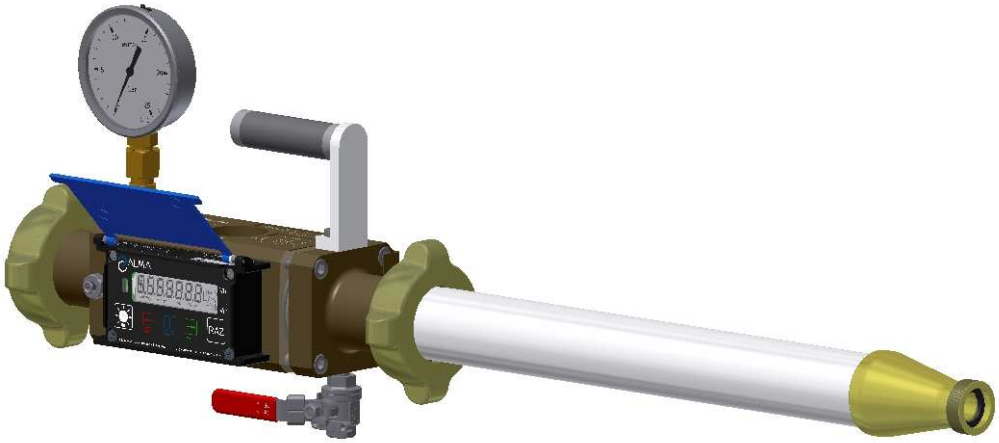
OPERATING MANUAL

MU 7060 EN C

LPG ETALCOMPT



Relevant software 434v1.05

Issue	Date	Nature of modifications	Written by	Approved by
C	2017/01/10	Add Annexe 3: Report of LPG meter calibration tests with LPG ETALCOMPT *[MDV 504]*. Update PPV049	DSM	OL
B	2013/01/24	Creation	DSM	OL

CONTENTS

1 GENERAL PRESENTATION AND DESCRIPTION

The LPG ETALCOMPT is a portable and autonomous device intended to the calibration of turbine or volumetric LPG meters (for LPG delivery tank-trucks and other use...

This operation must be performed by personnel previously trained in the use of this material.

The LPG ETALCOMPT includes:

- ⇨ An ALMA turbine meter, type ADRIANE DN50-30 LPG,
- ⇨ An intrinsic security indicator-calculator device, UNI type, powered by 2 lithium batteries (4 years life expectancy)
- ⇨ A [0-20 bar] pressure gauge class 1, calibrated by a laboratory accredited by an organisation member of ILAC
- ⇨ A temperature plug,
- ⇨ A removable upstream sleeve used as a flow conditioner

Before use, check that the LPG ETALCOMPT is in line with national standards and that its licence is not out of date. The volume measured by the ETALCOMPT since its last calibration must not exceed 200 m^3.

On the front of the electronic indicator-calculator UNI, you can see five buttons:

