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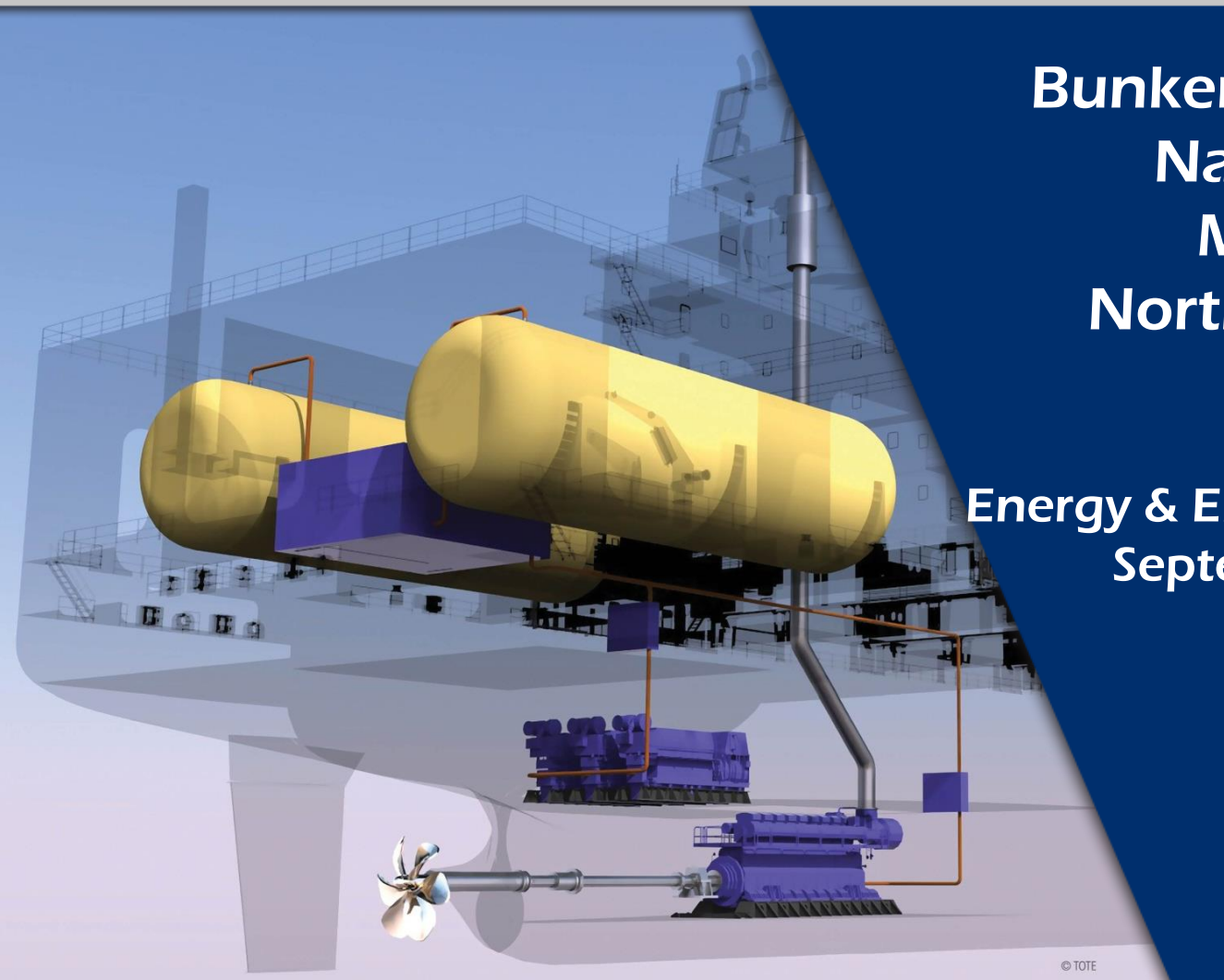

Bunkering of Liquefied Natural Gas-fueled Marine Vessels in North America Study

AAPA
Energy & Environment Seminar
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Study Objectives

Create a first of its kind guide to assist potential owner/operators of:

- Gas-fueled vessels,
- LNG bunker vessels, and
- LNG bunkering facilities

in the development of LNG bunkering projects in North America by describing:

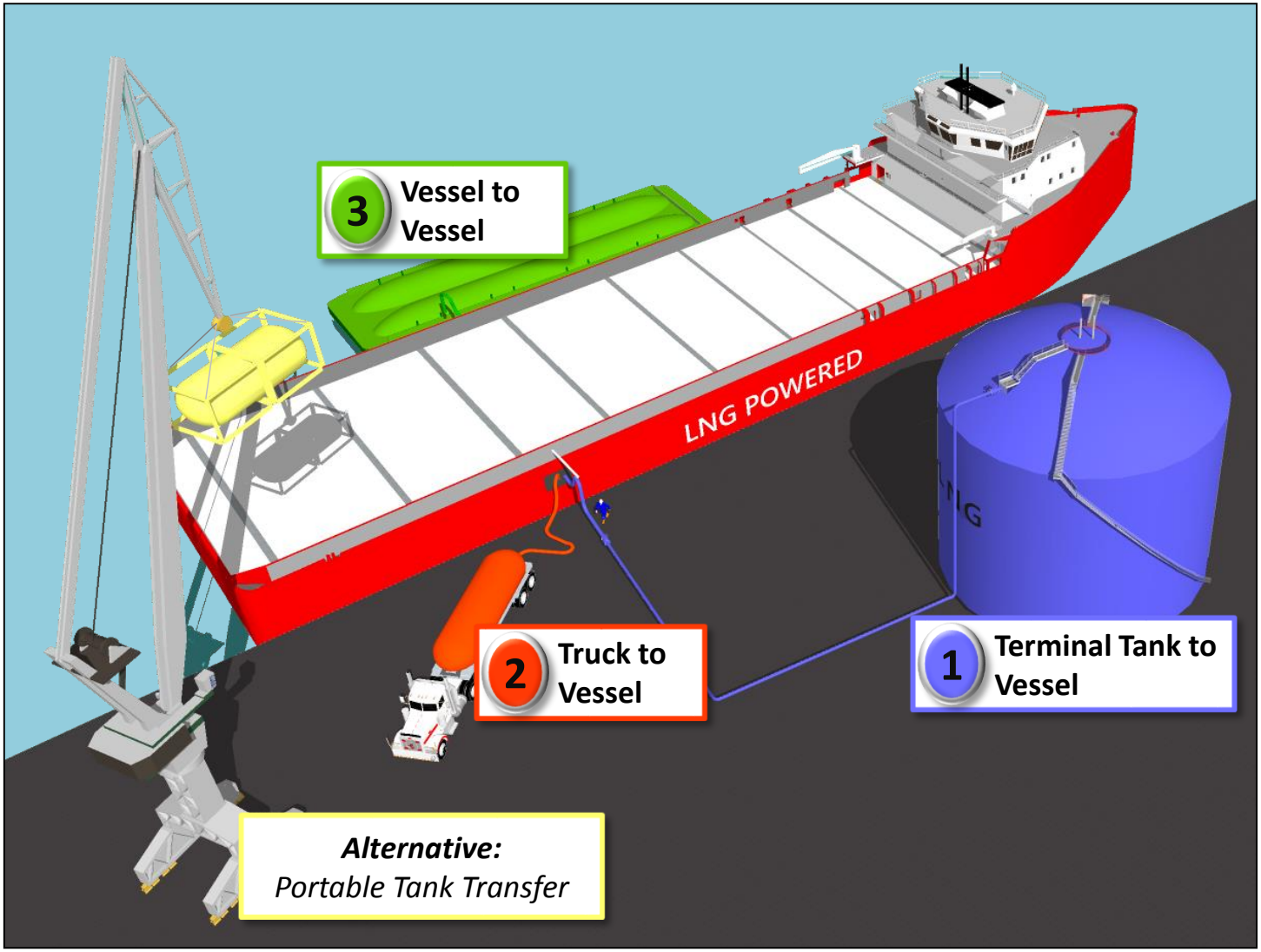
- Regulatory requirements
- Current and planned LNG supply infrastructure
- State, provincial, port, and local issues

