EMERSON

LNG supply chain and commercial solutions

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2017 Emerson At-A-Glance

FOUNDED

1890

HEADQUARTERS IN

ST. LOUIS, MO

USA

RECOGNITION

#139

2017
FORTUNE 500
AMERICA'S LARGEST CORPORATIONS BY REVENUE

Top 50 Employers
WOMEN ENGINEERS MAGAZINE

America's Best Employers
FORBES MAGAZINE

TWO BUSINESS PLATFORMS

WORLDWIDE

76,500
EMPLOYEES

200
MANUFACTURING LOCATIONS

INNOVATION

EMERSON EMPLOYEES WERE AWARDED MORE THAN

2,100 PATENTS WORLDWIDE IN 2017

$15.3
BILLION
IN GLOBAL SALES
FISCAL YEAR 2017

61
YEARS

CONSECUTIVE YEARS OF INCREASED DIVIDENDS

NYSE:

EMR

EMERSON

Improving Process and Industrial Manufacturing Performance with Measurable Results

Industries Served include

Oil and Gas/Refining

Chemical

Power

Food and Beverage

Metals and Mining

Water and Wastewater

Life Sciences

Automotive

Electronics

Core Expertise & Key Brands

Industrial Internet of Things
- Plantweb

Systems and Asset Management
- DeltaV
- Ovation

Measurement Instrumentation
- Rosemount
- Micro Motion

Solenoids and Pneumatics
- ASCO

Valves, Actuators and Regulators
- Bettis
- Crosby
- Fisher
- Keystone
- KTM
- Vanessa

Precision Welding
- Branson

Electrical and Lighting
- Appleton

Industry Services and Solutions

Introduction

Emerson in the LNG market chain

Emerson Flow Portfolio on the LNG supply chain

MID solutions LNG Bunkering

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Small scale **LNG** map

LNG import terminals offering new LNG services

- **Reloading**: Transfer of LNG from one [illegible] terminal into a vessel
- **Transhipment**: Direct transfer of LNG from one vessel to another
- **Loading of bunker ships**: LNG is loaded on bunkering ships which supply to LNG-fuelled ships or LNG bunkering facilities for vessels
- **Truck loading**: LNG is loaded on tank trucks which transport LNG in smaller quantities
- **Rail loading**: LNG is loaded on rail tanks which transport LNG in smaller quantities

LNG small-scale liquefaction plants:

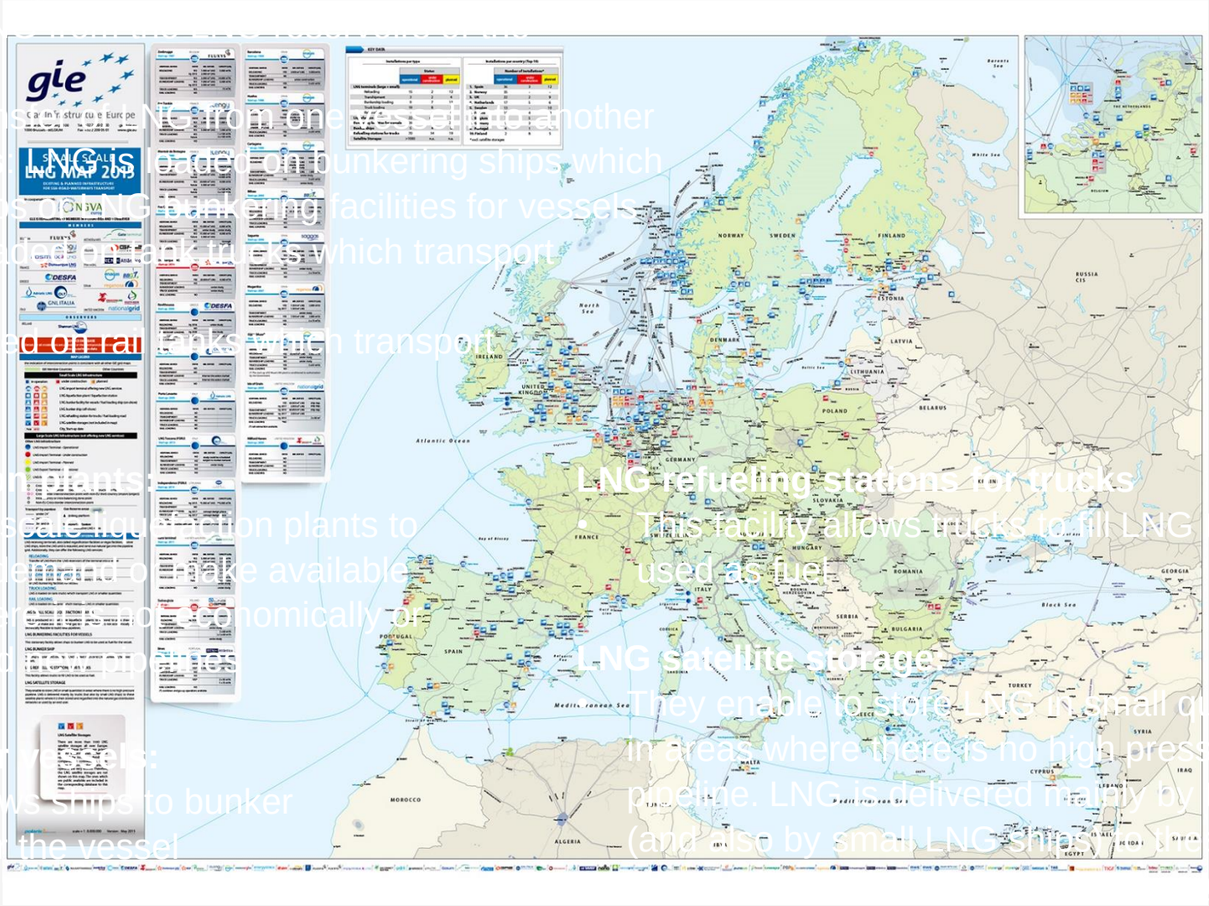
- LNG is produced in small scale liquefaction plants to respond to peak shaving demand or make available natural gas to regions where it is not economically or technically feasible to build a pipeline