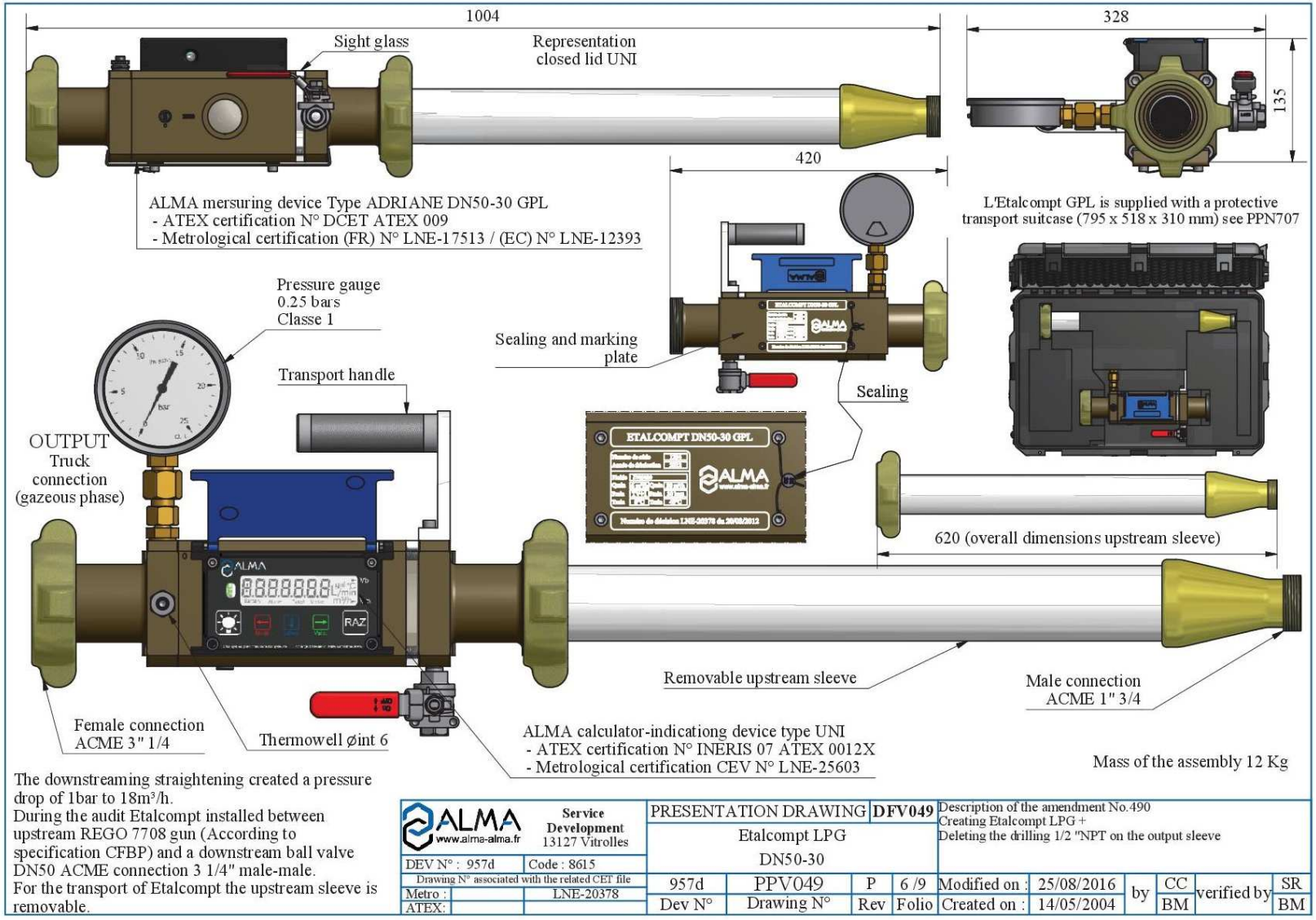
Light the display during 10 seconds

USER mode: return to previous menu
METROLOGICAL mode: increment the flashing figure when imputing a value

USER mode, metering off: select the menu
USER mode, metering on: display the values (immediate flow, temperature)
METROLOGICAL mode: select the figure to be modified

USER mode: validate the selected menu or value
METROLOGICAL mode: validate the displayed value
In case of default: acknowledge the default

Reset the volume to zero before a new measurement. The data of the last measurement are then recorded



The downstreaming straightening created a pressure drop of 1bar to 18m³/h.
During the audit Etalcompt installed between upstream REGO 7708 gun (According to specification CFBP) and a downstream ball valve DN50 ACME connection 3 1/4" male-male.
For the transport of Etalcompt the upstream sleeve is removable.

ALMA www.alma-alma.fr	Service Development 13127 Vitrolles	PRESENTATION DRAWING	DFV049	Description of the amendment No.490 Creating Etalcompt LPG + Deleting the drilling 1/2 "NPT on the output sleeve							
DEV N° : 957d	Code : 8615	Etalcompt LPG DN50-30									
Drawing N° associated with the related CET file		957d	PPV049	P	6 /9	Modified on :	25/08/2016	by	CC	verified by	SR
Metro :	LNE-20378	Dev N°	Drawing N°	Rev	Folio	Created on :	14/05/2004		BM		BM
ATEX:											

2 REQUIREMENTS OF USE

The LPG ETALCOMPT must always be transported in the transport case provided by Alma.

