MARITIME

LNG Bunkering – Recommended Practice

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Safeguarding Life, Property & the Environment

FOUNDED

- DNV in 1864 and GL in 1867

PEOPLE

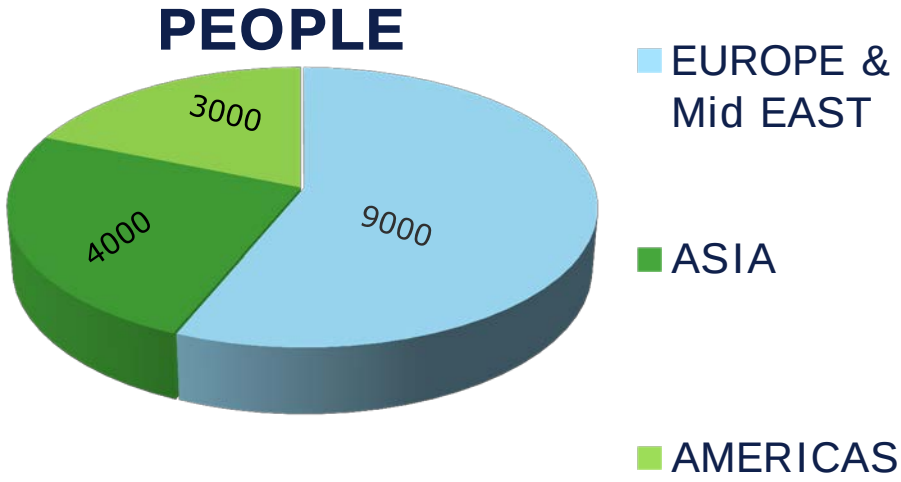
- 16000 employees worldwide in 100 countries
- Highly qualified surveyors & engineers with extensive knowledge in all disciplines

TECHNOLOGY

- 5% Revenue (MUSD170) devoted to R&I => Standards & Initiatives

Maritime Services:

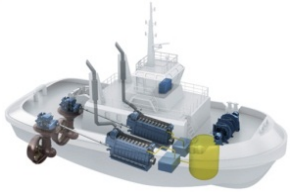
- Ship & Offshore Classification
- Maritime Advisory
- Verification



Vessels in Operation or On Order today

2012

31



66 ON ORDER

Commonality?

LNG BUNKERING - How the ISO Standard started?

- ISO TC67 approved the proposal provided more than 5 countries participated
- Kick off meeting was in June 2011 in Paris with 14 participants.
- Meetings held in Paris, Oslo, Dubai, Portsmouth, Washington DC, London, Brussels and Stockholm.
- Today the work group comprise 30+ participants representing
  - 15 countries.
  - 8 oil, gas and energy companies
  - 2 regulators (USCG included)
  - 3 shipping companies
  - 7 equipment providers
  - Sigtto and 3 class societies
- Draft Report in final stage

Globalization of LNG bunkering enhances the need for standard and compatible solutions

- Port Fourchon
- Plaquemine
- Baton Rouge

Gather experience and knowledge

ISO TC67/WG 10 → DNV GL RP

LNG BUNKERING TYPES

RP is divided into 3 main parts - together demonstrate compliance with the functional requirements in the ISO guidelines

Safety philosophy is based on a Bow-Tie model with 3 layers of defence representing safety critical design and operational barriers

