



Presentation on LNG Bunkering AAPA Facilities Engineering Panel IX: LNG Terminals

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INTRODUCTION



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01 **HDR Fast Facts**

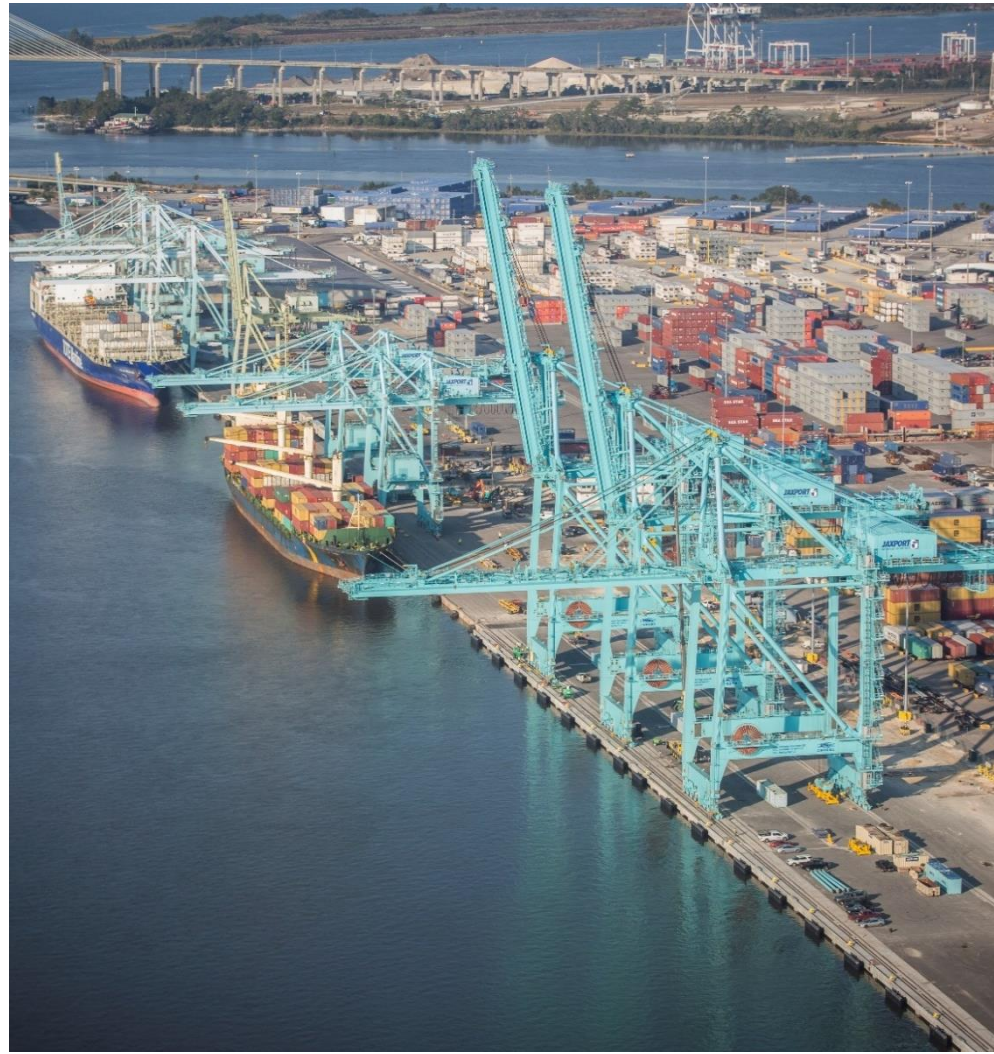
02 **LNG as a Marine Fuel**

03 **LNG Bunker Operations**

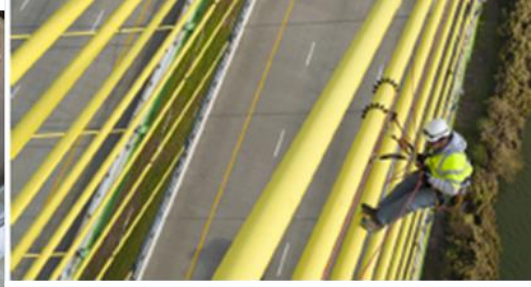
04 **LNG Bunkering in Jacksonville, FL**

HDR FAST FACTS

- Founded in 1917
- More than 9,900 employee-owners across 200+ locations worldwide
- Projects in all 50 states and in 60 countries
- Operations in 8 countries
- Approximately 800 staff in Florida
- ENR No. 6 in Marine & Port Facilities
- LNG services over 20 years



What We Do



Architecture

- Academic
- Civic
- Corporate
- Healthcare
- Justice
- Science + Technology

Federal

- Architecture
- Engineering
- Planning
- Environmental
- Energy
- Construction

Industrial

- Chemical & Pharmaceutical
- Food & Beverage
- Manufacturing & Basic Industry
- Primary Metals & Steel
- Pulp & Paper
- Agribusiness

Mining

- Markets & Economics
- Exploration
- Feasibility & Permitting
- Development
- Operations
- Closure

Oil & Gas

- Upstream
- Midstream
- Downstream

Power

- Power Delivery
- Power Generation
- Renewable Energy

Private Development

- Civil Design
- Environmental
- Master Planning & Urban Design
- Transportation Infrastructure

Transportation

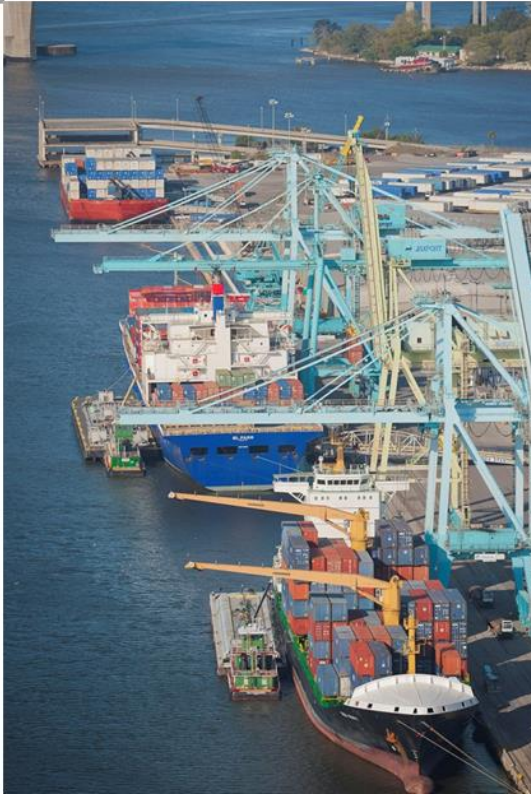
- Aviation
- Freight Rail
- Highways and Local Roads
- Maritime
- Transit

Waste

- Solid Waste Facilities & Landfills
- Energy-from-Waste & Organics Management
- Planning & Program Development
- HTRW & Environmental Restoration

Water & Natural Resources

- Water
- Wastewater
- Water Resource Management



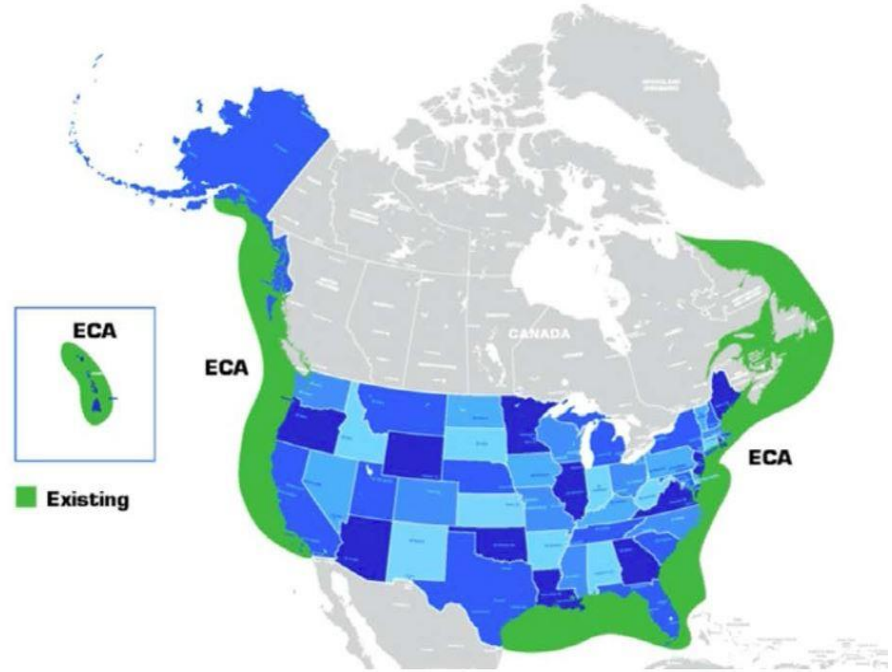
02

**WHY LNG AS A MARINE
FUEL?**

INTERNATIONAL MARITIME ORGANIZATION - 0.5% GLOBAL SULFUR CAP

October 27th, 2016 – IMO announces that the MEPC (Marine Environmental Protection Committee) agreed to a 0.5% global sulfur cap on Marine Fuel commencing January 1st, 2020