- **Study released on March 18th, 2014**

Study Overview

- Introduces LNG conversion drivers
- Describes bunkering options
- Introduces hazards, risks and recommended safeguards
- Presents current, applicable regulations, codes, and standards
- Discusses current/planned LNG supply infrastructure
- Provides examples of proposed and ongoing bunkering projects
- Outlines a recommended process for gaining approval of LNG bunkering projects
- Presents local, regional and port-specific issues

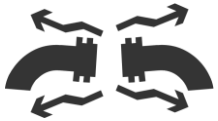
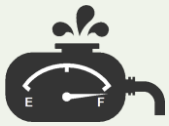
LNG Bunkering Options



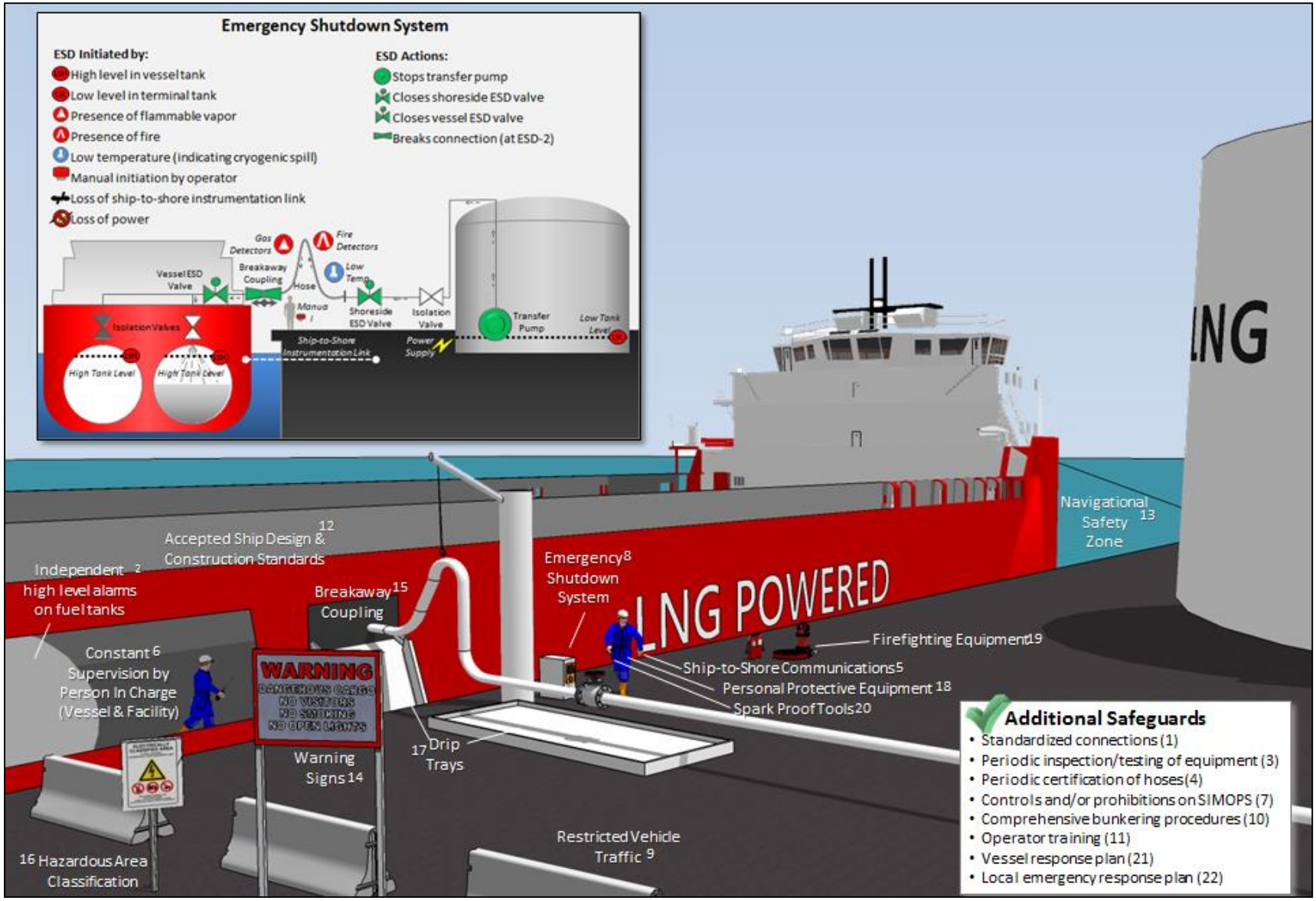
LNG Hazards

- **Unique hazards of LNG bunkering operations:**
  - Serious injuries to personnel coming into contact with cryogenic liquid (LNG is -260°F)
  - Brittle fracture damage to steel structures exposed to cryogenic temperatures
  - Formation of a flammable vapor cloud
  - Asphyxiation for personnel in the immediate area