Before using a LPG ETALCOMPT, it is necessary to define a safe area at the rear of the vehicle in order to work in security.

For intervention in a place where vehicles can circulate nearby, reflective clothing is mandatory.

It is recalled that in addition to the general precautions, the permanent wearing of Personal Protective Equipment is mandatory during its use (fireproof and anti-static cover clothing, suitable gloves, and eye protection goggles).

The use of any non-ATEX electronic device in the safety area is prohibited.

3 PREPARATION

3.1 Materials

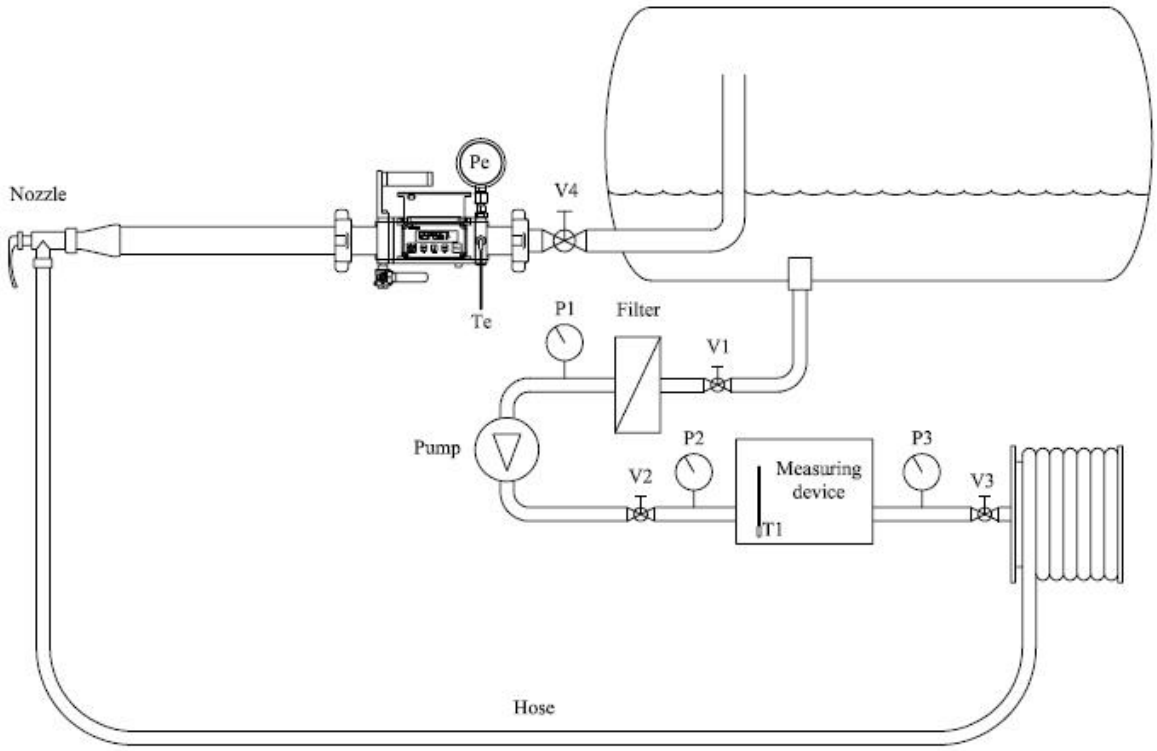
The following materials shall be useful to carry out the operation:

- A LPG ETALCOMPT meter in line with national standards, with a valid Alma license. It must be equipped with a pressure gauge class 1, calibrated by a laboratory accredited by an organisation member of ILAC, with its calibration certificate which validity is not out of date.
- Two thermometers (or a two-channel thermometer) calibrated by a laboratory accredited by an organisation member of ILAC with their calibration certificate which validity is not out of date. The diameter of the sensor element is less than 6 mm.
- A pressure gauge class 1, calibrated by a laboratory accredited by an organisation member of ILAC, with its calibration certificate which validity is not out of date.
- Marking and sealing equipment.

3.2 Connection diagram

The LPG ETALCOMPT is directly connected between the nozzle and the product return valve fitting, according to the diagram below.