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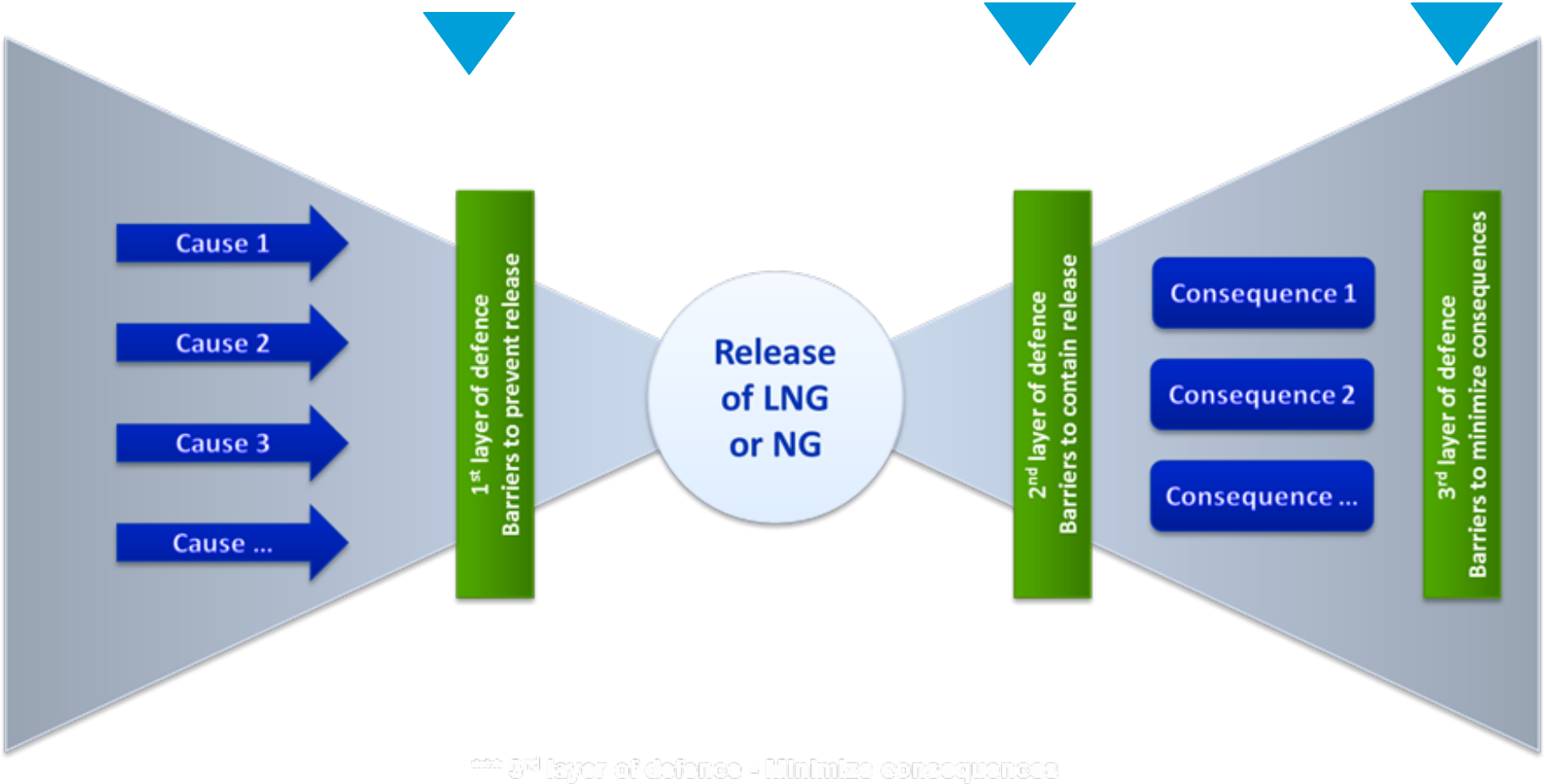

Functional requirements for 1st layer of defence as prevention against accidental releases

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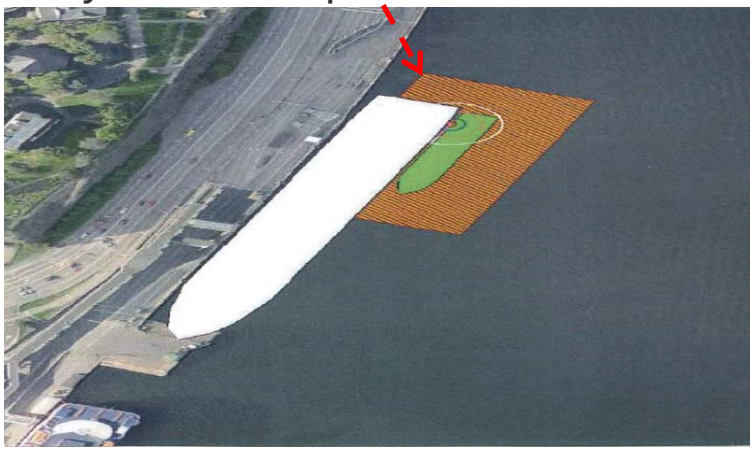
- **Compatibility** of equipment and operational practices between supplier and receiving ship
- No planned **release of LNG or natural gas** to the atmosphere during normal operations
- Requirements for **connection couplings**
- **Connect and disconnect without NG** in the lines
- Design to prevent **liquid locks**
- Safety requirements to **operating procedures**
- **Maintenance and testing**
- **Organizational plan**