- IMO cast aside concerns as to shortage of fuel to meet new cap
- Existing ECA's (including North American) will stay in place
 - N. American ECA has 0.1% sulfur cap
- Only exception to this limit are those vessels with abatement (scrubbing technology)



Emission Containment Area (ECA) – North America

MARINE FUEL SUPPLY BALANCE POST 2020

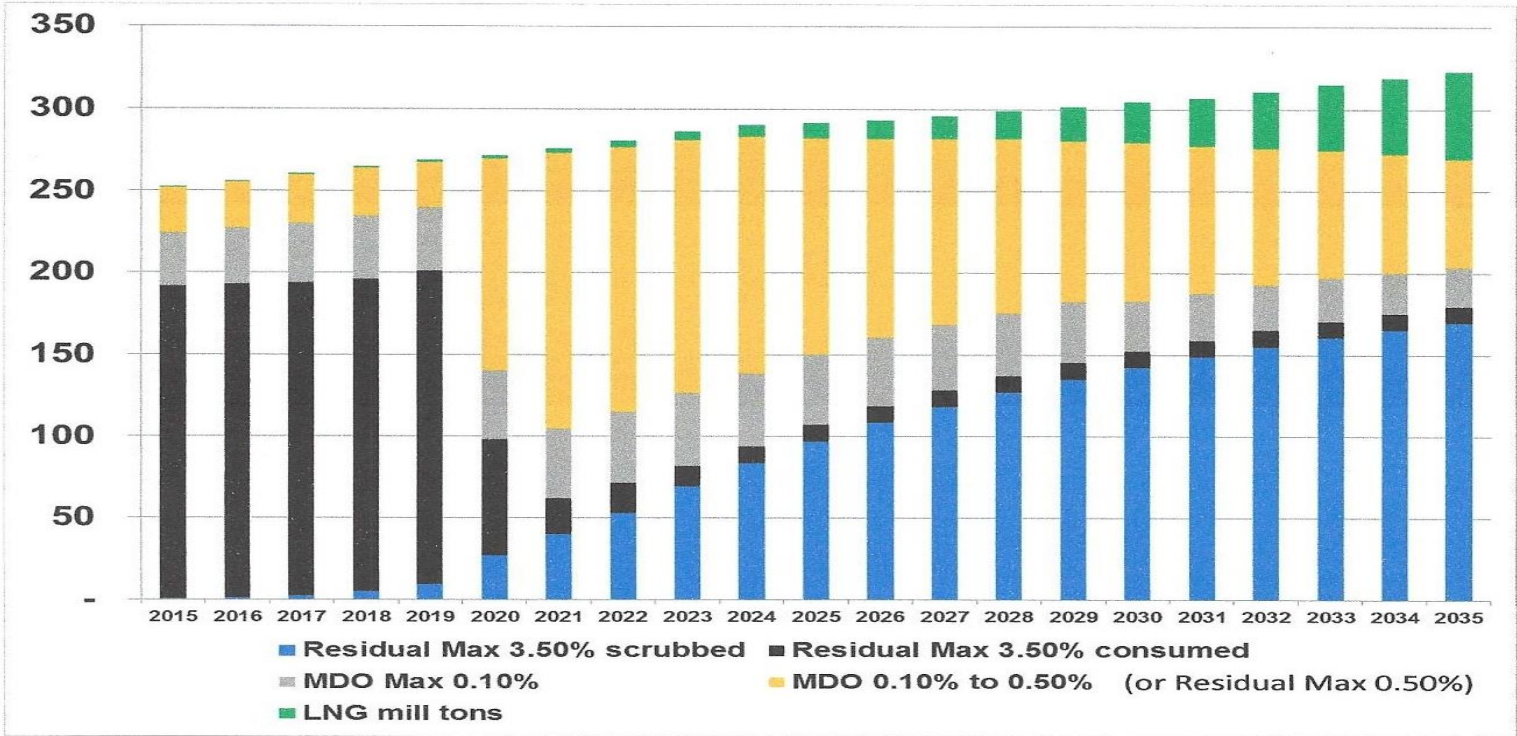


Figure 1- Post 2020 Global Bunker Demand by Product

Source : MECL (Marine Energy Consulting Limited)

WHERE IS THE BREAKEVEN BETWEEN LNG AND MGO?

