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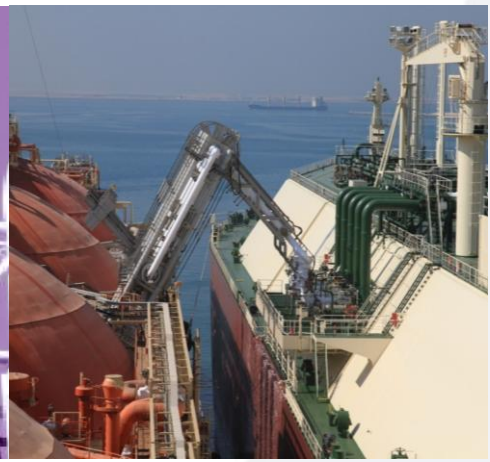
Transfer solutions for LNG bunkering

June 1st, 2016 – G.GATOUILLAT
"*114ème session de l'ATMA*"



Agenda

- **FMC Technologies**
  - Group overview
  - Loading Systems Division
- **LNG Bunkering market**
  - Context
  - LNG as fuel instead of cargo
  - Comparison with conventional LNG application
  - New LNG global chain
- **LNG Bunkering transfer solutions**
  - Loading arm : basic principle
  - Key drivers
  - FMC solutions
  - Others existing solutions
- **Conclusion**

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FMC Technologies at a glance



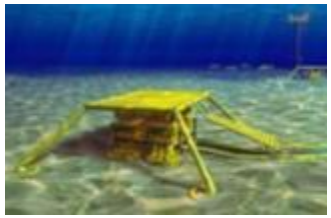

FMC Technologies Inc. (FMCTI)

An oilfield services and equipments company

66% 34%

66% Subsea Technologies

- Subsea Systems
- Schilling Robotics
- Multi Phase Meters
- Separation Systems
- Direct Drive Systems

34% Surface Technologies

- Surface Wellhead
- Fluid Control
- Completion Services
- Measurement Solutions
- **Loading Systems**
- Automation and Control




$7.9B Revenue in 2015

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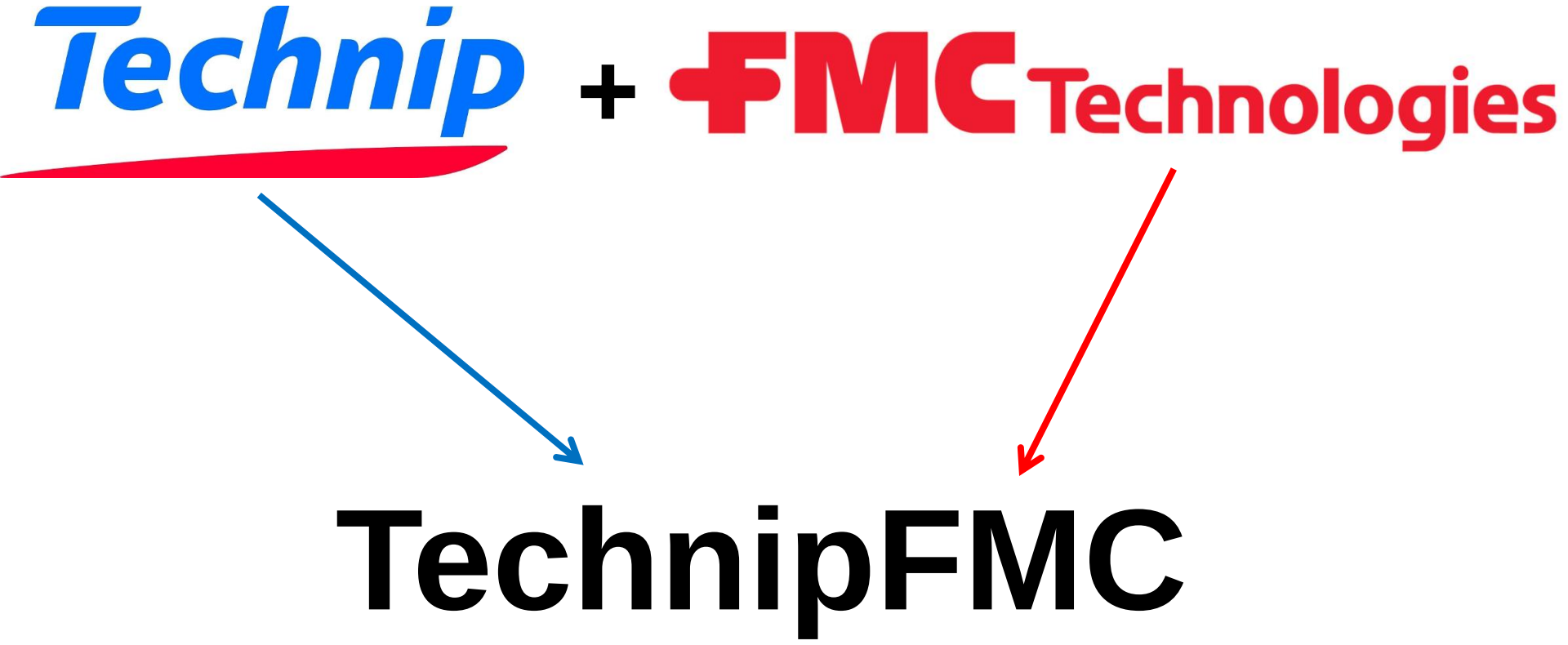
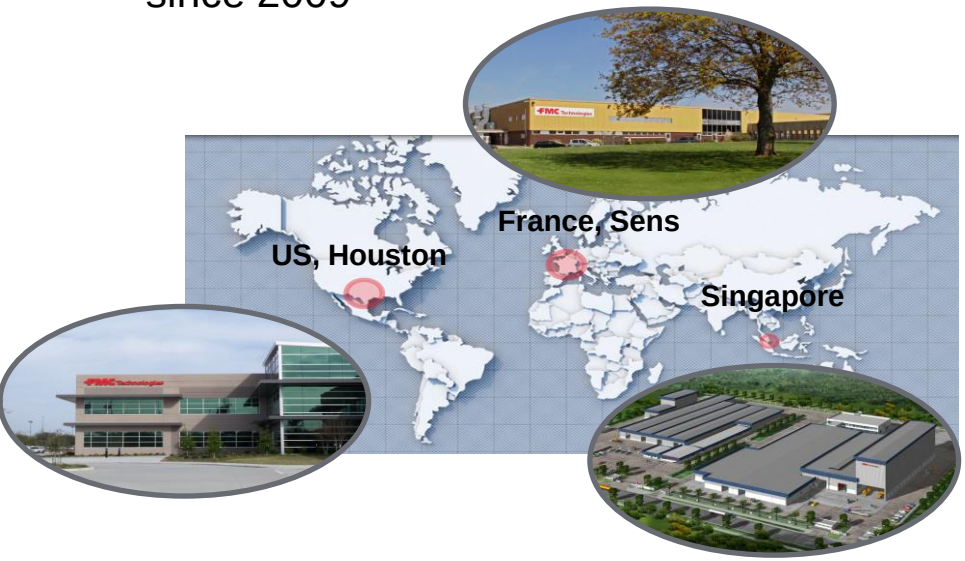
FMC Technologies and Technip to combine



