



Two methods for measuring large volume of LNG:

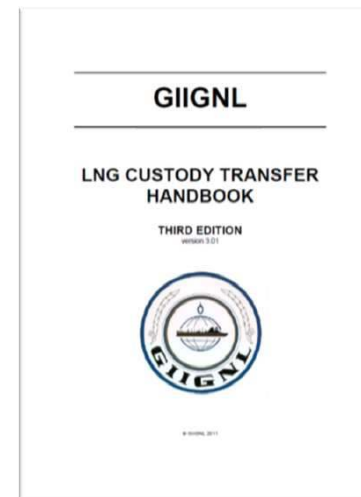
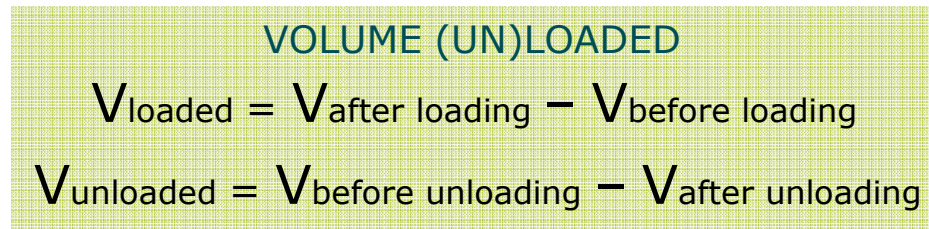
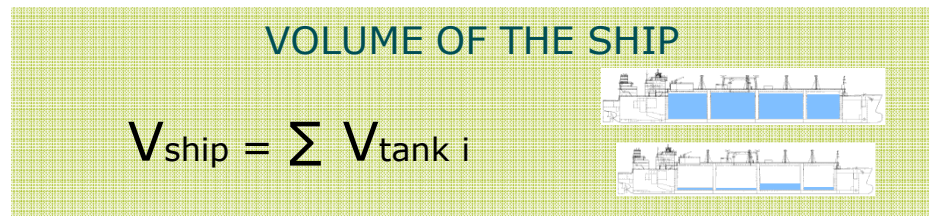
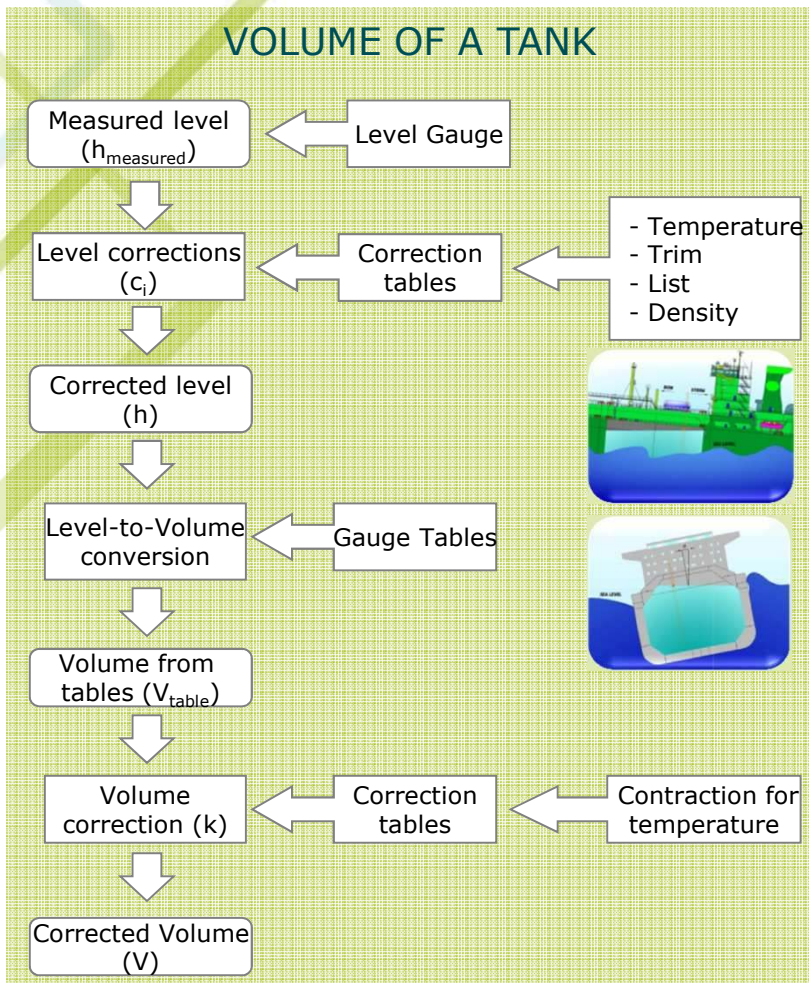
USM vs Custody Transfer Handbook