Fuel Spreads \$/MMBtu

Houston Spot

NYMEX Cal 2017



Crude Oil

Base Commodity		Crude Oil												Crude \$/bbl	
		\$ 20	\$ 30	\$ 40	\$ 50	\$ 60	\$ 70	\$ 80	\$ 90	\$ 100	\$ 110	\$ 120			
\$/DGE	\$/MT	\$ 1.00	\$ 1.24	\$ 1.48	\$ 1.71	\$ 1.95	\$ 2.19	\$ 2.43	\$ 2.67	\$ 2.90	\$ 3.14	\$ 3.38	**MGO		
		\$ 319	\$ 395	\$ 471	\$ 547	\$ 623	\$ 699	\$ 775	\$ 851	\$ 927	\$ 1,003	\$ 1,079	MGO		
		\$/MMBtu	\$ 7.88	\$ 9.75	\$ 11.63	\$ 13.50	\$ 15.38	\$ 17.25	\$ 19.13	\$ 21.00	\$ 22.88	\$ 24.75	\$ 26.63	MGO	
Natural Gas	\$ 1.00	\$ 1.33	\$ 425	\$ 10.50	\$ 2.62	\$ 0.75	\$ (1.13)	\$ (3.00)	\$ (4.88)	\$ (6.75)	\$ (8.63)	\$ (10.50)	\$ (12.38)	\$ (14.25)	\$ (16.13)
	\$ 1.25	\$ 1.36	\$ 435	\$ 10.75	\$ 2.87	\$ 1.00	\$ (0.88)	\$ (2.75)	\$ (4.63)	\$ (6.50)	\$ (8.38)	\$ (10.25)	\$ (12.13)	\$ (14.00)	\$ (15.88)
	\$ 1.50	\$ 1.40	\$ 446	\$ 11.00	\$ 3.12	\$ 1.25	\$ (0.63)	\$ (2.50)	\$ (4.38)	\$ (6.25)	\$ (8.13)	\$ (10.00)	\$ (11.88)	\$ (13.75)	\$ (15.63)
	\$ 1.75	\$ 1.43	\$ 456	\$ 11.25	\$ 3.37	\$ 1.50	\$ (0.38)	\$ (2.25)	\$ (4.13)	\$ (6.00)	\$ (7.88)	\$ (9.75)	\$ (11.63)	\$ (13.50)	\$ (15.38)
	\$ 2.00	\$ 1.46	\$ 466	\$ 11.50	\$ 3.62	\$ 1.75	\$ (0.13)	\$ (2.00)	\$ (3.88)	\$ (5.75)	\$ (7.63)	\$ (9.50)	\$ (11.38)	\$ (13.25)	\$ (15.13)
	\$ 2.25	\$ 1.49	\$ 476	\$ 11.75	\$ 3.87	\$ 2.00	\$ 0.12	\$ (1.75)	\$ (3.63)	\$ (5.50)	\$ (7.38)	\$ (9.25)	\$ (11.13)	\$ (13.00)	\$ (14.88)
	\$ 2.50	\$ 1.52	\$ 486	\$ 12.00	\$ 4.12	\$ 2.25	\$ 0.37	\$ (1.50)	\$ (3.38)	\$ (5.25)	\$ (7.13)	\$ (9.00)	\$ (10.88)	\$ (12.75)	\$ (14.63)
	\$ 2.75	\$ 1.56	\$ 496	\$ 12.25	\$ 4.37	\$ 2.50	\$ 0.62	\$ (1.25)	\$ (3.13)	\$ (5.00)	\$ (6.88)	\$ (8.75)	\$ (10.63)	\$ (12.50)	\$ (14.38)
	\$ 3.00	\$ 1.59	\$ 506	\$ 12.50	\$ 4.62	\$ 2.75	\$ 0.87	\$ (1.00)	\$ (2.88)	\$ (4.75)	\$ (6.63)	\$ (8.50)	\$ (10.38)	\$ (12.25)	\$ (14.13)
	\$ 3.25	\$ 1.62	\$ 516	\$ 12.75	\$ 4.87	\$ 3.00	\$ 1.12	\$ (0.75)	\$ (2.63)	\$ (4.50)	\$ (6.38)	\$ (8.25)	\$ (10.13)	\$ (12.00)	\$ (13.88)
	\$ 3.50	\$ 1.65	\$ 527	\$ 13.00	\$ 5.12	\$ 3.25	\$ 1.37	\$ (0.50)	\$ (2.38)	\$ (4.25)	\$ (6.13)	\$ (8.00)	\$ (9.88)	\$ (11.75)	\$ (13.63)
	\$ 3.75	\$ 1.68	\$ 537	\$ 13.25	\$ 5.37	\$ 3.50	\$ 1.62	\$ (0.25)	\$ (2.13)	\$ (4.00)	\$ (5.88)	\$ (7.75)	\$ (9.63)	\$ (11.50)	\$ (13.38)
	\$ 4.00	\$ 1.71	\$ 547	\$ 13.50	\$ 5.62	\$ 3.75	\$ 1.87	\$ (0.00)	\$ (1.88)	\$ (3.75)	\$ (5.63)	\$ (7.50)	\$ (9.38)	\$ (11.25)	\$ (13.13)
	\$ 4.25	\$ 1.75	\$ 557	\$ 13.75	\$ 5.87	\$ 4.00	\$ 2.12	\$ 0.25	\$ (1.63)	\$ (3.50)	\$ (5.38)	\$ (7.25)	\$ (9.13)	\$ (11.00)	\$ (12.88)
	\$ 4.50	\$ 1.78	\$ 567	\$ 14.00	\$ 6.12	\$ 4.25	\$ 2.37	\$ 0.50	\$ (1.38)	\$ (3.25)	\$ (5.13)	\$ (7.00)	\$ (8.88)	\$ (10.75)	\$ (12.63)
\$ 4.75	\$ 1.81	\$ 577	\$ 14.25	\$ 6.37	\$ 4.50	\$ 2.62	\$ 0.75	\$ (1.13)	\$ (3.00)	\$ (4.88)	\$ (6.75)	\$ (8.63)	\$ (10.50)	\$ (12.38)	
\$ 5.00	\$ 1.84	\$ 587	\$ 14.50	\$ 6.62	\$ 4.75	\$ 2.87	\$ 1.00	\$ (0.88)	\$ (2.75)	\$ (4.63)	\$ (6.50)	\$ (8.38)	\$ (10.25)	\$ (12.13)	

NG \$/MMBtu NG NG *LNG

WHAT IS LNG – WHY IT'S GOOD FOR SHIP FUEL

- LNG is natural gas (95% methane) that has been cleaned and cooled to -260F. By doing so, it has 1/600th of the volume of ambient gas. Thus lots of gas in a small volume
- LNG burns cleanly - emits 85% less nitrogen oxide (NOx) and sulfur oxides (SOx), 90% less particulate matter compared to Heavy Fuel Oil
- Price is more stable than traditional bunker fuel oils.
 - Currently, diesel somewhat cheaper on a \$/BTU basis
- Safety
 - A very narrow range of flammability in air (5%-15%) making it safe to handle on ships and at marine terminals

WHO'S DOING WHAT WITH LNG?

- Cruise Market
 - Royal Caribbean - 2 ships
 - MSC – 5 ships
 - Carnival – 9 ships
 - Disney – 3 ships
- Ferries
 - Europe
 - Canada – British Columbian ferries starting Spring 2019
- Closed loop cargo routes
 - Tote – Jacksonville to Puerto Rico – 2 ships
 - Crowley – Jacksonville to Puerto Rico – 2 ships
 - Returning to home base justifies investment in LNG facilities

13 of 73 Cruise Ships on Order are LNG-Powered

November 07, 2016



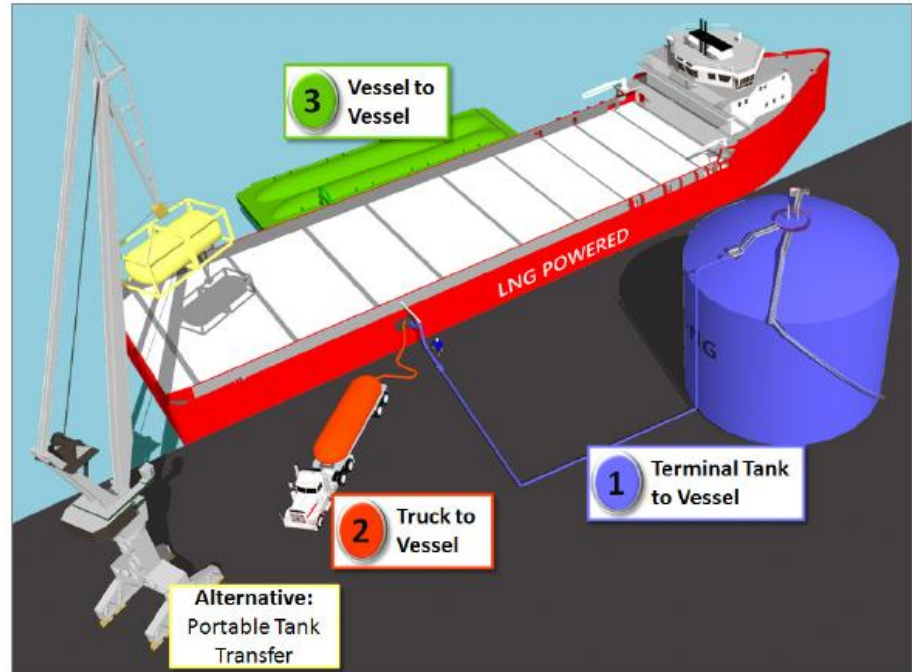
Thirteen of 73 cruise ships on order to be delivered between 2017 and 2026 will be powered by LNG (liquefied natural gas), and the trend toward LNG-powered cruise ships is moving forward as more operators commit to

03

LNG BUNKER OPERATIONS

LNG BUNKER OPERATIONS

- Bunker operations
 - Shore/Pipeline-to-Ship (PTS)- requires LNG plant and marine facility
 - Truck-to-Ship (TTS) – common with new installations, less capital investment
 - Ship-to-Ship (STS)-requires marine facility and bunker barge
 - Portable tanks-ISO containers (40-foot lg.) brought in by rail or truck
- Simultaneous Ops (fuelling while discharging cargo)



04

**LNG BUNKERING IN
JACKSONVILLE, FL**

LNG BUNKERING IN JACKSONVILLE, FL

- **JAXLNG**: Northstar/Pivotal built an LNG plant, pier and bunker barge for fueling TOTE's LNG cargo ships (**waterside bunkering**)

- **Eagle LNG**: Eagle LNG built LNG FACILITY at the JaxPort Talleyrand Terminal to fuel Crowley ships dockside; new LNG facility in Maxville, FL provides LNG for this bunkering operation (**shoreside bunkering**)