FMC Technologies : Loading Systems division

- 3 Facilities: France, US and Singapore
- Main production plant in France
- 320 skilled employees worldwide
- Sales and Marketing, R&D, Engineering, Production, Supply Chain…
- +100 Marine Loading Arms shipped every year since 2009



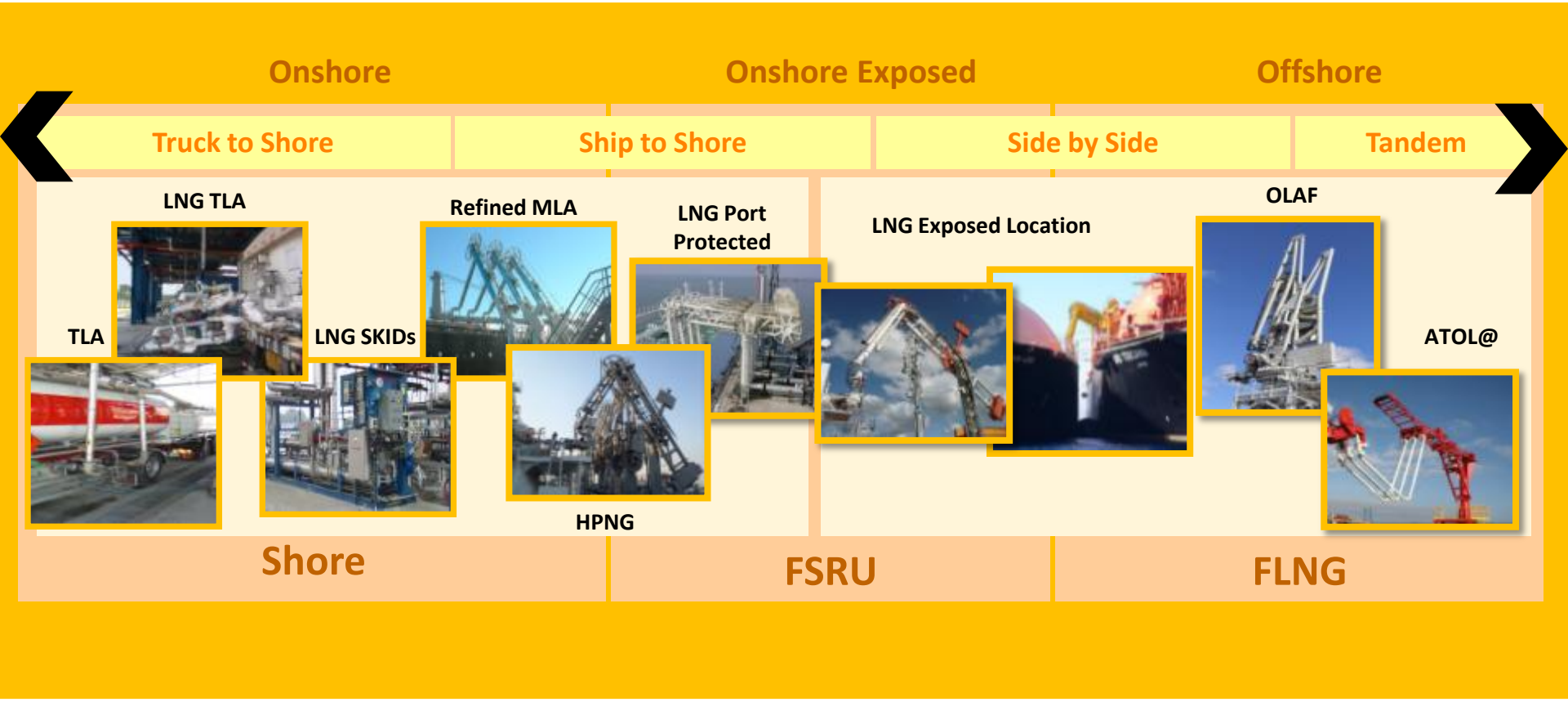
Certifications

ISO 9001 v2008 Design, manufacture and marketing of oil and gas equipment

ISO 14001 v2004 Environmental certification

OHSAS 18001 v2007 Occupational Health and Safety Management System

Products range and market covering



