FORTUM OIL & GAS
NAANTALI REFINERY
FINLAND
November 29. 1999

TEST REPORT
PORTABLE DENSITY METER DM-230.1

The portable density meter, model DM-230.1, manufactured by LEMIS Baltic and represented in Finland by PPM-Systems OY, was tested in the laboratory of Naantali refinery.

The measurement is based on the ancient Archimedes law, where a steel cylinder is immersed into the measured liquid and buoyant force, dependent on the liquid density is measured with a sensitive pressure sensor on the upper end of the cylinder.

i.e. The used method is well know and extremely sensitive method for measuring density, in this case used in a modern, microprocessor based portable instruments that can also be used for inside tank measurements.

The equipment itself is small portable and with its cable the probe can be immersed into a tank. A bigger version that can be used for density measurement in different depths of a big oil tank is also available. Cable length can be up to 30 meters.

The equipment performs self-calibration automatically in each measuring point before measurement and this way compensates the possible measuring errors caused by gravitation constant etc.

The instrument was tested in Naantali laboratory with the following density standards:

- Toluene
- I-Octane
- N-Heptane
- Distilled water
- Gasoil (DIMAR)

Densities of the a.m. standards are known in different temperatures within accuracy 0.1 kg/m^3.
The test results have been presented in the addendum.

CONCLUSIONS:

1. Both the easiness of use and accuracy were surprising.
2. After calibration the equipment is as accurate as the standard density meter in the laboratory, Anton Paar (ASTM D-4052).
3. After minor modifications, recommended by the testers, and EX-Approval by VTT (State Research Center) the instrument is suitable for the following measurements:

A. As a portable density meter, where the sample is taken into a beaker where the probe then will be immersed.
B. For density measurement in different sizes of tanks.
   In this case the probe will be immersed into the tank using the cable.
   Immersion depth can be controlled.

Remark: The original model of this instrument has been sold, e.g. to Russia more than 800 units so the equipment has already been in real use for a long time.

Addendum 1. TEST RESULTS

Tested equipment: Portable density meter DM-230.1

Manufacturer: LEMIS Baltic, Latvia

Distributor: PPM-Systems Oy, Finland

Measuring principle: Buoyancy force (Archimedes)

Test site: Fortum O&G Naantali refinery, laboratory, Finland

Date/Time: November 19.1999 9.00 – 14.00

Test samples:
I-Octane density at +15 C, 695.97 kg/m3
Heptane density at +15 C, 687.99 kg/m3
Distilled water density at +15 C, 999.10 kg/m3
Gasoil (DIMAR) density at +15 C, 865.40 kg/m3

TEST RESULTS (Converted to reference temperature +15 C)

Standard	Standard Density	DM-230.1 Result	Difference
Toluene	871.44 kg/m3	871.3	0,14
I-Octane	695.97 kg/m3	695.8	0.17
Heptane	687.99 kg/m3	687.9	0.09
Distilled water	999.10 kg/m3	998.9	0.20
Gasoil (DIMAR)	865.40 kg/m3	865.6	0.20

CONCLUSIONS:

1) Average error is $\pm$ 0.16 kg/m3.
2) ASTM D-4052 standard method reproducibility is $\pm$ 0.50 kg/m3.

Thus: The instrument is as accurate as the Standard laboratory method ASTM D-4052.

Naantali , FINLAND 29.11.1999