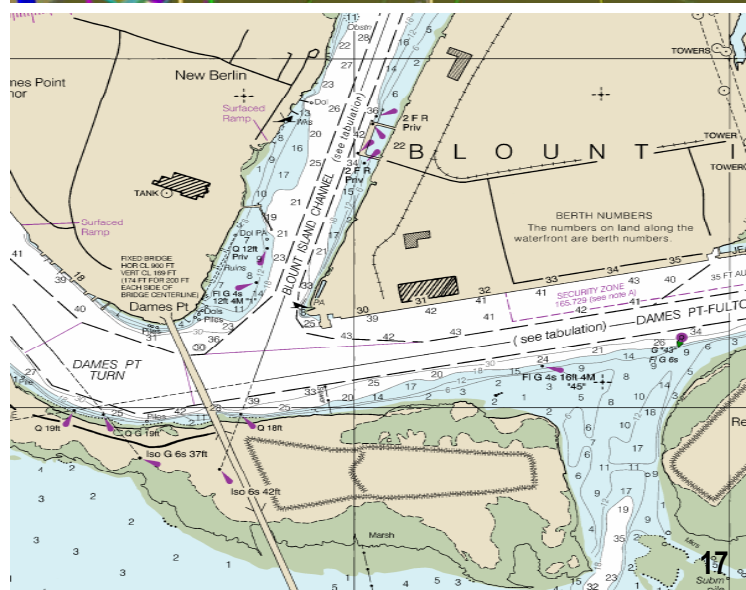
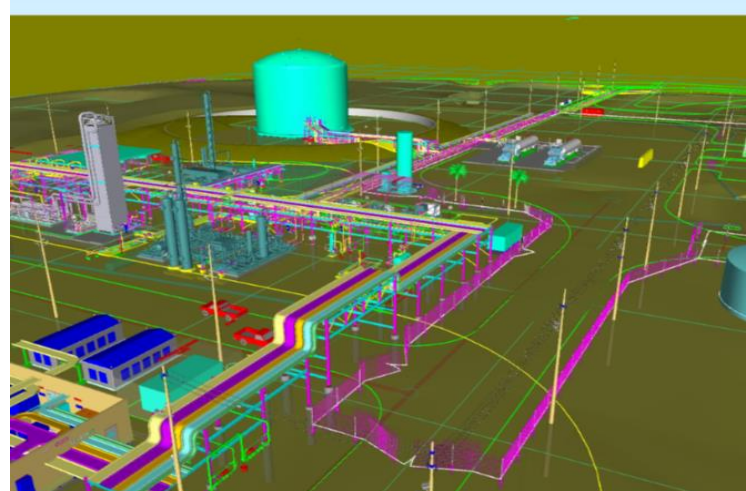
JAX LNG

LNG PRODUCTION AND DISTRIBUTION SITE (FUEL FOR 2 NEW TOTE MARITIME SHIPS)



JAX LNG

- TECO/peoples gas feed
- 120,000 gallons per day liquefaction
- 2,000,000 mg LNG storage tank
- Pier for bunker barge loading
- Truck bays (2) for tanker truck loading
- On-site power generation (JEA grid backup)
- Power generation uses bog and feed
- Future expansion to 360,000 GPD and 4mg storage



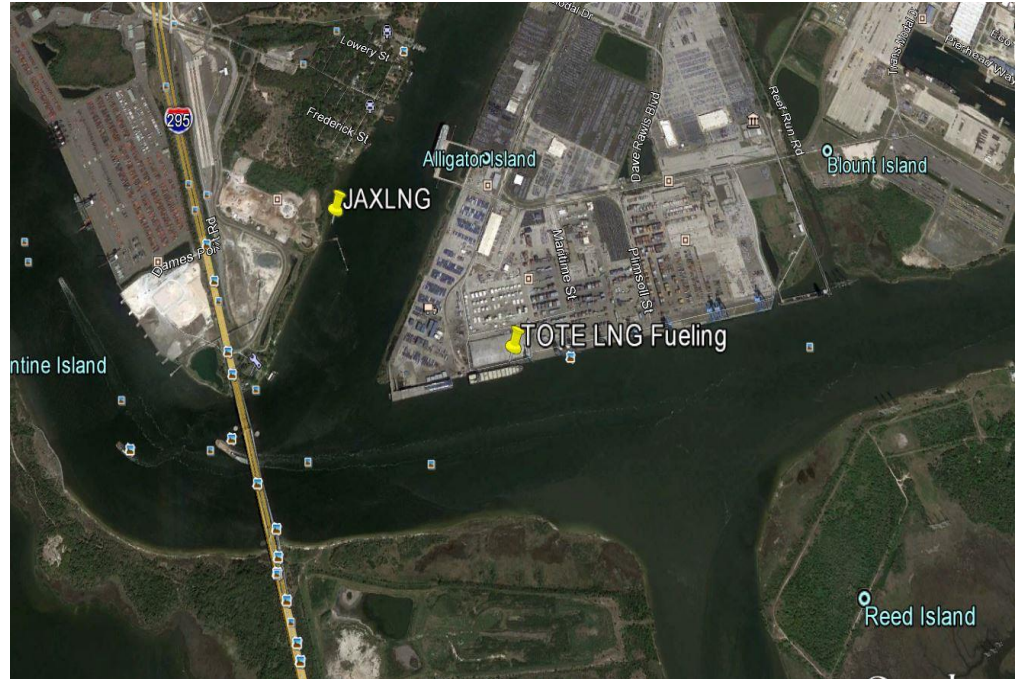
JAX LNG

DUE DILIGENCE AND CAPEX BUDGETS



JAX LNG BUNKERING

- Barge for bunkering 2 Tote Maritime LNG powered container ships
- Clean Jacksonville (barge)
 - 232' LOA, 49' beam, 9.4' draft fully laden
 - LNG storage 2,200 m³ (580,000 Gal)



JAX LNG BUNKER BARGE

582,000 USG / 2 200 m³ BUNKER BARGE

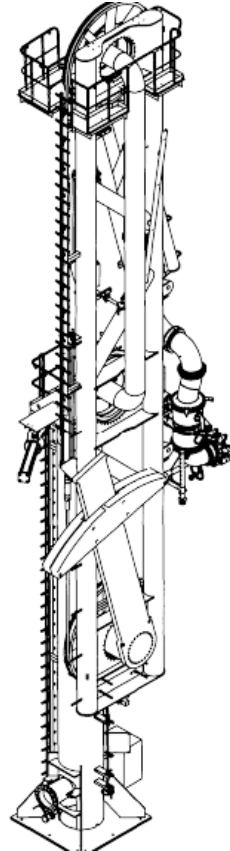


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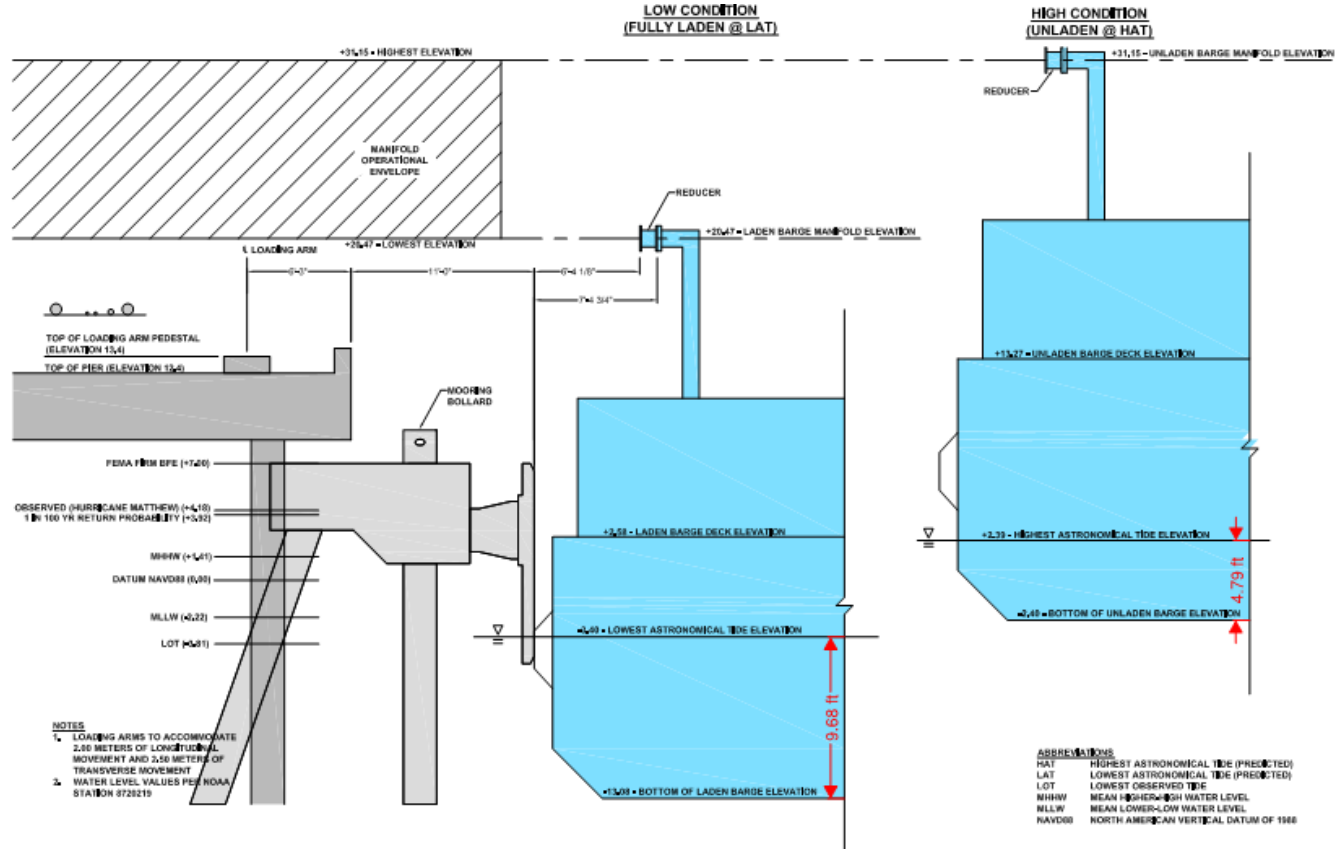
JAX LNG

