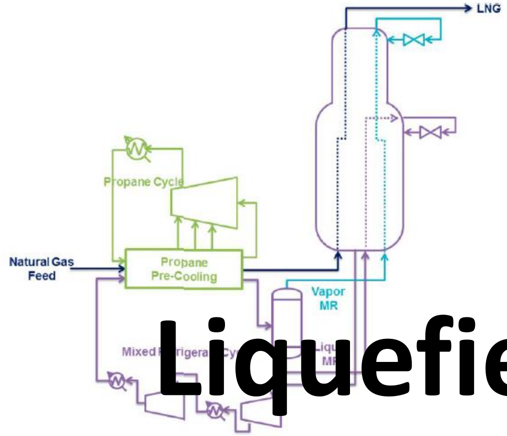
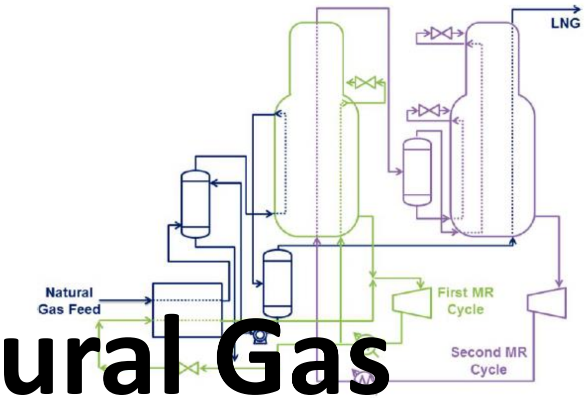
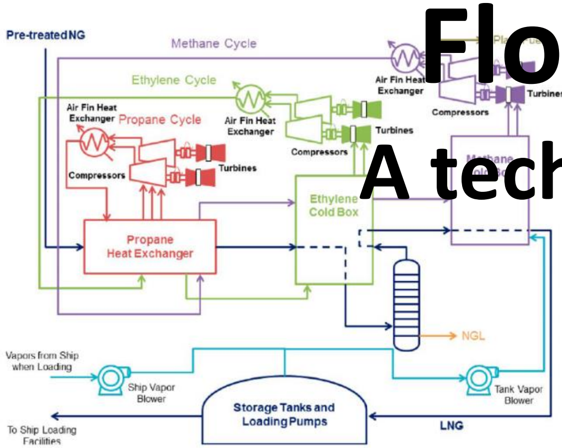
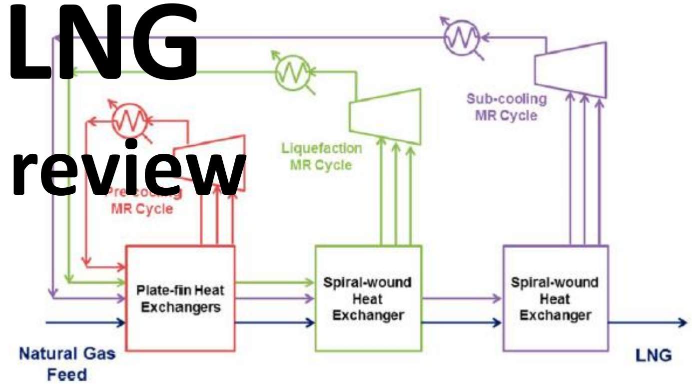




Liquefied Natural Gas
and
Floating LNG
A technology review

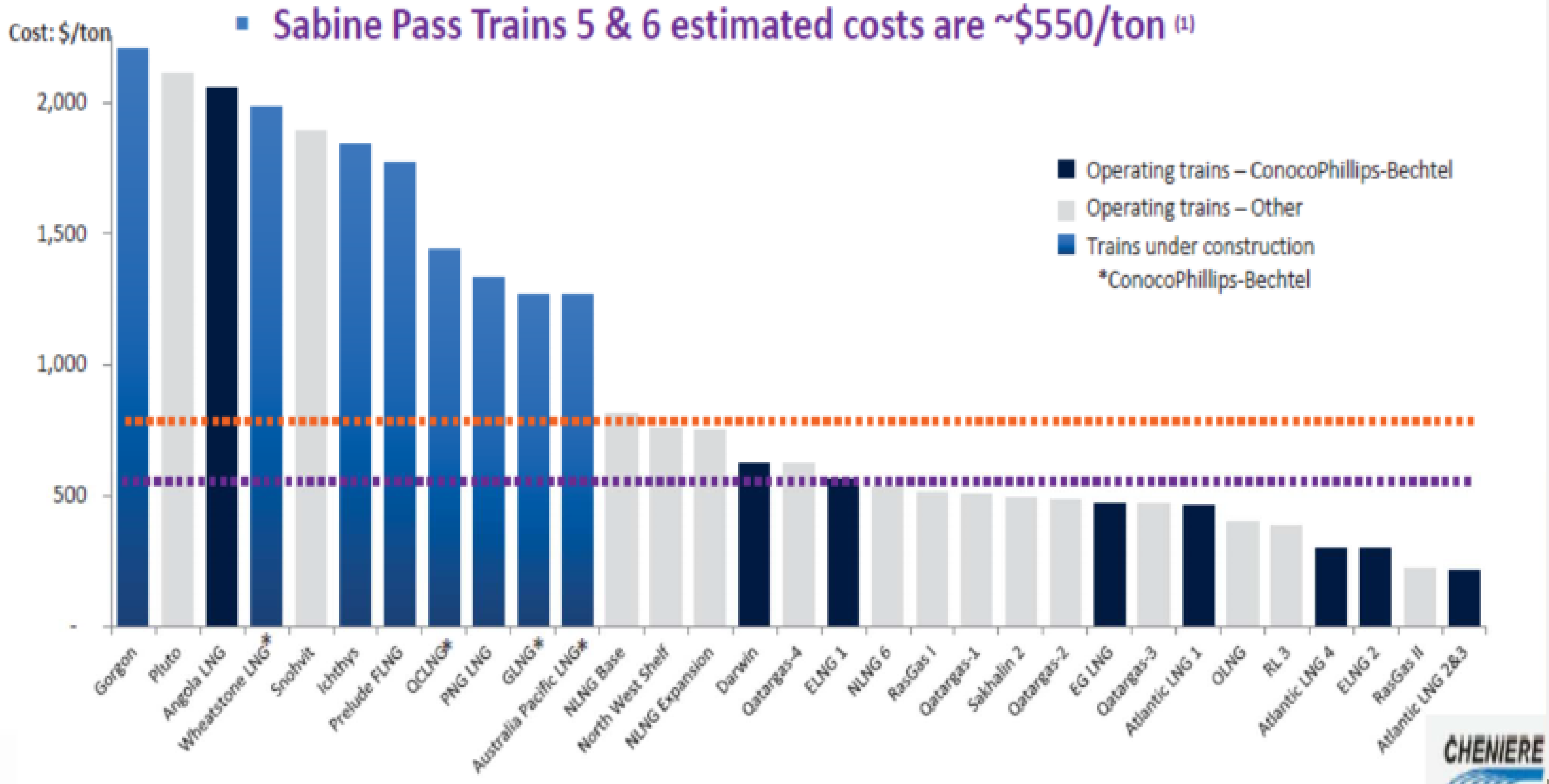




Gabriel Castaneda, P.E.
(713) 873 1708
Gabriel @gabcheminc.com

Construction Costs

- Range of liquefaction project costs: $200 - $2,000+ per ton
- 1 Bcf/d of capacity = $1.5B to $15.0B+
- Corpus Christi liquefaction project estimated costs are ~$800/ton [1]
- Sabine Pass Trains 5 & 6 estimated costs are ~$550/ton [1]



Gorgon $52 Billion dollars

King & Spalding 2014

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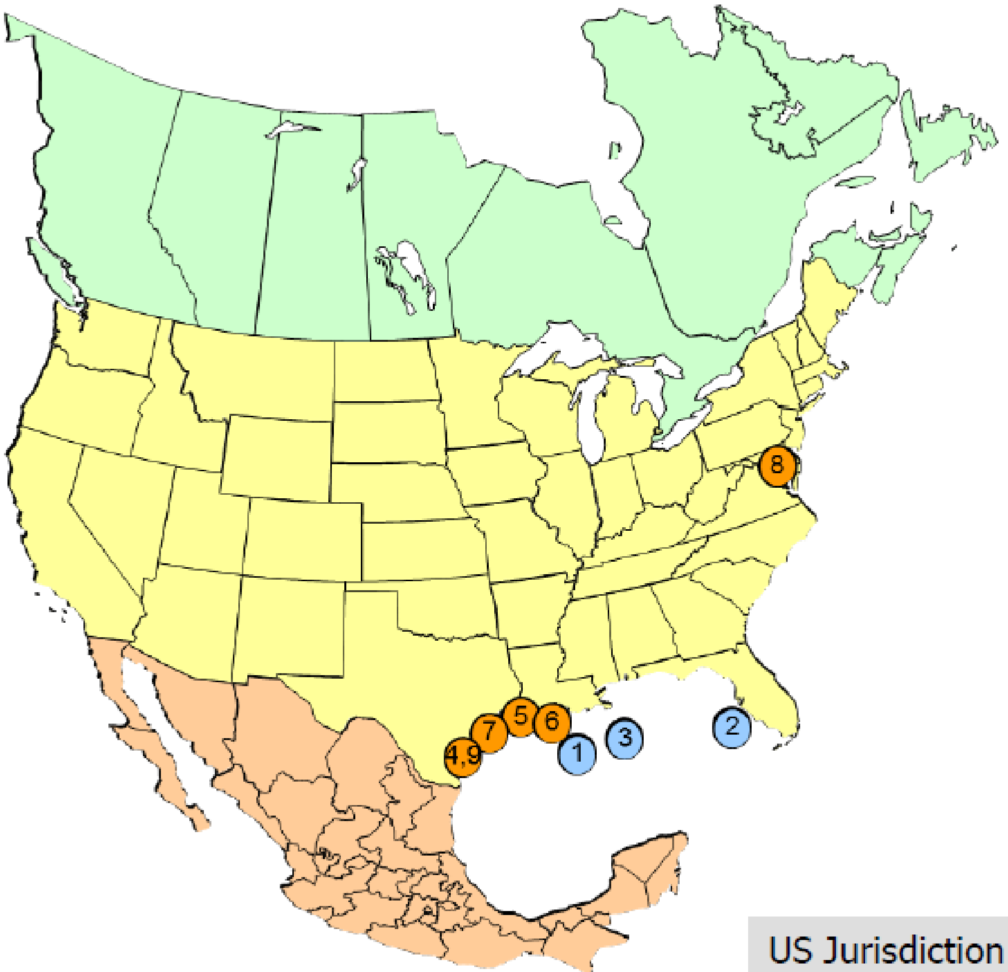
Approved LNG Plants



Import Terminal

APPROVED - NOT UNDER CONSTRUCTION

U.S. - MARAD/Coast Guard

1. Gulf of Mexico: 1.0 Bcfd (Main Pass McMoRan Exp.)
2. Offshore Florida: 1.2 Bcfd (Hoëgh LNG - Port Dolphin Energy)
3. Gulf of Mexico: 1.4 Bcfd (TORP Technology-Bienville LNG)
4. Corpus Christi, TX: 0.4 Bcfd (Cheniere – Corpus Christi LNG) (CP12-507)

Export Terminal

APPROVED - UNDER CONSTRUCTION

U.S. - FERC

5. Sabine, LA: 2.76 Bcfd (Cheniere/Sabine Pass LNG) (CP11-72 & CP14-12)
6. Hackberry, LA: 1.7 Bcfd (Sempra – Cameron LNG) (CP13-25)
7. Freeport, TX: 1.8 Bcfd (Freeport LNG Dev/Freeport LNG Expansion/FLNG Liquefaction) (CP12-509)
8. Cove Point, MD: 0.82 Bcfd (Dominion – Cove Point LNG) (CP13-113)
9. Corpus Christi, TX: 2.14 Bcfd (Cheniere - Corpus Christi LNG) (CP12-507)

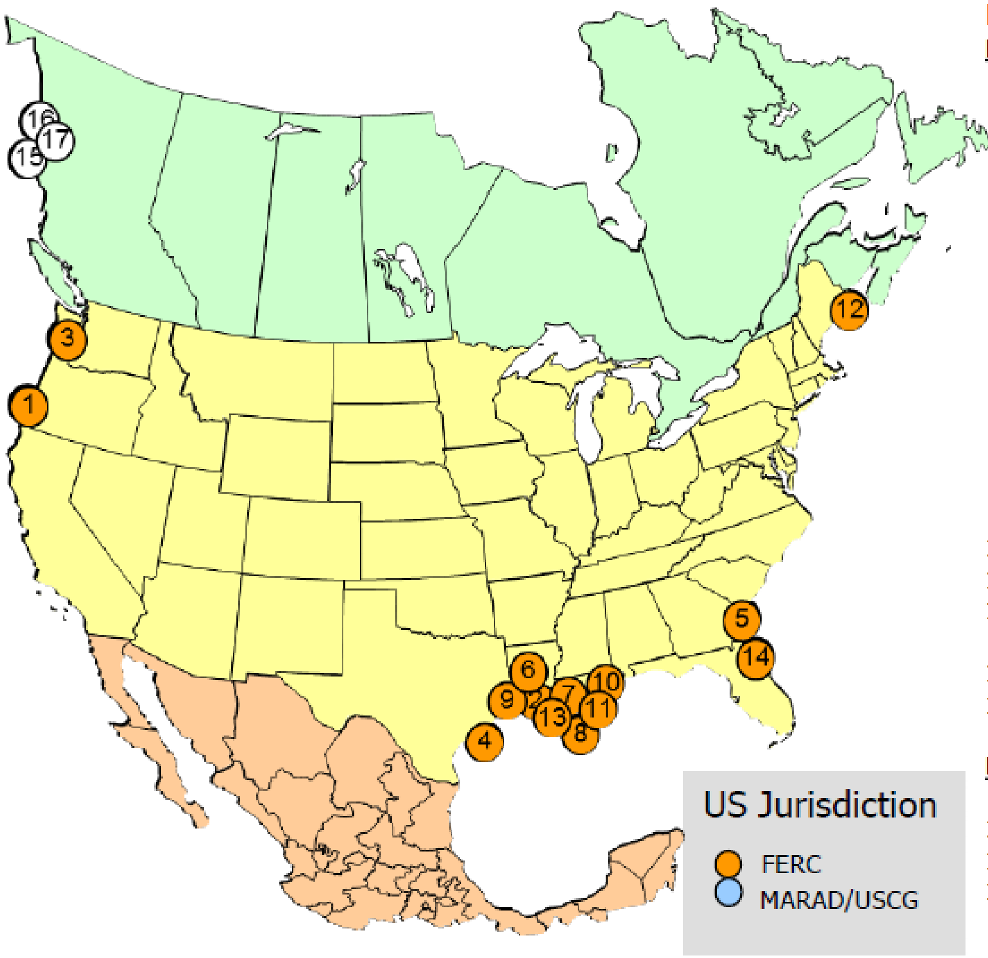
US Jurisdiction

- FERC
- MARAD/USCG

As of February 5, 2015

FERC

Proposed LNG Plants in North America



Export Terminal

PROPOSED TO FERC

1. **Coos Bay, OR:** 0.9 Bcfd (Jordan Cove Energy Project) (CP13-483)
2. **Lake Charles, LA:** 2.2 Bcfd (Southern Union - Trunkline LNG) (CP14-120)
3. **Astoria, OR:** 1.25 Bcfd (Oregon LNG) (CP09-6)
4. **Lavaca Bay, TX:** 1.38 Bcfd (Excelerate Liquefaction) (CP14-71 & 72)
5. **Elba Island, GA:** 0.35 Bcfd (Southern LNG Company) (CP14-103)
6. **Sabine Pass, LA:** 1.40 Bcfd (Sabine Pass Liquefaction) (CP13-552)
7. **Lake Charles, LA:** 1.07 Bcfd (Magnolia LNG) (CP14-347)
8. **Plaquemines Parish, LA:** 1.07 Bcfd (CE FLNG) (PF13-11)
9. **Sabine Pass, TX:** 2.1 Bcfd (ExxonMobil – Golden Pass) (CP14-517)
10. **Pascagoula, MS:** 1.5 Bcfd (Gulf LNG Liquefaction) (PF13-4)
11. **Plaquemines Parish, LA:** 0.30 Bcfd (Louisiana LNG) (PF14-17)
12. **Robbinston, ME:** 0.45 Bcfd (Kestrel Energy - Downeast LNG) (PF14-19)
13. **Cameron Parish, LA:** 1.34 Bcfd (Venture Global) (PF15-2)
14. **Jacksonville, FL:** 0.075 Bcfd (Eagle LNG Partners) (PF15-7)

