EXCHANGING IDEAS.
CREATING SOLUTIONS.
2011 Emerson Global Users Exchange

LNG Dispensing Made Simple Using Micro Motion

EMERSON GLOBAL USERS EXCHANGE

Presenters

- Kegan Kavander
- Nicole Rundlett

Introduction

- LNG Market Considerations:
  - Drivers/Need for LNG Mobile Delivery Systems
  - U.S. Terminal locations
  - Advantages of LNG over CNG
- Mobile Delivery Systems by INOXCVA:
  - Description / Highlights
  - Control Summary and Safety
  - Micro Motion and Custody Transfer
- Why Micro Motion for Cryogenic Service Meters:
  - Flow Measurement Challenges
  - Micro Motion Experience in LNG Applications
  - The Elite Solution for LNG!
  - Advantages of Coriolis over Turbine Meters
  - Smart Meter Verification- Superior Diagnostics
  - Additional Diagnostics- Density and Drive Gain
  - Focused on Cryogenic Liquids
- Business Results Achieved
- Summary / Resources

Cryogenic Vessel Alternatives

- Founded in 1999, we are a global cryogenic equipment leader offering storage, transportation, and distribution solutions to the industrial gas, oil field services, and LNG industries.

USA Corporate Headquarters
Mont Belvieu, Texas

CVA – Other Facilities

Red Deer, Alberta, Canada

JAT-CVA Hebel Province, China

Baytown, TX

India (4 Plants)

CVA – Product Overview

ISO/IMO Containers

Skid Mounted Tanks

Horizontal Bulk Storage Tanks

Porta-Cryo Mini Bulk Tanks

Dewar Containers

Vaporizers

CVA – Product Overview

Mini Bulk Delivery Units

Hydraulic Fracture Units

Mobile Transport Trailers

Truck Mounted Nitrogen Pumpers

Cryogenic Railcars

Skid Mounted Nitrogen Pumpers

CVA – LNG Special Products

LNG Mobile Delivery Trailers

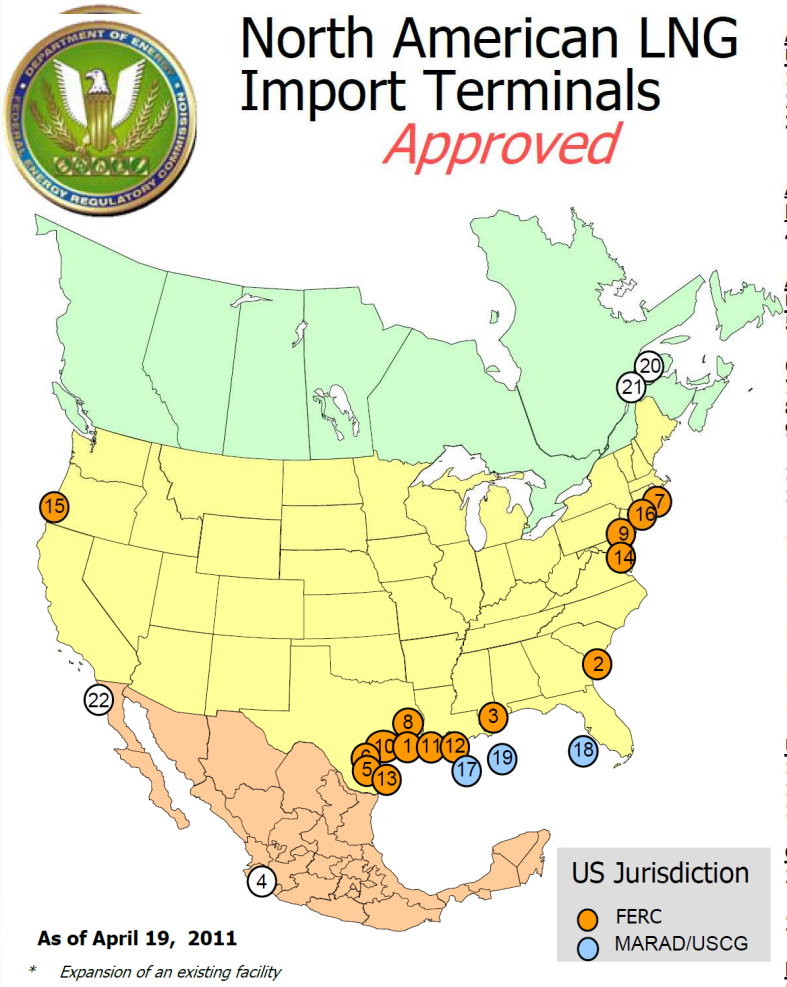
Trailer Mounted Mobile Vaporizers

Truck Mounted ISO/IMO Containers

LNG Market Considerations:

- LNG takes up 1/600 of the volume of gaseous state making it ideal for transport
- LNG is transported to regasification terminals for introduction into existing pipeline infrastructure
- LNG sources:
  - predominantly imported from Trinidad, Tobago, and Algeria
  - Indonesia, Malaysia, and Qatar are also the leading exporters of LNG
- U.S. is developing supply chain, but it takes time to set up infrastructure (limited LNG import terminals)
- LNG powered vehicles are growing in number but need secure and dependable supply (trucking industry is primary user)

Location of U.S. LNG Import Terminals



APPROVED - UNDER CONSTRUCTION
U.S.
1. **Sabine, TX:** 1.0 Bcfd (ExxonMobil - Golden Pass) (Phase II)
2. **Elba Island, GA:** 0.5 Bcfd (El Paso - Southern LNG Expansion)*
3. **Pascagoula, MS:** 1.5 Bcfd (El Paso/Crest/Sonangol - Gulf LNG Energy LLC)

APPROVED - UNDER CONSTRUCTION
Mexico
4. **Manzanillo, MX:** 0.5 Bcfd (KMS GNL de Manzanillo)