- TLA = Truck & Rail Car Arms
- MLA = Marine Loading Arms

Our LNG experience : more than 45 years









Our last achievements : Shell Prelude

Our last achievements : Petronas PFLNG Satu

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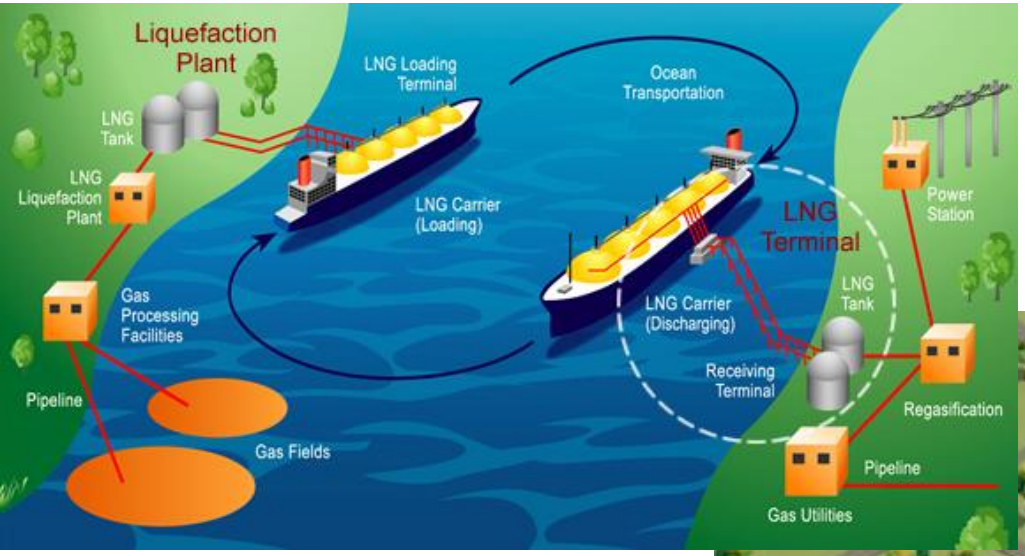
LNG Bunkering market




LNG Bunkering : context

- The meeting point between fuel bunkering and conventional LNG transfer

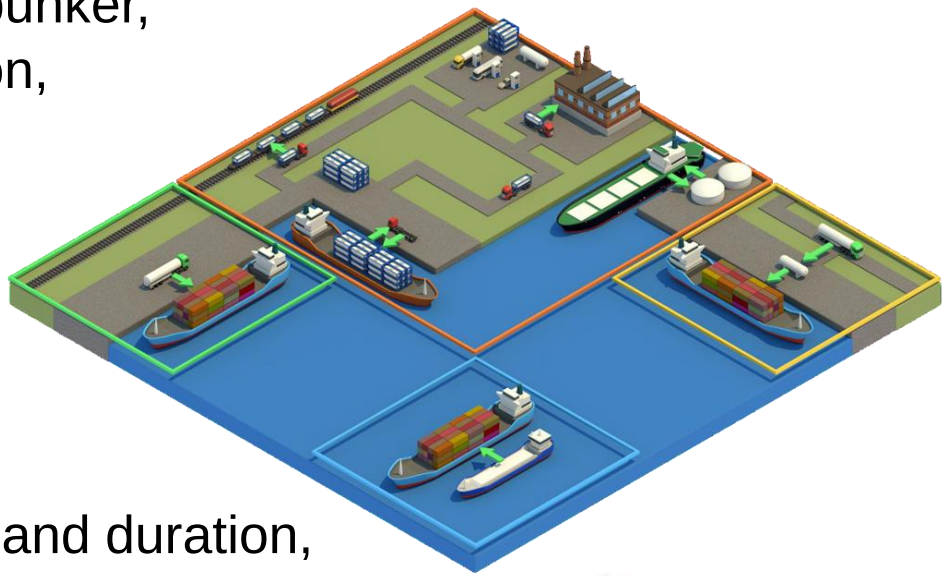
LNG Bunkering : Fuel instead of cargo



LNG Bunkering : what does it change ?