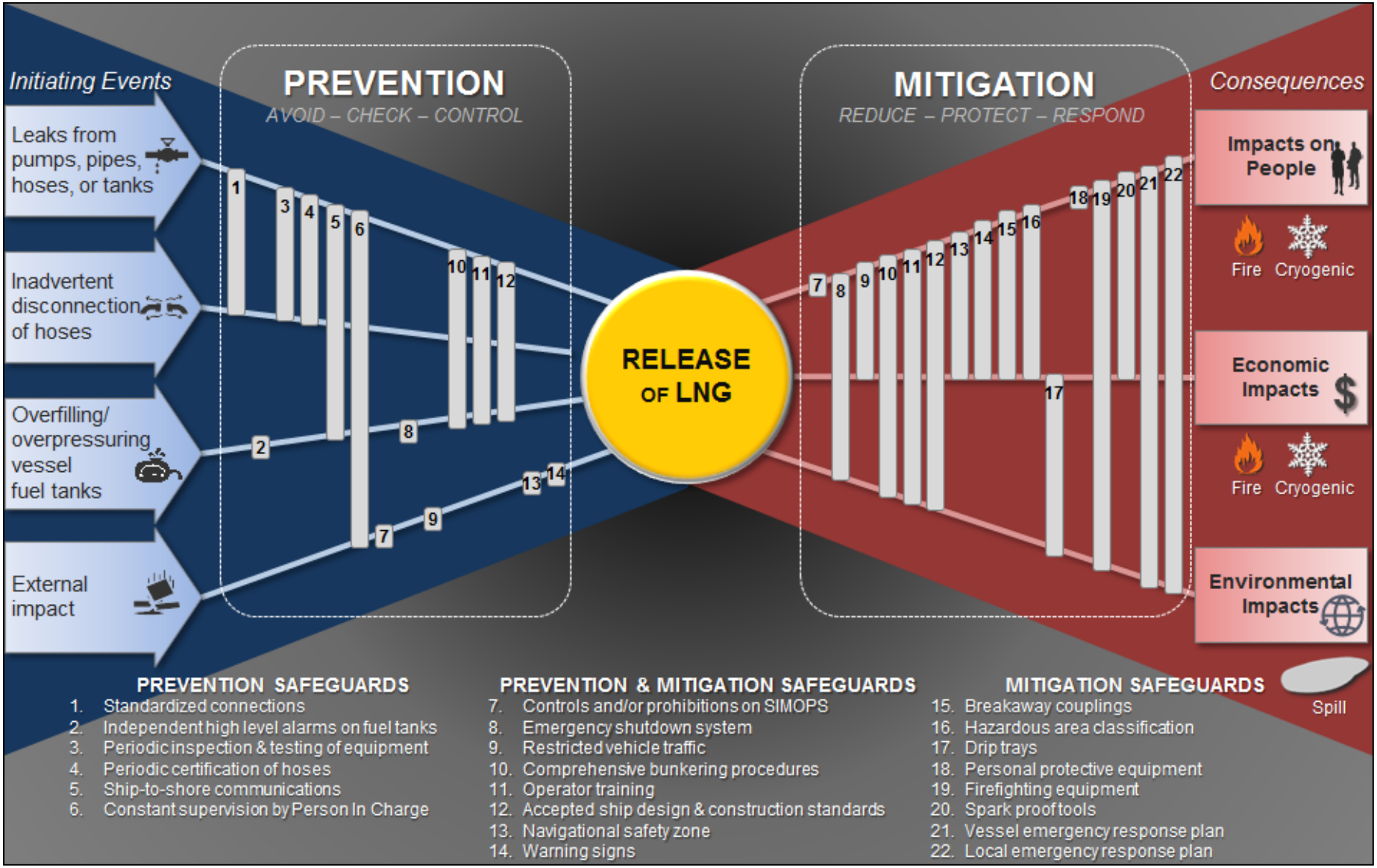
LNG Bunkering Risk Drivers

Initiating Events	Common Causes
Leaks from LNG pumps, pipes, hoses, or tanks 	• Corrosion/erosion, fatigue failure, hose failure, & seal failure • Improper maintenance • Use of inappropriate hoses (e.g., not LNG rated) • Vibration • Improper installation or handling • Improper bunkering procedures
Inadvertent disconnection of hoses 	• Improper hose connection or hose failure • Excessive movement of the loading arm or transfer system • Inadequate mooring or mooring line failure • Supply truck drives/rolls or supply vessel drifts/sails away with hose still connected • Extreme weather or natural disaster
Overfilling vessel fuel tanks 	• Operator and level controller fail to stop flow when tank is full
External Impact 	• Cargo or stores dropped on bunkering equipment • Vessel collides with the receiving or bunkering vessel • Vehicle collides with bunkering equipment

Recommended Safeguards for LNG Bunkering



Bow-Tie Diagram Illustrating Recommended Safeguards for LNG Bunkering Operations



Regulatory Framework

U.S. regulatory framework

- Regulations for facilities are written for import/export terminals
- Robust regulations for bulk LNG transfers between vessels and facilities (tanks, trucks, and railcars)
- LNG bunkering guidelines/policy remain a work in progress

Canadian regulatory framework

- Also has regulations for import/export terminals
- No regulations directly addressing LNG bunkering or use of LNG as fuel for vessels
- Canada is actively studying the issue

Collaborative effort

- Transport Canada and USCG are collaborating at strategic level

Potentially Applicable Regulations, Codes, & Standards for LNG Bunkering in the United States

A
- 33CFR 155: *Oil Or Hazardous Material Pollution Prevention Regulations for Vessels (USCG)*
- 46 CFR Sub D/O: *Tank Vessels, Certain Bulk Dangerous Cargoes (USCG)*

B
- CG-OES Policy Letter No.01-12: *Equivalency Determination – Design Criteria for Natural Gas Fuel Systems (USCG)*
- 46CFR Parts 10, 11, 12, 13, 15: *Merchant Marine Officers and Seamen Credentials & Requirements (USCG)*