LNG bunkering facilities for vessels:

- This stationary facility allows ships to bunker LNG to be used as fuel for the vessel

LNG bunker ship:

- This ship supplies LNG directly to LNG-fuelled ships or to LNG bunkering facilities for vessels



LNG refueling stations for trucks

- This facility allows trucks to fill LNG to be used as fuel

LNG satellite storage:

They enable to store LNG in small quantities in areas where there is no high pressure pipeline. LNG is delivered mostly by trucks (and also by small LNG ships). In these satellite [illegible] gasified into the natural gas distribution networks or used by an end user.

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Major LNG Operations from Earth to Client

Gas Production

Compression & Pipeline

Onshore Liquefaction

FPSO/GBS

Ship Loading

LNG Shipping

Offshore & Onshore LNG

Receiving & Regasification

Terminals

Pipeline Delivery

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Emerson is committed to the **LNG** Market

Gas Production 100%

Liquefaction plant 95-100%

Shipping 90-100%

Fisher Control Valves & Regulators, DeltaV, PlantWeb & AMS, Rosemount Measurement, Valve Automation, SAAB Ship Gauging & Ultrasonic

Regasification Terminal 95-100%

Pipeline delivery 100%

emote Operations
s & Analyzers,

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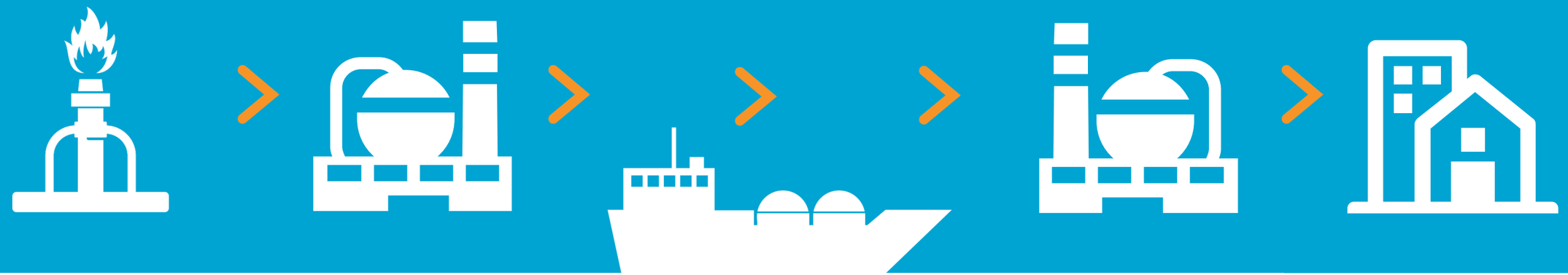
LNG Value Chain