OPERATING CONNECTION DIAGRAM
OF THE LPG ETALCOMPT



V valve
P pressure gaugue p pressure value in bar
T thermometer t temperature value in °C

3.3 Before starting

1. Put the 2 temperature sensors in glass of water, shake them and after stabilization, mark the difference $dT = T_e - T_c$ (to avoid any offset between the 2 temperature sensors)
2. Pick up the totalizer value of meter to calibrate, without reset it.
3. Check the LPG ETALCOMPT calibration validity date.
4. Plug the LPG ETALCOMPT according to the scheme above. The nozzle and the V4 valve must be closed.
5. Check that the V1, V2, V3 valves are completely open. Tests should be performed with the tank instrumented valve remains closed, if allowed by the automation.
6. Check that the temperature probe thermowells are full of heat transfer fluid.
7. Install one temperature sensor in the LPG ETALCOMPT thermowell and the second one in the measuring system control well (usually on gas separator)
8. Plug the control pressure gauge instead of P3 (pressure after the meter):
   ⇒ Close the vehicle P3 pressure gauge shut-off valve;

⇒ Cautiously unscrew the fitting, and drain the pipe between the valve and the P3 pressure gauge. **This operation has to done by a qualified personnel**;

⇒ Plug the control pressure gauge;

⇒ Check that the drain valve is well close;

⇒ Cautiously open the shut-off valve and check the good sealing of the fitting.

4 USE

4.1 Use of the UNI electronic indicator-calculator

4.1.1 Reset the indicator

At zero flow, pressing RAZ records the last measurement data and reset the volume.

4.1.2 Display during metering

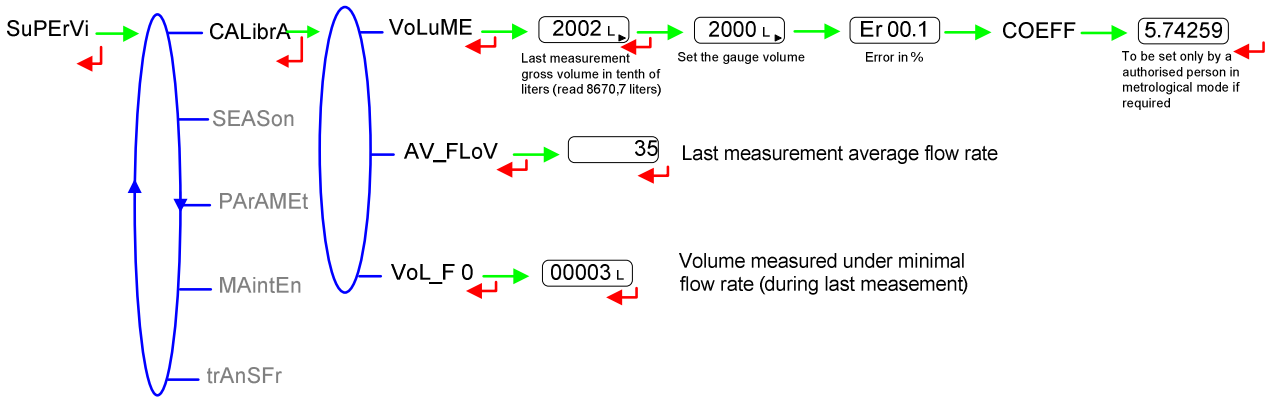
Flowrate may be displayed by pressing Select.

The display will return automatically to the current volume.

4.1.3 CALIBRATION mode

The CALIBRATION mode is accessible this way:

- Reset the UNI
- Use Select. to select the "SuPErVi" menu and validate with Valid.
- Then choose the "CALibrA" menu by the same way
- Then are displayed the last measurement volume in tenth of liters, and the volume measured at a lower flowrate than the minimum flowrate. The Select. button allows choosing the parameter to display. The Valid. button validates the choice and the Modif. button returns to previous menu.