PROPOSED CANADIAN SITES IDENTIFIED BY PROJECT SPONSORS

15. **Kitimat, BC:** 1.28 Bcfd (Apache Canada Ltd.)
16. **Douglas Island, BC:** 0.23 Bcfd (BC LNG Export Cooperative)
17. **Kitimat, BC:** 3.23 Bcfd (LNG Canada)

FERC, Feb 5 2015

LNG Specifications

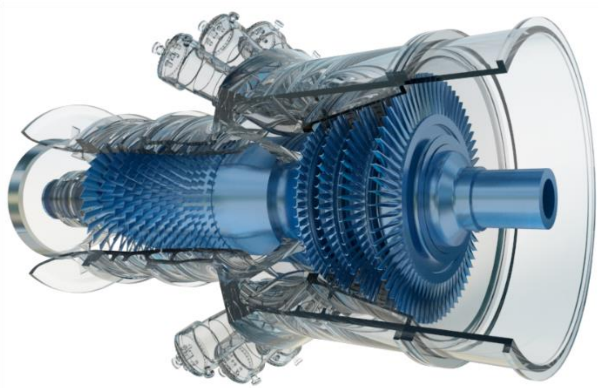
component	limit	comments
CO_2	50 ppm	freezing
H_2S	3.5 ppm	LNG Spec
total sulfur	20-25 mg/m^3	LNG Spec
mercury	.01 μg/Nm^3	aluminum exchangers
C_5+	<0.1% mol	issues in liquefaction section
benzene	<1 ppm (mole)	
water	1 ppmv	freezing in liquefaction section
nitrogen	1% mol	
ethane	<6-8% mol	Ethylene
propane	<3% mol	
butane	<2% mol	
heating value	1050 BTU/SCF	Europe and USA
	1140 BTU/SCF	East Asia

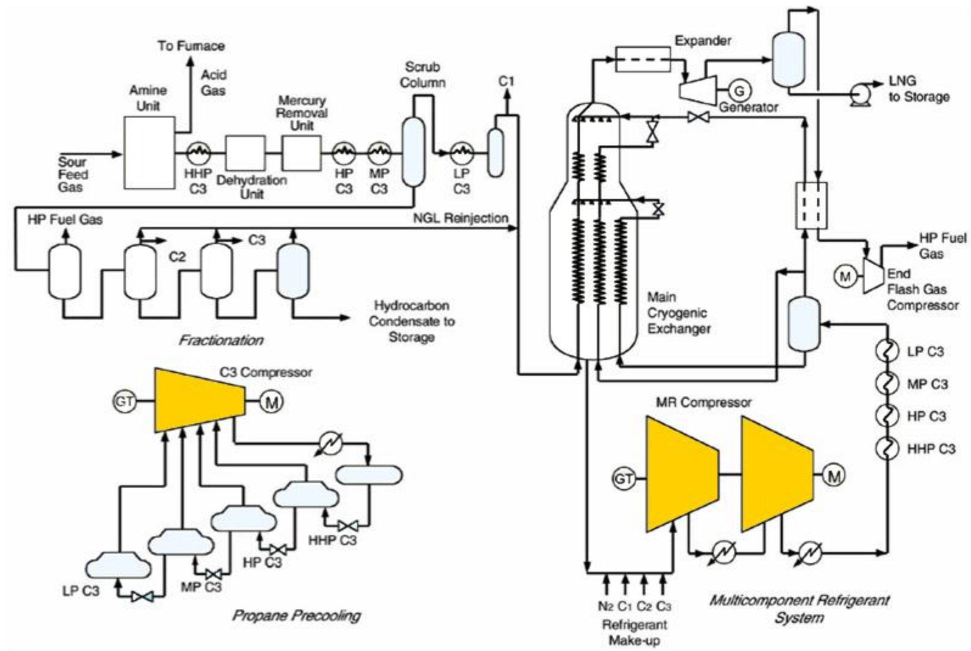
melting point	^{o}F
pentane	-202
hexane	-139
heptane	-131

LNG temp
-161^{o}C
-258^{o}F

Gabriel Castaneda, P.E.

Turbines in LNG

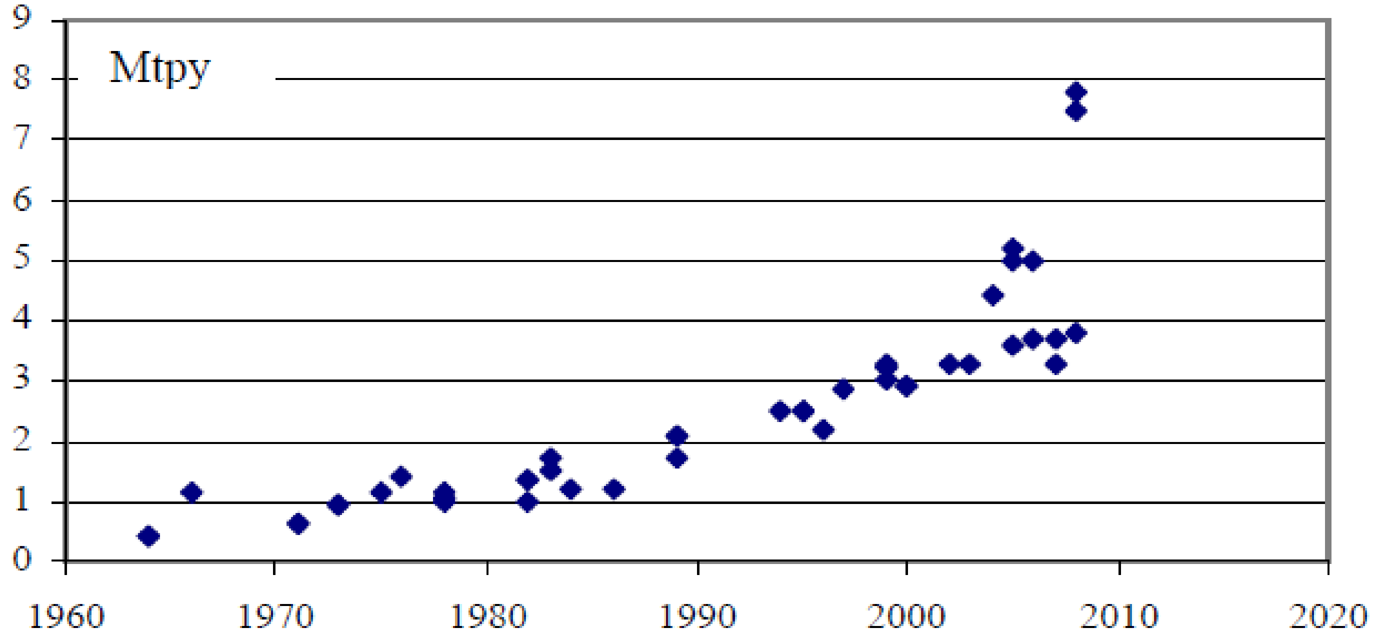




Turbines in LNG – Table of Contents

- Trends in LNG Train Size, MTPY
- LNG Refrigerant Compressor Drives
- Gas Turbines Driver Benefits
- Aeroderivative vs Industrial Turbines
- Inlet Turbine Cooling

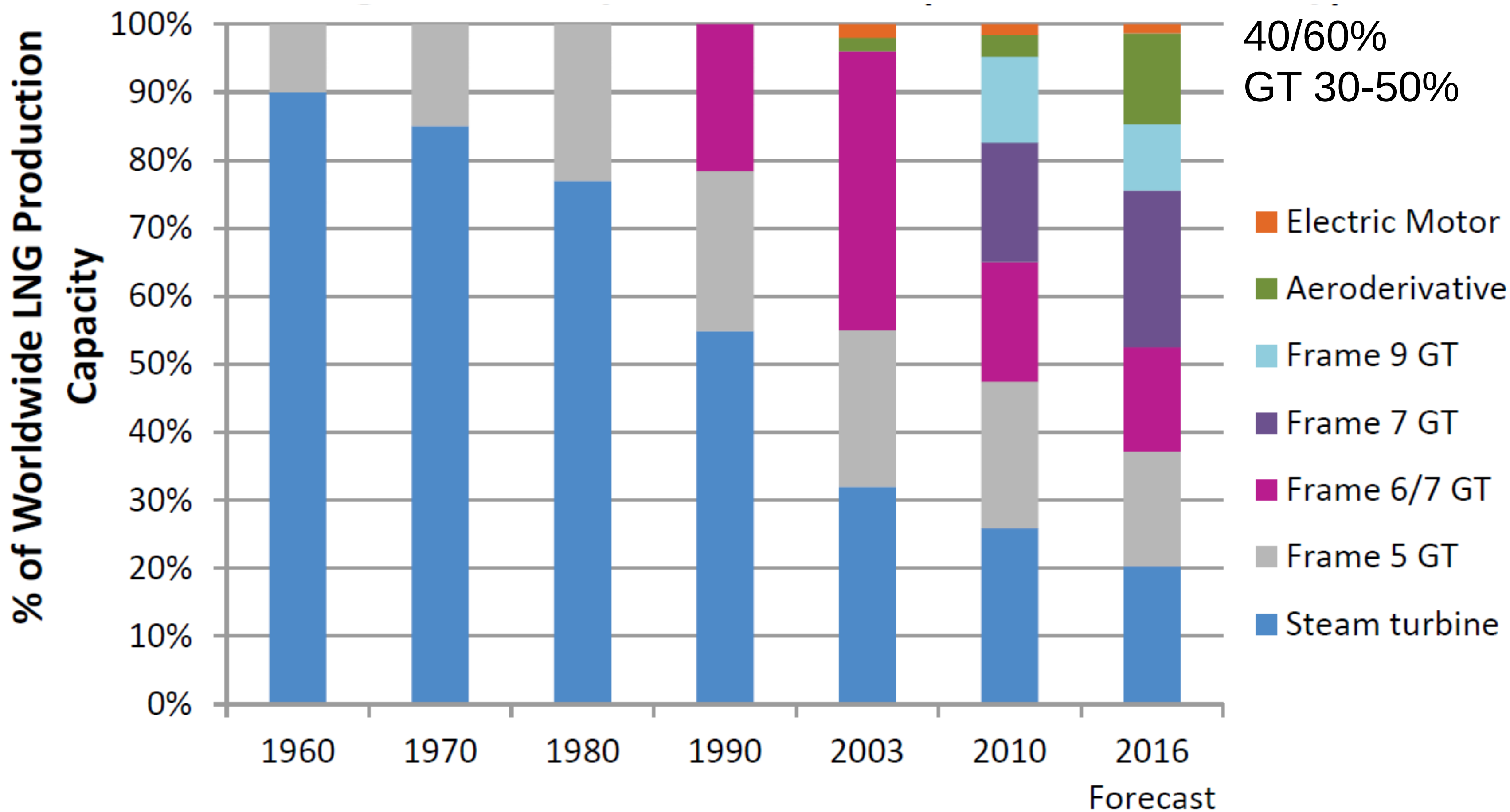
Trends in LNG Train Size, MTPY



5 MTPY, 86MW turbine, GE Frame 7EA
8 MTPY, 123 MW turbine, GE Frame 9E

Buonocristiano et al, GE

LNG Refrigerant Compressor Drives



Driver Efficiency
Aeroderivative
40/60%
GT 30-50%

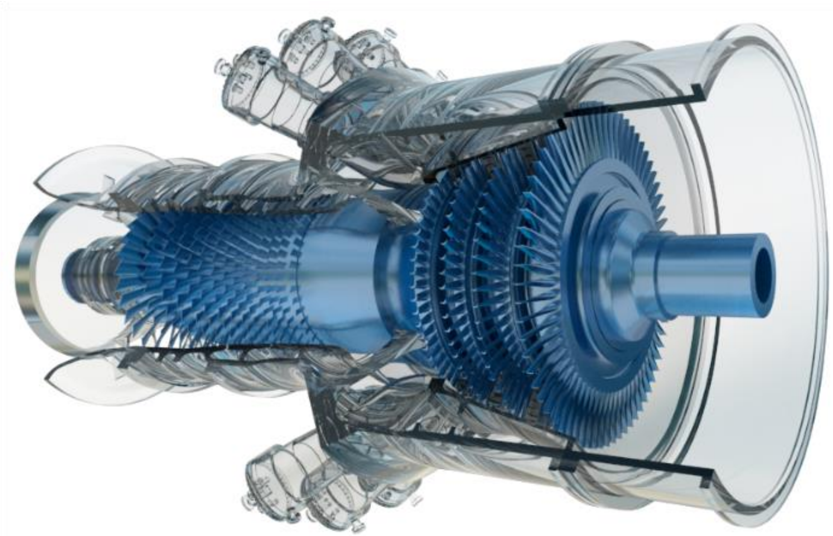
Marybeth Nored, Apache Corporation

Gas Turbines Driver Benefits

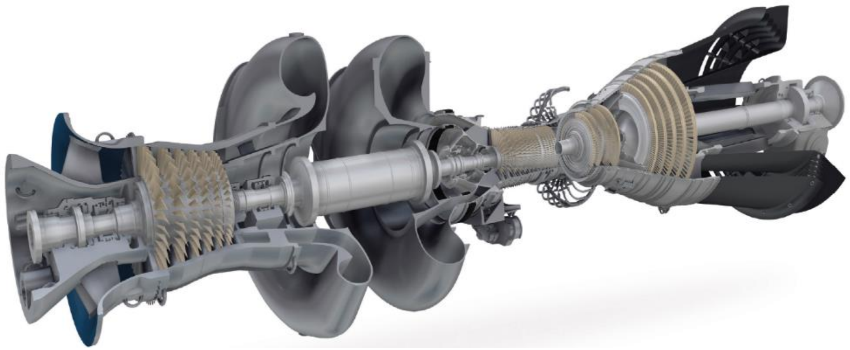
- Smaller plot space
- Shorter delivery time
- Lower transportation costs
- Lower installation costs
- Lower foundation costs
- No need for boiler feed water treatment
- No need for cooling water

Cyrus Meher et al, Bechtel

Aeroderivative vs Industrial Turbine



Industrial Frame 9E, 123 MW



Aeroderivative LMS 100, 100 MW

General Electric

Aeroderivative vs Old Industrial Turbines

	Old Heavy Industrial	Aeroderivative
speed	slower	faster
starting time	10-15min	5 min
loading time	6-10% per minute, some in 13 min	10 min
maintenance time	more	less
bearings	hydrodynamic	antifriction
technology	conventional	aerospace
modularity	none	highly modular
efficiency	less	10-15% more
temperature	lower	higher
emissions	higher	lower
	25 ppm	some below 15 ppm NO_X
compression ratio	lower, 10	higher, 18
reliability	lower	higher
load range	narrow	wider
operational expenses	higher	lower
price	20-30% lower	higher
air inlet system requirements	low inlet Mach number	high inlet Mach number
fuel requirements	wider range of fuels	narrower range of fuels
footprint	bigger	less than 50%
weight	more	less than 40%

$$n_B = 1 - \frac{T_{atmospheric}}{T_{compressor\ exit}}$$

Firing temperature from 1149^oC to 1400^oC
Efficiencies from 30/50% to 40/60%

New turbines have integrated a lot of the aeroderivative benefits but they need to be requested

water injection in combustion chamber lowers NO_X

Lawrence Kaempffer, P.Eng.
Amin Almasi

Gabriel Castaneda, P.E.