MARINE LOADING ARMS (2)



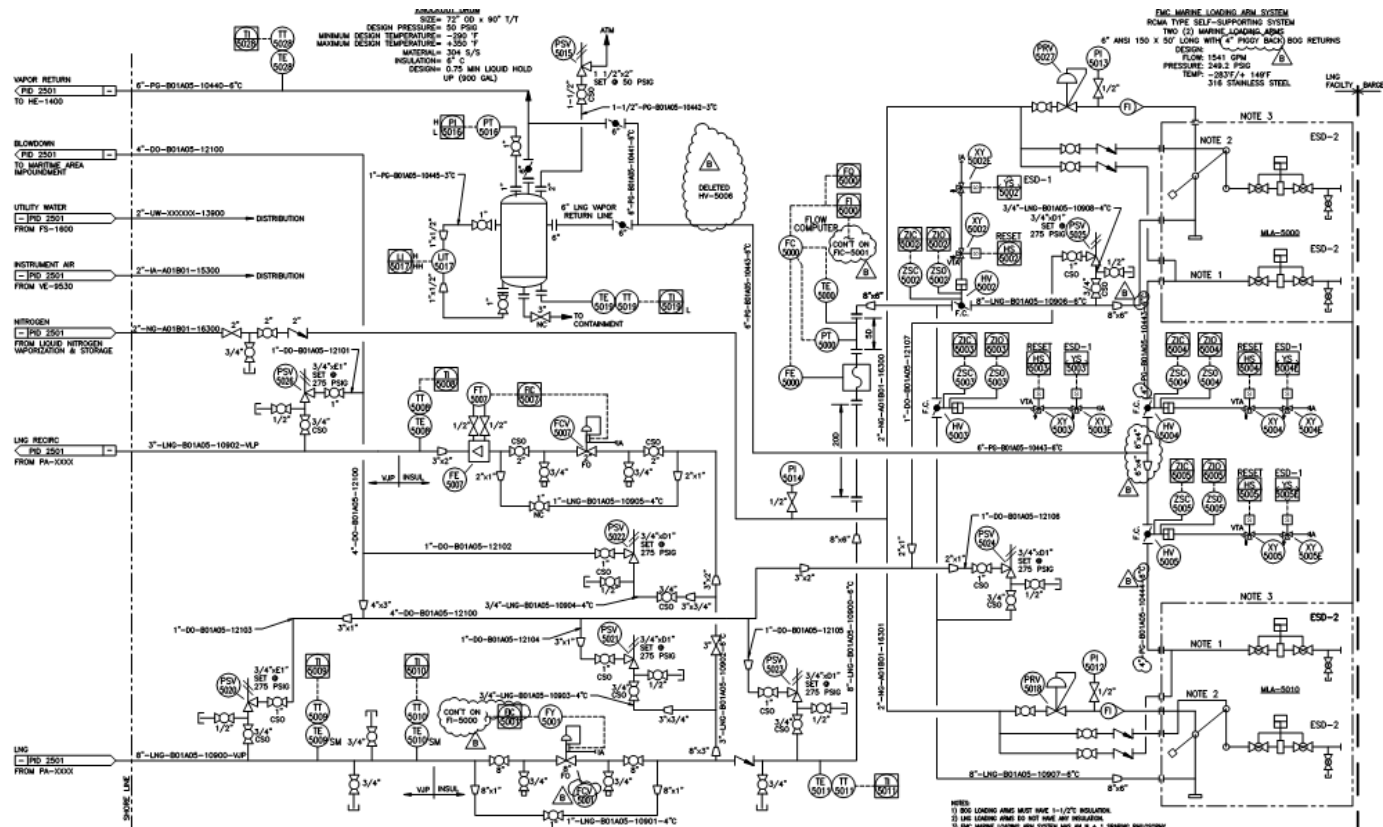
JAX LNG

BARGE HEADER OPERATIONAL ENVELOPE



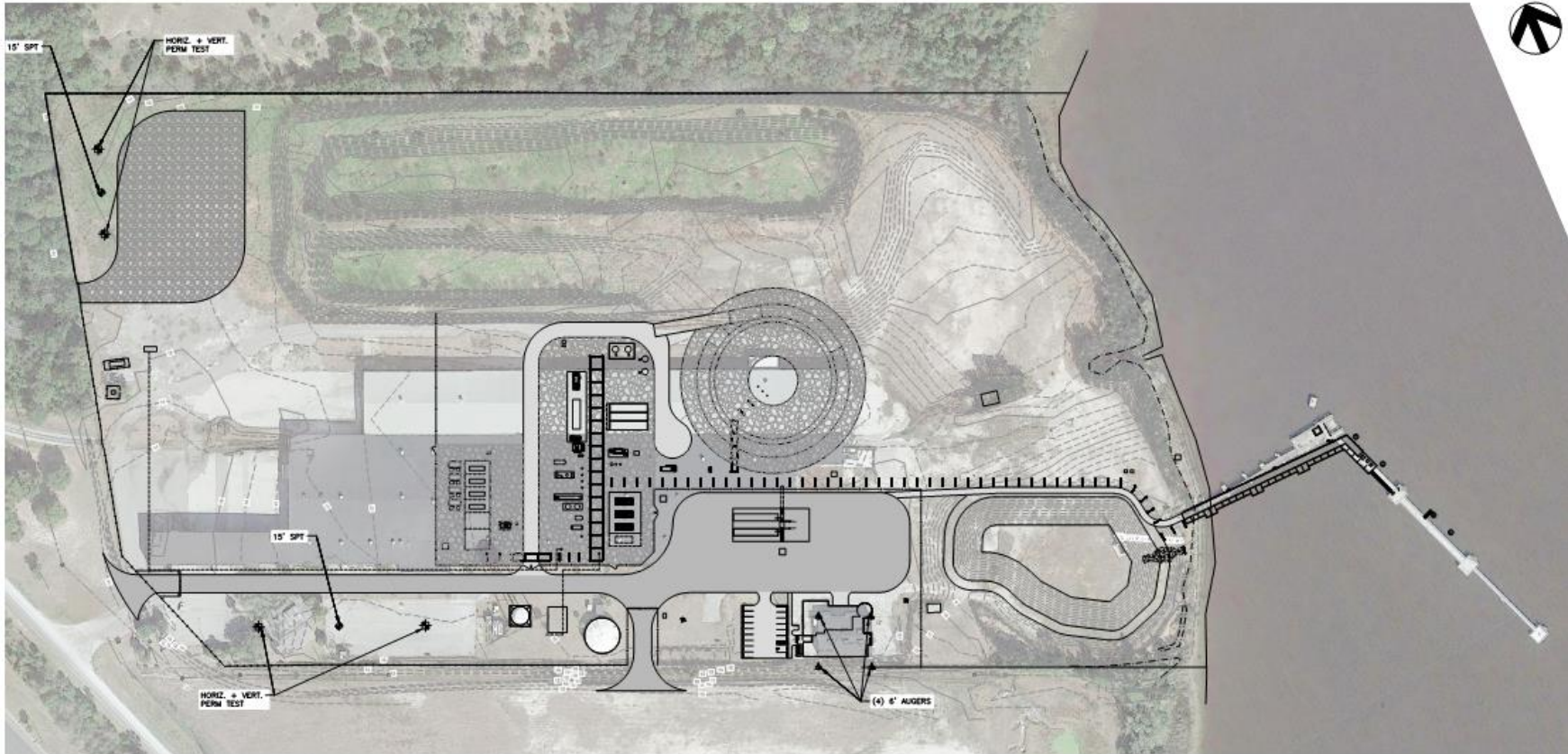
JAX LNG

PIER PIPING AND INSTRUMENTATION



JAX LNG

SITE/CIVIL DEVELOPMENT



JAX LNG

16" WATER MAIN EXTENSION



PROJECT AREA

VICINITY MAP

JAX LNG TEMPORARY BUNKERING

- Tote Maritime Temporary LNG Bunkering Station
JAXPORT's Blount Island Marine Terminal