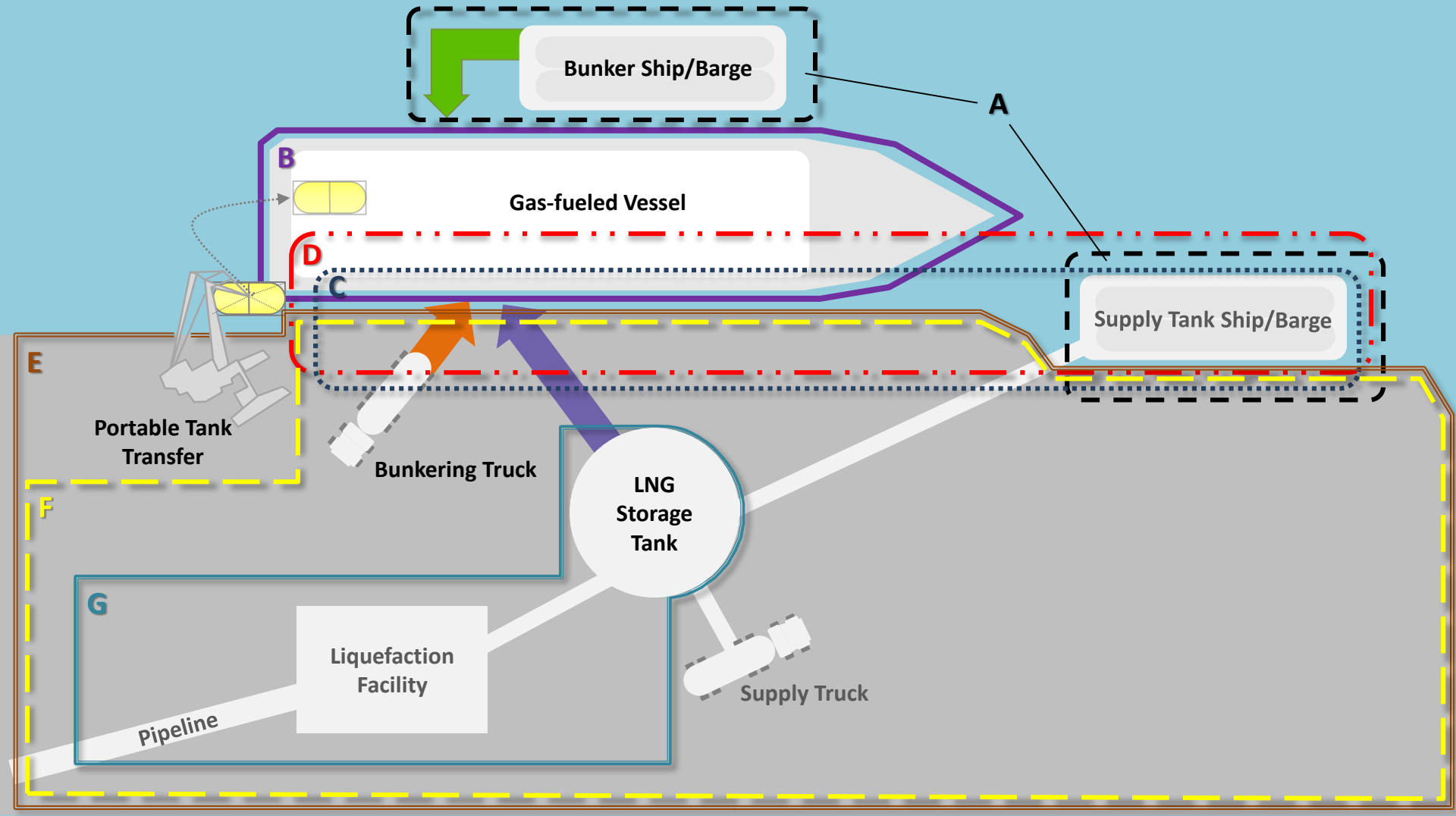
C
- 33CFR 156: *Oil and Hazardous Material Transfer Operations (USCG)*

D
- 33CFR 127: *Waterfront Facilities Handling LNG and Liquefied Hazardous Gas (USCG)*

E
- 33CFR 105: *Maritime Security: Facilities (USCG)*
- NFPA 52: *Vehicular Gaseous Fuel Systems Code*

F
- 33CFR 154: *Facilities Transferring Oil Or Hazardous Material In Bulk (USCG)*
- 40 CFR 68: *Chemical Accident Prevention Provisions (EPA)*
- 29 CFR 1910.119: *Process Safety Management of Highly Hazardous Chemicals (OSHA)*
- NFPA 59A: *Standard for the Production, Storage, and Handling of LNG*