APPROVED - NOT UNDER CONSTRUCTION
U.S. - FERC
5. **Corpus Christi, TX**: 1.0 Bcfd (Occidental Energy Ventures – Ingleside Energy)
6. **Corpus Christi, TX:** 2.6 Bcfd, (Cheniere – Corpus Christi LNG)
7. **Fall River, MA :** 0.8 Bcfd, (Hess LNG/Weaver's Cove Energy)
8. **Port Arthur, TX:** 3.0 Bcfd (Sempra)
9. **Logan Township, NJ :** 1.2 Bcfd (Hess LNG - Crown Landing LNG)
10. **Cameron, LA:** 3.3 Bcfd (Cheniere - Creole Trail LNG)
11. **Freeport, TX:** 2.5 Bcfd (Cheniere/Freeport LNG Dev. - Expansion)*
12. **Hackberry, LA:** 0.85 Bcfd (Sempra - Cameron LNG - Expansion)*
13. **Port Lavaca, TX:** 1.0 Bcfd (Gulf Coast LNG Partners – Calhoun LNG)
14. **Baltimore, MD:** 1.5 Bcfd (AES Corporation – AES Sparrows Point)
15. **Coos Bay, OR:** 1.0 Bcfd (Jordan Cove Energy Project)
16. **LI Sound, NY:** 1.0 Bcfd (Broadwater Energy-TransCanada/Shell)

U.S. - MARAD/Coast Guard
17. **Gulf of Mexico:** 1.0 Bcfd (Main Pass McMoRan Exp.)
18. **Offshore Florida:** 1.2 Bcfd (Hoëgh LNG - Port Dolphin Energy)
19. **Gulf of Mexico:** 1.4 Bcfd (TORP Technology-Bienville LNG)

Canada
20. **Rivière-du- Loup, QC:** 0.5 Bcfd (Cacouna Energy - TransCanada/PetroCanada)
21. **Quebec City, QC :** 0.5 Bcfd (Project Rabaska - Enbridge/Gaz Met/Gaz de France)

Mexico
22. **Baja California, MX :** 1.5 Bcfd (Sempra - Energia Costa Azul - Expansion)

Office of Energy Projects

Advantages – LNG Vs. CNG

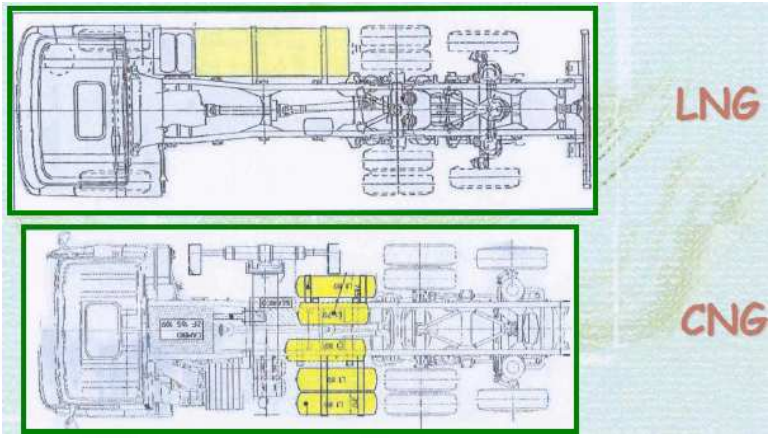
- **LNG allows 1.5 times more range (in hours) than an equivalent CNG vehicle.**
  - **Example for a 25 M3 side loader:**

	TANK CAPACITY	CONSUMPTION	RANGE
DIESEL	250 Liter diesel	14 l_{diesel}/h	17.8 h
LNG	315 Liter LNG	25 l_{LNG}/h	12.6 h
CNG	640 Liter CNG	75l_{CNG}/h	8 h

LNG Vehicle Vs. CNG Vehicle

	DIESEL	LNG	CNG
Consumption/year	1,580,085 L	2,844,080 l	6,399,545 l
Cost/liter	0.541 euro/L	0.109 euro	0.0618 euro/l
Total cost/year	854,826 euro	310,000 euro	395,492 euro

Annual cost for a 40 - vehicles fleet

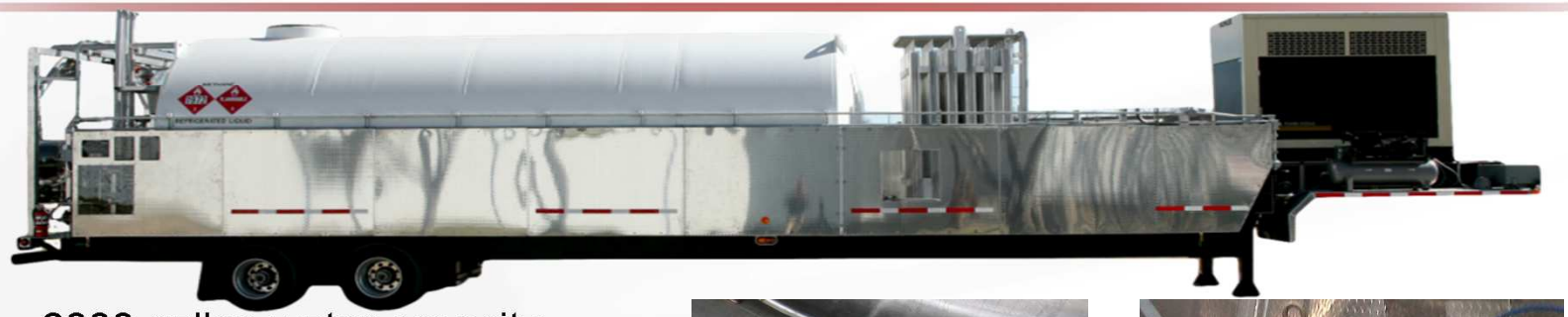


LNG Station	390,660 euro
CNG fast - fill station	751,265 euro

Charging station for 40 vehicles

Resource – ROS ROCA Group

LNG Mobile Fueling Station



- 6000 gallon water capacity
- 2200 hour hold time
  (.5% in 24hrs evap. rate)
- -260 Deg. F
- 175 PSIG MAWP
- 22 HP cryogenic submersible pump
- 30 HP external on-load pump (optional)
- 30kW self contained natural gas generator
  (460VAC 3 phase) for remote operations
- Transformer (460VAC -110VAC)
- Programmable ladder logic controller (PLC)
- VFD for submersible pump