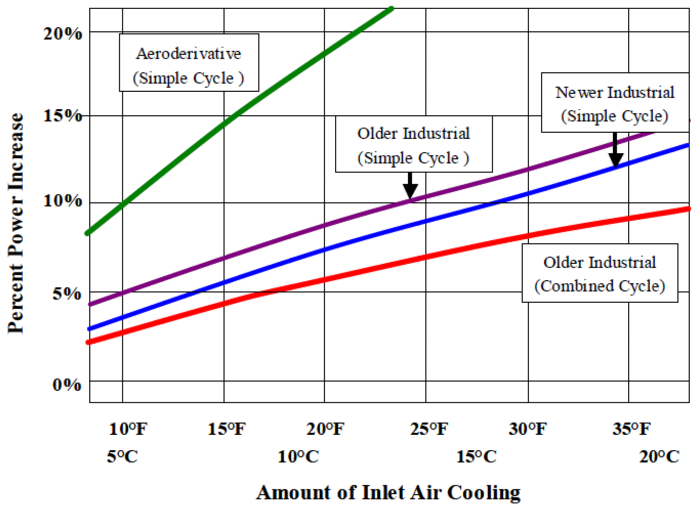
Turbine Inlet Cooling, TIC Benefits

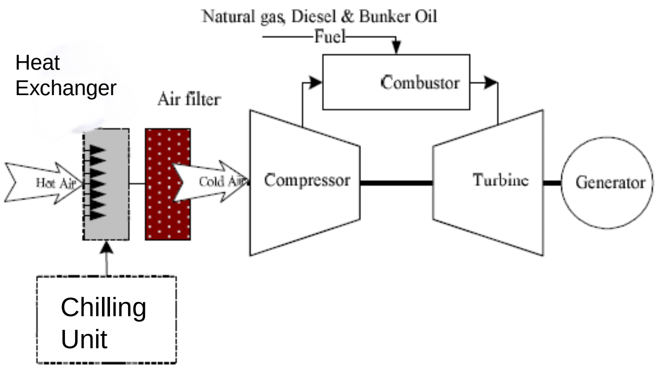
- Increased LNG production

Assuming that the plant is designed such that the gas turbine driver becomes a production bottleneck during hot weather.

- More stable liquefaction process, minimizes production swings
- Possible optimization of compressor selections for the liquefaction process.
- Chilled water-glycol loop

0.7%/°C heavy duty, 1%/°C for aeroderivative





Technology is commonly used in Power Plants
11 LNG COP Optimized Cascade Process plants

John Forsyth, P.Eng.
Mehaboob Basha et al
Cyrus Meher- Homji
Shell, GE

Emissions in LNG – Table of Contents

- Causes and mitigation measures
- Relative CO_2 emissions of gas turbines
- NO_X emissions
- BOG compressors

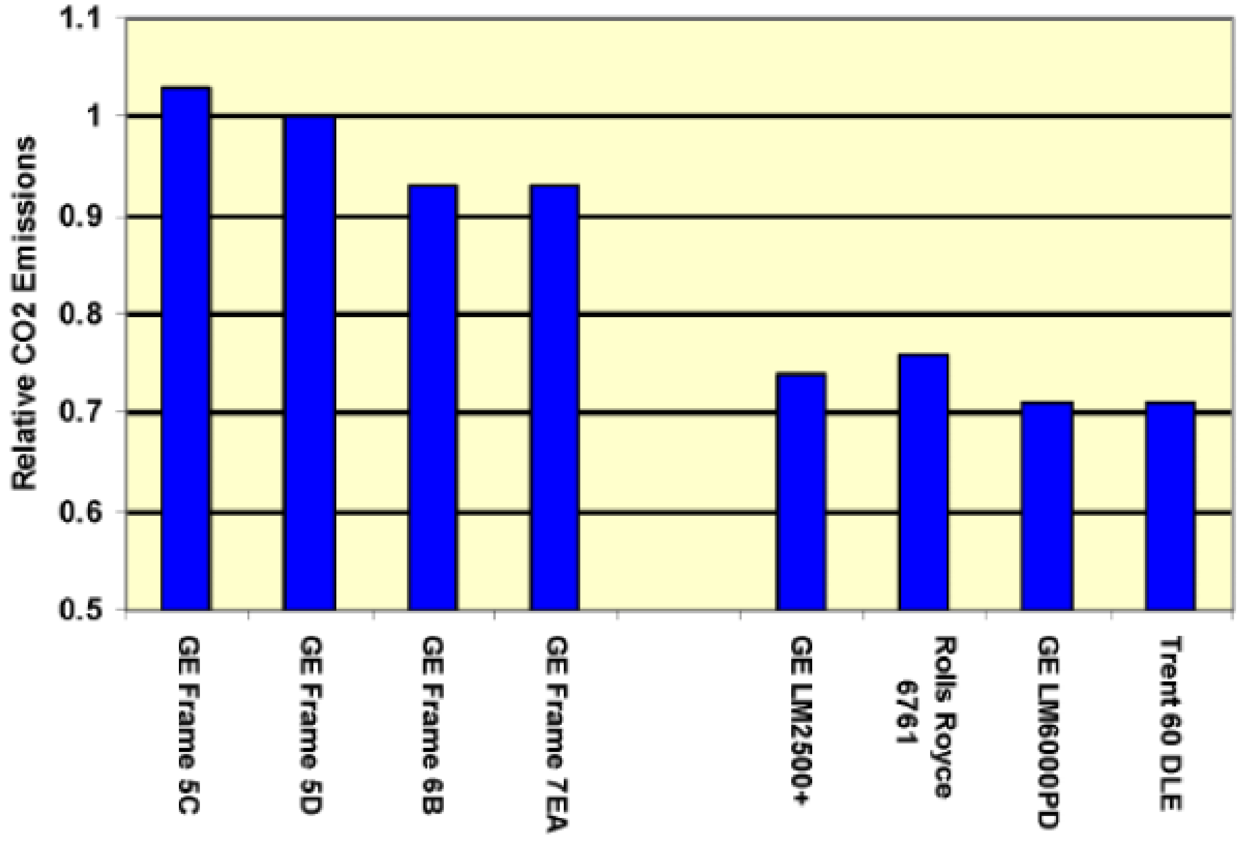
CO_2 Emission Causes – Mitigation Measures

Causes	Mitigation Measures
Use of turbines to power up plant	• Use aeroderivative/ new efficient turbines • Install waste heat recovery units, 9% reduction • Use a more efficient liquefaction technology
Flaring and venting	• Use of boil-off gas compressors during ship loading operations • Use a compressor to capture gas to be flared and route it to be used as fuel gas
Furnaces	• Install high efficiency burners in furnaces

Gas to be flared comes from fired heaters, incinerators, venting, startup and shutdown conditions, depressurization of plant

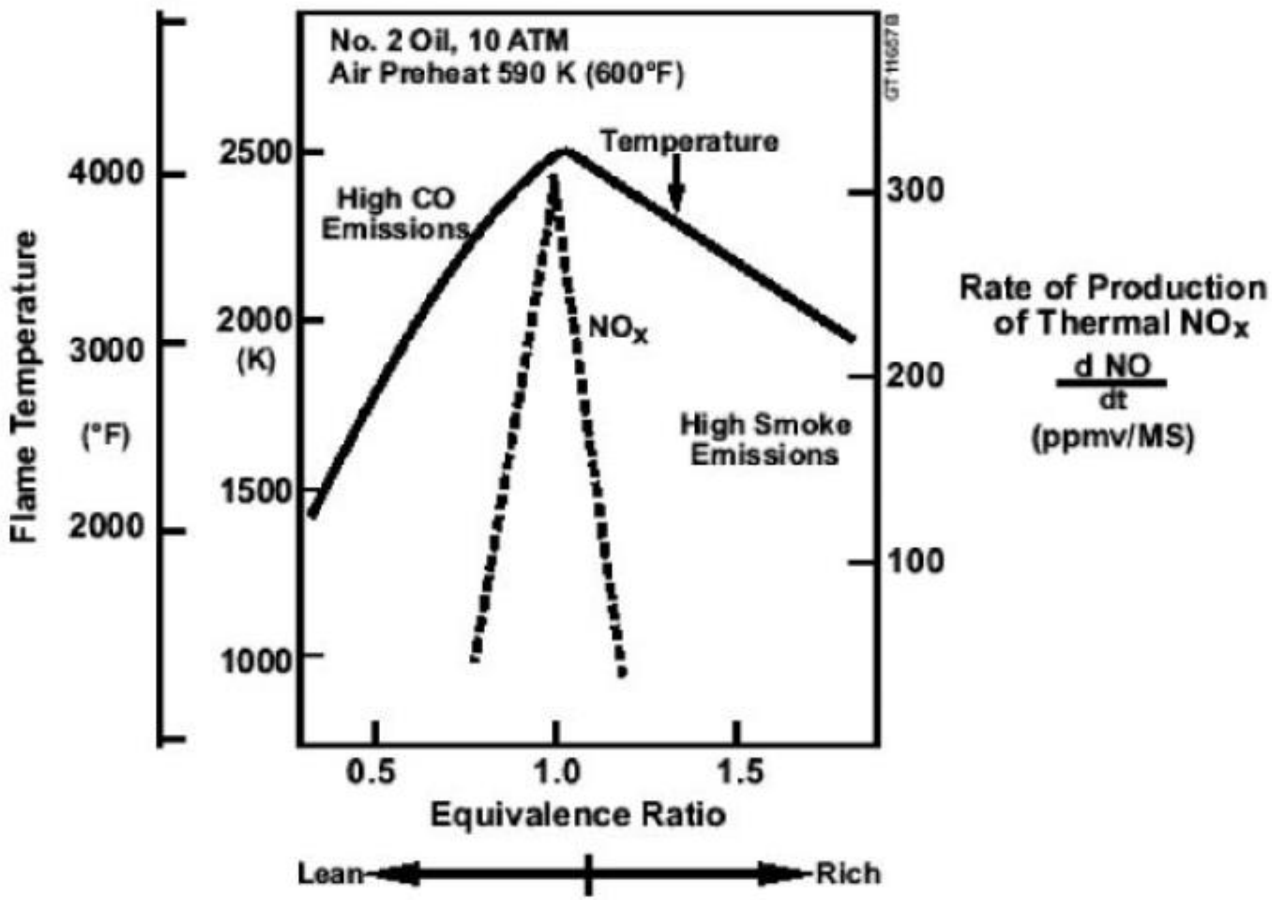
Australia Pacific LNG Project

Relative CO_2 Emissions From Different Gas Turbines



Cyrus Meher- Omji et al
Bechtel

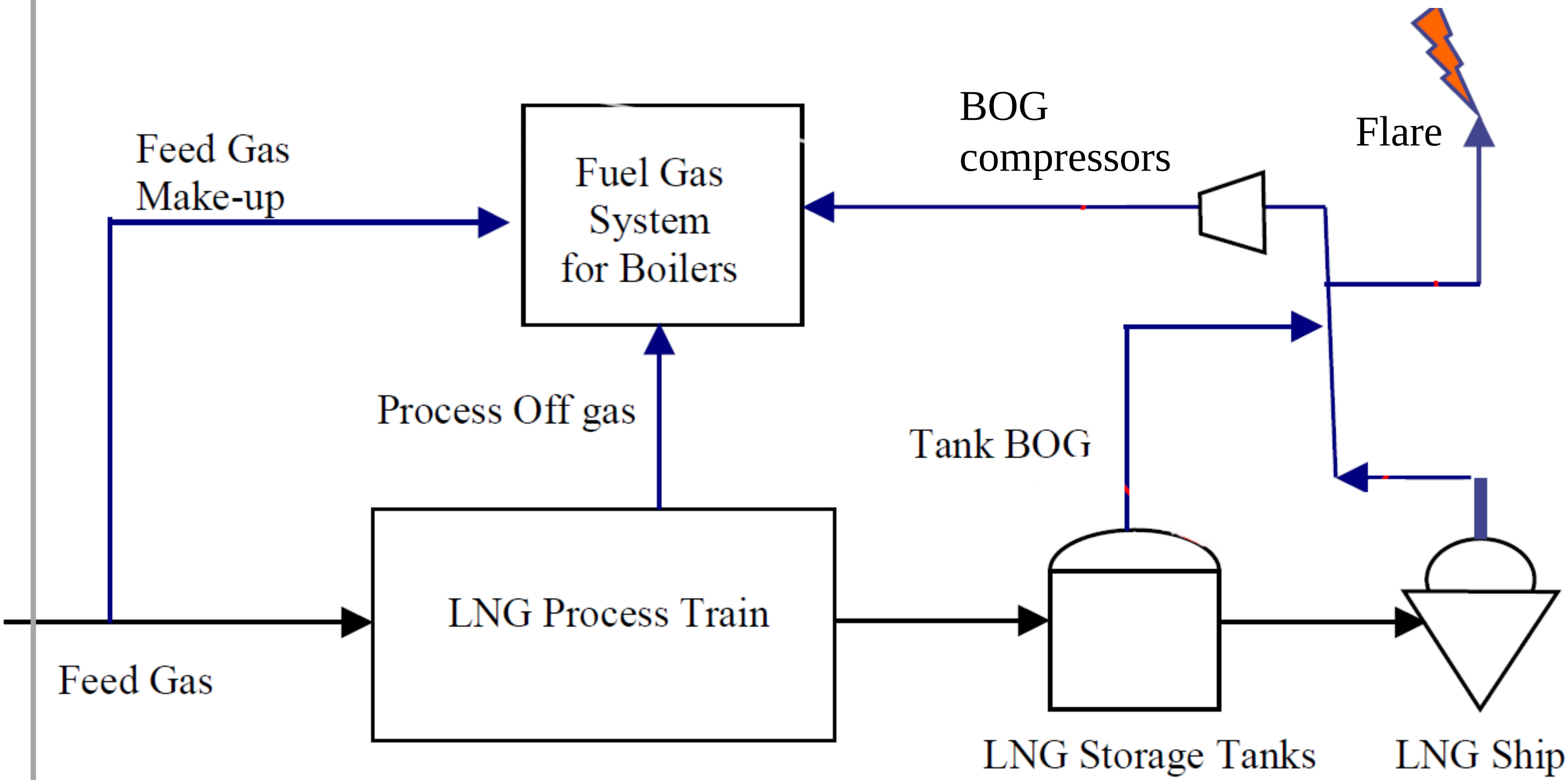
NOX Emissions



$$\text{Equivalence Ratio} = \frac{(\text{fuel/oxidant})_{\text{actual}}}{(\text{fuel/oxidant})_{\text{stoichiometric}}}$$

Cyrus Meher-Homji et al
Bechtel

BOG Compressors



LNG Process Safety –Table of Contents

- 33 CFR 127 — Waterfront Facilities Handling Liquefied Natural Gas and Liquefied Hazardous Gas
- 49-CFR-193 — LNG Facilities: Federal Safety Standards
- NFPA 59A (2001) — Standard for the Production, Storage and Handling of LNG

49-CFR-193 is based on NFPA 59A, 2001

49-CFR-193

- Protection of persons and property near an LNG facility from :

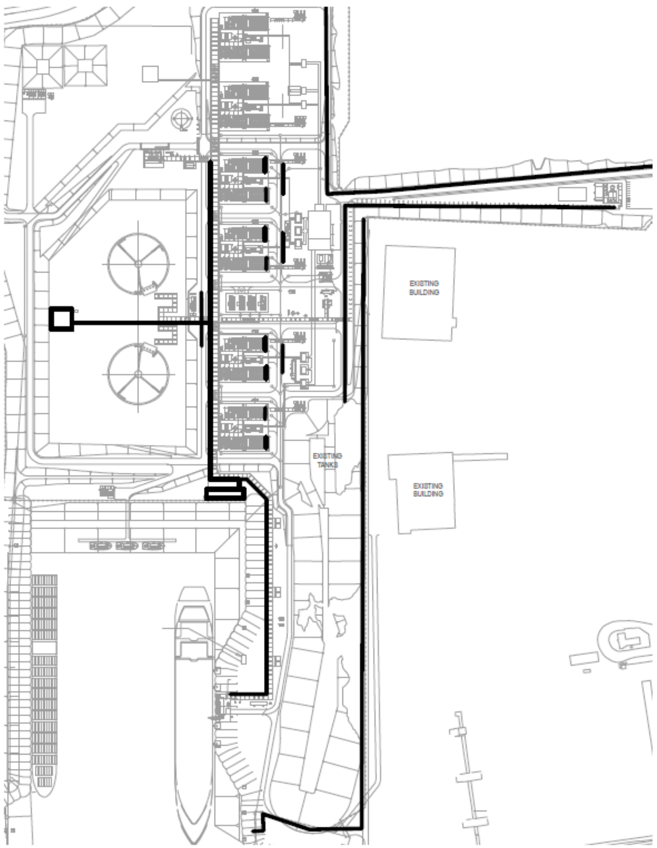
  - Thermal radiation
  - Dispersion and delayed ignition
  - Explosions

  arising from an LNG spill

- Reduction of the potential for a catastrophic spill of LNG
- Sets design spill requirements for each specific major area:

  - LNG storage tanks
  - Process areas
  - Vaporization areas
  - Transfer Areas

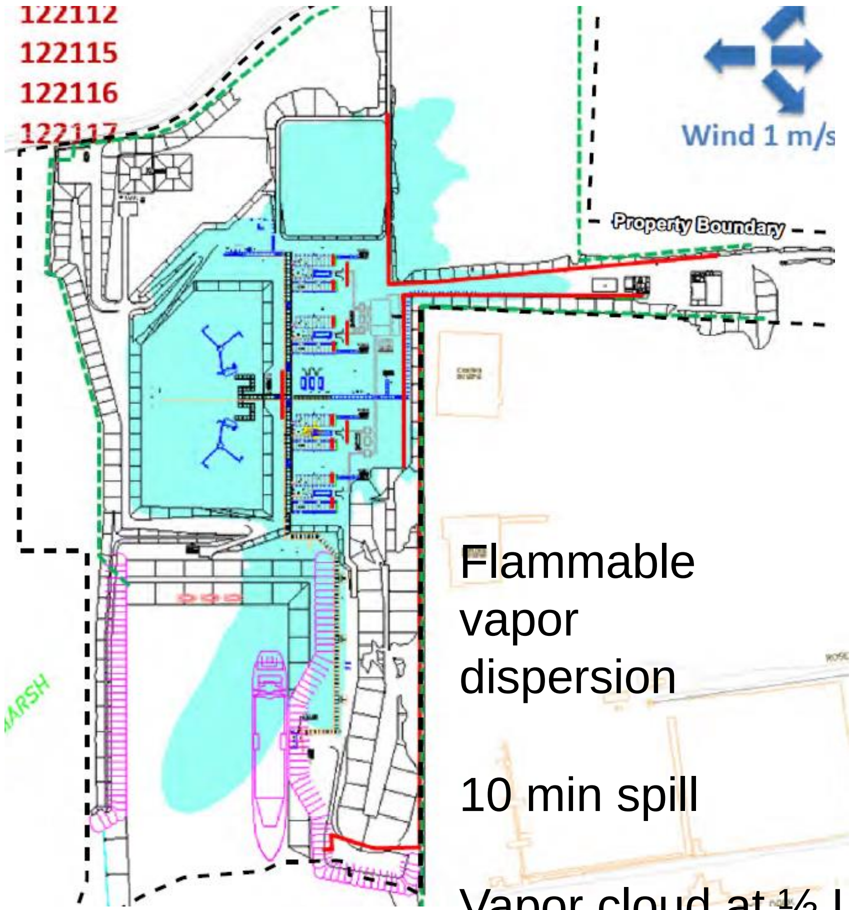
Methane is denser than air by a factor of 1.5, propane by about 2, LNG spills will behave as a dense gas.