Ángel Benito

Delft, October 17th 2013

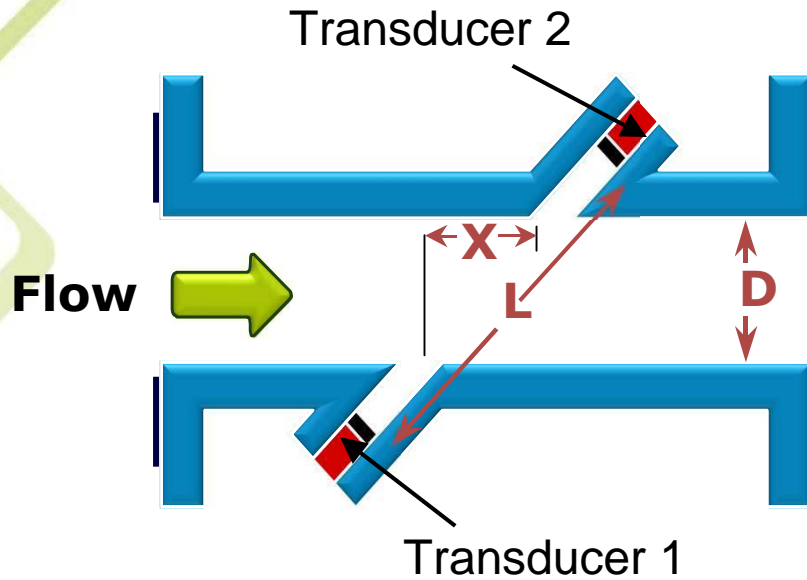
Introduction

Current Volume Measurement



Introduction

Volume Measurement using an USM

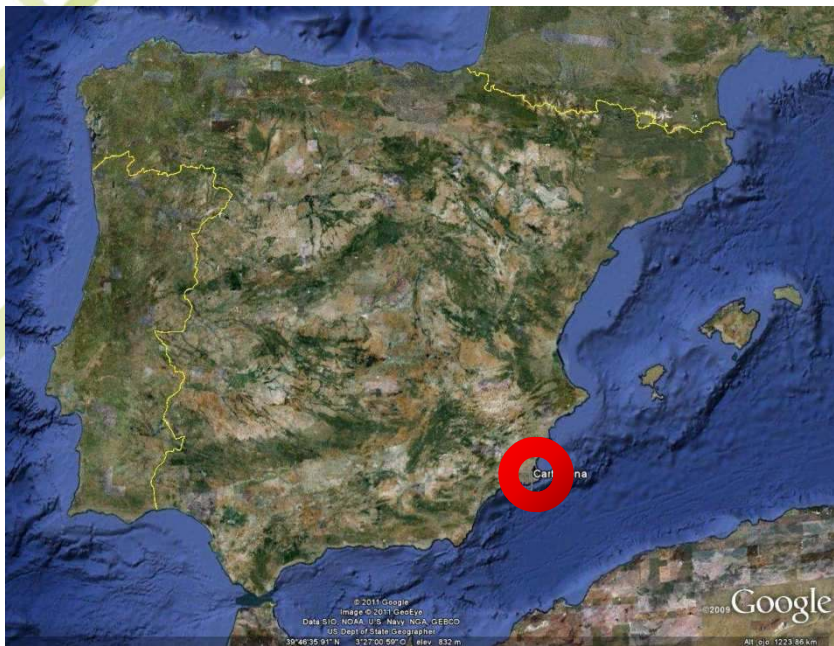


$$V = \frac{L^2}{2X} \left(\frac{T_{21} - T_{12}}{T_{21} \cdot T_{12}} \right)$$



Project location

Enagás Terminal: Cartagena



Flowmeter Characteristics

Manufacturer / Model

KROHNE ALTOMETER / UFM 530 HT

Design

Dual path construction

Diameter

32"