Other Features

- Pneumatic actuated valves (on deck A/C)
- Rear panel view instructional screens for easy operation
- Pressure build unit (TSCP)
- Saturation vaporizer for product pressure control
- Methane and flame detectors
- 10 minute rule impoundment area

More Features

- Liquid level and pressure transducers
- Working/Warning lights
- Emergency Horn
- Emergency stops (all for corners)
- Card Reader
- Air Link Modem w/ GPS (optional)
- Micro Motion Coriolis flow meter

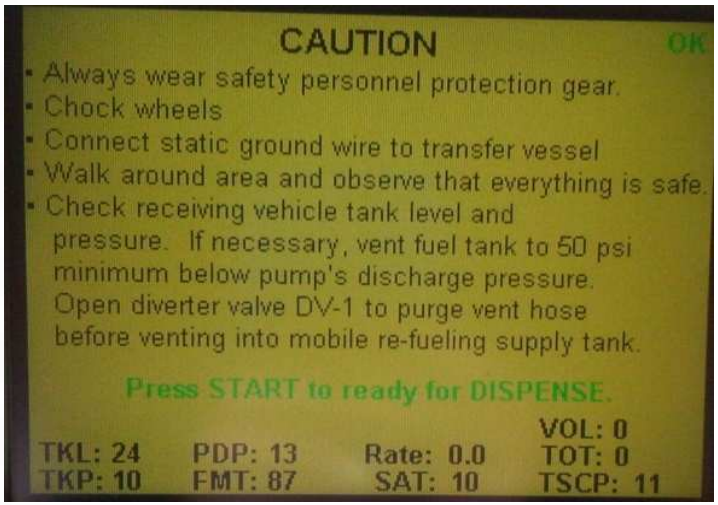
Operation

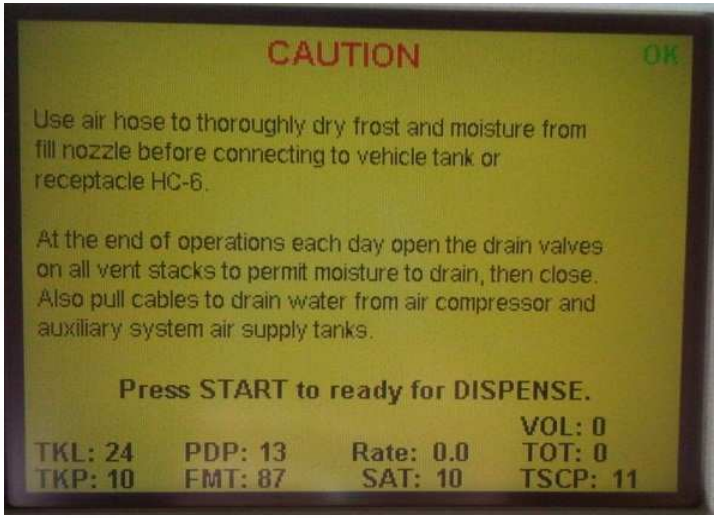

1
GENERATOR POWER
OFF
1
2
2
SHORE POWER
BREMAS


0
1
2
E-STOP
TEMP OK
24V DC POWER ON
AREA SAFE
GENERATOR START
115VAC CONTROL ON
BATT PWR OFF ON
LIGHTS OFF ON
GENERATOR STOP
115VAC CONTROL OFF

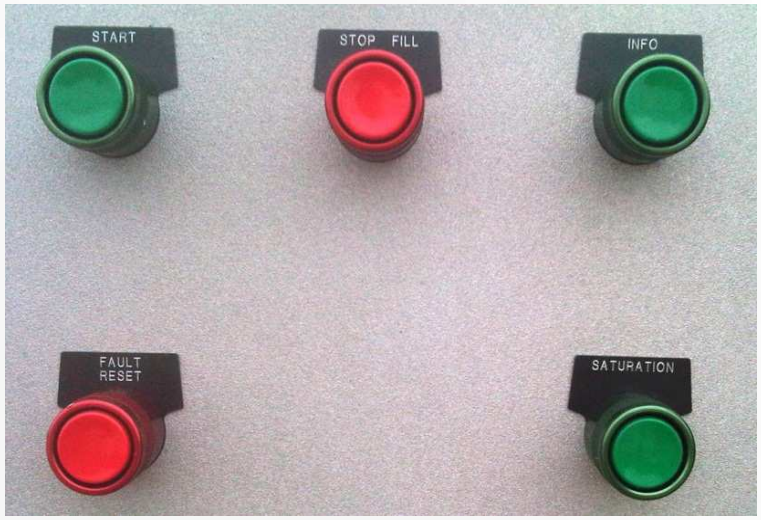
Operation

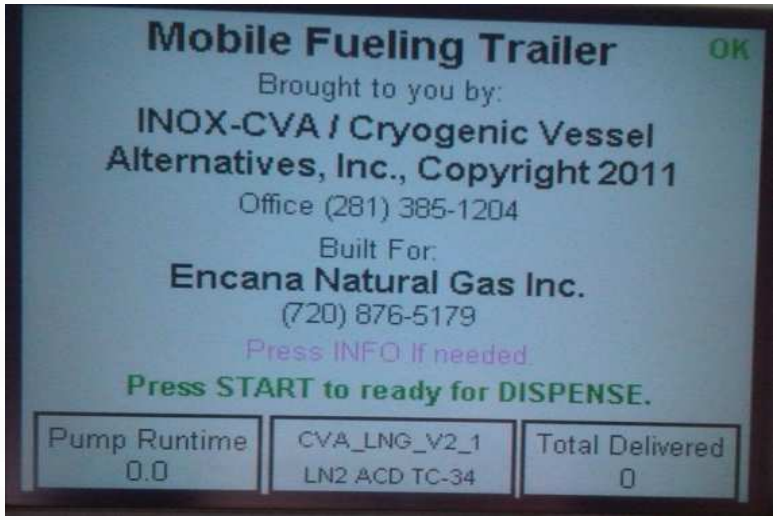

PREVENT STA
SPARK DISCHA
USE GROUNDIN
DEVICES


CAUTION
OK
• Always wear safety personnel protection gear.
• Chock wheels
• Connect static ground wire to transfer vessel
• Walk around area and observe that everything is safe.
• Check receiving vehicle tank level and pressure. If necessary, vent fuel tank to 50 psi minimum below pump's discharge pressure. Open diverter valve DV-1 to purge vent hose before venting into mobile re-fueling supply tank.
Press START to ready for DISPENSE.
VOL: 0
TKL: 24 PDP: 13 Rate: 0.0 TOT: 0
TKP: 10 FMT: 87 SAT: 10 TSCP: 11