- Common point : LNG

- New market needs :
  - Large range of vessels to bunker,
  - Different types of application,
  - Volume to be transferred,



- Impacts (on loading arms) :
  - Reduced transfer flow rate and duration,
  - Number of arms and diameter,
  - Shape and size of the working envelope,
  - Type of loading arm,

New LNG global chain

Large Scale Storage

Small Scale Distribution

Small Scale Storage

Truck to Ship

Shore to Ship

Ship to Ship

Shore to Ship

Ship to Ship

Ship to Ship

Nearshore FLNG

Large Import/ Export Terminal

Nearshore FSRU

Loading Truck

Small Scale LNG Carrier

Port with Small Size LNG Storage

Port with Medium Size LNG Storage

Small Scale Terminal

Bunkering Vessel Small < 1000m3

Bunkering Vessel Medium 1000m3 < - < 5000m3

Bunkering Vessel Large > 5000m3

LNG Fueled Vessel – Tank Capacity

Pipe Diameter

Dedicated to Adaptable

Small Scale LNG

LNG Bunkering

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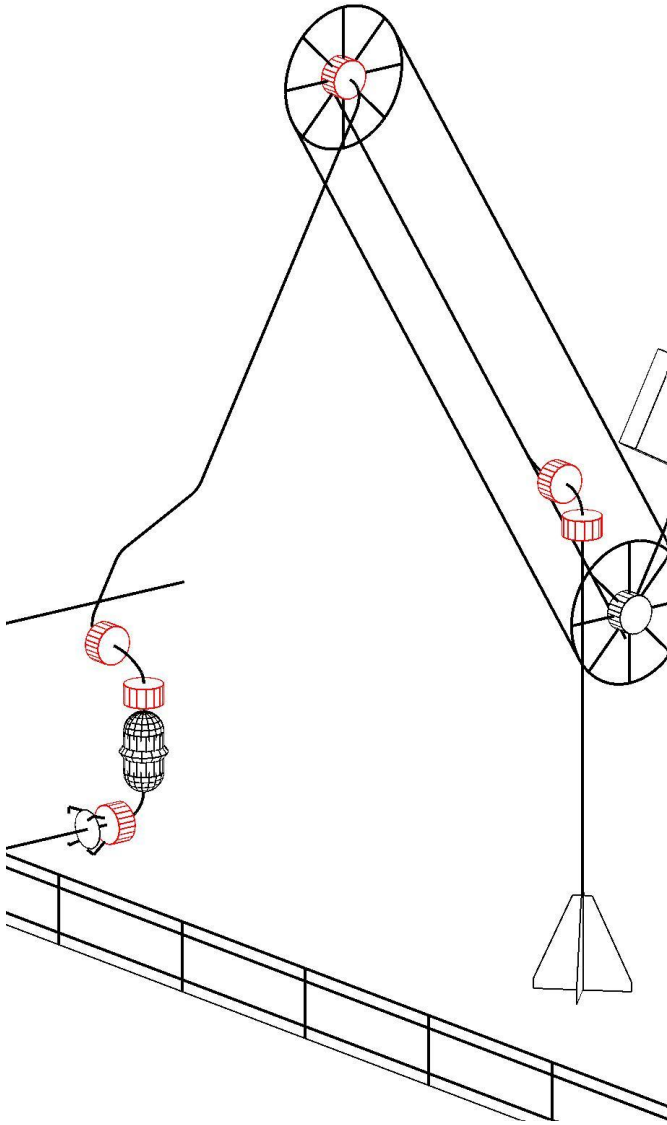
LNG Bunkering transfer solutions




Loading arm : Basic principle

- Rigid links articulated by swivel joints,
- Balanced system (in empty condition),



- Especially for LNG :
  - Supported product line,
  - ERS (Emergency Release System),
  - Coupler (Manual or hydraulique),

Key drivers for LNG transfer system selection

Performance

- The performance is defined by the ration diameter versus flow rate and pressure loss.
- Flow rate is limited in transfer system to maximum flow speed : i.e for liquid 12 m/s in rigid piping (which is by construction the more efficient solution for this purpose)

Reliability

- Using Proven components technology
  - (ERS, QCDC…)
  - Qualified components
- Monitoring
- Transfer system experience

