LNG supply chain and commercial solutions

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2017 Emerson At-A-Glance

FOUNDED
1890

HEADQUARTERS IN
ST. LOUIS, MO
USA

RECOGNITION

2017
FORTUNE 500
AMERICA’S LARGEST
CORPORATIONS BY REVENUE

Top 50 Employers
WOMEN ENGINEERS MAGAZINE

America’s Best Employers
FORBES MAGAZINE

TWO BUSINESS PLATFORMS

EMERSON AUTOMATION SOLUTIONS

EMERSON COMMERCIAL & RESIDENTIAL SOLUTIONS

$15.3 BILLION
IN GLOBAL SALES
FISCAL YEAR 2017

61 YEARS
CONSECUTIVE YEARS OF
INCREASED DIVIDENDS

NYSE:
EMR

WORLDWIDE

76,500 EMPLOYEES

200 MANUFACTURING LOCATIONS

INNOVATION
EMERSON EMPLOYEES WERE AWARDED MORE THAN
2,100 PATENTS WORLDWIDE IN 2017
**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**

<table>
<thead>
<tr>
<th>Industrial Internet of Things</th>
<th>Valves, Actuators and Regulators</th>
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<tbody>
<tr>
<td>• Plantweb</td>
<td>• Bettis</td>
</tr>
<tr>
<td>• Systems and Asset Management</td>
<td>• Fisher</td>
</tr>
<tr>
<td>• DeltaV</td>
<td>• Crosby</td>
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<tr>
<td>• Ovation</td>
<td>• Keystone</td>
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<tr>
<td>Measurement Instrumentation</td>
<td>• KTM</td>
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<tr>
<td>• Rosemount</td>
<td>• Vanessa</td>
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<tr>
<td>• Micro Motion</td>
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<tr>
<td>Solenoids and Pneumatics</td>
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<td>• ASCO</td>
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</tbody>
</table>

**Precision Welding**
- Branson

**Electrical and Lighting**
- Appleton

**Industry Services and Solutions**
- Fisher
- Keystone
- KTM
- Vanessa
Introduction

Emerson in the LNG market chain

Emerson Flow Portfolio on the LNG supply chain

MID solutions LNG Bunkering
Introduction

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MID solutions LNG Bunkering
LNG import terminals offering new LNG services

- **Reloading**: Transfer of LNG from the LNG reservoirs of the terminal into a vessel
- **Transhipment**: Direct transfer of LNG from one vessel into another
- **Loading of bunker ships**: LNG is loaded on accessory bunkering ships which supply to LNG-fueled 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, make available natural gas to regions where it is not economically or technically feasible to build pipelines

**LNG bunkering facilities for vessels**

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

**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 mainly by trucks and, also by small LNG ships to these satellite storage. Then LNG gasified into the natural gas distribution networks or used by an end user.
Introduction

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MID solutions LNG Bunkering
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
Emerson is committed to the LNG Market

Gas Production 100%

Liquefaction plant 95-100%

Shipping 90-100%

Regasification Terminal 95-100%

Pipeline delivery 100%

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

1. Gas Production
2. Liquefaction
3. LNG Shipping
4. Regasification
5. Customers
LNG Flow supply chain
LNG Value Chain; Terminal

Terminal Management System

Tank Monitoring Systems

Blending

Movement

Pipelines

Unit Feed

Vessels

Trucks

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

Bunkering loading / unloading on-shore / marine
LNG supply chains supported by Emerson

Dispensers

Tank truck loading/unloading
Wide success in LNG

- Best-in-class mass and density flow accuracy
- Meter robustness and expert consultation to ensure correct first time installation
- Proven track record worldwide
- Density measure to avoid flashing during transfer
- Global 3rd party Custody Transfer measuring system approval for line sizes from 0.25" to 14"
- Smart Meter Verification for in-line check of your instruments health, integrity and performance
Few of the **LNG** related customers

**Emerson** was chosen as Main Automation Contractor for:
- Shell Prelude FLNG
- Petronas FLNG1
Cost of Uncertainty – Why Measurement Matters

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

<table>
<thead>
<tr>
<th>Measurement Uncertainty</th>
<th>0.20%</th>
<th>0.40%</th>
<th>0.80%</th>
<th>1.00%</th>
<th>1.50%</th>
<th>2.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial Risk (+/- $)</td>
<td>$50300</td>
<td>$100600</td>
<td>$201200</td>
<td>$251500</td>
<td>$377250</td>
<td>$503000</td>
</tr>
</tbody>
</table>

Minimizing measurement uncertainty is extremely important
Flow Solutions

Micro Motion

Daniel

Rosemount Flow

Regulator Technologies

Roxar

Lifecycle Services

Performance
Reliability
Maintenance

EMERSON
LNG metering
Fully insulated for LNG Service
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MID solutions LNG Bunkering
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.
What is OIML and MID?
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)
  - Gases (MI-002)
- Accuracy classes

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

Cryogenics- LNG accuracy class will change to 1.5 (meter 1.0)
EC Type Examination Certificate
System Certificate

Measures required to meet MID integrity
Responsibilities

MID Certification Process

Emerson / NMi

MID Approval

Subsequent Verification

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