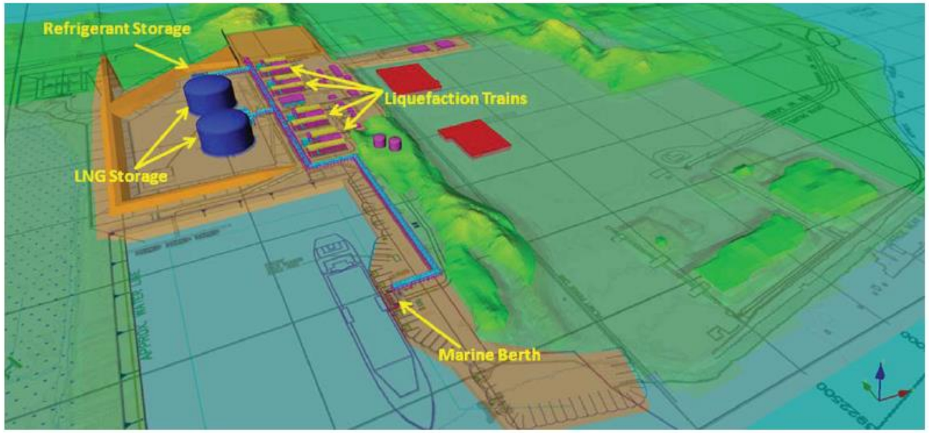


Vapor Fences
Precast lightweight concrete
8-12ft, 20ft high
Yield below 1psig threshold

Jordan Cove Point LNG

Liquid Spill Hazard





Flammable vapor dispersion

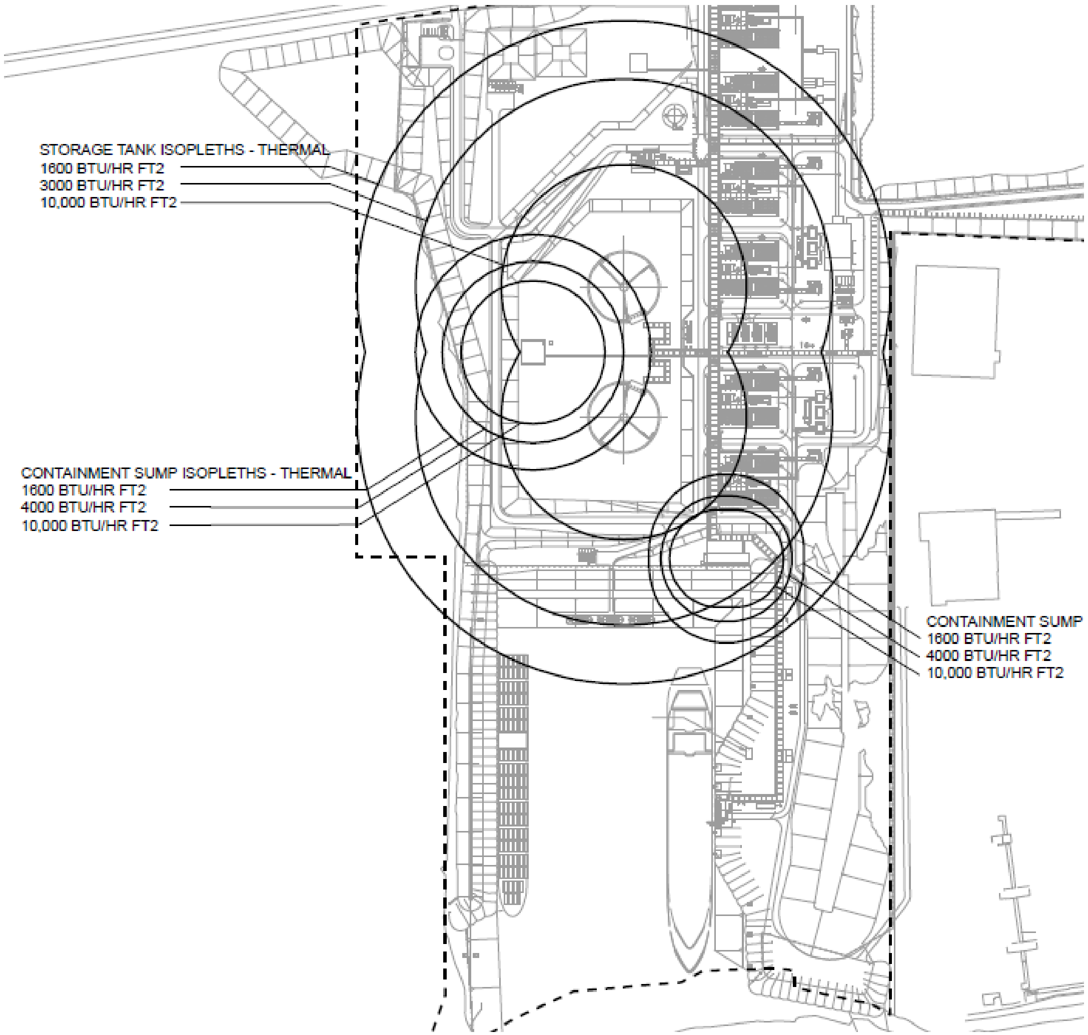
10 min spill

Vapor cloud at ½ LFL

FLACS – vapor dispersion and deflagration
PHAST – screening calculation on flow rate, rainout and unobstructed vapor dispersion

GexCon
DNV

Thermal Radiation Hazard



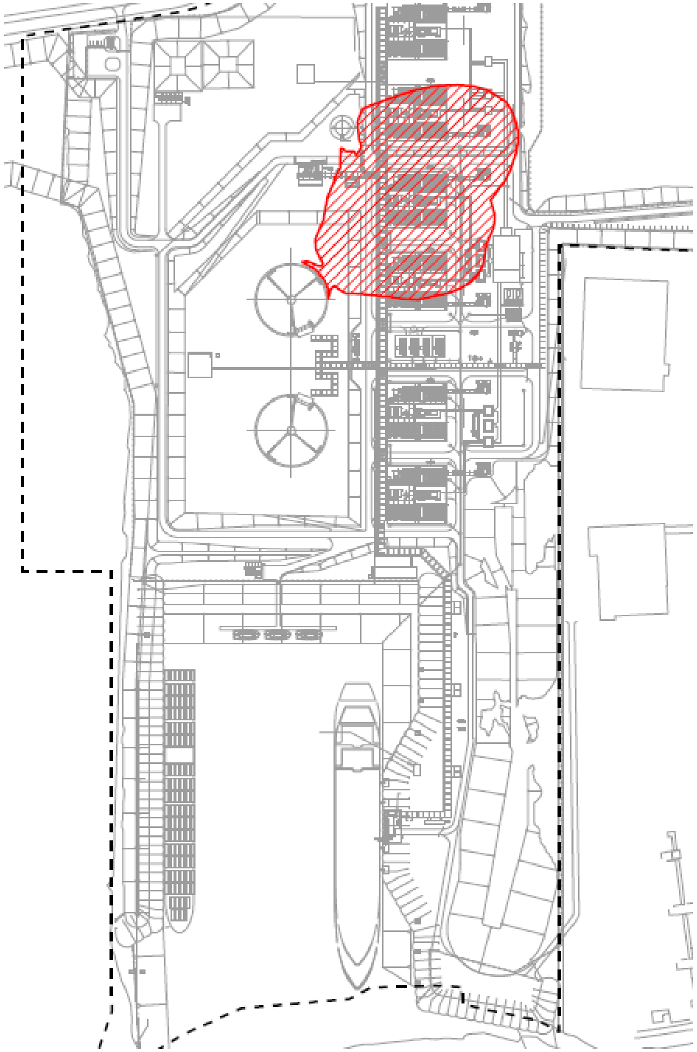
LNGFIRE3
Predicts thermal radiation from onshore LNG pool fires

Pool fires

49 CFR 193

Jordan Cove Point LNG

Overpressure Hazard



DOT requirement is 1psi at facility boundaries

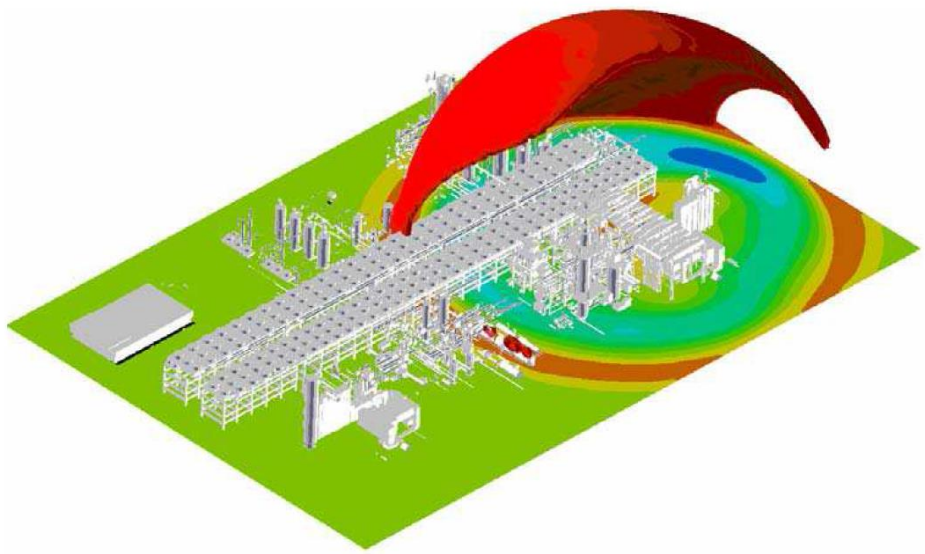
0.5 psi overpressure in FLACS for safety factor

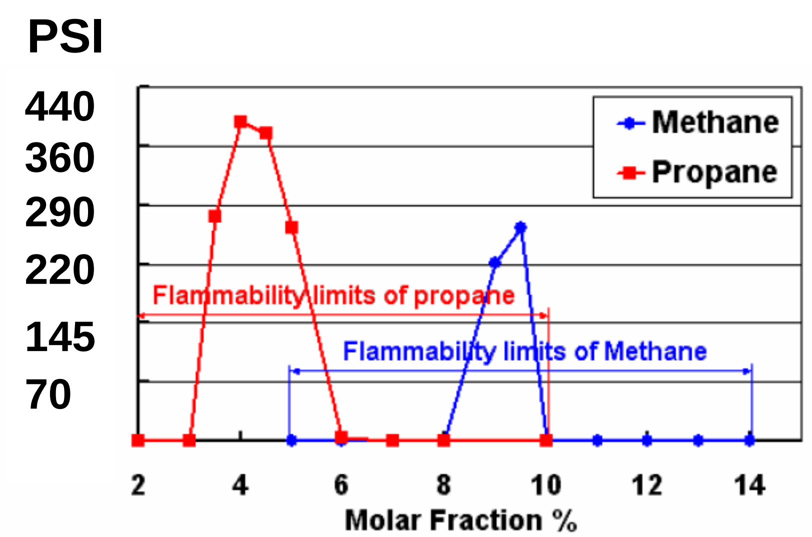
Ignition of vapor clouds in congested areas

Effect	Overpressure, psi
Eardrum rupture	
Threshold	5
50% (20 or more years old)	15-20
Lung Damage	
Threshold	12 (8-15)
Severe	25 (20-37)
Lethal	
Threshold	40 (30-50)
50 percent	62 (50-75)
100 percent	92 (75-115)

Effects of Nuclear Weapons, Atomic Energy commission, 1977

Maximum Overpressure vs Gas Type





Flammability limits for the different components are taken into consideration in the simulations

Structural Response analysis – Abaqus Simulia / USFOS

DNV-RP-C204 Design against accidental loads

Skikda, Algeria, 2004

Kiminori Takahashi et al
JGC Corporation

Autoreagas, FLACS, CFX are standard in Offshore Industry
TNT model is an empirical model and is not used in Offshore

CFD models should require:

- Fuel type (reactivity of fuel)
- Stoichiometry of fuel
- Ignition source type and location
- Confinement and venting (location and size)
- Initial turbulence level in the cloud
- Blockage ratios
- Size, shape and location of obstacles
- Number of obstacles (for a given blockage ratio)
- Cloud size

Explosion effects will depend on maximum pressure, duration of the shock wave and interaction with structures

Hocquet, Technip

Explosion Blast Simulators

CFD

https://www.youtube.com/watch?v=zjRlKTzS5_c

https://www.youtube.com/watch?v=wWv2MdP-IG0

https://www.youtube.com/watch?v=QxaKxVAR1g0

FEA

https://www.youtube.com/watch?v=jESt5Ipjhu8

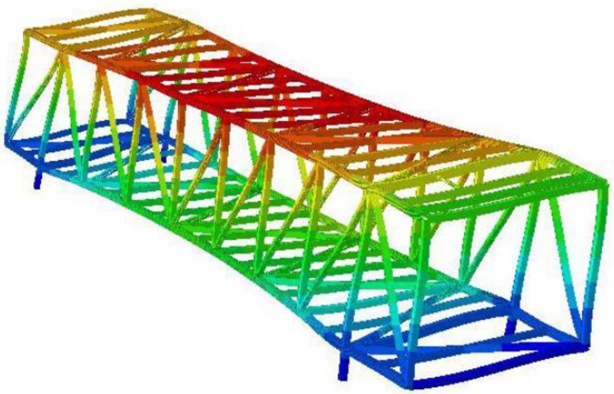
https://www.youtube.com/watch?v=uFSiG7PY23M

https://www.youtube.com/watch?v=T6PyX8rUyL4

https://www.youtube.com/watch?v=WGqC0JPFi_Y

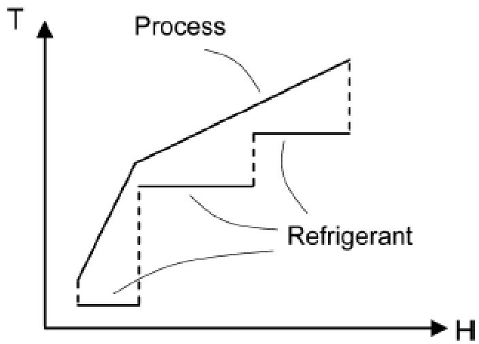
Other

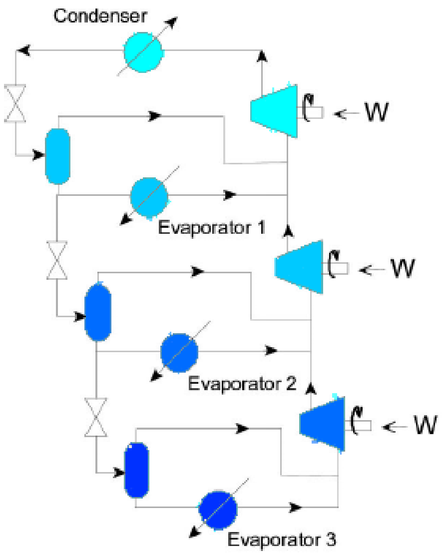
https://www.youtube.com/watch?v=fmKKFkREu8Q