Gas Production > Liquefaction > LNG Shipping > Regasification > Customers

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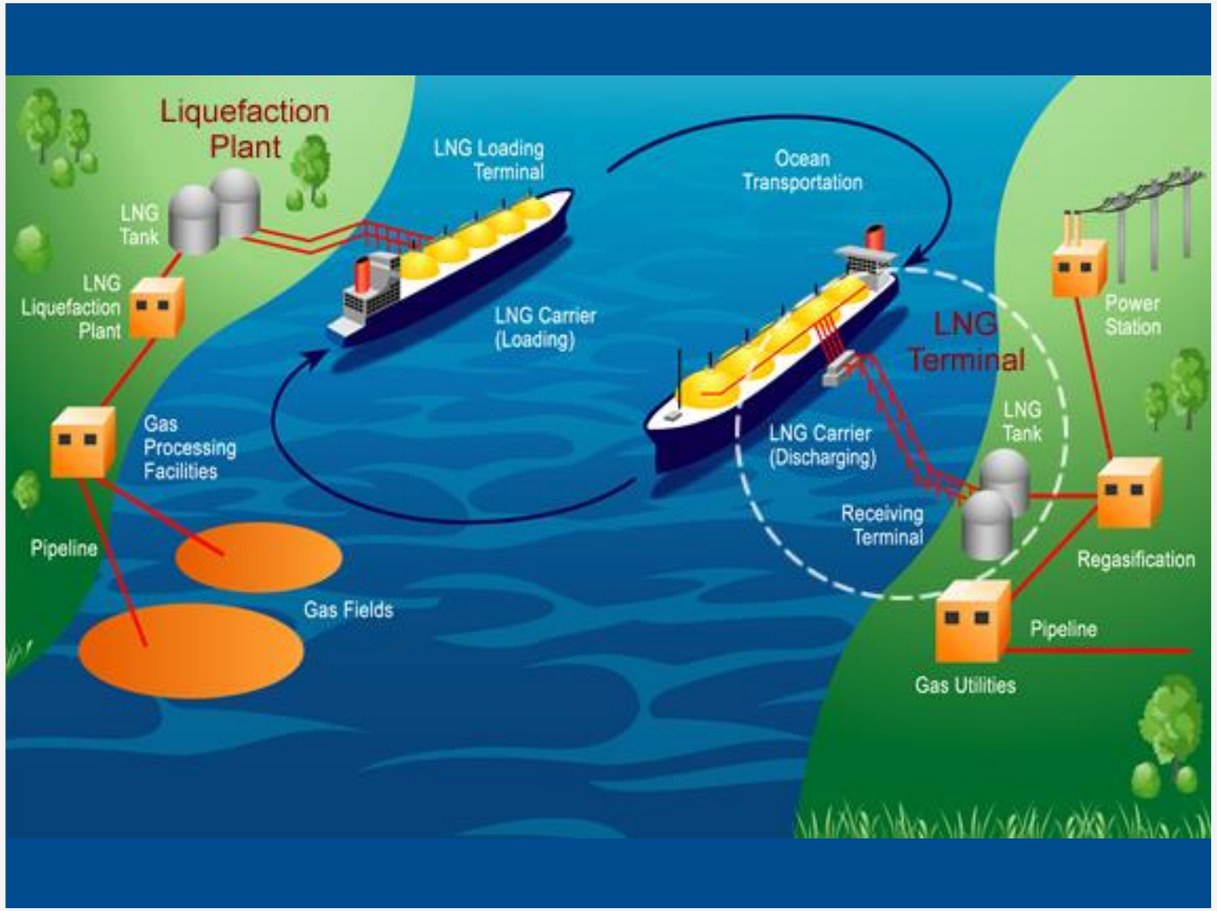
LNG Value Chain