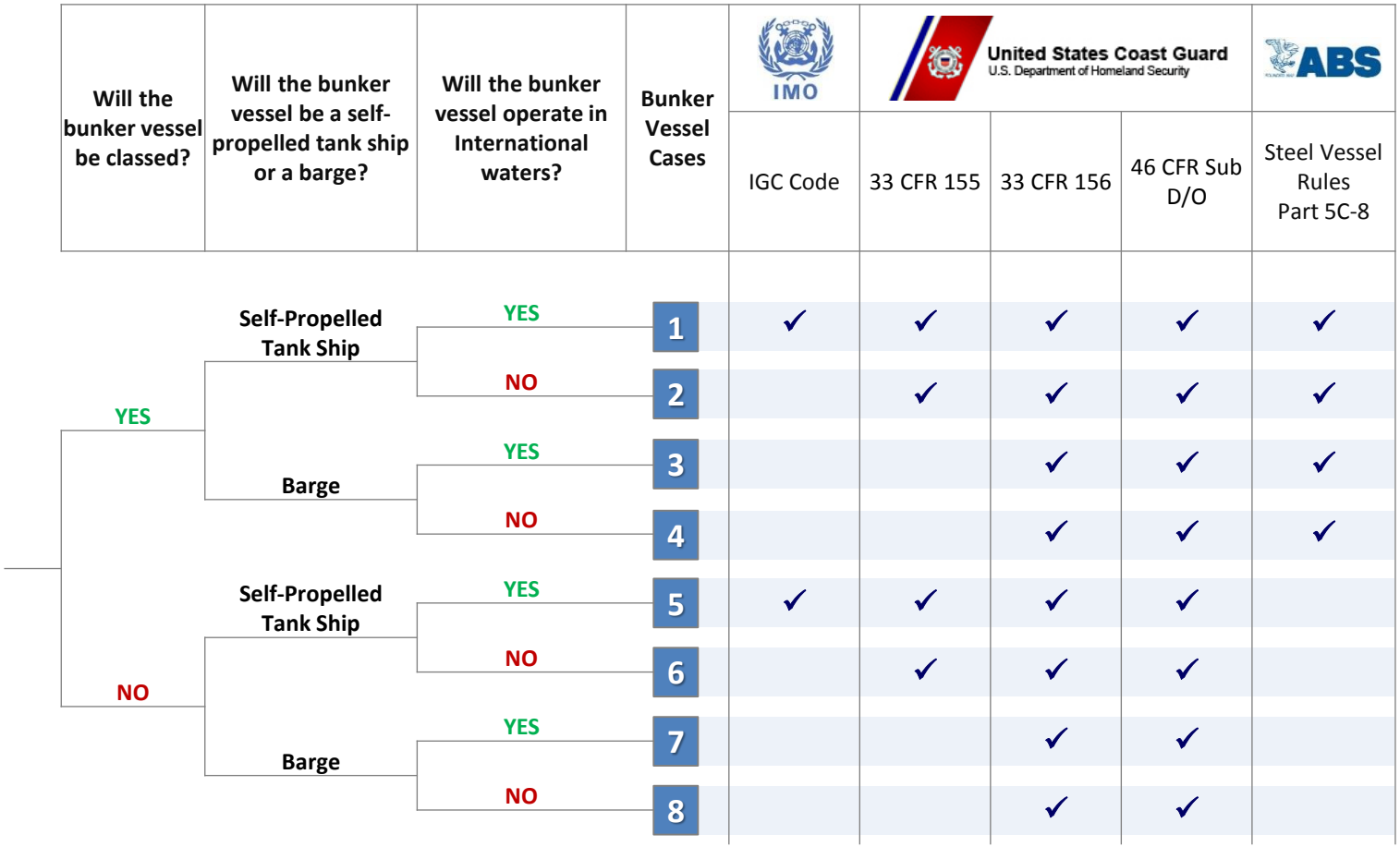
G
- 49 CFR 193: *Liquefied Natural Gas Facilities: Federal Safety Standards (DOT)*



Gas-fueled Vessel Decision Tree

Gas Fueled Vessel Cases	IMO	United States Coast Guard U.S. Department of Homeland Security		ABS
	MSC 285(86)	CG-521 Policy Letter 01-12**	46 CFR Parts 10, 11, 12, 13, 15	ABS Guide
1	✓	✓	✓	✓
2		✓	✓	✓
3	✓	✓	✓	✓
4		✓	✓	✓
5	✓	✓	✓	
6		✓	✓	
7	✓	✓	✓	
8		✓	✓	