Velocity range

0 ... 20 m/s

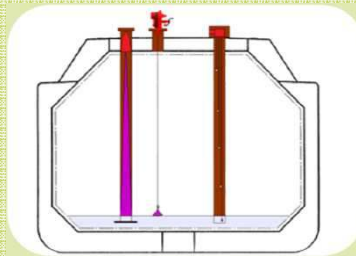
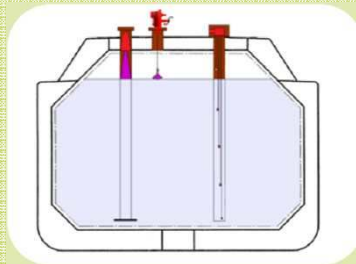
Temperature range

-170 ... 600 °C

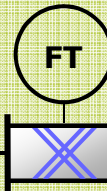


Comparison of Results

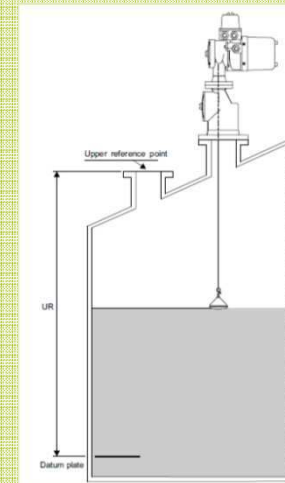
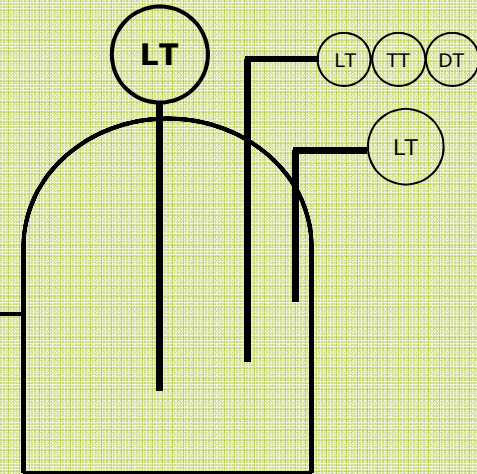
CARRIER'S TANKS



USM



TERMINAL TANKS



Comparison of Results

Required data

$$V_{USM} \pm U(V_{USM})$$

$$V_{LNG \text{ carrier}} \pm U(V_{LNG \text{ carrier}})$$

Difference

$$\text{Difference} = \frac{V_{USM} - V_{LNG \text{ carrier}}}{V_{LNG \text{ carrier}}}$$

E_n number

$$E_n = \frac{|V_{USM} - V_{LNG \text{ carrier}}|}{\sqrt{U^2(V_{USM}) + U^2(V_{LNG \text{ carrier}})}}$$