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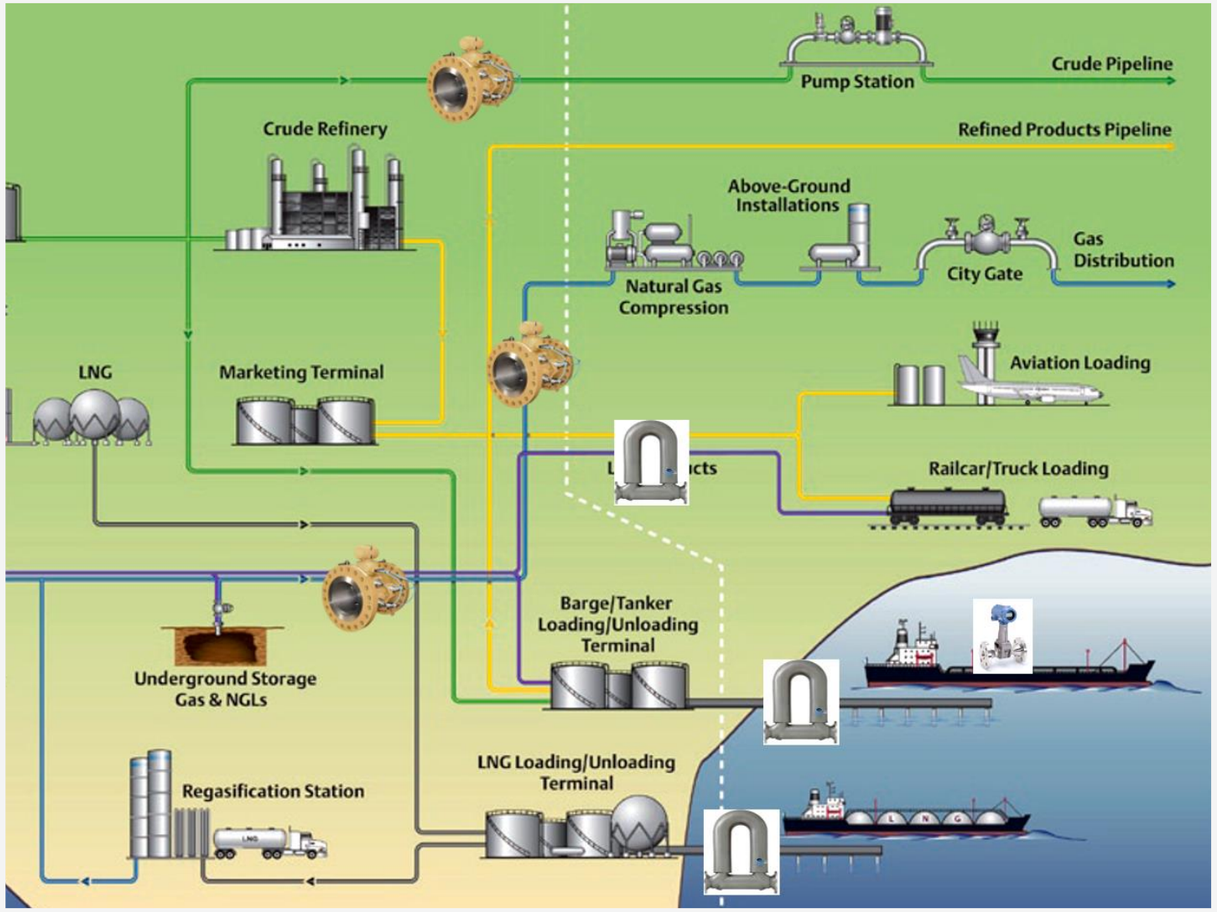
LNG Flow supply chain



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LNG Value Chain; Terminal

Blending

Movement

Pipelines

Unit Feed

Vessels

Trucks

Railroad

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LNG supply chains supported by Emerson;
many include custody transfer applications

Bunkering loading / unloading
on-shore / marine

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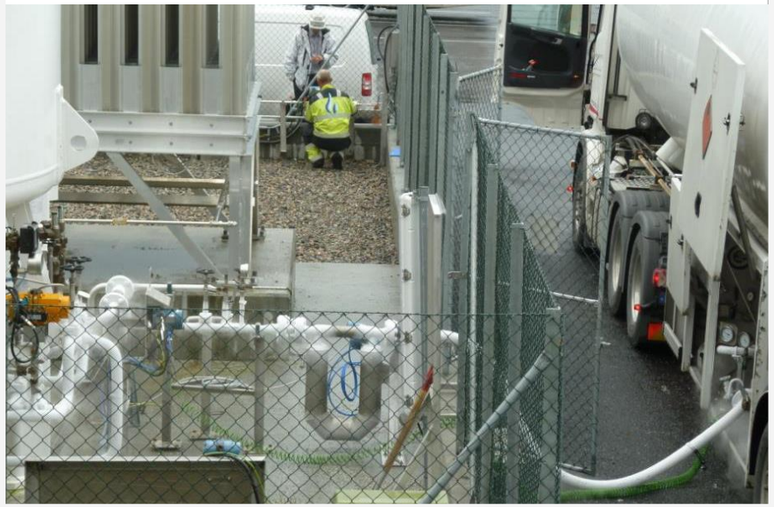
LNG supply chains supported by Emerson