4.2 Circuit conditioning

1. Open completely the nozzle.
2. Open the V4 valve, step by step, and observe the progressive filling of LPG ETALCOMPT through the sight glass.
3. Check that the indications on the thermometers are stable: temperature variation must be less than 0.2°C in 1 minute.
4. Start the distribution and let it works, in order to:
   ⇒ Ensure the complete filling of the circuit with liquid, draining the gas if necessary
   ⇒ Allow the temperature stabilization (when the LPG ETALCOMPT temperature Te ranges from less than 0.2°C in 1 minute.
5. Stop the distribution and note:
   ⇒ The difference between P_e and P_3 (in bar): $dP = P_e - P_3$ (pressure gauge offset)
   ⇒ The value of P_e (tank vapour pressure or TV) and of the LPG ETALCOMPT temperature Te,
6. Start the distribution (no matter the flow), if necessary partly close the V4 valve to read on P_e pressure gauge, a pressure equal to TV + 1 bar. Check that no gas bubble appears on the sight glass.
7. Stop the distribution and mark the totalizer value of meter to verify.

4.3 Determination of the verified meter error

1. Reset the indicators of the meter to verify and of the LPG ETALCOMPT.
2. Start the distribution in high flow and let flow at least 1000 L.
   ⇒ On the beginning, bring out the 2 temperatures: T_e and T1 in °C, and the 2 pressures: P_e and P_3 in bar.
   ⇒ During delivery
   - Check on P_e manometer that pressure is always greater than or equal to TV+1 bar and that there's no gas bubble appearing on the sight glass.
   - Control the stability of T_e and T_1
   - Control that $|T_e-T_1| \leq 0,5°C$
   - Control that $P_3-P_e \leq 9$ bar
   - Control the flowrate stability which ensures that there is neither hydraulic problem nor gas problem such as invisible cavitations.
     If one of these conditions is not met, the test results should not be validated.

   ⇒ At the end, bring out the 2 temperatures T_e and T_1 in °C.
3. Stop the distribution,
4. Put the LPG ETALCOMPT in gauging mode and check the value:
   - Of volume in liters and tenth of liters,
   - Of flowrate in m^3/h.
   - Of volume measured at a flowrate lower than the LPG ETALCOMPT minimum flowrate value: this volume must be less than 1 liter.
5. Note the volume displayed on the indicator in liters and tenth of liters (if available).

4.4 Calculation of the error at operation flow

Meter error calculation must be done in accordance with the method shown below and using the calculation formulas in annex.

The calculation should be carried out with a suitable tool, such as an Excel worksheet or equivalent. Alma can provide such means if necessary: see Annex 3.

Moreover, you must control that the calculated ratio between flowrate and viscosity (Q/ν) is included in the LPG ETALCOMPT calibration range.

If this is not the case, the test results should not be validated.

4.4.1 Correction of the verified meter volume

Correct the volume measured by the measuring system (V_c) to LPG ETALCOMPT flow conditions (T_e and P_e); taking into account the measured quantity (T_1 and P_2), pressure gauges offset (dP) and thermometers offset (dT):

$$V_{meter}(T_e, P_e) = V_C \times C_{tl} \times C_{pl}$$

With C_{tl}: correction factor of LPG thermal expansion between the verified meter and the standard meter

C_{pl}: correction factor of LPG pressure expansion between the verified meter and the standard meter

4.4.2 Correction of the LPG ETALCOMPT volume

Correct the volume displayed by the LPG ETALCOMPT (V_e) to the temperature and pressure conditions of its calibration; taking into account the flow/viscosity ratio value (Q/ν) compared to the calibration results.

$$V_{e\_corrected} = V_e \times Ct_e \times Cp_e \times C_{Q/v}$$

4.4.3 Calculation of the verified meter error

The meter relative error E in percent is:

$$E = \frac{V_{meter}(T_e, P_e) - V_{e\_correctéd}}{V_{e\_corrected}} \times 100$$

4.4.4 Calculation of the verified meter new factor

With an electronic calculator device, the meter factor in p/L is calculated by this way:

$K_{corrected} = K_{meter} \times (1 + E)$ with K_{meter} = factor memorised in the meter to verify

$K_{corrected}$ = new factor

In case of adjustment of the verified meter, an additional control test must be performed and the measuring system error recalculated.