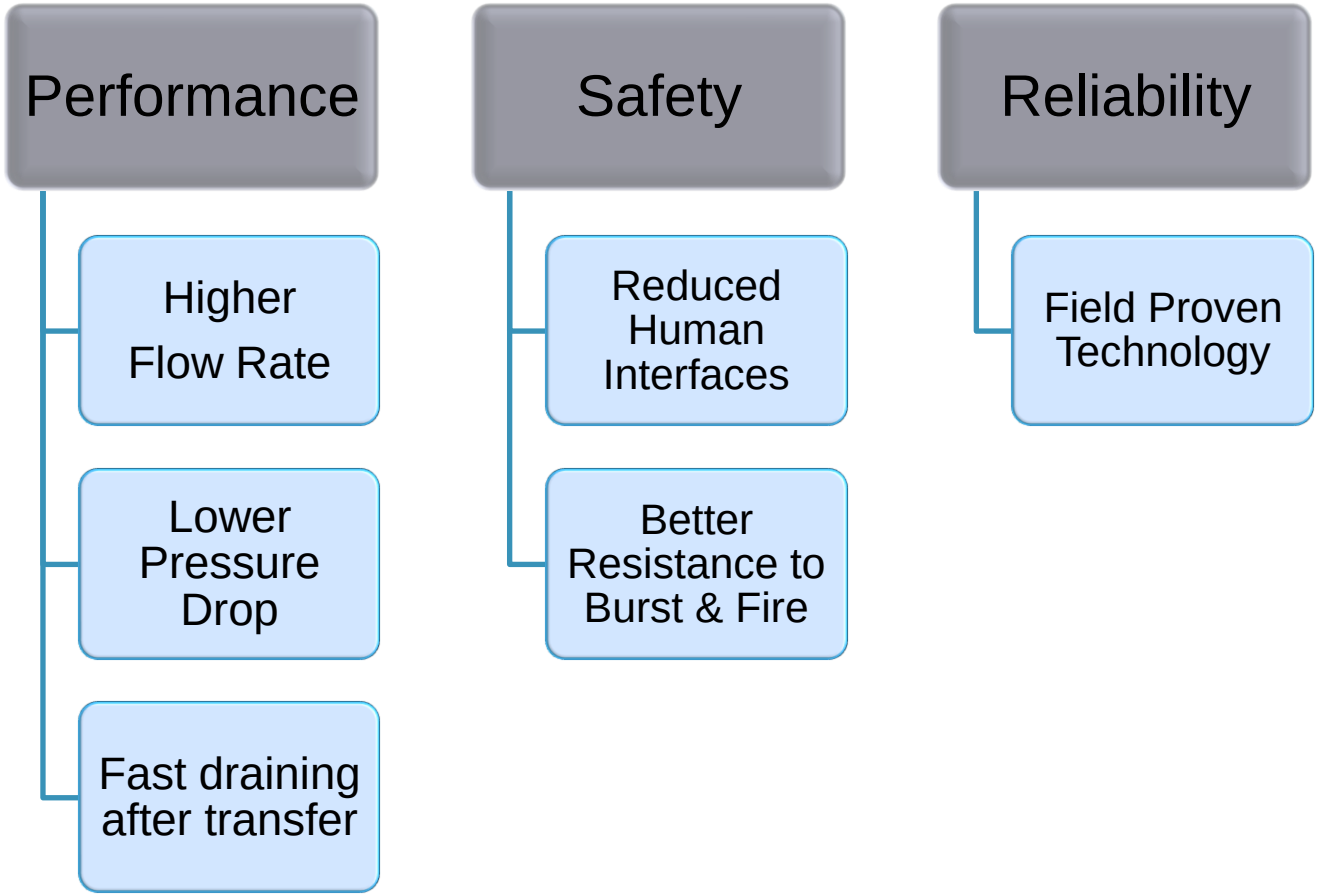
Safety

With regards of :

- Product
- Process
- Operators
- Transfer system itself
- Other equipment
- Environment

How to maximize these key drivers ?

- By using rigid pipes :



Bonus : High OPEX efficiency (especially for recurrent operations)

LNG transfer solutions : Basic design parameters

Bunkering Infrastructure (Application)	• Truck to Ship • Shore to Ship • Bunkering vessel
Transfer Rate & Diameter	• 2” – 3” (100-200 m3/h) • 4” (350 m3/h) • 6” – 8” (800-1400 m3/h)
Operating envelope size	• Dedicated fleet Vs Adaptable fleet

LNG transfer solutions : FMC philosophy

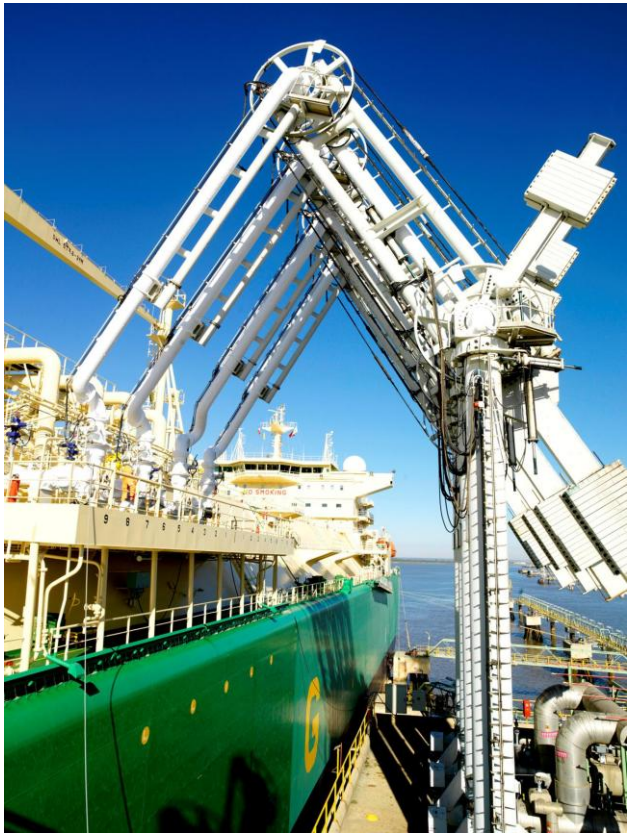
- Provide a dedicated design to define the most appropriate solution (technically and economically) based on our large range of products and experience :