Two measurements are comparable if $E_n \leq 1$

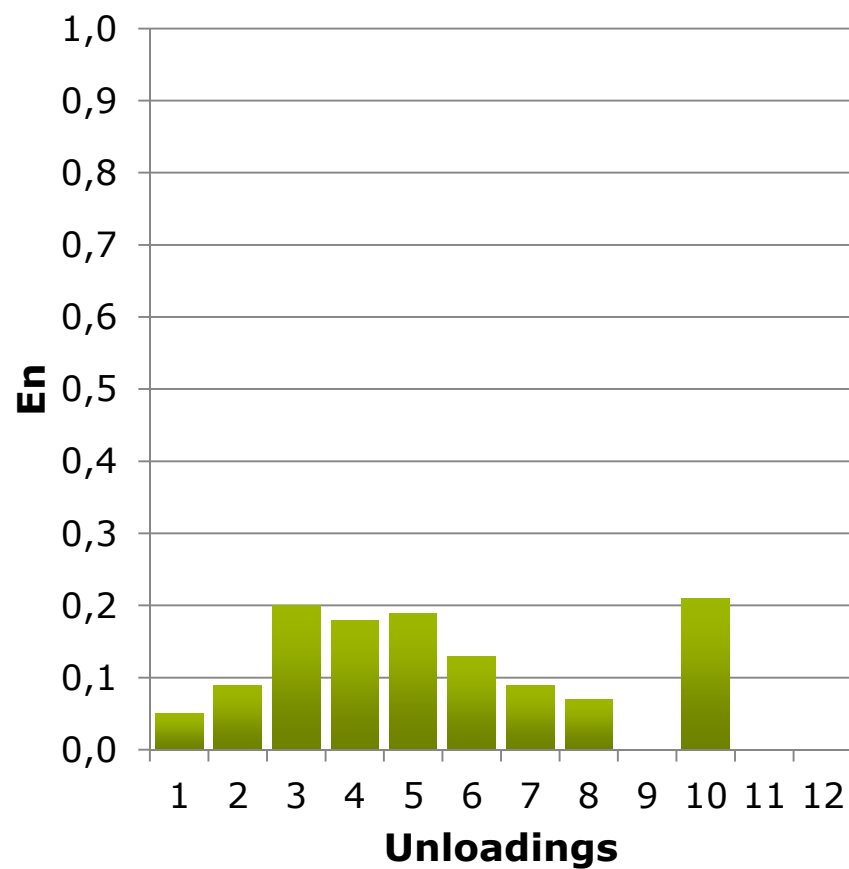
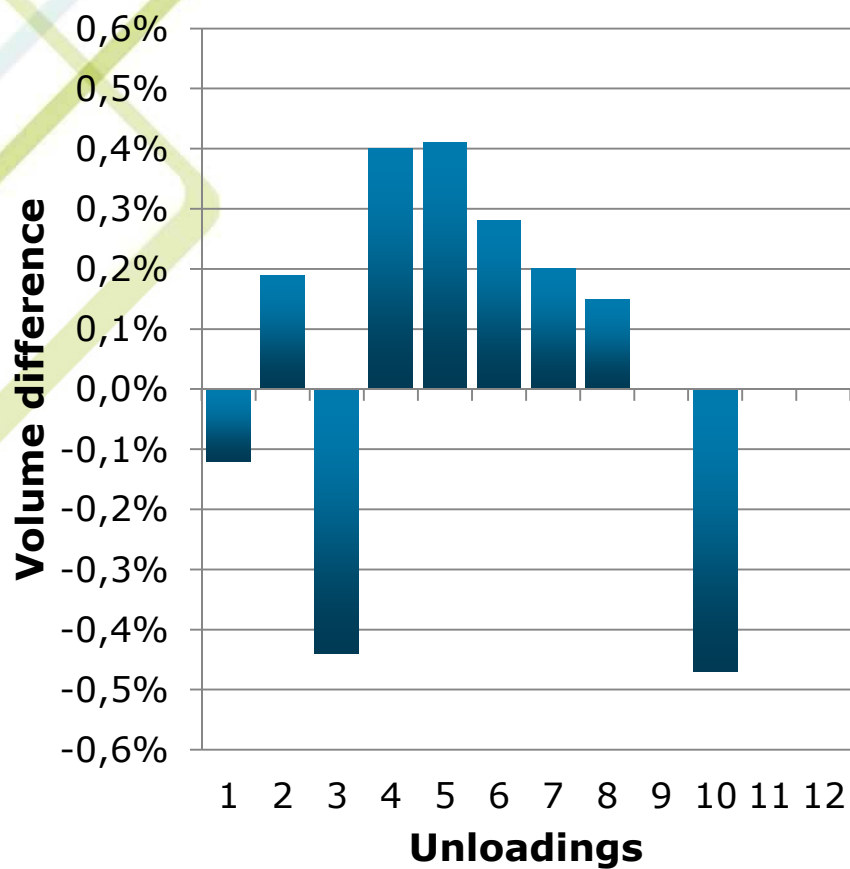
Results

- April 2011 – April 2013
- Suitable scenario only in 12 unloadings
- Two comparisons:
USM-Terminal tank & USM-LNG carrier