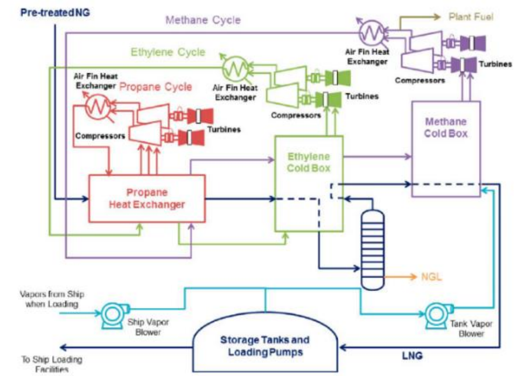


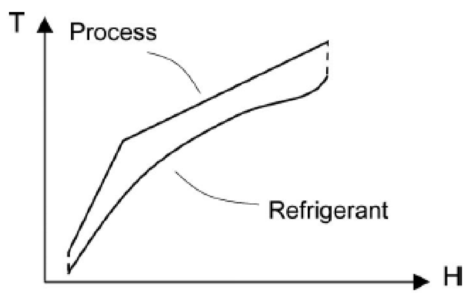
Abaqus Simulia
Regas

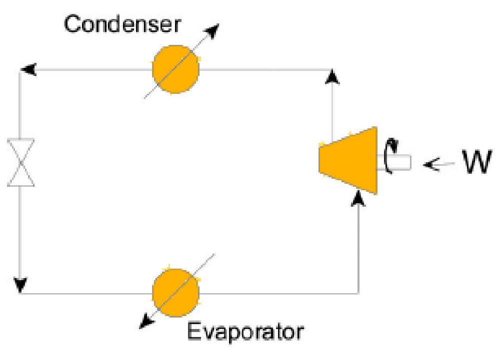
Refrigeration and Liquefaction Technologies

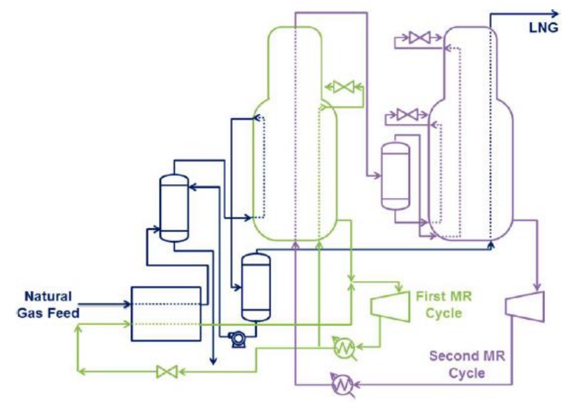








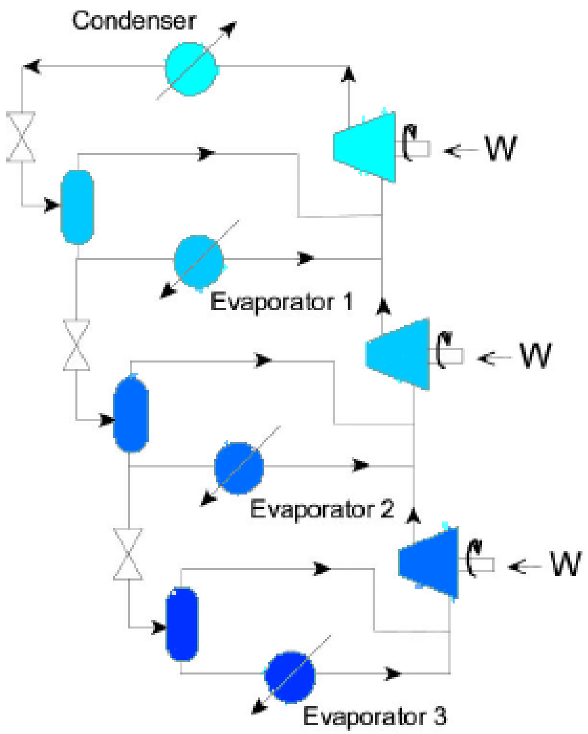


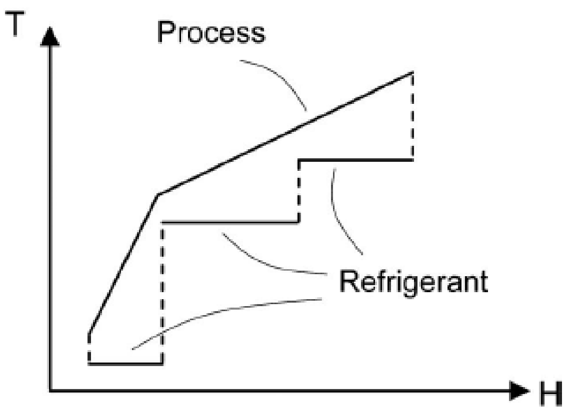


Refrigeration and Liquefaction Technologies – Table of Contents

Single or Mixed Refrigerant?