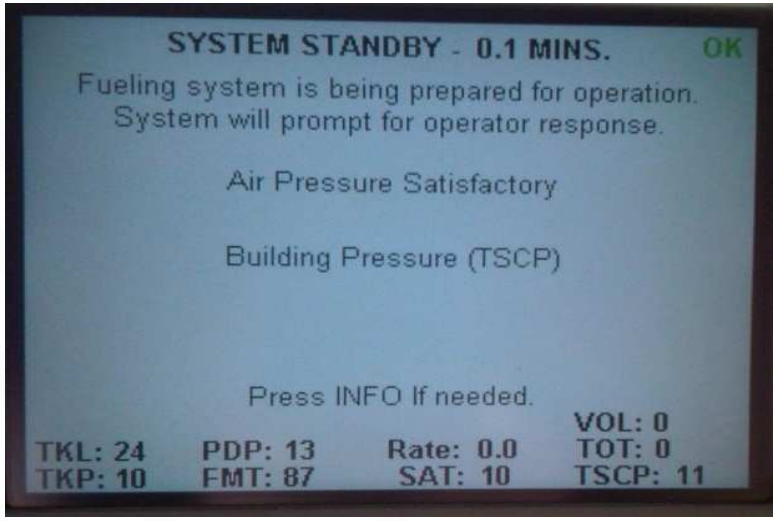

CAUTION
OK
Use air hose to thoroughly dry frost and moisture from fill nozzle before connecting to vehicle tank or receptacle HC-6.
At the end of operations each day open the drain valves on all vent stacks to permit moisture to drain, then close. Also pull cables to drain water from air compressor and auxiliary system air supply tanks.
Press START to ready for DISPENSE.
VOL: 0
TKL: 24 PDP: 13 Rate: 0.0 TOT: 0
TKP: 10 FMT: 87 SAT: 10 TSCP: 11

Operation


START
STOP FILL
INFO
FAULT RESET
SATURATION

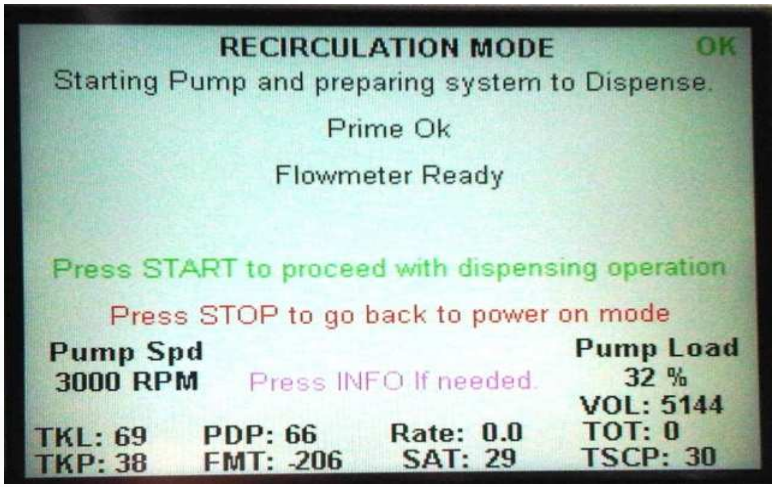

Mobile Fueling Trailer
OK
Brought to you by:
INOX-CVA / Cryogenic Vessel Alternatives, Inc., Copyright 2011
Office (281) 385-1204
Built For:
Encana Natural Gas Inc.
(720) 876-5179
Press INFO If needed.
Press START to ready for DISPENSE.
Pump Runtime 0.0
CVA_LNG_V2_1 LN2 ACD TC-34
Total Delivered 0

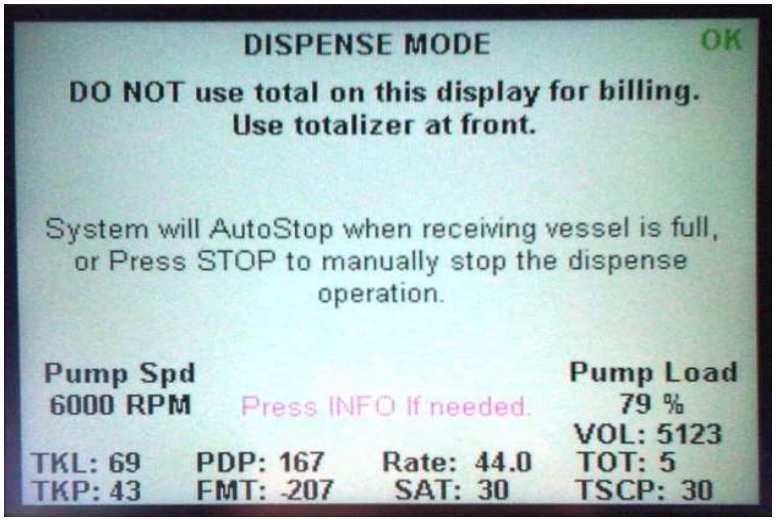

KOHLER.
30
01/27/2011


SYSTEM STANDBY - 0.1 MINS.
OK
Fueling system is being prepared for operation.
System will prompt for operator response.
Air Pressure Satisfactory
Building Pressure (TSCP)
Press INFO If needed.
TKL: 24
TKP: 10
PDP: 13
FMT: 87
Rate: 0.0
SAT: 10
VOL: 0
TOT: 0
TSCP: 11