- Skid & TLA
  (Truck Loading Arm)

LNG transfer solutions : FMC philosophy

- Provide a dedicated design to define the most appropriate solution (technically and economically) based on our large range of products and experience :

- Conventional MLA
  (Marine Loading Arm)



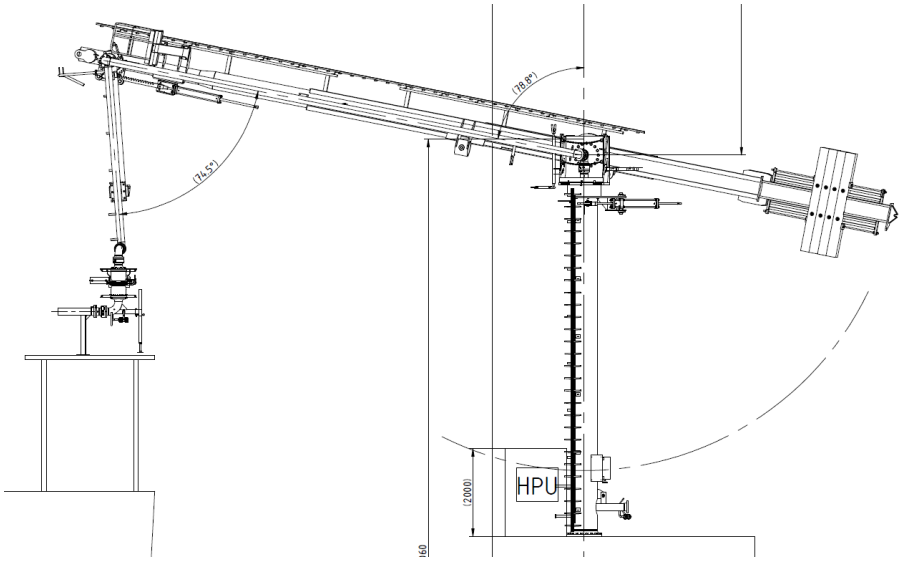
LNG transfer solutions : FMC philosophy

- Provide a dedicated design to define the most appropriate solution (technically and economically) based on our large range of products and experience :

