This report carried a recommendation that Industry should adopt Standard Temperature Accounting as a means to improve efficiency and reduce operating costs.

It took a further ten years, before there was any significant move to installing dispensers with Automatic Temperature Compensation and the eventual adoption of the EU Measuring Instruments Directive (MID) provided an easy entry for other European manufacturers to introduce equipment with ATC, including retrofits for existing dispensers.

Factors to consider

Retailers should always seek independent advice before installing ATC equipment as some have already regretted hasty decisions. Some have gone ahead with ATC because they have signed a supply contract to receive fuel on an STA basis and in so doing remove temperature related losses or gains altogether. Others have installed ATC equipment because they are always storing fuel well below fifteen degrees Celsius and are able to recover their costs quite quickly.

When buying new dispensers, it probably makes sense to buy them with ATC capability, but a decision to enable them, should be made only after a calculation is made, taking into consideration a number of factors.

1. Do the average annual tank temperatures lie significantly below fifteen degrees Celsius? (This must take into consideration the seasons where the volume throughput may be higher than other seasons but also when tank temperatures are at their highest).
2. Don't assume that tank temperature will have the controlling influence on compensation negatively or positively. The temperature of the fuel in pipelines just below the surface and immediately before entering the dispensers will be the temperature used in the compensating factors, and on warm summer afternoons when sales are slow, those temperatures may well be above fifteen degrees.
3. Will the fuel supplied always be delivered from cool terminals? If so, will there then be scope to negotiate an STA supply contract?

The advantage to the motorist will be in buying fuel with consistent energy content. At the present time a motorist might well be influenced by the price of the fuel but be unaware that the energy content is considerably less.