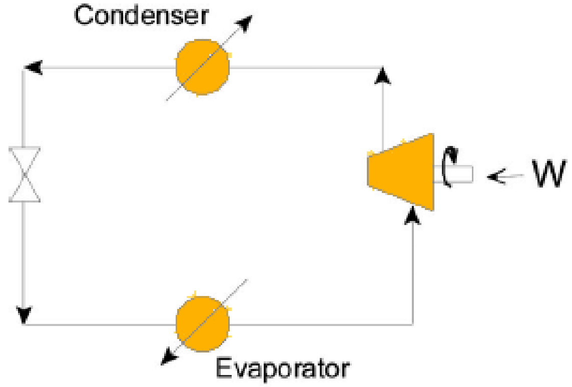
Single Refrigerant

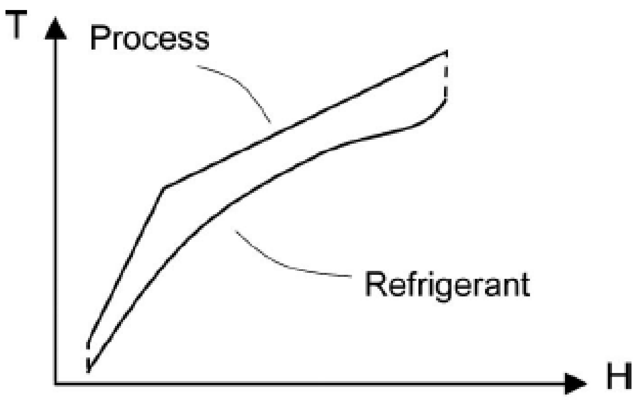




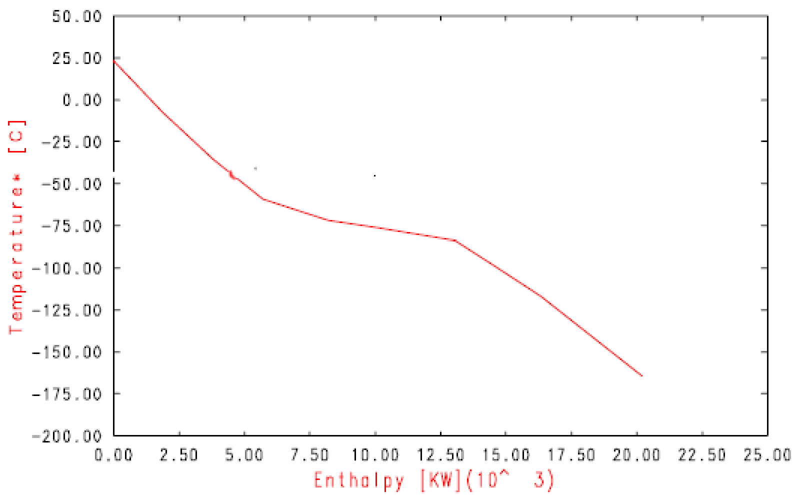
Frank Del Nogal

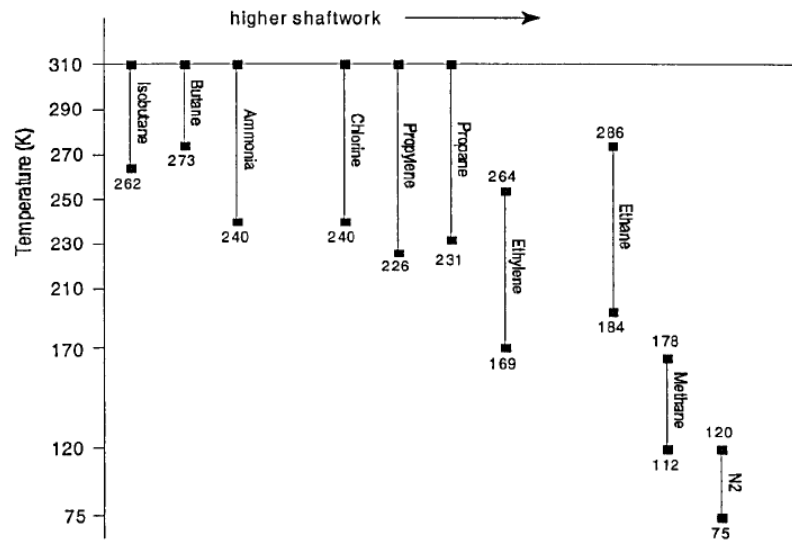
Mixed Refrigerant





Refrigerants and Shaftwork



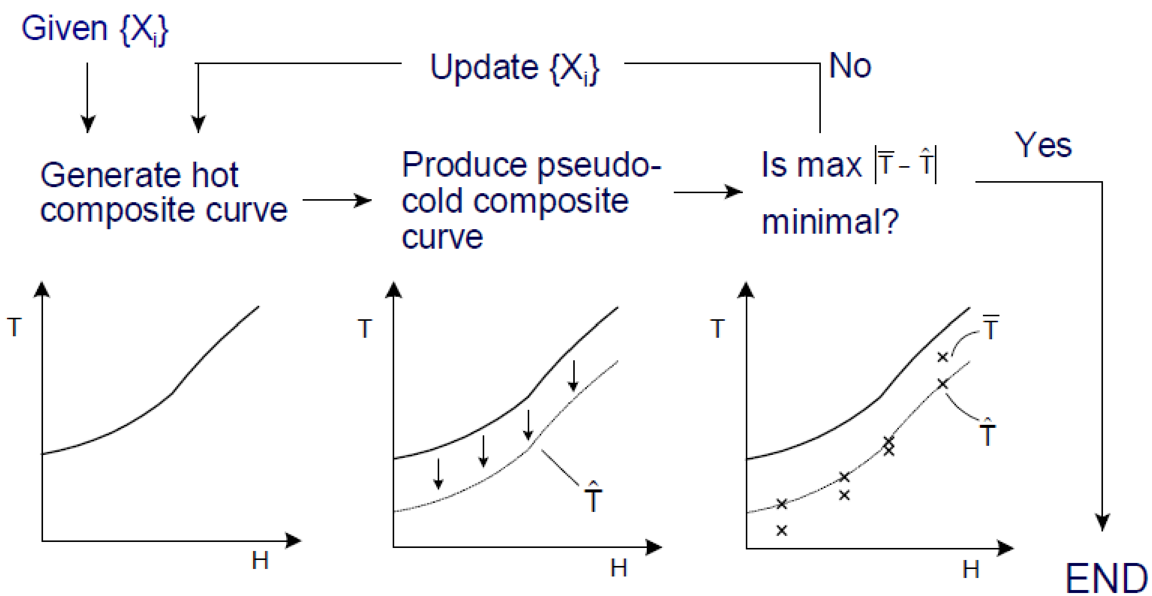


Natural gas MR: 8% N2 45% C1,45%C2, 2% C3

Lee

Selection of Mixed Refrigerant Composition

C1 to C3 and Nitrogen

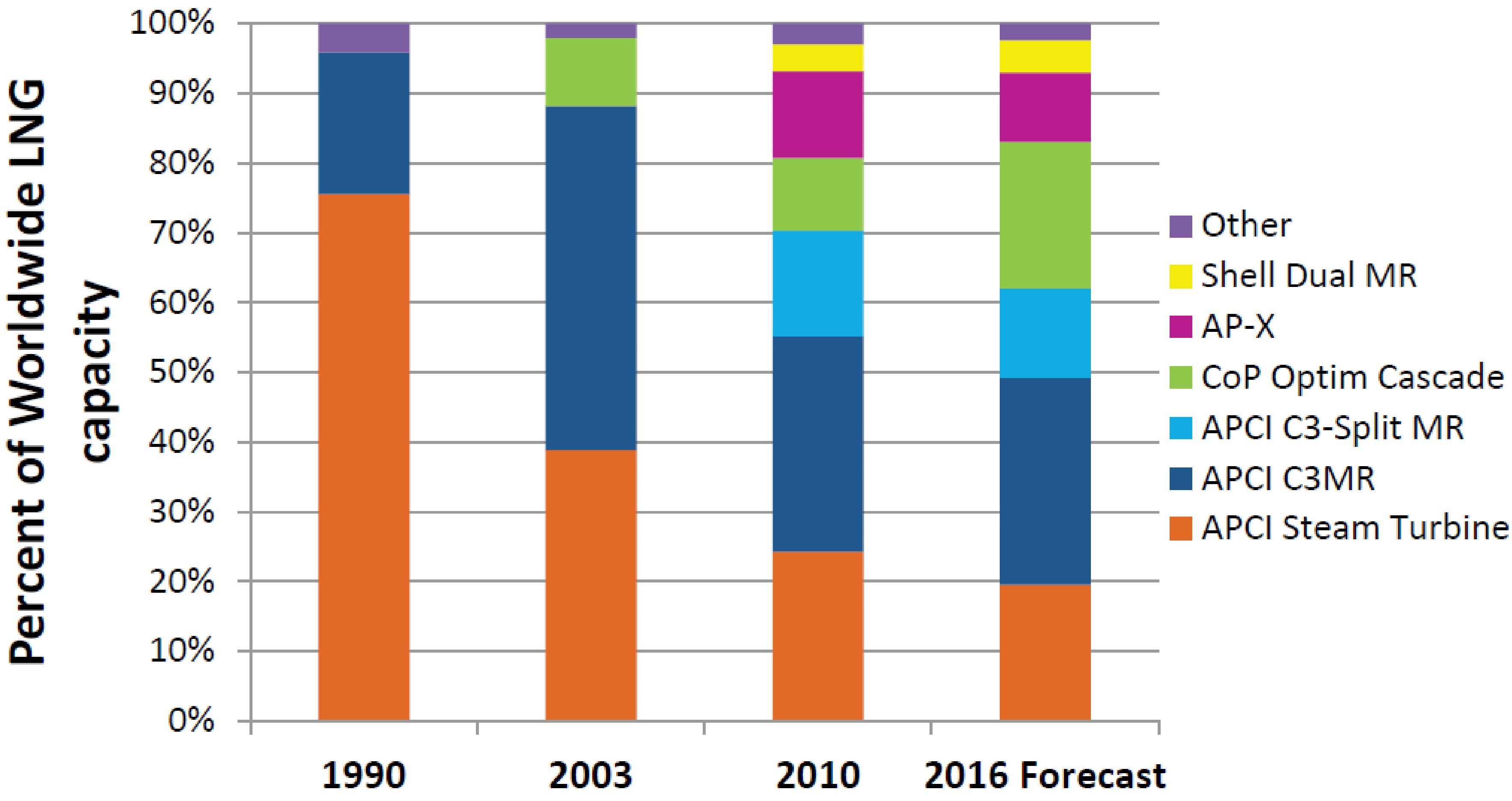


X_i : composition of component i

Natural gas MR: 8% N2 45% C1,45%C2, 2% C3

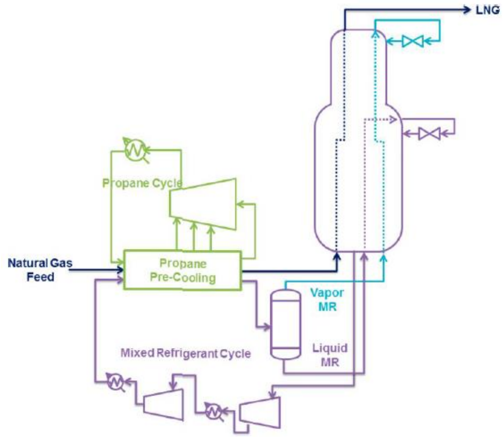
Lee

LNG Refrigeration Technology

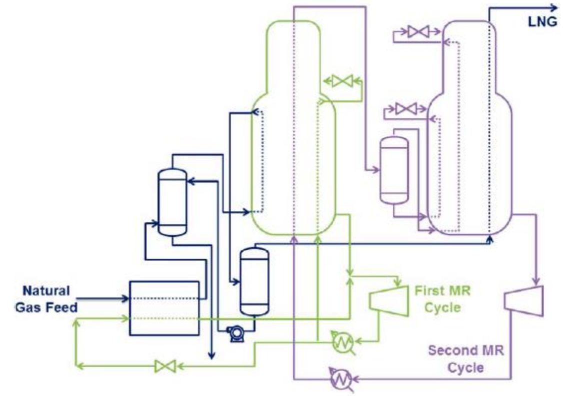


Marybeth Nored Apache Corporation

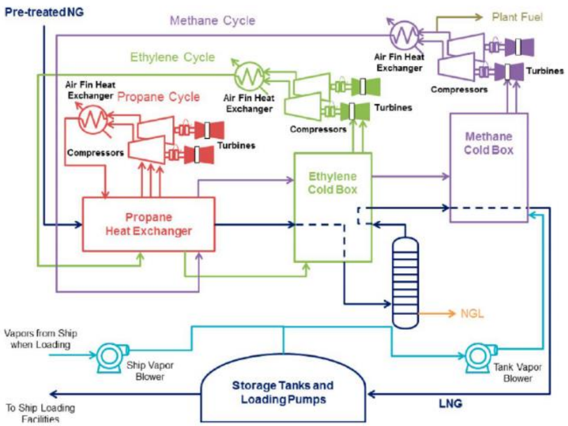
Liquefaction Processes



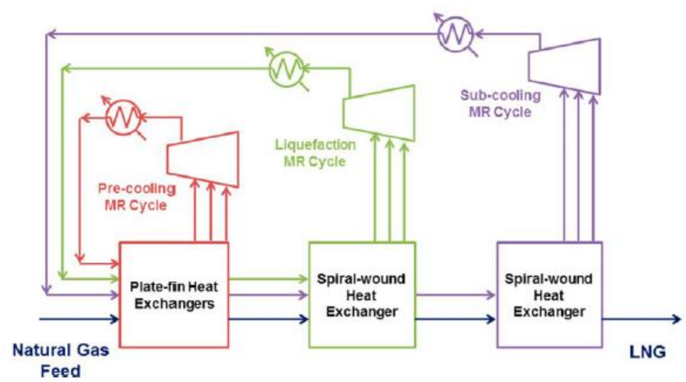
C3MR



DMR



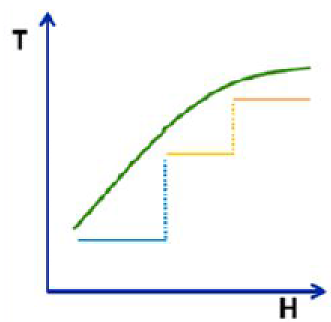
POC



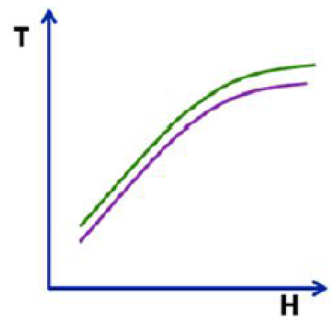
MFC

Natural Gas Cooling Curves

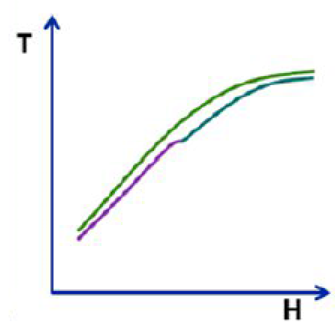
Single Refrigerant



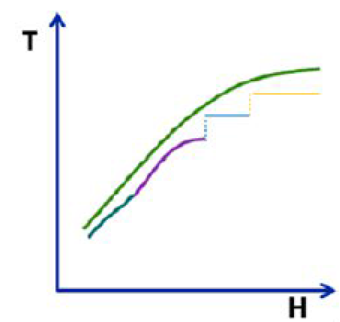
Mixed Refrigerant



Double
Mixed Refrigerant



Mixed and
Single Refrigerant



Il Moon et al

Liquefaction Technologies – General Comparison

Process	SMR	Cascade	DMR	C3-MR	AP-X	N2 Expansion
Core Heat Exchanger	PFHE	PFHE	SWHE	SWHE	SWHE	PFHE
Equipment Count	L	H	L	H	H	L
Hydrocarbon Refrigeration Storage	L	H	L	H	H	N/A
CAPEX	L	M	M	H	H	L
Capacity, mtpa	2-2.5	4	11	8	11	2
Licensor	BV (Prico), APCI	COP	Shell, APCI	Shell, APCI	APCI	KA, Linde, Costain, etc

PHFE – plate fin heat exchanger
SWHE – spiral wound heat exchanger, coil wound heat exchanger

L –Low
M-Medium
H-High
N/A – Not applicable

AP-X used the recently introduced Frame 9 turbine of GE in Qatar
5 MTPA corresponds to a GE Frame 7

Global Markets Research, Floating LNG, Deutsche Bank, 2009

Liquefaction Technologies – Relative Specific Work

PROCESS	Finn et al (relative to Cascade)	Dam et al (relative to MFC)	Foerg (relative to MFC)	Vink et al (relative to C3-MR)	Barclay et al (relative to C3-MR)	Pwaga (relative to DMR)
Cascade	1.0	1.4	1.2	1.2		
SMR	1.3		1.1	1.2		1.1
C3-MR	1.2	1.1	1.0	1	1	
DMR		1		1.0		1
MFC			1			
single N2 Expander	2				3.1	
C3 precooled single N2 expander	1.7				3.3	
double N2 Expander	1.7				1.4	1.5
NICHE LNG						1.4

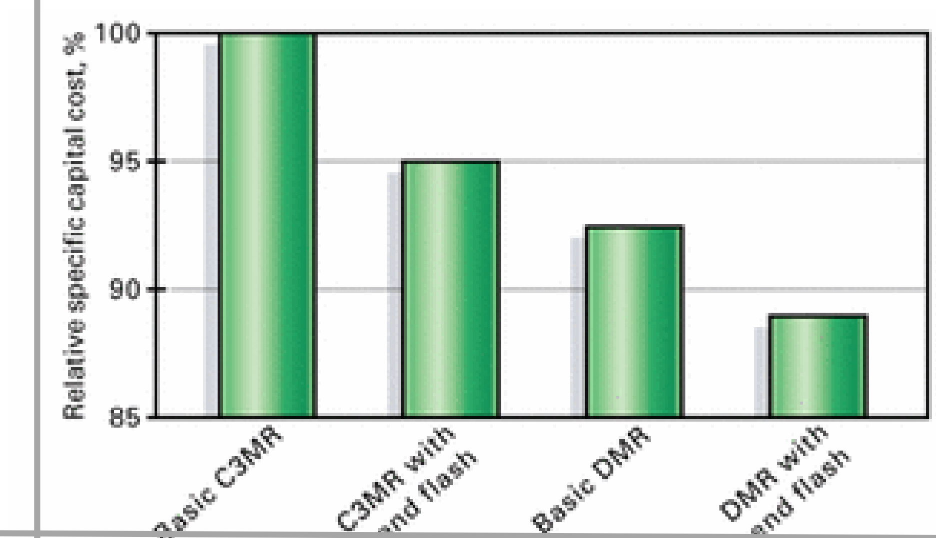
Walter Chukwunonso et al

Pwaga

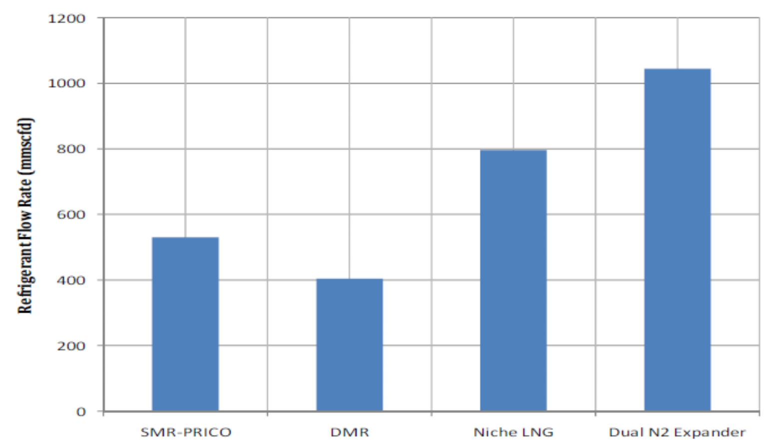
DMR Process

- APCI mentions that it is safer on FLNG applications as it has less propane
- DMR process has less equipment and allows a wider range of operating conditions than C3MR
- DMR process has more exploitable power than C3MR
- DMR has more specific capacity than C3MR process

Cost Comparison



Refrigerant Flow Rate



APCI, Shell, Pwaga

LNG selection based on capacity

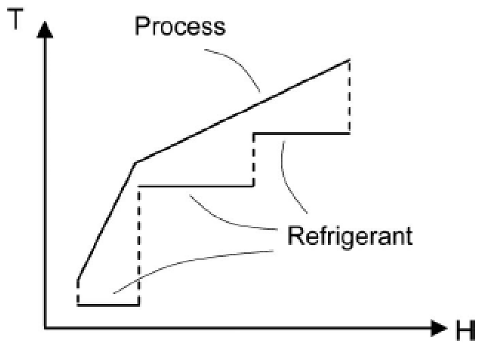
Capacity, MTPA	Liquefaction Technology
< 0.2	Expander processes
	Nitrogen expander
	Feed Gas (Niche Process)
2 - 3	Single Mixed Refrigerant, PRICO
> 3	DMR

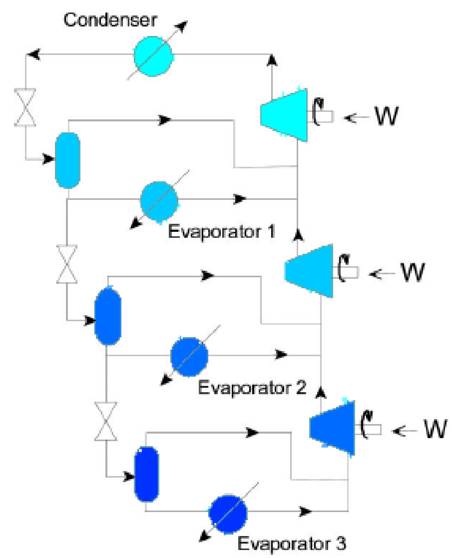
Based on efficiency, complexity, capital investment, equipment count, safety

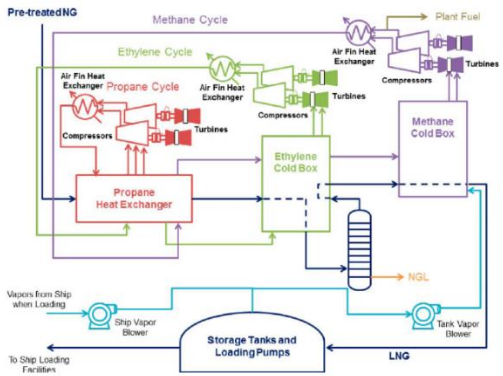
MTPA – million tons per year

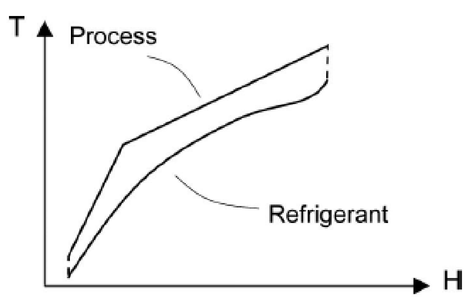
Maneenapang Bunnag et al, PTT

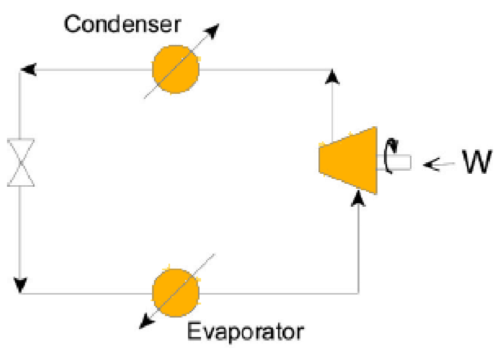
Refrigeration and Liquefaction Technologies

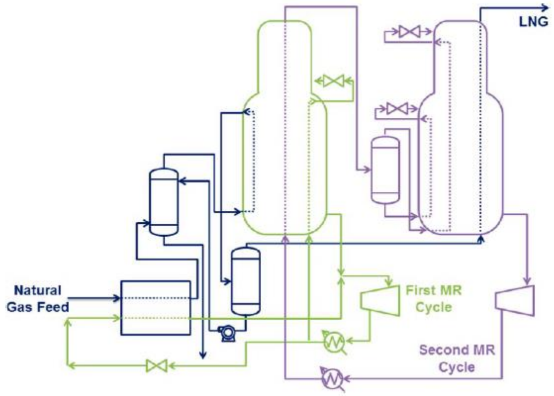












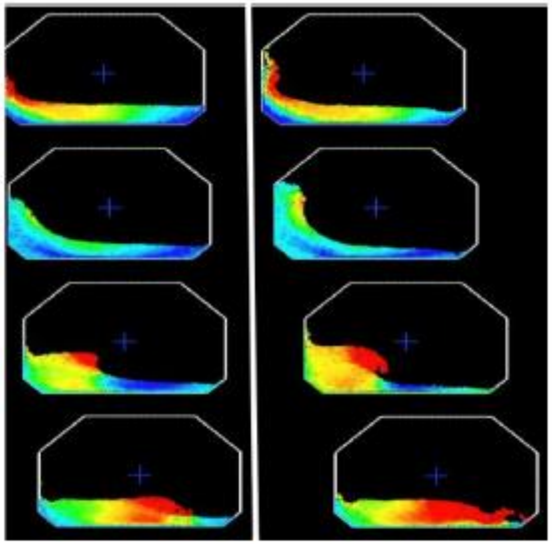
FLNG Table of Contents

- Process Design Considerations
  - Process Flexibility
  - Motion
    - Sloshing
    - Distillation
    - Separators
    - Heat Exchange
    - Flow Motion
    - Structural Issues
  - Weight and Space Limits
  - Safety
- Commercial FLNG projects

FLNG – Process Flexibility

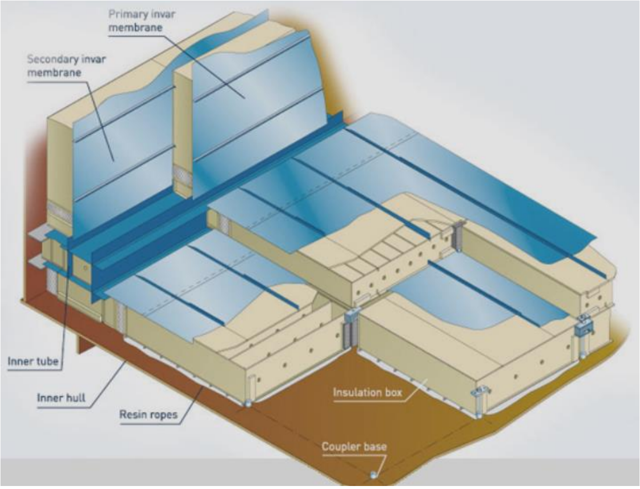
- Processes need to be flexible as the ship will change location.
- Changes in gas composition affect the entire process:
  - CO_2/H_2S removal
  - HRU (demethanizer)
  - Compressors
  - Mixed Refrigerant Compositions

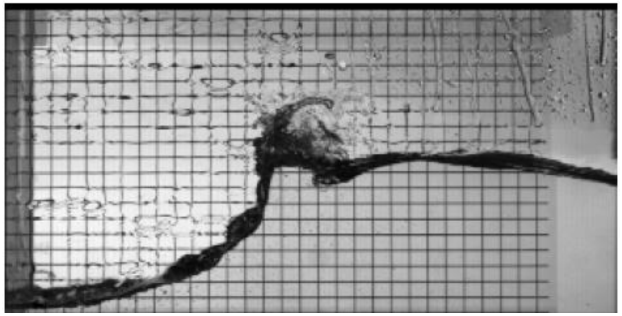
Sloshing



Sloshing leads to high impact pressures on thermal insulation, which translates in maintenance downtimes

Tanks need to withstand sloshing effects, currently GTT has a membrane based design that is favored by the industry because it is efficient and is cost effective.