- Trailer mounted MLA
- Horizontal MLA

FMC last projects realized

- 6’’ x 50’ CMA

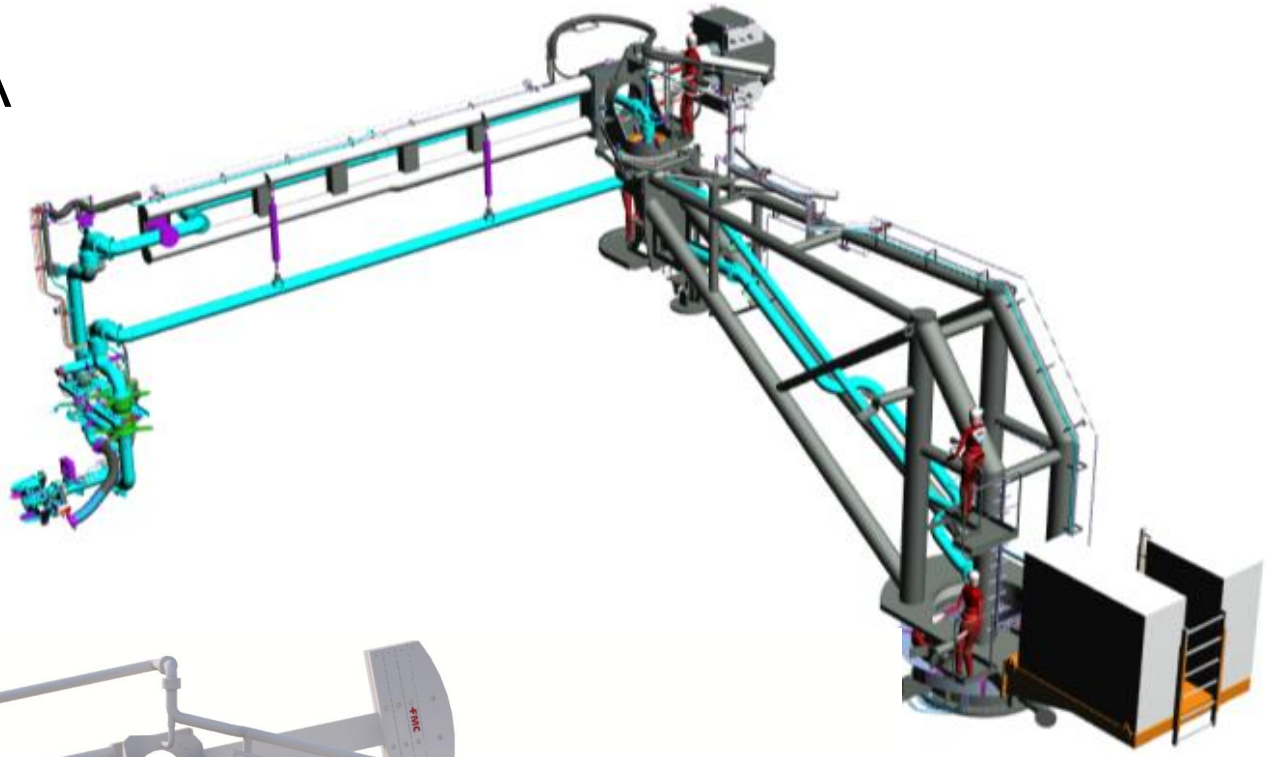


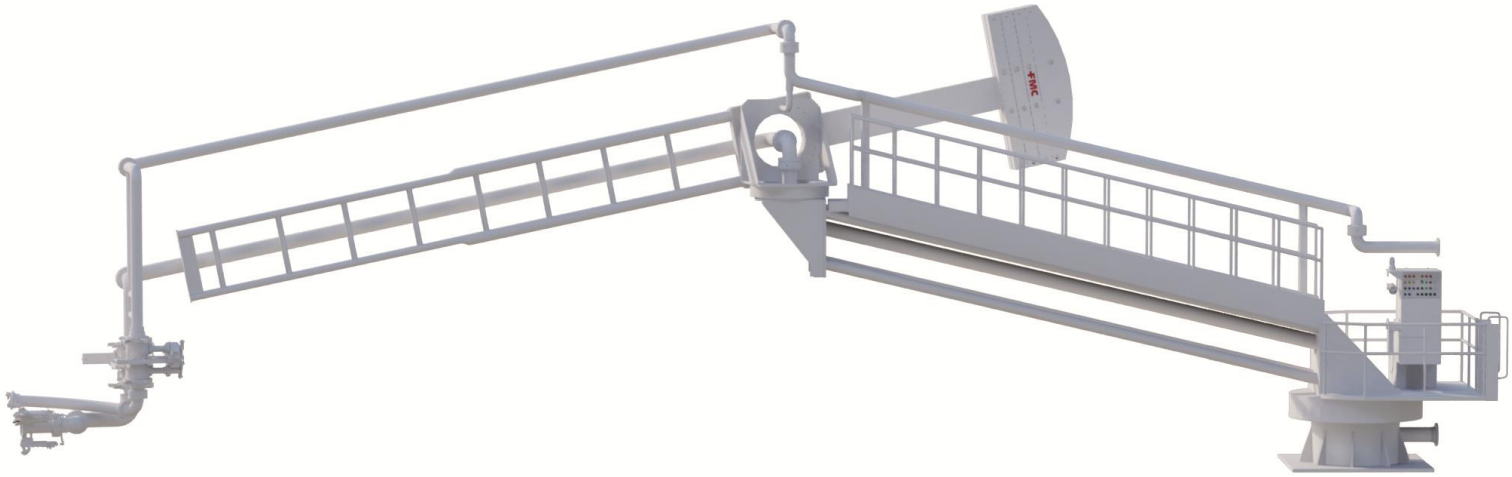
FMC last projects realized

- 8’’/6’’ x 57’ BOA (Bunkering Offloading Arm)