Functional requirements for 2nd layer of defence, focused on ability to contain and control releases

- Effective **detection** of potential LNG and natural gas releases
- Minimise the likelihood of **igniting** a potential LNG release
- Effective and accountable **Emergency Shut-Down** (ESD) systems
- **Dry Break Coupling** shall be installed to minimise damage to the transfer system in case of ships drift or vehicle movement.
- **Cryogenic protection**
- Personnel shall use **PPE** (Personnel protective equipment)
- A **Safety Zone** shall be established around the bunkering operation into which only essential personnel shall have access

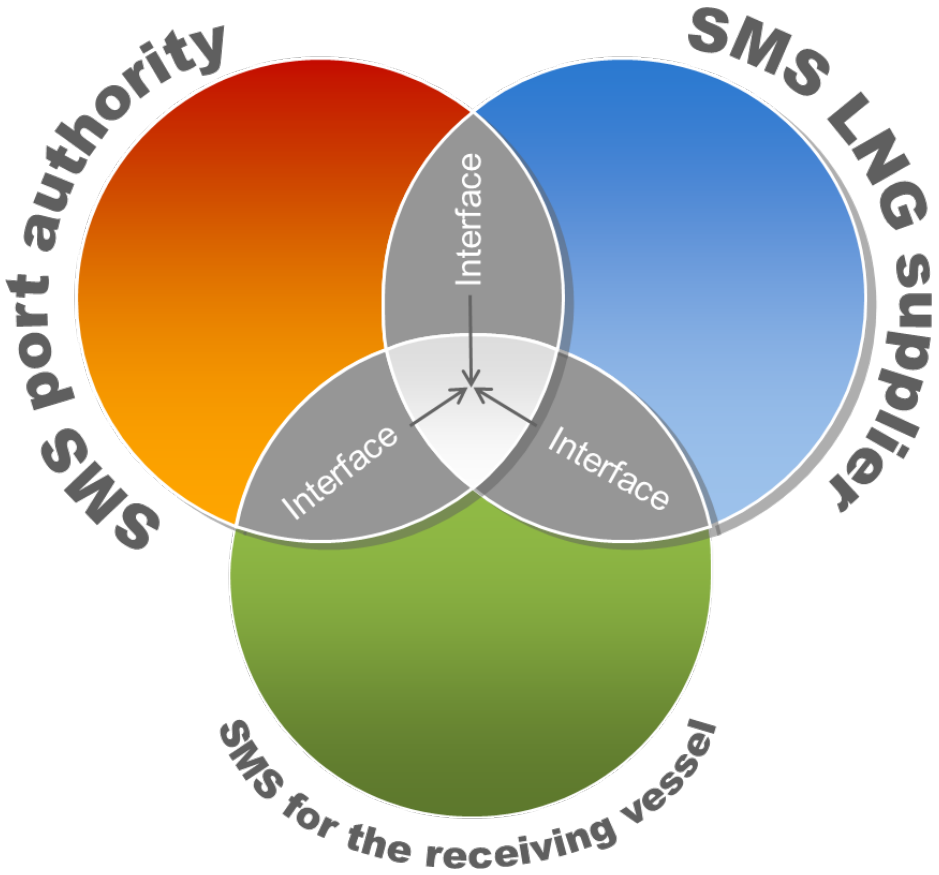


Crack or Frost Burn

Functional requirements for 3rd layer of defence, barriers to minimize consequences that are not contained