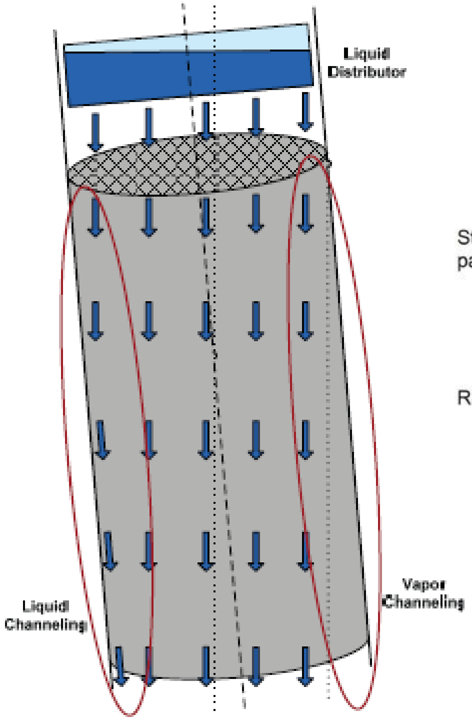
GTT

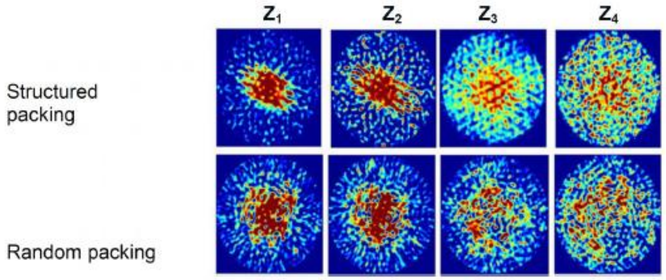
GDF Suez LNG

Exxonmobil

Distillation - Tilting Towers

- Reduction in performance from 10 to 60%
- Random and structured packing are less sensitive to motion than trays.
- Mellapack can be three times less affected by motion than pall rings.
- L/Ds of 2 or less and frequent redistributors. Redistributors may have a higher residence time.
- 50 ppmv CO_2 to HRU tower, <0.1% mol C5+ to liquefaction section

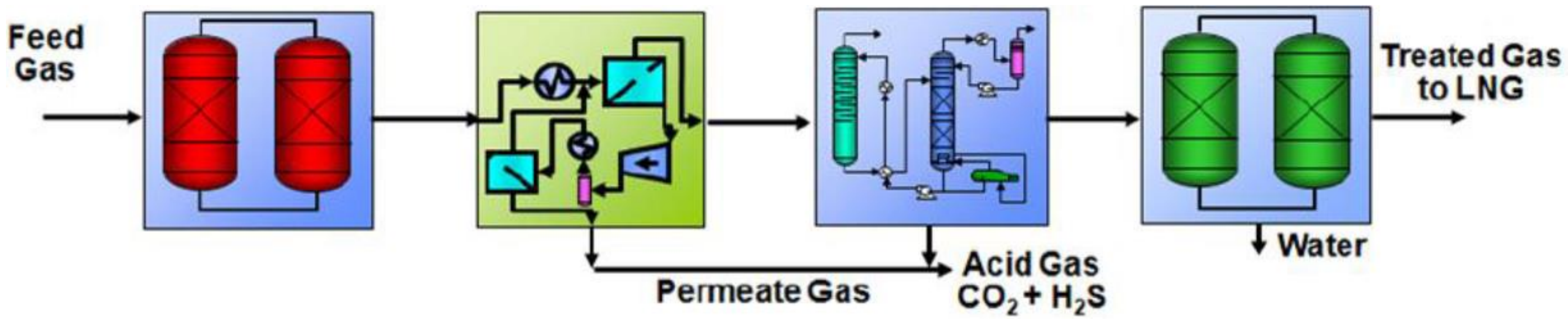


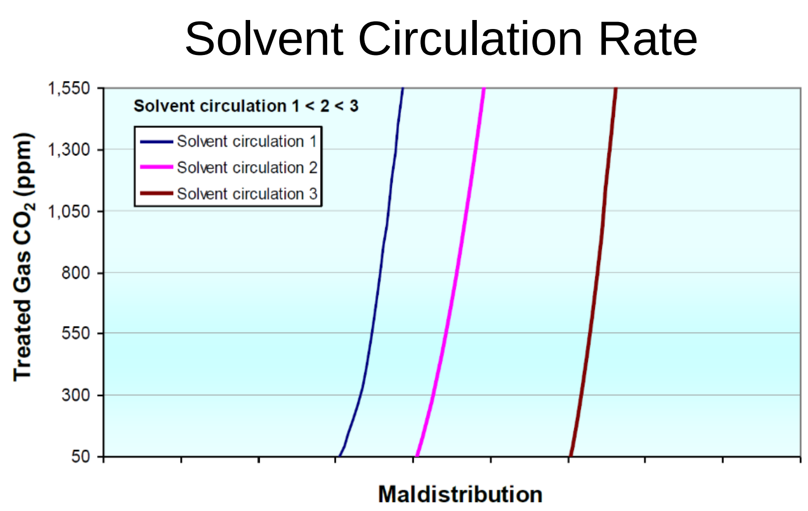


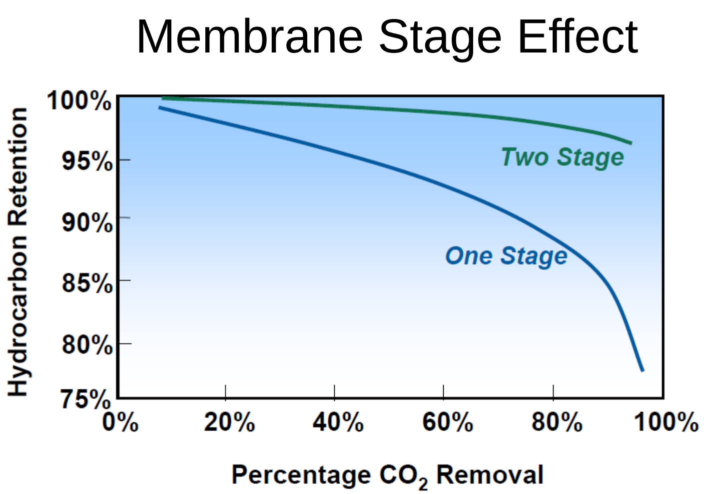
Gamma Tomography

Weiss et al, Total, IFP
Tim Cullinane et al, Exxon

Distillation - Amine System

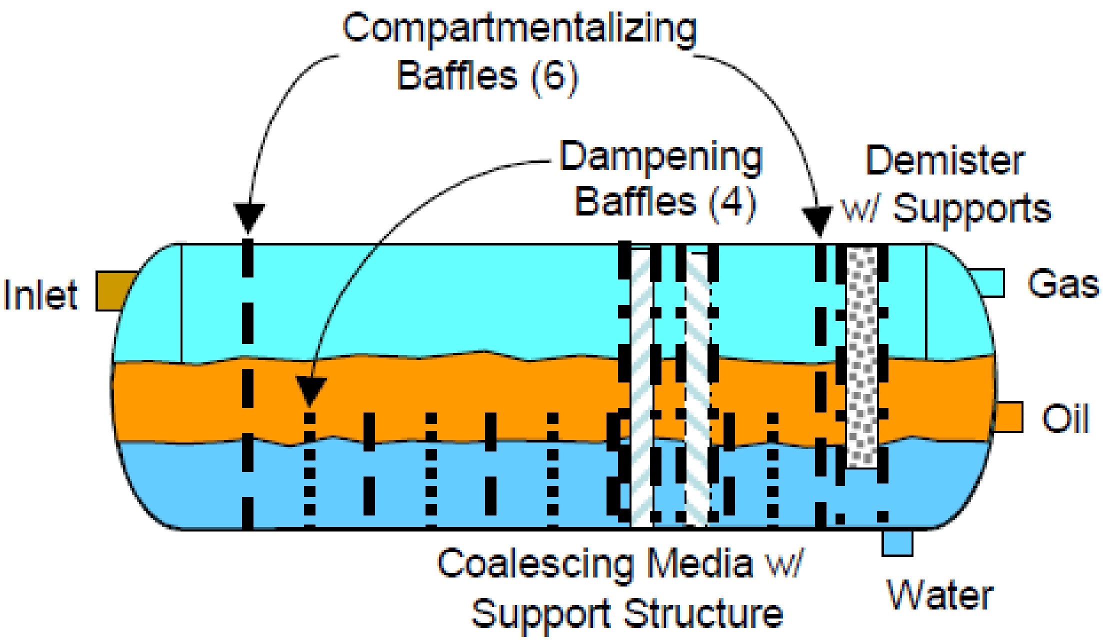


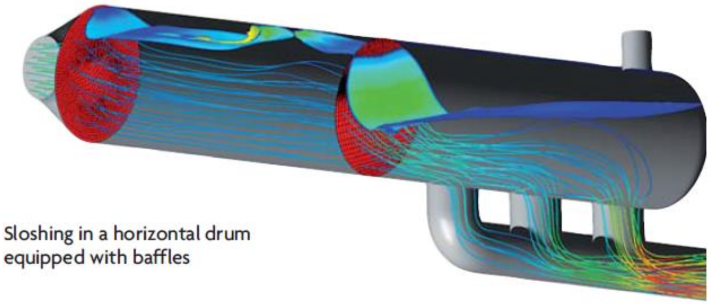




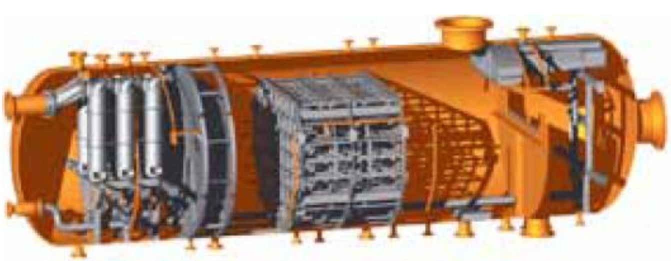
UOP

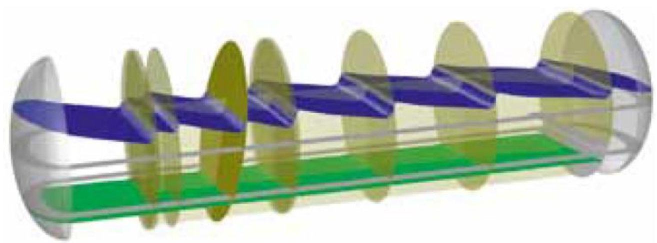
FLNG - Separators





Sloshing in a horizontal drum equipped with baffles





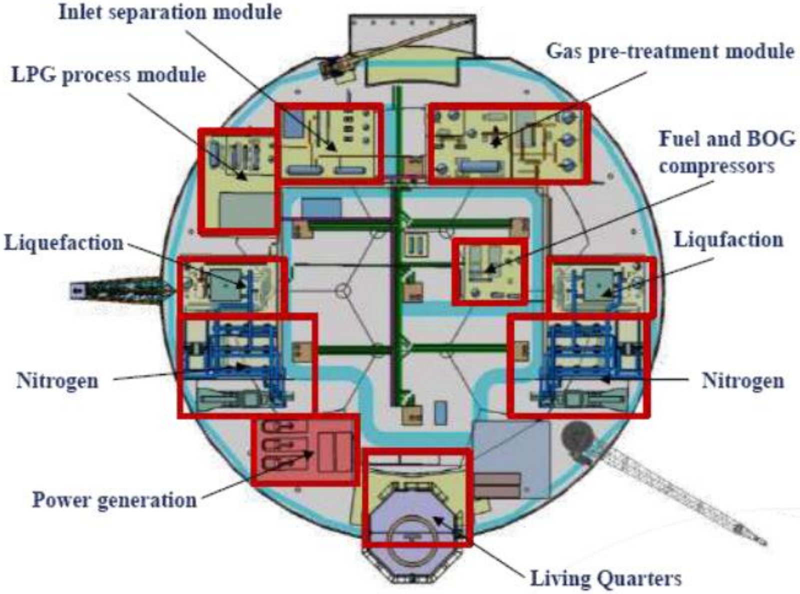
Hamworthy

FMC

Natco

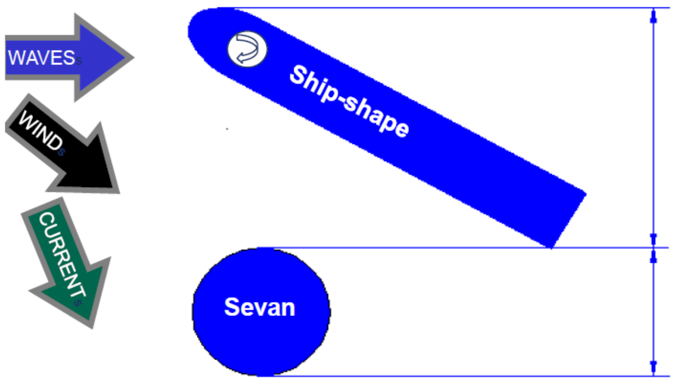
FLNG - Flow Motion

- Layout, check valves and process control should enforce the flow direction within the process
- Layout of equipment should follow a homogeneous weight distribution to decrease oscillations/ improve stability



Motion – Consider Round FPSO

- Eliminates typical wave inducing fatigue loads
- Minimal hull deflections (sag/hog) simplifying topside design
- Hull does not need to rotate even in harshest environmental conditions
- Eliminates turret and swivel
- Tolerant for weather spreading (waves/wind/current from different directions)



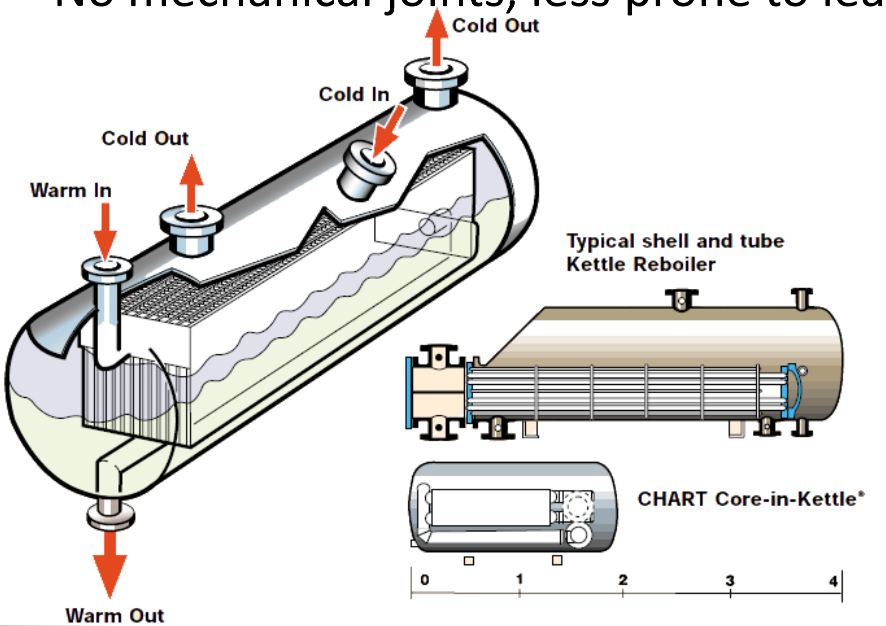
Fredrik Major Sevan Marine

FLNG - Structural Issues - Fatigue

- Mechanical fatigue on distillation columns and cold box
- Load assessments
- Full mechanical /naval considerations

Weight and Space Limits - Core-in-Kettle Heat Exchangers

- 10 times more heat transfer surface per unit volume
- Temperature approach of 2°F/1°F (instead of 15°F)
- Lower capital costs
- 75% less weight
- Less plant space, about 50% of size of shell and tube
- Lower compressor power
- No mechanical joints, less prone to leaks