Dispensers

Tank truck loading/unloading



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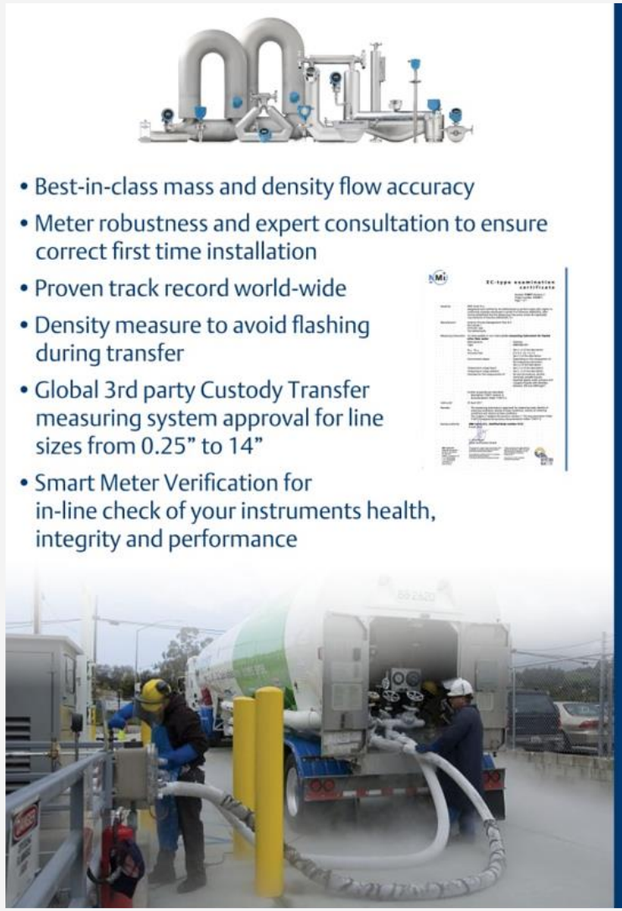
Wide success in **LNG**



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Few of the **LNG related** customers

Emerson was chosen as
Main Automation Contractor for:

- Shell Prelude FLNG
- Petronas FLNG1

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Cost of Uncertainty – Why Measurement Matters

QUICK EXERCISE

- An LNG ship has a capacity of 140,000m³
- The gross calorific value of the LNG is 1060 Btu/scf
- The LNG selling price is $8/MMBtu
- What is the value of the cargo?
- N.B 1m³ = 35.31ft³

Answer

Convert m³ from liquid into gas ———— 140,000 * 600

Convert from m³ of gas into ft³ gas ———— 84,000,000 * 35.31

Convert from ft³ to Btu ———— 2,966,040,000 * 1060

Convert from Btu to MMBtu ———— 3,140,000,000,000 / 1,000,000

Convert into $———— 3,144,002 * 8 = **$25.15 million**

- **Quick exercise for a transaction with $ value of 25.15 million**
- **Measurement uncertainty ties directly to $ throughput**
- **Financial risk quickly builds with poor measurement**

Financial Risk Associated With Measurement Accuracy						
Measurement Uncertainty	**0.20%**	**0.40%**	**0.80%**	**1.00%**	**1.50%**	**2.00%**
Financial Risk (+/- $)	**$50300**	**$100600**	**$201200**	**$251500**	**$377250**	**$503000**