JAX LNG



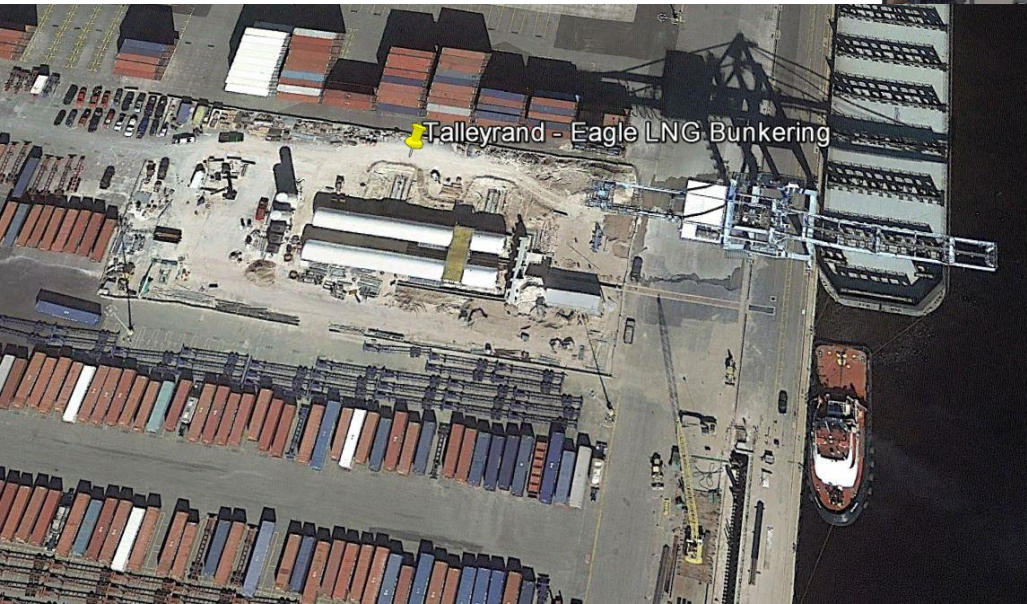
EAGLE LNG

- Maxville LNG Plant
 - 100,00GPD LNG Production Capacity
 - 1M Gal LNG Storage Tank

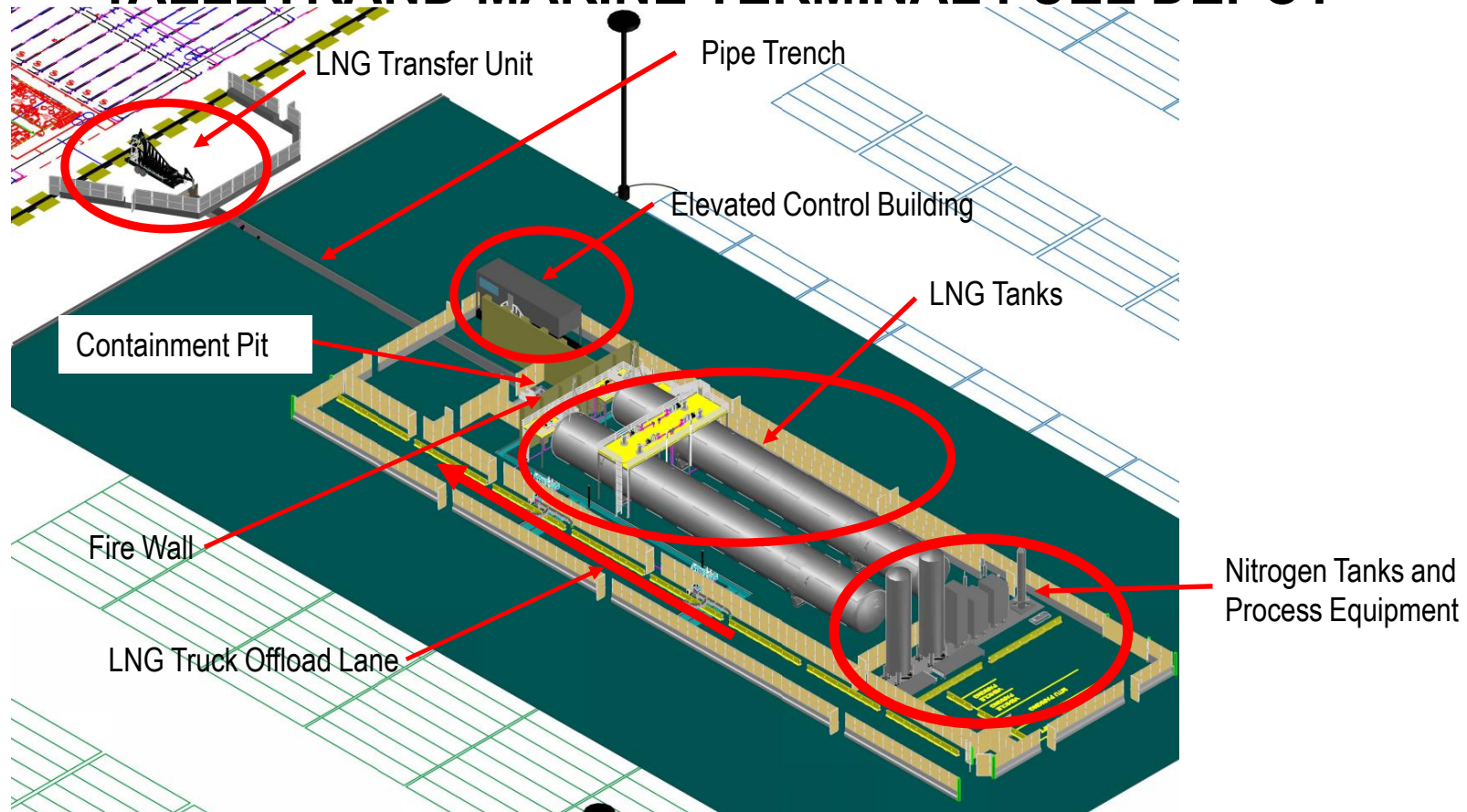


EAGLE LNG BUNKERING (SHORESIDE)

- Talleyrand Marine Terminal LNG Bunkering Site
 - 2 each 250,000 Gal LNG Storage Tanks