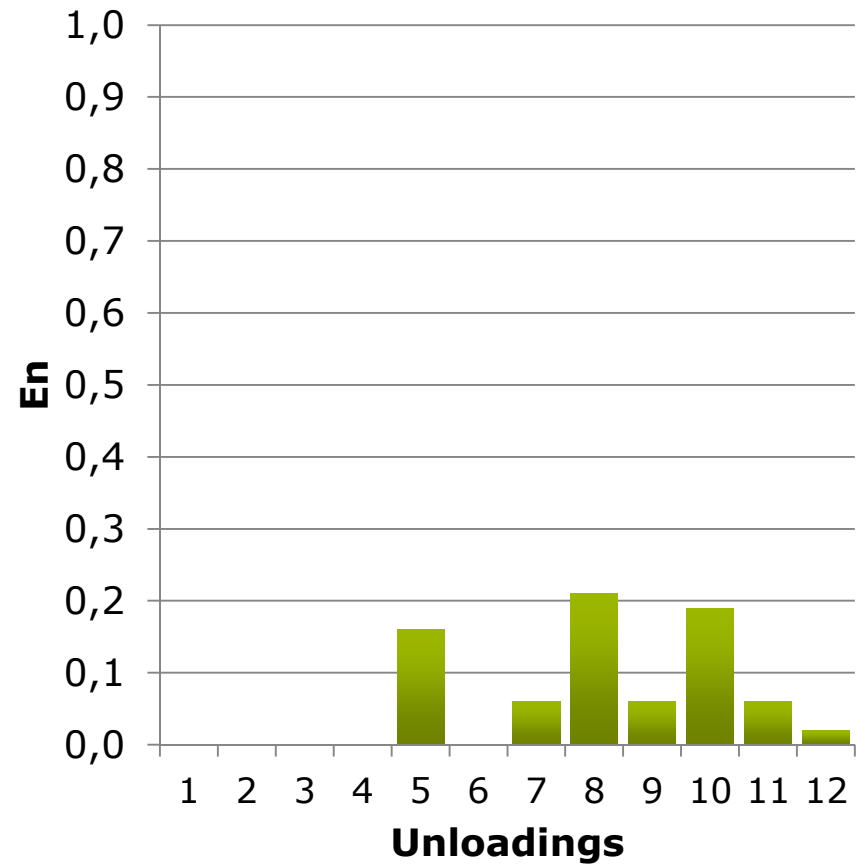
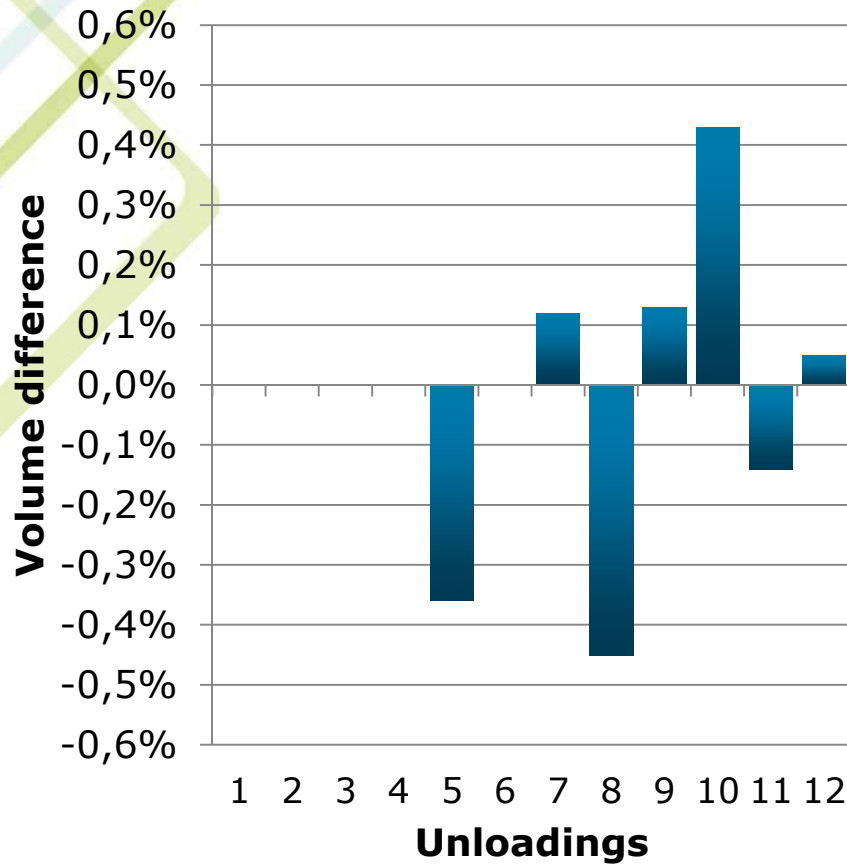
Results

Comparison USM vs Terminal tank



Results

Comparison USM vs LNG carrier



Conclusions

- Tests on LNG volume measurement have been carried out comparing Ultrasonic Flowmeter with Terminal tank instrumentation and LNG carrier instrumentation on board.
- An Ultrasonic Flowmeter, 2 path and 32", has been calibrated with water, traceable to VSL (The Netherlands). The flow measurements have correction for temperature and NRe.
- Results from 12 comparisons allow us to ensure that measurements are statistically comparable ($\pm 0.5\%$).
- The suitable location for the USM would be in the berth, instead of the current location in the input pipe of one tank.
- The validity of the USM measure should be supported by the following:
 - Reduction of the USM uncertainty
 - Synchronism between the carrier unloading and the USM measurement



Thank you for your attention

Delf, 18th October 2013