Minimizing measurement uncertainty is extremely important

Flow **Solutions**

Micro Motion

MICRO MOTION™

Daniel

DANIEL™

Rosemount Flow

ROSEMOUNT™

Regulator Technologies

FISHER™

Roxar

ROXAR™

Lifecycle Services

Performance

Reliability

Maintenance

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LNG metering

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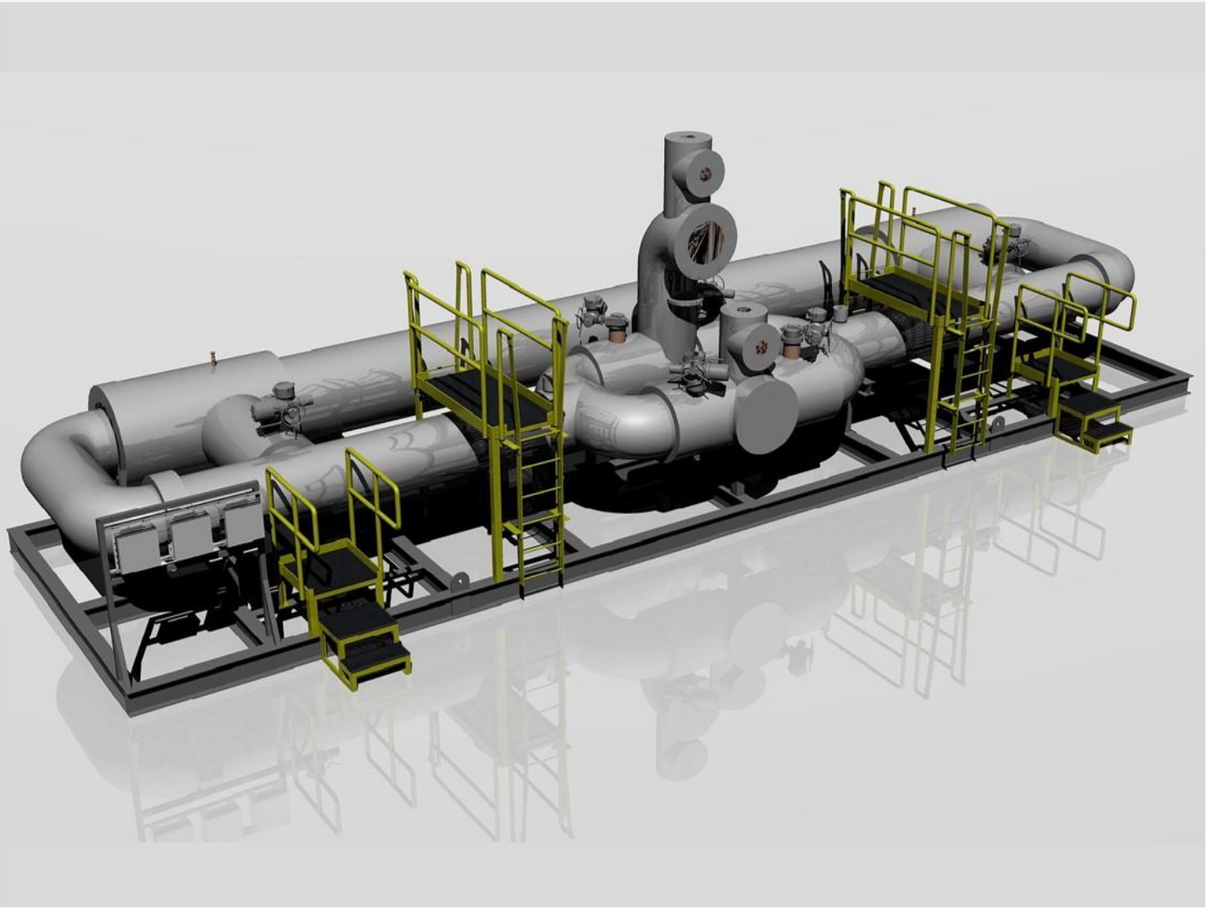
Fully insulated for LNG Service



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Emerson for PGNIG – Master Meter LNG

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What is **OIML** and **MID**?

A set of Measuring System requirements to guarantee:

- You get what you are paying for and you can prove it
- You deliver what you are being paid for and you can prove it

- OIML is **global standard** and MID is **European Directive**.
- **NMi** and **Emerson** (if applicable, cooperative with system-owners) to achieve fulfillment of MID (and OIML) for Legal applications.

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What is **OIML** and **MID**?