Bunker Vessel Decision Tree



Facility Decision Tree

What is the source of LNG to your facility?	Will your facility have an onsite bulk storage tank?	Bunker Facility Cases	United States Coast Guard U.S. Department of Homeland Security				OSHA			NFPA	
			33CFR 105	33 CFR 127	33CFR 154	33CFR 156	29 CFR 1910. 119	40 CFR 68	49 CFR 193	52	59A
Truck	Yes	1	✓	✓	✓	✓	✓	✓		✓	✓
	No	2	✓	✓	✓	✓				✓	✓
Ship/Barge	Yes	3	✓	✓	✓	✓	✓	✓		✓	✓
	No	4	✓							✓	✓
Container		5	✓							✓	
Interstate Pipeline w/ local liquefaction	Yes	6	✓	✓	✓	✓			✓	✓	✓
Intrastate Pipeline w/ local liquefaction	Yes	7	✓	✓	✓	✓	✓	✓		✓	✓

Facility Requirements Crosswalk

Key Elements	United States Coast Guard U.S. Department of Homeland Security				OSHA	EPA	DOT	NFPA	
	33CFR 105	33 CFR 127	33CFR 154	33CFR 156	29 CFR 1910. 119	40 CFR 68	49 CFR 193	52	59A
	Applicable Bunker Facility Cases								
	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
Emergency Response Program									
Emergency Response Program. Pre-planning and training to make employees aware of, and able to execute, proper actions in the event of an emergency.		✓	✓	✓	✓	✓	✓	✓	✓
Spill Response Plan. Pre-planning to ensure facilities are prepared to respond in the event of a spill incident.			✓						
Letter of Intent									
Letter of Intent. Submission of a letter to the USCG Captain of the Port (COTP) that documents owner/operator contact information, location, description, and vessel traffic characteristics.		✓	✓	✓					
Operations Manual									
Operations Manual. Comprehensive documentation addressing full scope of bunkering operations, including: operating conditions, required equipment, equipment compatibility, mooring, pre-start checks, connection, transfer, disconnection, shutdown, safety equipment, training, communications, SIMOPS, and emergency operations.		✓	✓	✓					✓

Potential LNG Supply Sources

- Existing LNG import facilities
- Proposed LNG export facilities
- Existing LNG peakshaving/satellite facilities
- Existing and proposed liquefaction facilities supporting other transportation modes
- Proposed bunkering facilities with liquefaction process
- Proposed bunkering facilities supplied via trucks/transportation containers

State, Provincial, Local, and Port Issues

- **Port authorities are generally taking a wait-and-see approach**
- **Projects have thus far been driven by the developers**
- **Port/local representatives are generally supportive of potential LNG bunkering in their ports**
- **Some uncertainty as to which agencies will be responsible for permitting and authorizing facilities**
  - USCG and state/local fire marshals will likely play key roles

Evidence suggests that developers should not be dissuaded from pursuing projects in maritime markets due to fear of regulatory impasses

Need for Communication & Coordination

- **Good communication with stakeholders is essential in the development of an LNG bunkering facility project**
- **Each port is unique and the regulatory agencies and stakeholders will vary**
  - For U.S. projects, the local USCG Captain of the Port is a good starting point
- **Key concepts to address in communications**
  - Address the project's impacts, risks, and benefits
  - Do not wait until controversial issues are raised
  - Be inclusive
  - Accept people's concerns as valid

Organizations for Consultation & Coordination

- **Federal Regulators**
  - USCG/Transport Canada
  - Pipeline and Hazardous Materials Safety Administration/National Energy Board
  - U.S. Army Corps of Engineers
  - Environmental Protection Agency/Environment Canada
- **State/Provincial/Local Regulators**
  - State/Provincial Pipeline Inspection Agency
  - State, Provincial and/or Local Fire Marshal Office
  - State or Provincial Natural Gas Regulator
  - State, Provincial and Local Environmental Regulators
  - Local planning/zoning commission
- **Local Maritime Community**
  - Port Authority
  - Marine Exchange
  - Marine Pilot Associations
- **Other Local Organizations**
  - Local Fire Department
  - Emergency Medical Services Agency
  - State/Provincial/Local/Port Law Enforcement Agencies

Contact

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