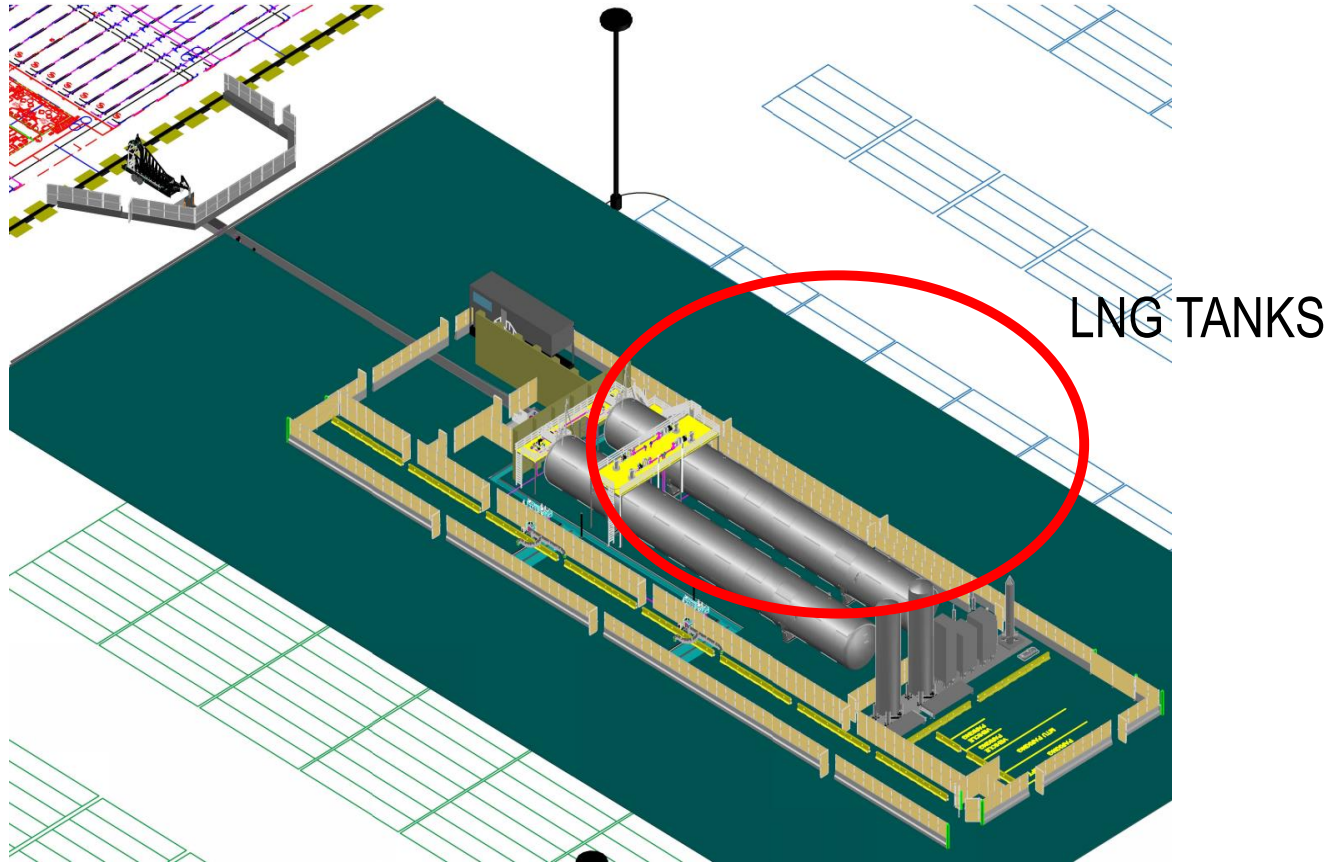


EAGLE LNG TALLEYRAND MARINE TERMINAL FUEL DEPOT



EAGLE LNG

PHASE 1 – GET READY FOR TANK DELIVERY



EAGLE LNG PILES FOR TANK SUPPORTS



EAGLE LNG

250,000 GALLON LNG STORAGE TANKS



EAGLE LNG

LOADING ONTO GOLDHOFER TRAILER



EAGLE LNG

HAULING TANK TO FOUNDATIONS

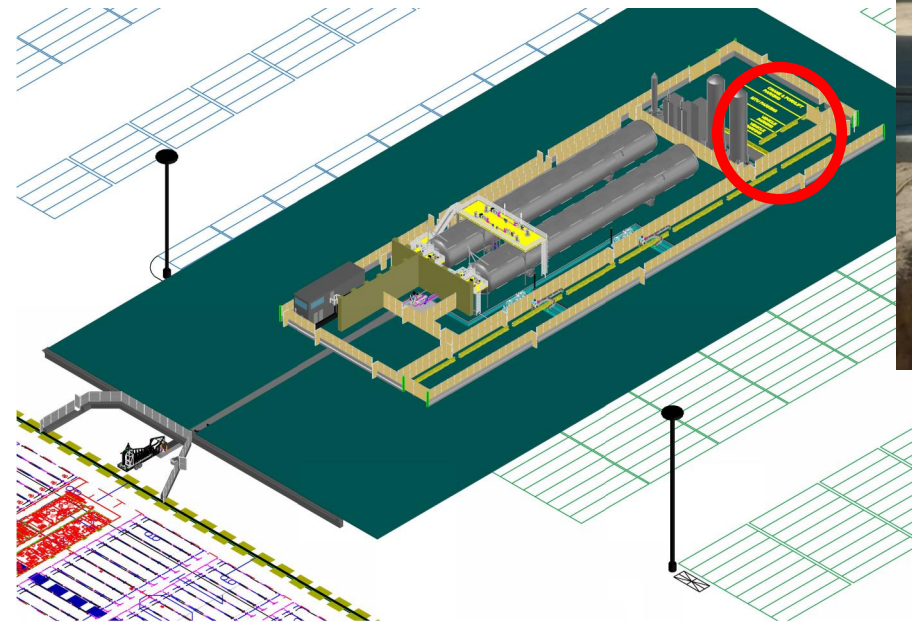


EAGLE LNG

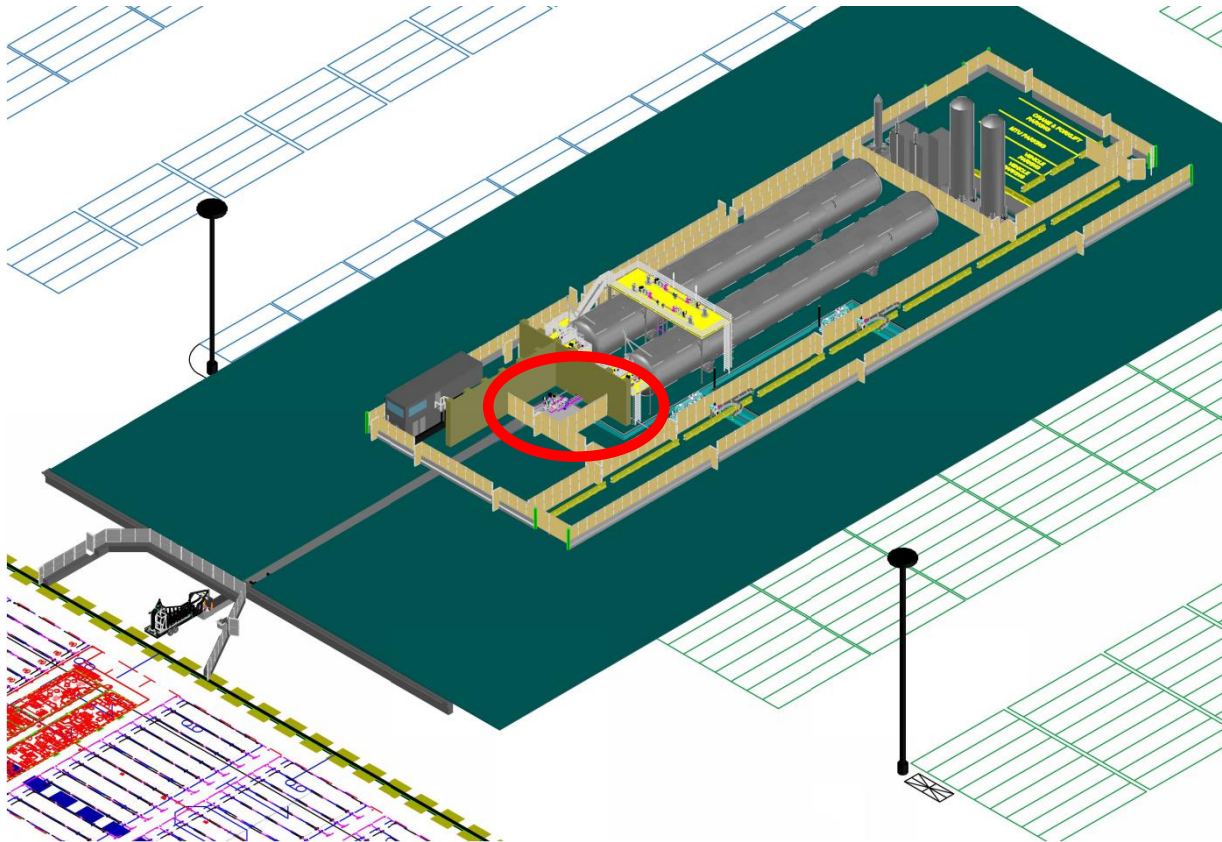
LIFTING TANK WITH GANTRY SYSTEM



EAGLE LNG NITROGEN TANKS



EAGLE LNG CONTAINMENT PIT



EAGLE LNG

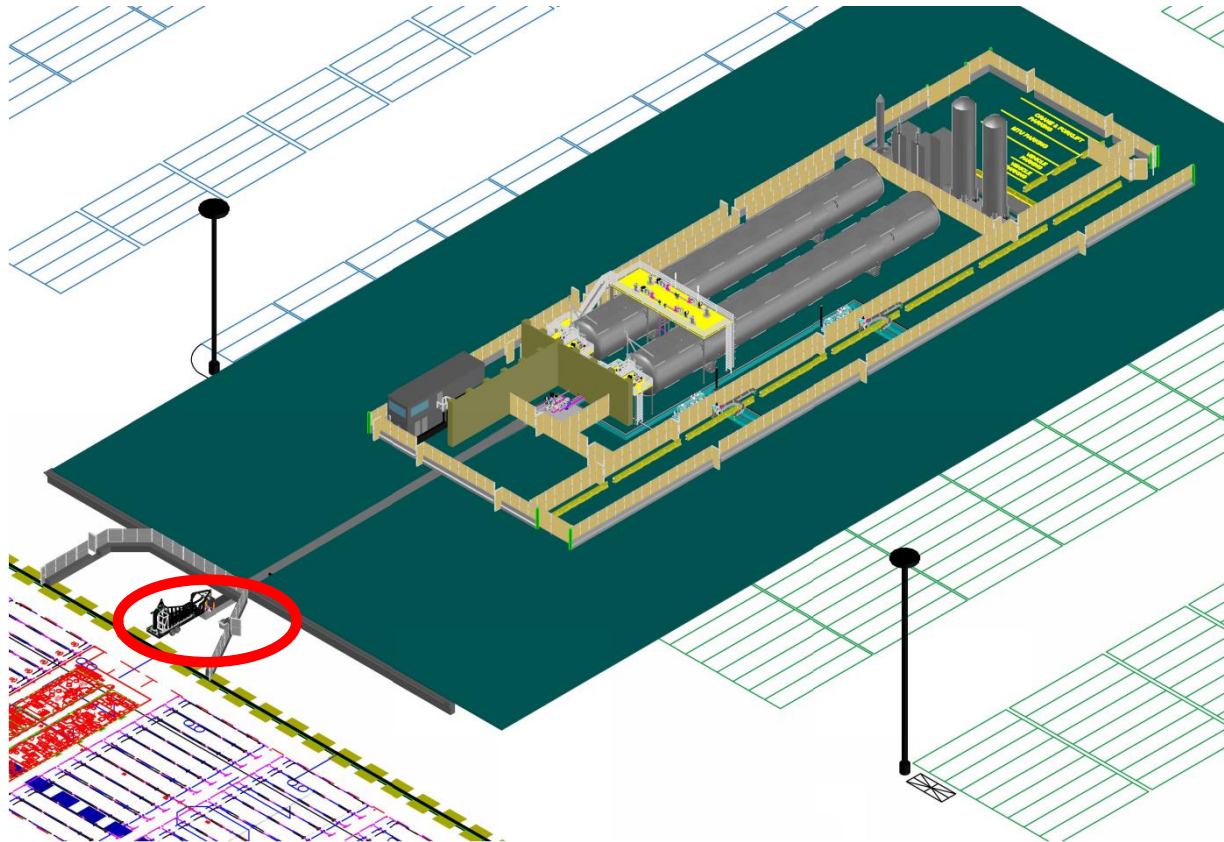
CONTAINMENT PIT SUMP



EAGLE LNG CONTAINMENT PIT FLOOR



EAGLE LNG PIPE TRENCH



EAGLE LNG