ANNEXE 1: CALCULATION OF THE ERROR AT OPERATING FLOW

⇨ Temperature correction

First, correct the volume to temperature T_e using the following formula:

$V_C(T_e) = V_C \times C_{tl}$ with $Ctl = 1 + \alpha(T_e) \cdot (T_e - T_C - dT)$

With $\alpha(T_e) = 2.56 \cdot 10^{-5} \times T_e + 2.55 \cdot 10^{-3}$

⇨ Pressure correction

Then apply a correction factor taking into account the pressure difference.

$V_{meter}(T_e, P_e) = V_C(T_e) \times C_{pl}$, with $C_{pl} = 1 + F \cdot (P_2 + dP - P_e)$

with “F” = LPG compressibility factor as laid down in the NF M 08-009 standard and calculated according to the following formula; with the hypothesis that the product density at 15°C Mv_{15} is 512 kg/m^3 and temperature is equal to T_e:

$$F = \exp\left(A + B \cdot T + \frac{C}{Mv_{15}} + D \cdot T + E \cdot \frac{T}{Mv_{15}} + \frac{G}{Mv_{15}^{\,2}} + H \cdot T^3 + I \cdot \frac{T^2}{Mv_{15}} + J \cdot \frac{T}{Mv_{15}^{\,2}} + \frac{K}{Mv_{15}^{\,3}} \right)$$

With

A = 5.658198
B = 0.0170071
C = -9475.792
D = 0.0002433111
E = -13.41805
G = 6950593
H = 0.00000006098546
I = -0.1135126
J = 4874.498
K = -1312233000

ANNEXE 2: CALCULATION OF THE LPG ETALCOMPT VOLUME

First, correct the volume displayed by the LPG ETALCOMPT (V_e) to the temperature and pressure conditions of its calibration using the following formula:

$$V_e(T_{calibration}, P_{calibration}) = V_e \times Ct_e \times Cp_e$$

with

$$Ct_e = 1 + \alpha \cdot (T_e - T_{calibration}) \text{ and } Cp_e = 1 + \beta \cdot (P_e - P_{calibration})$$

with $\alpha = 7\ 10^{-5}\ °C^{-1}$. Thermal expansion coefficient of the turbine

$T_{calibration}$ = LPG ETALCOMPT calibration temperature

and $\beta = 2\ 10^{-6}$ /bar. Pressure expansion coefficient of the turbine

$P_{calibration}$ = LPG ETALCOMPT calibration pressure

Then apply a correction factor taking into account the flow/viscosity ratio value (Q/ν) compared to the error calibration curve using the following formula:

$$V_{e\_corrected} = V_e(T_{calibration}, P_{calibration}) \times C_{Q/\nu}$$

with $C_{Q/\nu} = A_0 + A_1 \cdot \log(Q/\nu) + A_2 \cdot \log(Q/\nu)^2 + A_3 \cdot \log(Q/\nu)^3$

with A_0, A_1, A_2, A_3= coefficients based on the LPG ETALCOMPT calibration

Q= flowrate in m^3/h, recorded on the LPG ETALCOMPT

ν= kinematic viscosity in mm^2/s, calculated from the following formula, as a function of temperature T_e:

$$\nu(Mv_{15}, T) = a_0 + a_1 \cdot (Ctl \times Mv_{15}) + a_2 \cdot (Ctl \times Mv_{15})^2 + a_3 \cdot (Ctl \times Mv_{15})^3$$

with a_0 = -38,9343

a_1 = 0,231049

a_2 = -0,000455644

a_3 = 0,000000300243

$$Ctl = 1 + \left(\frac{-4.075}{Mv_{15}} + 0.00505\right) \times (T - 15) + \left(\frac{-0.0275}{Mv_{15}} \times 0.000045\right) \times (T - 15)^2$$

ANNEXE 3: REPORT OF CALIBRATION TESTS

Refer to Excel file: '*MU 7060 EN_Annexe3*': Report of LPG meter calibration tests with LPG ETALCOMPT

Form filling assistance:

Choose the relevant tab:

⇨ '2 temperature sensors': two thermometers, one for the measuring system and the other for the LPG ETALCOMPT

⇨ '1 temperature sensors': a two-channel thermometer with one display and two temperature sensors, one for the measuring system and the other for the LPG ETALCOMPT.