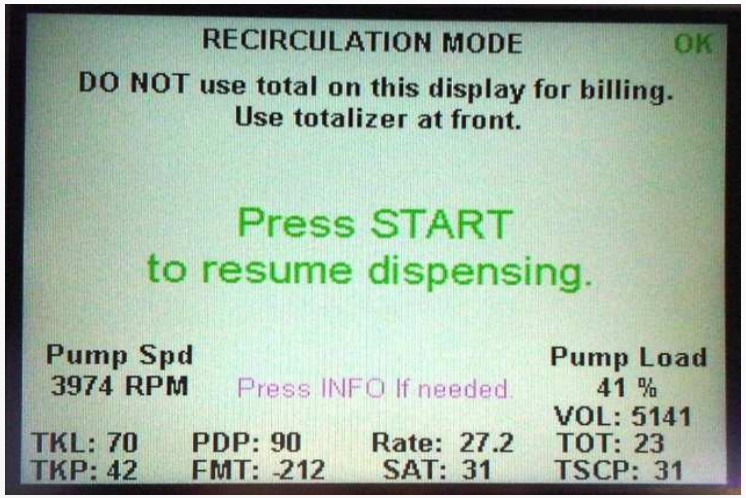
Operation

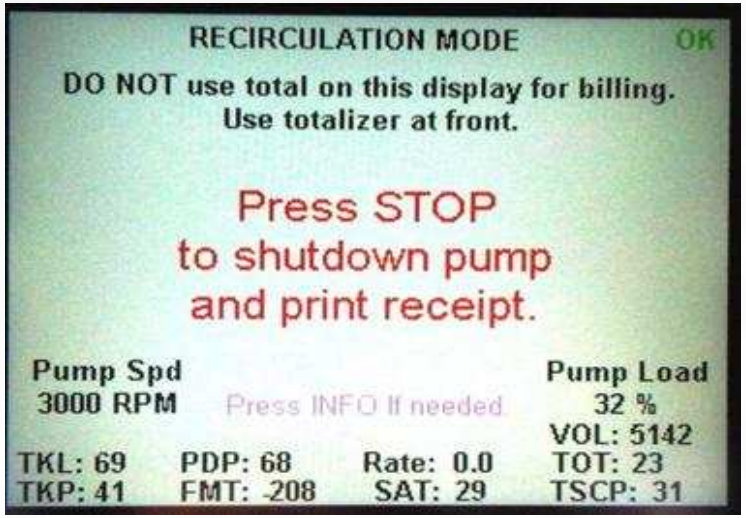
mb.wordpress.com





Operation


RECIRCULATION MODE
OK
DO NOT use total on this display for billing.
Use totalizer at front.
Press START
to resume dispensing.
Pump Spd
3974 RPM
Press INFO If needed.
Pump Load
41 %
VOL: 5141
TKL: 70
PDP: 90
Rate: 27.2
TOT: 23
TKP: 42
FMT: -212
SAT: 31
TSCP: 31


RECIRCULATION MODE
OK
DO NOT use total on this display for billing.
Use totalizer at front.
Press STOP
to shutdown pump
and print receipt.
Pump Spd
3000 RPM
Press INFO If needed.
Pump Load
32 %
VOL: 5142
TKL: 69
PDP: 68
Rate: 0.0
TOT: 23
TKP: 41
FMT: -208
SAT: 29
TSCP: 31

Certified Fuel Delivery

National Conference on Weights and Measures
15245 Shady Grove Road, Suite 130 • Rockville, MD 20850

Certificate Number: 95-055A7
Page 1 of 6

National Type Evaluation Program
Certificate of Conformance
for Weighing and Measuring Devices

For:	Submitted by:
Mass Flow Meter Digital Electronic Sensor Model: CMF Series* (See Page 2) Mass Flow Transmitter Models: RFT9739X Series*, 2700 Series*, 3500 Series*, and 3700 Series* Flow Rate: (See Page 2)	Micro Motion, Inc. 7070 Winchester Circle Boulder, CO 80301-3506 Tel: (303) 530-8400 Fax: (303) 530-8459 Contact: Michael Zinn

Standard Features and Options

- Dual tube design
- Liquid crystal display (LCD)

Options:

- NEMA-4X enclosure
- Hand-held programmers: Rosemont Model SFI 2678, Hart Model HC 275, or Hart Model HC375
- Computer interface
- Printer
- Heater
- Local display on Model 2700 Series transmitter
- Air/vapor eliminator or effective means of air/vapor elimination
- ProLink II communications software for PC

* Digital indicator: Flow Monitoring System Model FMSXXXXXX
Model 3300XXX1XXXXXXXX (rack or panel mount)
Model 3350XXX1XXXXXXX (field mount)

* Numbers or letters in the model number indicated by an "X" represent non-metrological features of the device. However, if the eighth digit of the model number 3300, 3350, 3500 or 3700 is a number other than zero, the device has metrological sealing and software.

This device was evaluated under the National Type Evaluation Program (NTEP) and was found to comply with the applicable technical requirements of Handbook 44, "Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices." Evaluation results and device characteristics necessary for inspection and use in commerce are on the following pages.

G. Weston Diggs
Chairman, NCWM, Inc.

Dennis E. Ehrhart
Chairman, National Type Evaluation Program Committee
Issued Date: January 11, 2005