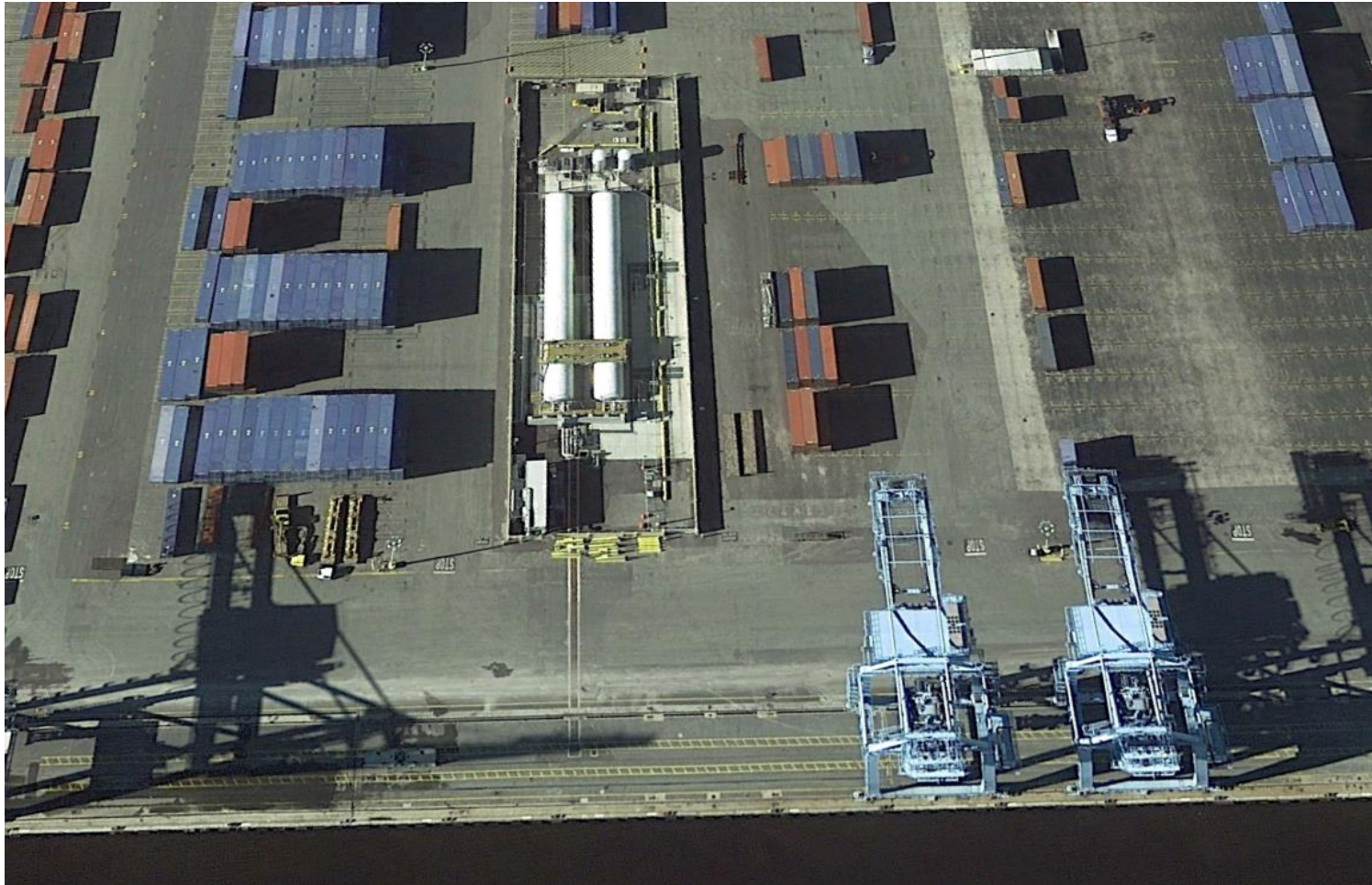
PIPE TRENCH AND CRANE BEAM REBUILD



EAGLE LNG CRANE BEAM REBUILD



EAGLE LNG



SHORESIDE OR WATERSIDE

- Shoreside Pro
- **Low initial capital cost** – *Doesn't require LNG barge for conventional waterside bunkering or LNG load out facility for the barge.*
- Shoreside Con's
- **Bunkering restricts operations** – *Ship-to-Shore Cranes have restricted access to portions of the vessel, trucks need to drive around the bunkering station.*
- **Higher operating cost?** – *Trucks need to deliver LNG to the fuel depot.*
- **Infrastructure required in Container Yard** – *Facility occupies prime real estate, facility must be compact*



QUESTIONS