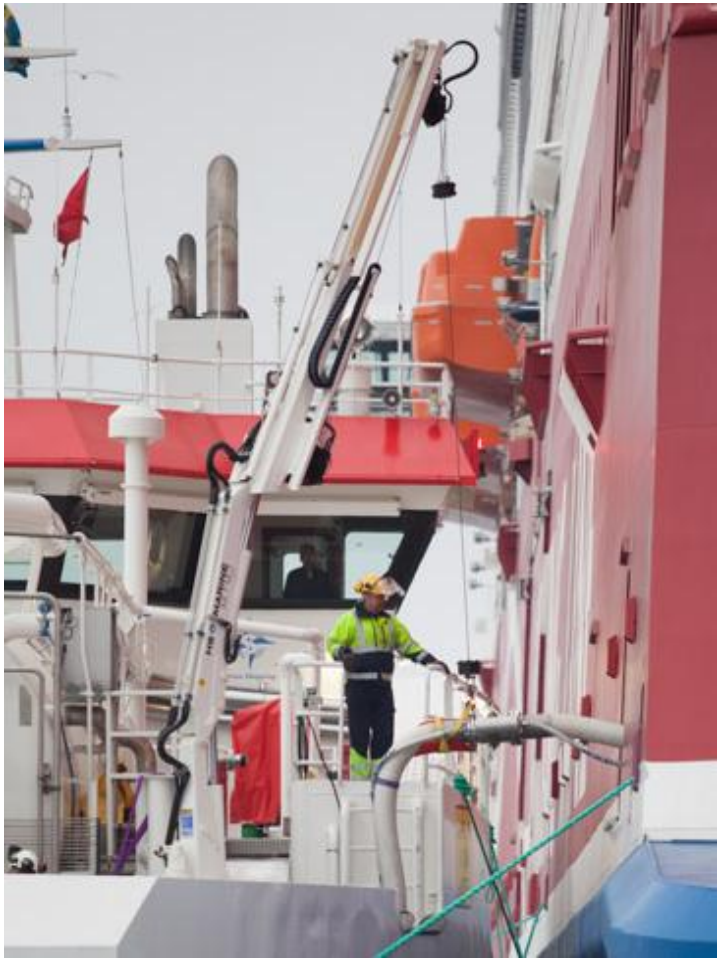
- A **Security Zone** shall be established to monitor and control activities in the area adjacent to the bunkering operation to reduce possible ignition sources
- An **Emergency Response plan** shall be in place outlining the requirements for fire fighting, evacuation, first aid, ambulances and communication to authorities
- **Emergency response plan shall be communicated** to all parties involved in the bunkering operation including the planned emergency response team and be part of the training program.

Focus areas to be included in the Safety Management System, and also to align and provide compatibility between different stakeholders



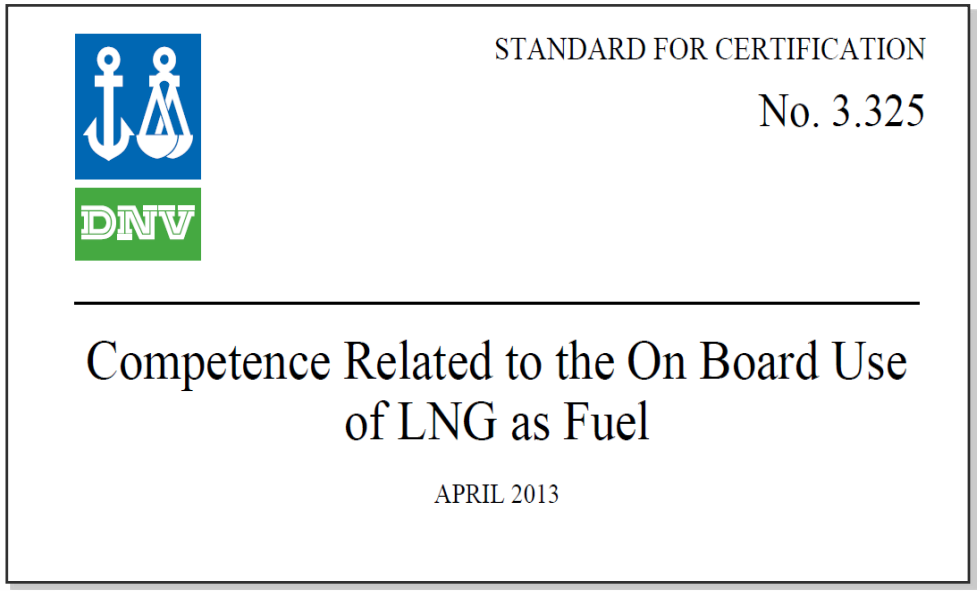
Training for personnel shall be in place reflecting Roles and Responsibilities and the complexity of the operation and facilities

- **Basics of LNG handling**
  - Hazards and properties of LNG, Natural Gas and inert gases
  - Use of PPE equipment
  - Safety and fire fighting
- **Use of equipment**
  - Hoses, couplings, valves, ESD, etc.
- **Facility specific operations**
  - Organisation/communication
  - Emergency preparedness.