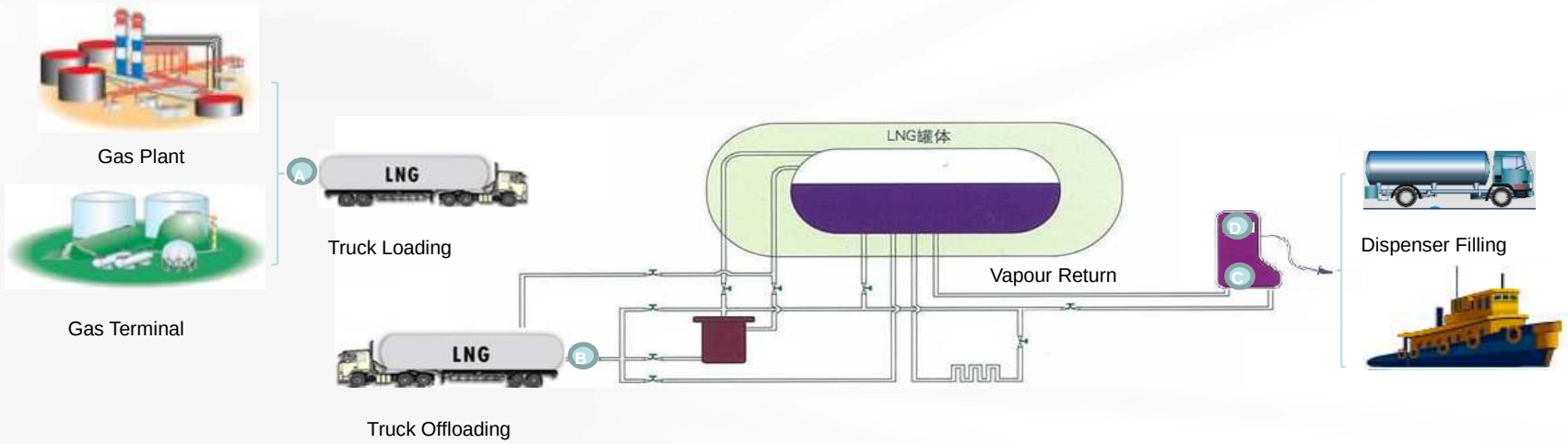
Note: The National Conference on Weights and Measures does not "approve", " recommend", or "endorse" any proprietary product or material, either as a single item or as a class or group. Results shall not be used in advertising or sales promotion to indicate explicit or implicit endorsement of the product or material by the NCWM.

LNG Dispensing Presents Measurement Challenges!

- **Challenges of LNG flow measurement**
  - Cryogenic - -163C
  - Temperature cycling on equipment
  - 2 Phases - vaporizing
  - Temperature & Density control is critical

- **Traditional flow technologies requirements**
  - Insulation jacket needed
  - On line densitometer
  - On line temperature
  - Pressure
  - PTZ compensation must be considered

Micro Motion has experience in LNG!



Coriolis LNG Measurement Solution

- Over 15 Years Experience of LNG Measurement & Dispensing
- MVD Diagnostics enable Liquid / Vapour Phase Control
- MVD Multivariable Measurement improves Monitoring & Control
- MID Certification assists OEM and Operators with Regulatory Compliance

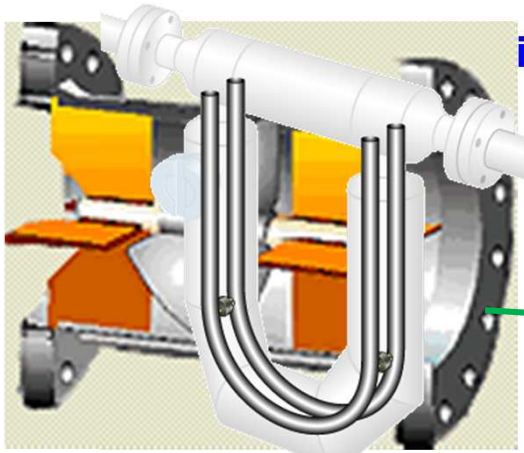
Meter	Application	Meter Type	Meter Flow Rate
A	Truck Loading	CMF 200 CMF 300	87,100 kg/h 272,000 kg/h
B	Truck Offloading	CMF 200 CMF 300	87,100 kg/h 272,000 kg/h
C	Vapour Return	CMF 025 CMF 050	2,180 kg/h 6,800 kg/h
D	Dispenser Filling	CMF 100	27,200 kg/h

Micro Motion's Solution for LNG Measurement

Elite Family

- Highest Mass Accuracy: +/-0.10% of rate (optional +/0.05%)
- Temperature Ratings: -240C to +240C (rated for Cryogenic)
- Approved for Custody Transfer of Cryogenic Liquids
- Three process measurements from one meter:
  - Mass Flow
  - Density
  - Temperature
- Accurate in Empty-Full-Empty Service
- Smart Meter Verification: Safety and Accuracy
- Phase (liquid vs. vapor) of LNG known instantly
- OEM ready: Direct Modbus communications

Advantages of Coriolis Vs. Turbine Meters



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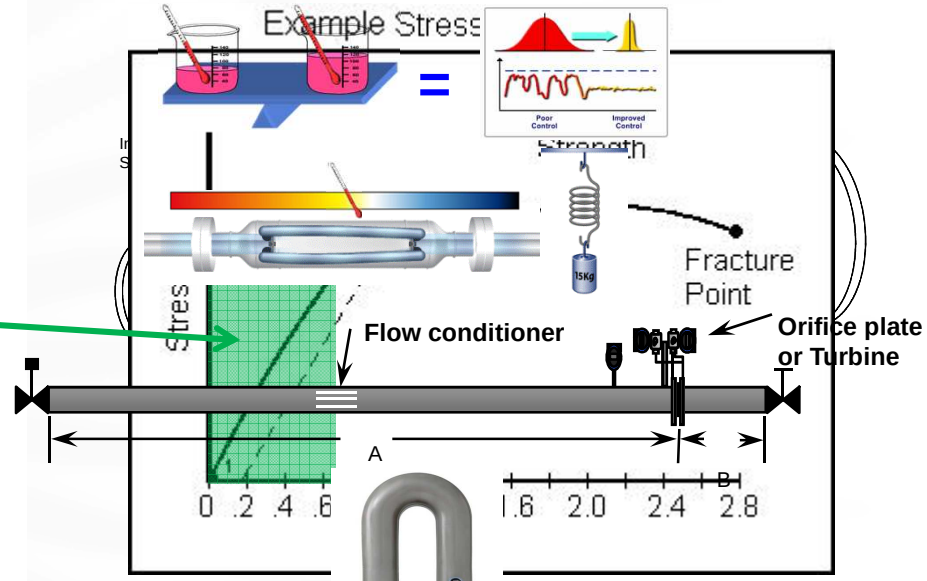