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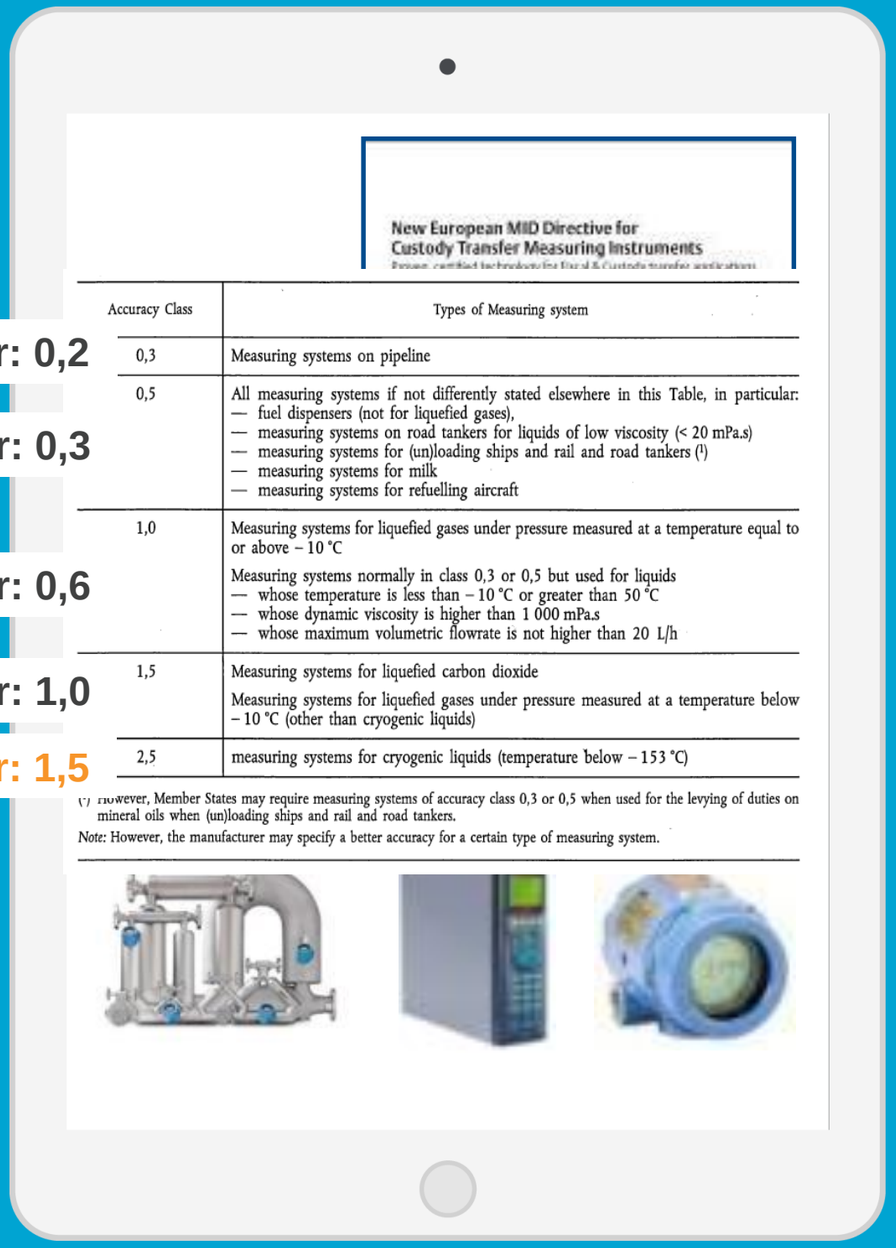
MID-General

- MID stands for Measuring Instruments Directive
- EU harmonization & standardization around the transfer of ownerships of liquids and gases and the method of tax paying around it:
  - 1 European union, 1 set of rules for custody transfer 28 EU countries + CH, NO & TR
  - Introduction– transition time – Obligation by October 31, 2016
    - Liquids (MI-005) (other than water) and Gases (MI-002)
    - Accuracy classes

      Applications:
      - Loading / unloading, pipeline
      - % alcohol measurement

Cryogenics- LNG accuracy class will change to 1.5 (meter 1.0)



New European MID Directive for Custody Transfer Measuring Instruments

	Accuracy Class	Types of Measuring system
Meter: 0,2	0,3	Measuring systems on pipeline
Meter: 0,3	0,5	All measuring systems if not differently stated elsewhere in this Table, in particular: — fuel dispensers (not for liquefied gases), — measuring systems on road tankers for liquids of low viscosity (< 20 mPa.s) — measuring systems for (un)loading ships and rail and road tankers (1) — measuring systems for milk — measuring systems for refuelling aircraft
Meter: 0,6	1,0	Measuring systems for liquefied gases under pressure measured at a temperature equal to or above – 10 °C Measuring systems normally in class 0,3 or 0,5 but used for liquids — whose temperature is less than – 10 °C or greater than 50 °C — whose dynamic viscosity is higher than 1 000 mPa.s — whose maximum volumetric flowrate is not higher than 20 L/h
Meter: 1,0	1,5	Measuring systems for liquefied carbon dioxide Measuring systems for liquefied gases under pressure measured at a temperature below – 10 °C (other than cryogenic liquids)
Meter: 1,5	2,5	measuring systems for cryogenic liquids (temperature below – 153 °C)

(1) However, Member States may require measuring systems of accuracy class 0,3 or 0,5 when used for the levying of duties on mineral oils when (un)loading ships and rail and road tankers.