FMC last projects realized

- 8’’/6’’ x 57’ BOA



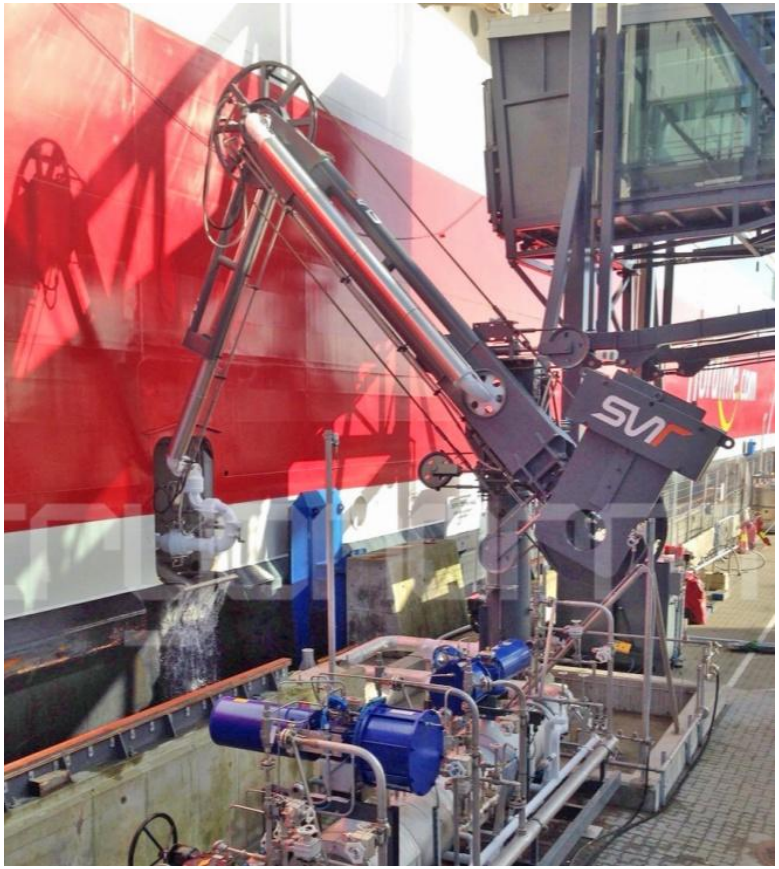


Others existing solutions

- Ferry + hose

Others existing solutions

- Ferry + Loading Arm

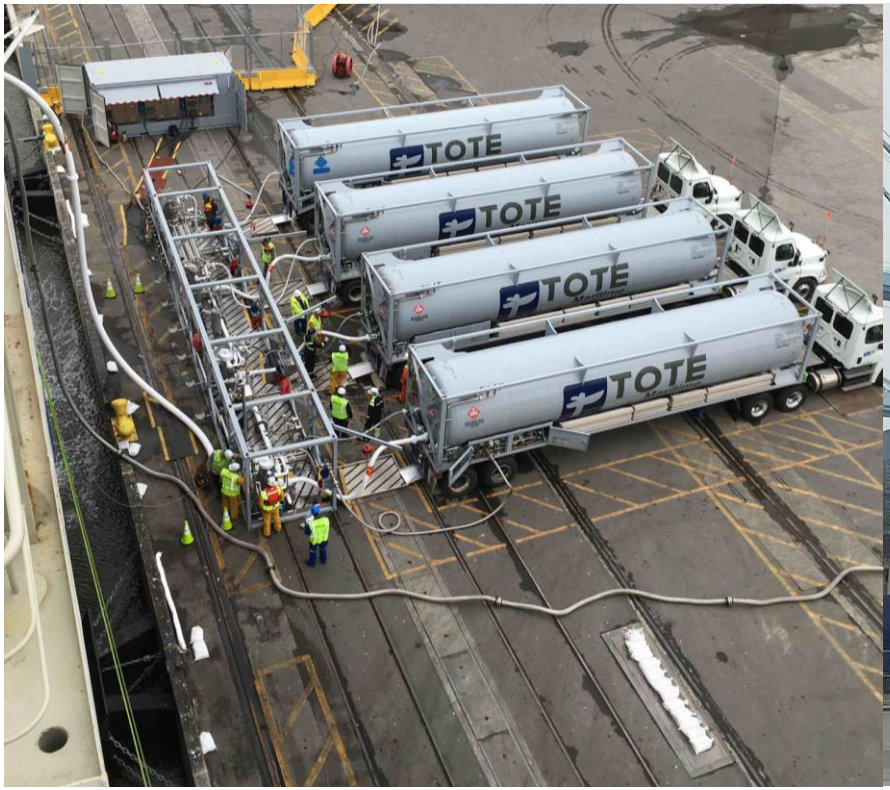


Others existing solutions

- Truck to ship

Others existing solutions

- Trucks to ship via skid



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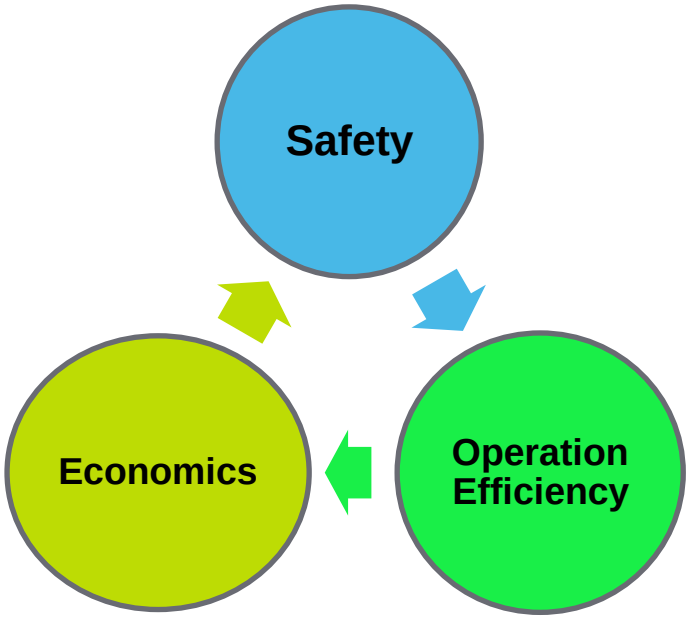
Conclusion




Conclusions

- The LNG transfer system is identified as part of the top critical elements for the LNG installation.
- Any LNG transfer system is a balance between:



- A transfer system is a solution integrated in an overall operation and project context.

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Thank you

Questions ?

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