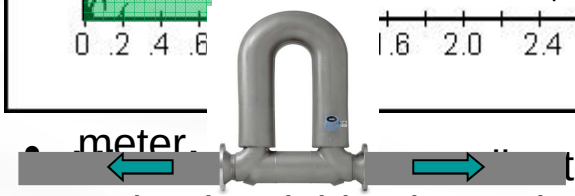
Turbine Limitations

- Over registering due to coating
- Accuracy is density dependent
- Mechanical wear (maintenance)
- Limited turndown
- Uni-directional measurement
- Different calibration factor for each fluid
- Requires vapor eliminator and straightening vanes
- Volume based measurement
- Poor cleanability

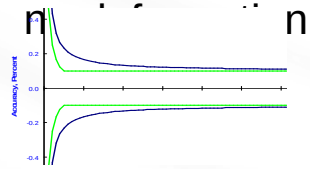
Bi-Directional Capability

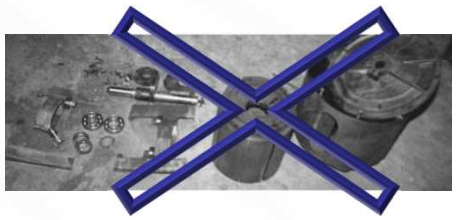
Wider Turndown

No moving parts

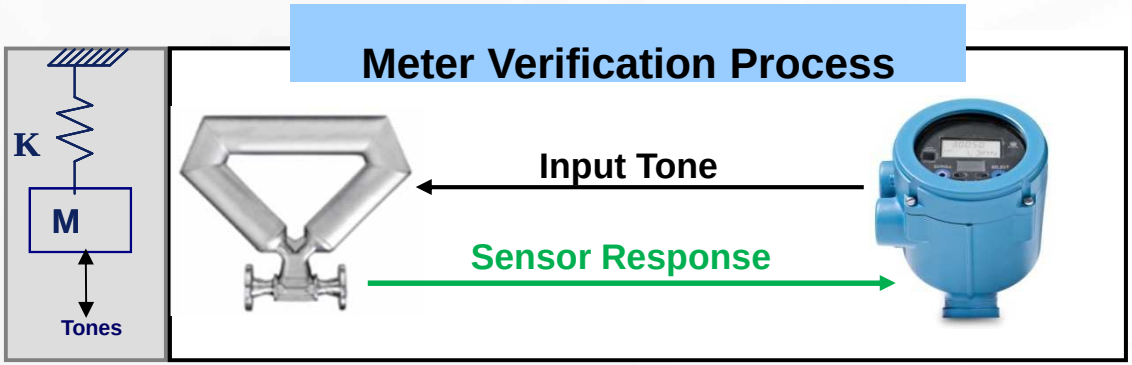


meter te well under the yield point so there is n n or wear!!



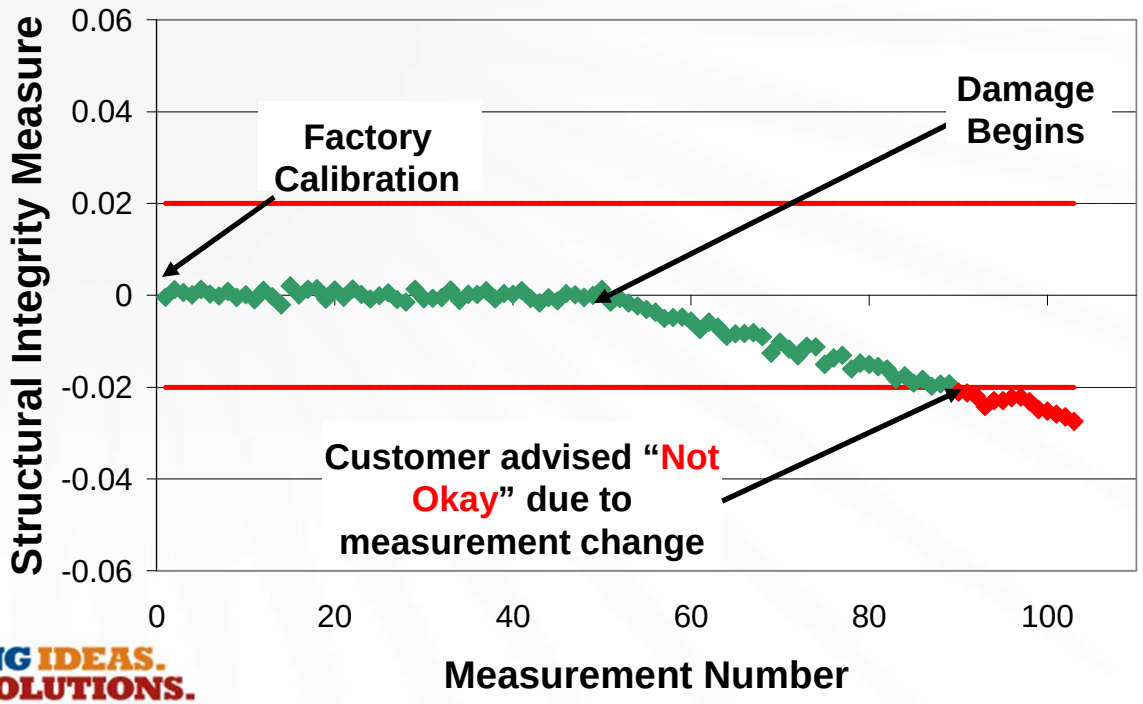


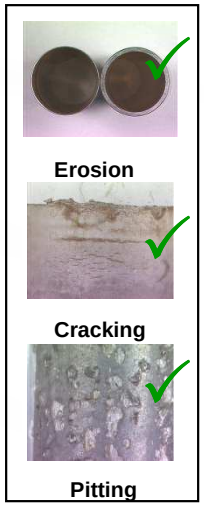
Micro Motion's Smart Meter Verification = Confidence