Note: However, the manufacturer may specify a better accuracy for a certain type of measuring system.

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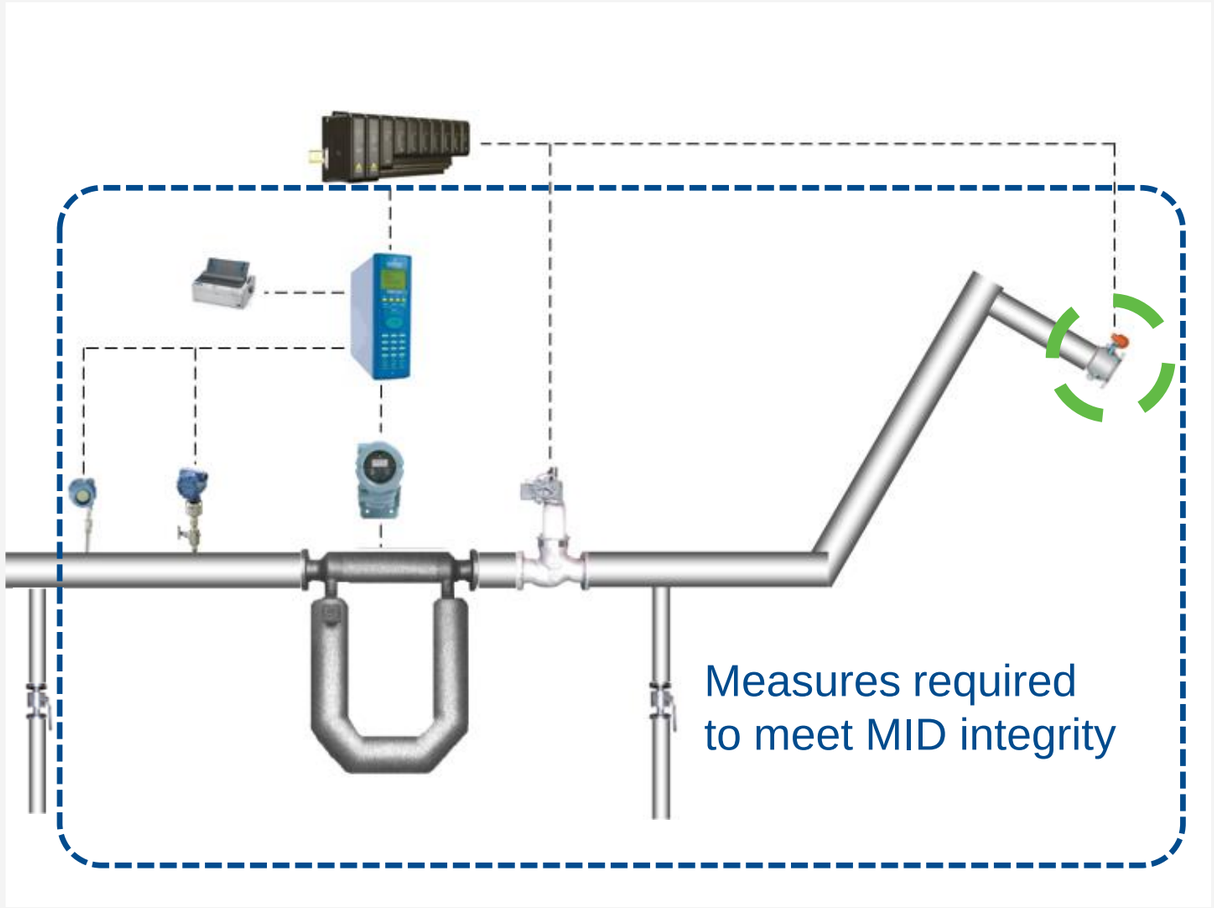
EC Type Examination Certificate

System Certificate



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Responsibilities

MID Approval

MID Certification Process

Emerson / NMi

Subsequent Verification

Local Notified Body

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LNG energy measurement according MID/OIML

Emerson accepts full responsibility for the custody transfer certification of whole measuring system and energy calculation (less burden for end-user)

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Key messages

- Emerson ready for LNG solutions, including custody transfer regulations MID
  - Accuracy and stability of installed LNG Coriolis meters excellent
    - Additional diagnostic tools (SMV) to verify the health of the meter and reduce the re-calibration frequency

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