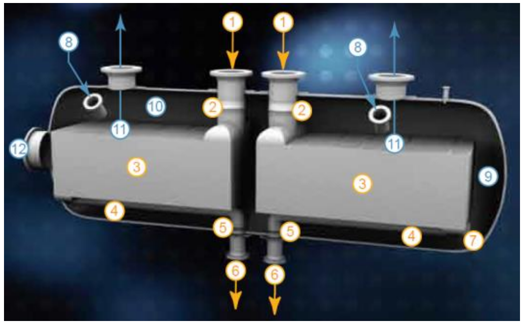
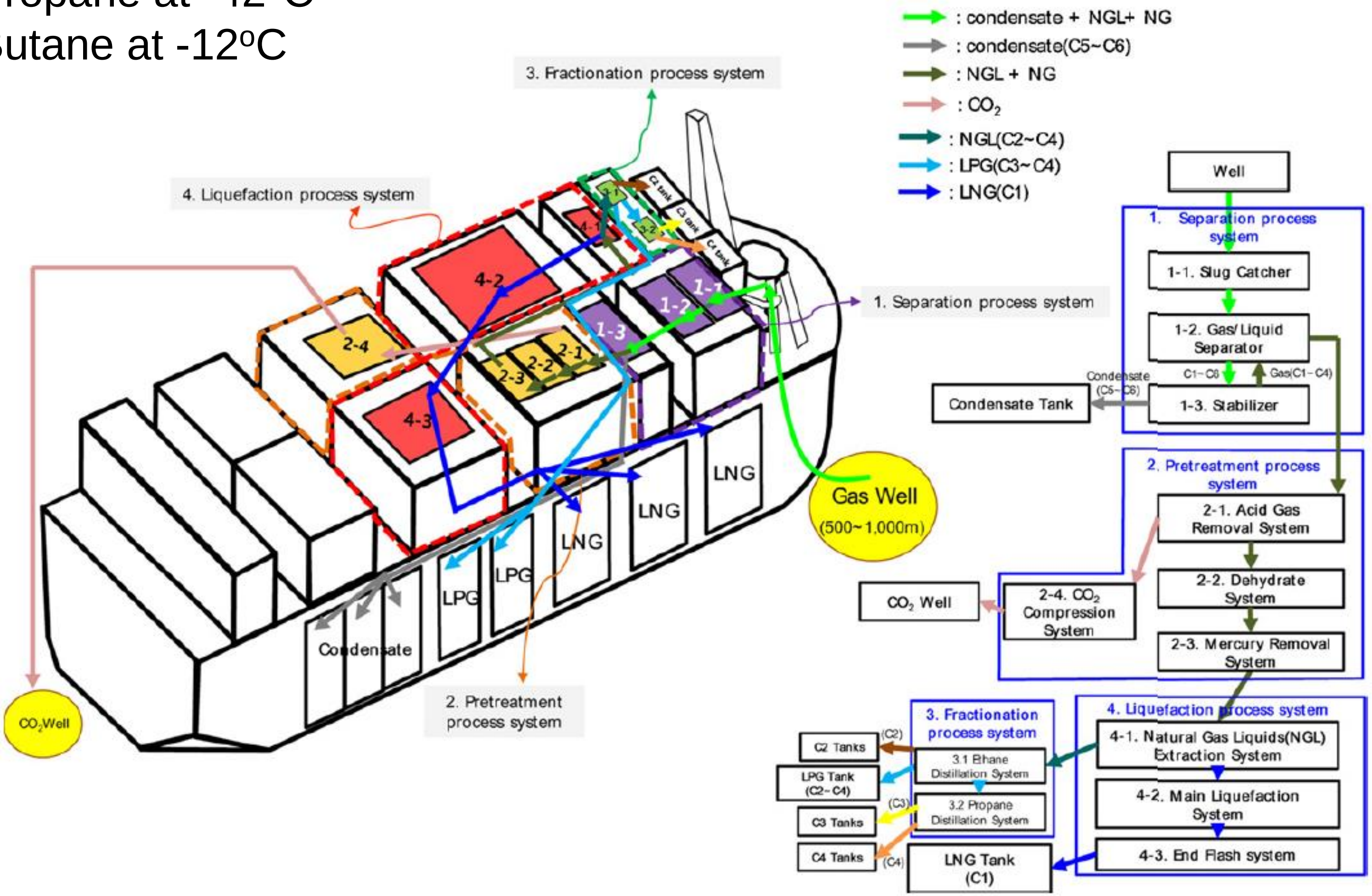


Chart Industries

FLNG Safety – Table of Contents

FLNG Topsides Arrangement

LNG is stored at -161°C
Propane at -42°C
Butane at -12°C



Ji-Hyun Hwang, SBM Offshore

FLNG Safety – Main Process Hazards

- Leak Hazards

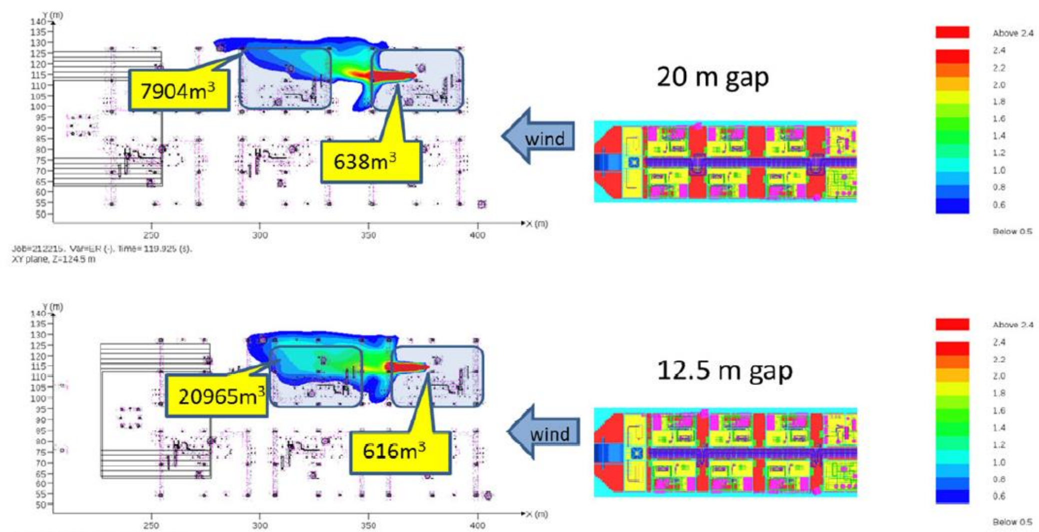
- Asphyxiation Risk
- Explosion Risk
- Cryogenic Spill Risk
  - Embrittlement of steel structures (module structure, hull)

- BLEVE Hazard (C2+ vessels)
- Management of Rapid Phase Transition

  Kevlar

FLNG Safety – Explosion/Asphyxiation Risk

- Promote ventilation
  - Grated vs Plated Process Decks
  - Limitation of module congestion level
  - Optimization of module arrangement and ventilation



- Minimizing LPG inventories

ENI, Gavelli

FLNG Safety – Cryogenic Spills Risk

Effects

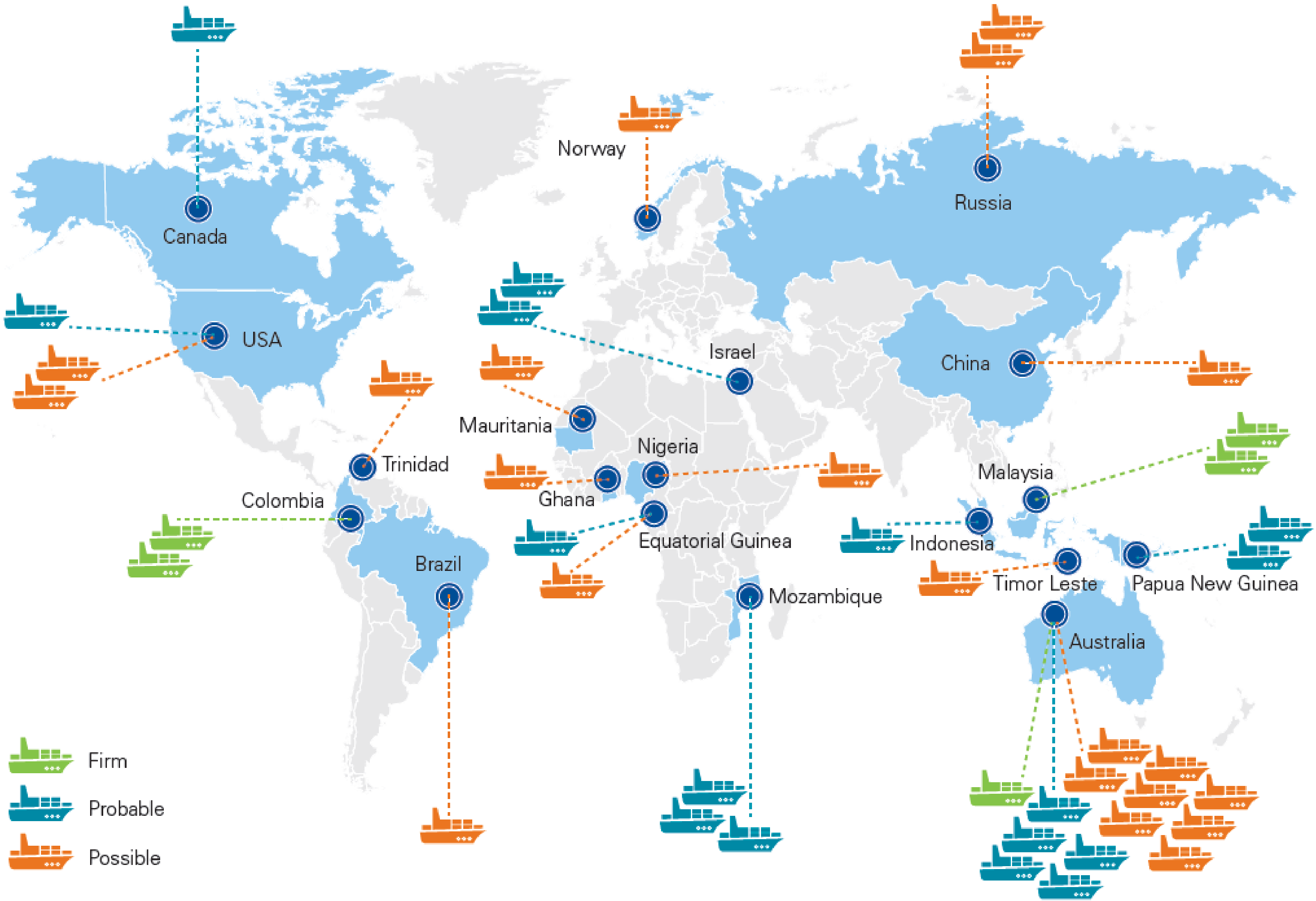
Embrittlement of steel structures (module structure, hull)

Solutions

- Minimize leak points (flanges, pumps, valves)
  - HSE hydrocarbon release database (HCRD)
- Collect spill locally
- Direct overboard
- Use polyurethane, wood or concrete insulation to avoid contact with metal structures
- Use insulation and spray guards to protect personnel
- Collect smaller spills locally in drip trays of suitable material (Stainless Steel)

DNV Veritas

FLNG Projects in the pipeline boat



KPMG, September 2014

FLNG Projects - Under Construction

Project	Exmar	Exmar 2	PFLNG 1	PFLNG 2	Prelude
capacity, MTPA	0.5	0.6	1.2	1.5	3.6 LNG+0.4 LPG + 1.3 condensate
technology	PRICO SMR	PRICO SMR	N2 Expansion (AP-NTM)	N2 Expansion (AP-NTM)	DMR
cost, million USD	300	414	2,000	2,000-3,000	12,000+
EPC	Wison Offshore	Wison Offshore	Technip - Daewoo	JGC - Samsung	Technip - Samsung
Field	La Cresciente	La Cresciente	Kanowit	Rotan	Prelude
Country	Colombia	Colombia	Malaysia	Malaysia	Australia
distance from shore (miles)	shoreside	shoreside	100	70	130
mechanical drivers	gas turbine	gas turbine	AGT	AGT	steam turbine

Japan imported 37% of global LNG in 2013

185 FPSOs in service
40 FPSO on order

FLNG – Technologies

Project / Equipment	Prelude	Kanowit	Santos Basin	Scarborough	Bonaparte
Capacity	(3.6 MTPA + liquids)	(1.2 MTPA)	(2.7 MTPA + liquids)	(6/7 MTPA)	(2.4 MTPA)
Owner	Shell/ Inpex / Kogas /CPC	Petronas	Petrobras /BG	Exxonmobil/ BHP	GDF SUEZ / Santos
Engineering / Shipyard	Technip / Samsung	Technip / DSME	Technip / JGC / Modec SBM/ Chiyoda / SAIPEM	?	Technip / KBR
Liquefaction process	DMR	N2 Expansion (AP-N)	DMR	Mix Refrig	DMR
Mechanical Drivers	redesigned steam turbines	gas turbines	gas turbines	gas turbines	gas turbines
Containment System	Mark III membranes	No 96 membranes	SPM	?	membranes
LNG Offloading	side by side	side by side	tandem	tandem	side by side

GDF SUEZ LNG

FLNG Projects - Probable

FLNG Project	Field	Country	Build Date	Distance from Shore (km)	Operator
Abadi FLNG	Abadi	Indonesia	2019	102	INPEX Masela
Area 4 Mamba FLNG 1	Mamba North	Mozambique	2020	49	ENI
Area 4 Mamba FLNG 2	Mamba South	Mozambique	2020	48	ENI
BC LNG Canada FLNG Barge	Douglas Channel	Canada	2016	Shoreside	Exmar
Bonaparte FLNG	Petrel	Australia	2020	158	GDF Suez
Browse FLNG 1	Brecknock	Australia	2017	259	Woodside Energy
Browse FLNG 2	Calliance	Australia	2018	247	Woodside Energy
Browse FLNG 3	Torosa	Australia	2019	285	Woodside Energy
Coral FLNG	Coral	Mozambique	2020	65	ENI
Fortuna Complex FLNG	Fortuna	Equatorial Guinea	2018	91	Ophir Energy
Golar FLNG	Unknown		2016		Golar LNG
Lavaca Bay FLSO	Unknown	United States	2019	Shoreside	Excelerate Energy
Leviathan FLNG	Leviathan	Israel	2020	126	Noble
Pandora FLNG	Pandora	Papua N. Guinea	2018	148	Cott Oil and Gas
PNG Petromin FLNG	Unknown	Papua N. Guinea	2019		Petromin PNG
Scarborough FLNG	Scarborough	Australia	2021	236	ExxonMobil
Tamar Israel FLNG	Tamar	Israel	2017	94	Noble Energy

Clarksons

FLNG Projects - Possible

FLNG Project	Field	Country	Build Date	Distance from Shore (km)	Operator
Acme FLNG	Acme	Australia	2017	83	Chevron Australia
Arnhem/Pinhoe FLNG	Arnhem	Australia	2019	290	Chevron WA-364-P
Block 22/NCMA 4 FLNG	Unknown	Trinidad	2017		Centrica
Bumi FLNG	Unknown	Equatorial Guinea	2017		
Caldita/Barossa FLNG	Barossa	Australia	2018	157	Conoco Australia
Cambridge Energy FLNG 1	FSO	United States	2018	Mississippi River	Cambridge Energy
Cambridge Energy FLNG 2	FSO	United States	2018	Mississippi River	Cambridge Energy
Cash Maple/Oliver FLNG	Cash-Maple	Australia	2019	266	PTTEP Australia
Crux FLNG	Crux	Australia	2020	180	Nexus/Shell
Dongfang 13-2 FLNG	Dongfang 13-2	China	2020	91	CNOOC
Echuca Shoals FLNG	Echuca Shoals	Australia	2019	174	Nexus
Ghana FLNG		Ghana	2016		ENI
Greater Chuditch FLNG	Chuditch	Aust-East Timor JDZ	2019	246	Minza
Greater Sunrise FLNG 1	Greater Sunrise	Australia	2020	306	Woodside Energy
Greater Sunrise FLNG 2	Greater Sunrise	Australia	2022	306	Woodside Energy
NNPC Niger Delta FLNG		Niger	2017		NNPC
Pechora FLNG	Unknown	Russia	2018		Pechora LNG
Pelican/Faucon FLNG	Faucon	Mauritania	2020	210	Dana Petroleum
Petrobras FLNG	Lula	Brazil	2018	276	Petrobras
SBM FLNG	Unknown				Unknown
Sevan FLNG	Unknown	Norway	2018		Sevan Marine
Shtokman FLNG	Shtokman	Russia	2020	283	Shtokman Development

Clarksons

Thanks!

Gabriel Castaneda, P.E.
(713) 873 1708
Gabriel @gabcheminc.com