Operation at Local Display

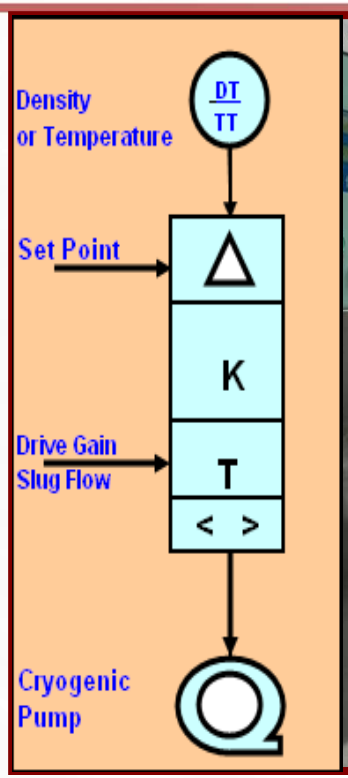
- Okay
- Not Okay





Diagnostics Ensure Accuracy in LNG Dispensing

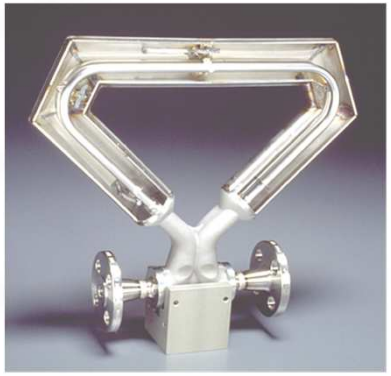
- **MODBUS Direct connection**
  - Drive gain
  - Slug Flow → Pump Start
  - Density
  - Temperature → Fluid Status
  - Mass Flow
  - Volume flow → Measurement

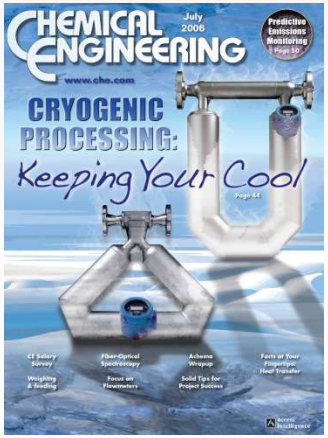


- **Traditional technology or other Coriolis manufacturers**
  - Analog (4 - 20mA) or Frequency only
  - No fluid phase status available
  - No Smart Meter Verification

Micro Motion- Focused on Cryogenic Applications!

- Has developed more robust sensor internals to address rapid temperature cycling
- Cryogenic Service- Now standard offering on Elite sensors (“C” under *Measurement Application Code*)
- Cryogenic Best Practices presentations, white papers, and application notes written by Micro Motion
- Elite sensors tested by NIST in cryogenic service and found factory calibration to be transferable





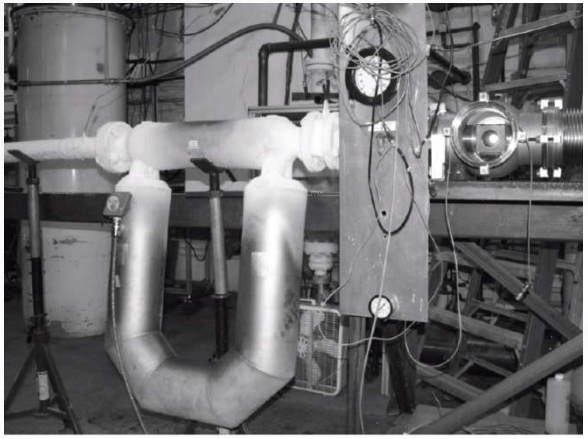
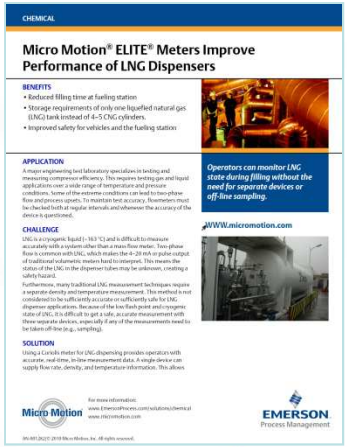


Figure 2. Micro Motion Coriolis meter mounted in a NIST liquid nitrogen test stand



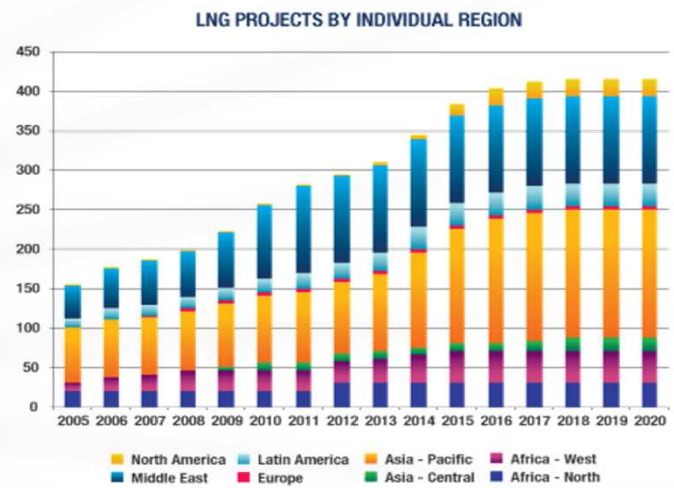
Business Results Achieved

- Environmentally cleaner, cheaper fuel costs, and safer operations provide good selling points for liquid natural gas
- INOXCVA's automated fuel delivery system saves time at the fuel station
- Micro Motion's safe, accurate metering features saves time for customers
- Micro Motion's capability of being approved for custody transfer from state to state and country to country catches the attention of industry suppliers
- 13 mobile fuel stations for 2011 with new customer interest frequently

Experience Expertise Excellence

Summary

- Because of new drilling technology the LNG market is rapidly growing in the US and worldwide
- More infrastructure is needed to transition from less abundant fossil fuels to the cleaner energy of natural gas
- The combination of Micro Motion's accurate and reliable cryogenic flow meters and INOXCVA's innovative mobile fuel stations will provide a solution to a transition that will change the energy crisis drastically



Where To Get More Information

- LNG Import/Export Terminal Information (FERC)
  http://ferc.gov/industries/gas/indus-act/lng/exist-term.asp
- *www.naturalgas.org*
- *INOXCVA Website:* *www.cvatanks.com*
- *Micro Motion Website*: *www.micromotion.com*