'GENERAL DATA'

- *Calibration date*: Date of calibration tests
- *Vehicle identification*: Registration number of the vehicle
- *LPG meter to calibrate identification*: Identifier of the meter

'CALIBRATION MATERIALS'

- *Calibration product*: Name of the product used for calibration tests

'LPG ETALCOMPT MASTER METER' is filling by ALMA:

- Identification: Reference number of the LPG ETALCOMPT
- *log (Q/nu) range*: Plage du rapport débit/viscosité de l'étalonnage de LPG ETALCOMPT.
- *Pref* : Calibration pressure of the LPG ETALCOMPT
- *Tref* : Calibration temperature of the LPG ETALCOMPT
- *Ct* : Thermal expansion coefficient of the turbine (/°C)
- *Cp* : Pressure expansion coefficient of the turbine (/bar)
- *A0*: Polynomial coefficient determined from the LPG ETALCOMPT calibration.
- *A1*: Polynomial coefficient determined from the LPG ETALCOMPT calibration.
- *A2*: Polynomial coefficient determined from the LPG ETALCOMPT calibration.
- *A3*: Polynomial coefficient determined from the LPG ETALCOMPT calibration.

'DATA TO BE RECORDED BEFORE CALIBRATIONS TESTS'

- *Tank vapour pressure*: Saturation vapour pressure of the measured liquid Pe brought up after conditioning (see §4.2)
- *LPG Etalcompt temperature*: Temperature brought up at the beginning of the test on the LPG ETALCOMPT temperature sensor
- *Temperature difference between the two temperature sensors (Te-Tc)*: Deviation brought up at the beginning of the test between both temperature sensors (LPG ETALCOMPT and measuring system).
- *Pressure difference between the two pressure gauges (Pe-Pc)*: Deviation brought up at the beginning of the test between both pressure gauges (LPG ETALCOMPT and measuring system).

'CALIBRATION TESTS'

⇨ Values to be set

- *Flowrate*: Average flowrate of the test.
- *LPG Etalcompt Temperature at the start*: Temperature brought up at the beginning of the test on the LPG ETALCOMPT temperature sensor.
- *Meter to calibrate temperature at the start*: Temperature brought up at the beginning of the test on the verified meter temperature sensor.
- *LPG Etalcompt pressure*: Pressure brought up on the LPG ETALCOMPT pressure gauge.
- *Meter to calibrate pressure*: Pressure brought up on the verified meter pressure gauge.
- *LPG Etalcompt Temperature at the end*: Temperature brought up at the end of the test on the LPG ETALCOMPT temperature sensor.
- *Meter to calibrate temperature at the end*: Temperature brought up at the end of the test on the verified meter temperature sensor.
- *Volume displayed by meter to calibrate*: Volume of product counted by the verified meter
- *Volume displayed by LPG Etalcompt*: Volume of product counted by the LPG ETALCOMPT.
- *Volume measured at a flowrate lower than minimum flowrate*: Volume counted at a flow < Qmin during the test.
- *Adjustment after calibration (Yes/No)*: Adjustment of the coefficient or not

⇨ Calculated values

- *LPG Etalcompt average temperature*: Average temperature of the LPG ETALCOMPT during the test
- *Average difference of temperature*: Difference between the LPG ETALCOMPT average temperature and the verified meter average temperature.
- *Calculated viscosity*: Kinematic viscosity of the product, calculated according to the temperature.
- *log (Q/nu) value for the calibration*: Flow/viscosity factor of the test.
- *Converted meter to calibrate volume*: Volume measured by the verified meter, restored to flowing conditions of the LPG ETALCOMPT, taking into account the measured quantities and the temperature and pressure deviation
- *Corrected LPG Etalcompt volume*: Volume displayed by the LPG ETALCOMPT corrected as a function of its conditions of use (pressure, temperature, product viscosity and flowrate) based on the result of its calibration.
- *Error* : Relative error of the verified meter