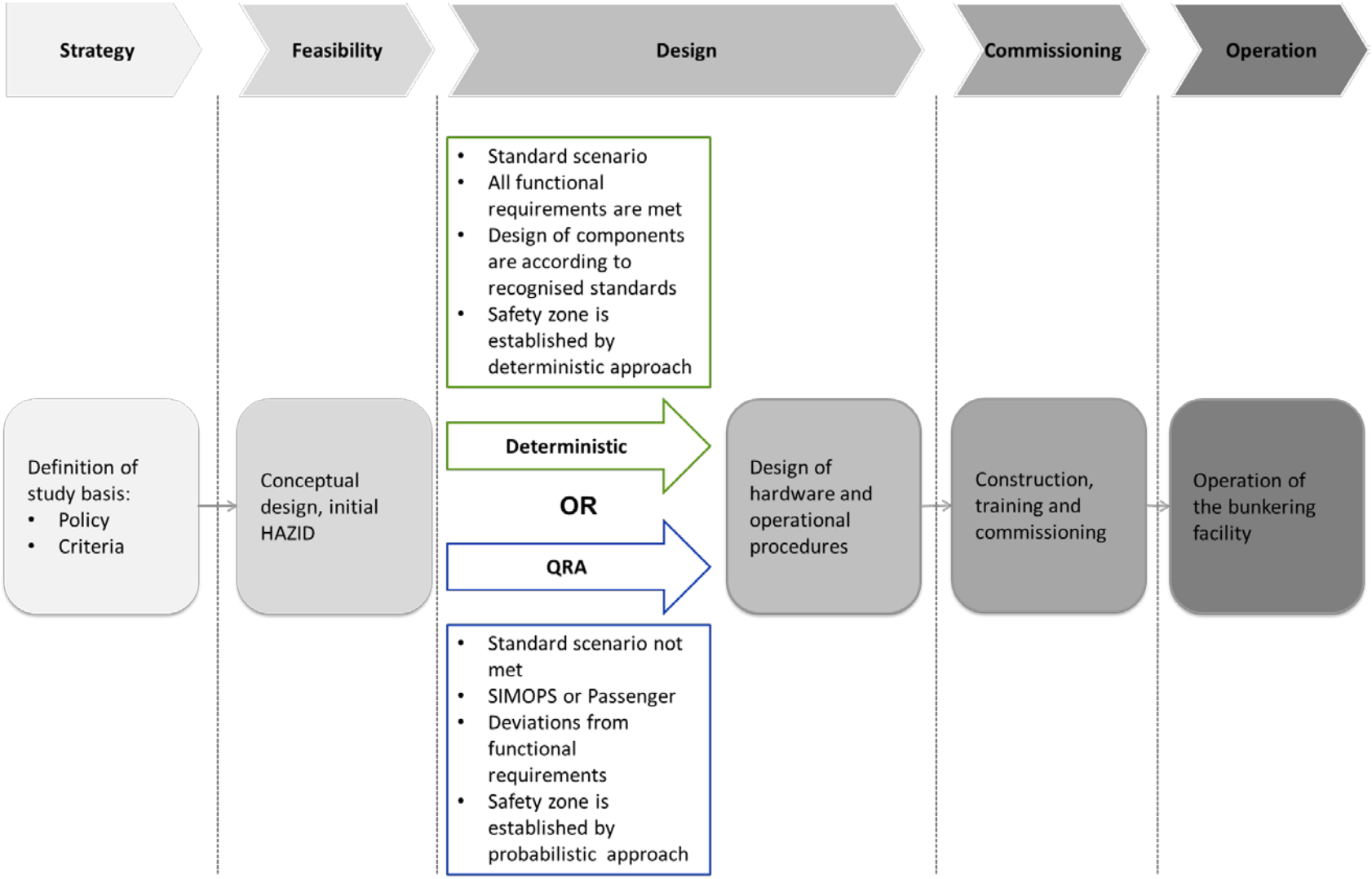


Competence Standard 3.325 on LNG Fuel for Training Centres

- General knowledge & understanding
- The storage system
- The gas supply system
- The LNG monitoring system
- Venting & ventilation
- Compressors
- Safety systems & components
- Auxiliary systems
- Bunkering
- Tank conditioning
- Warm up / heating
- Contingencies

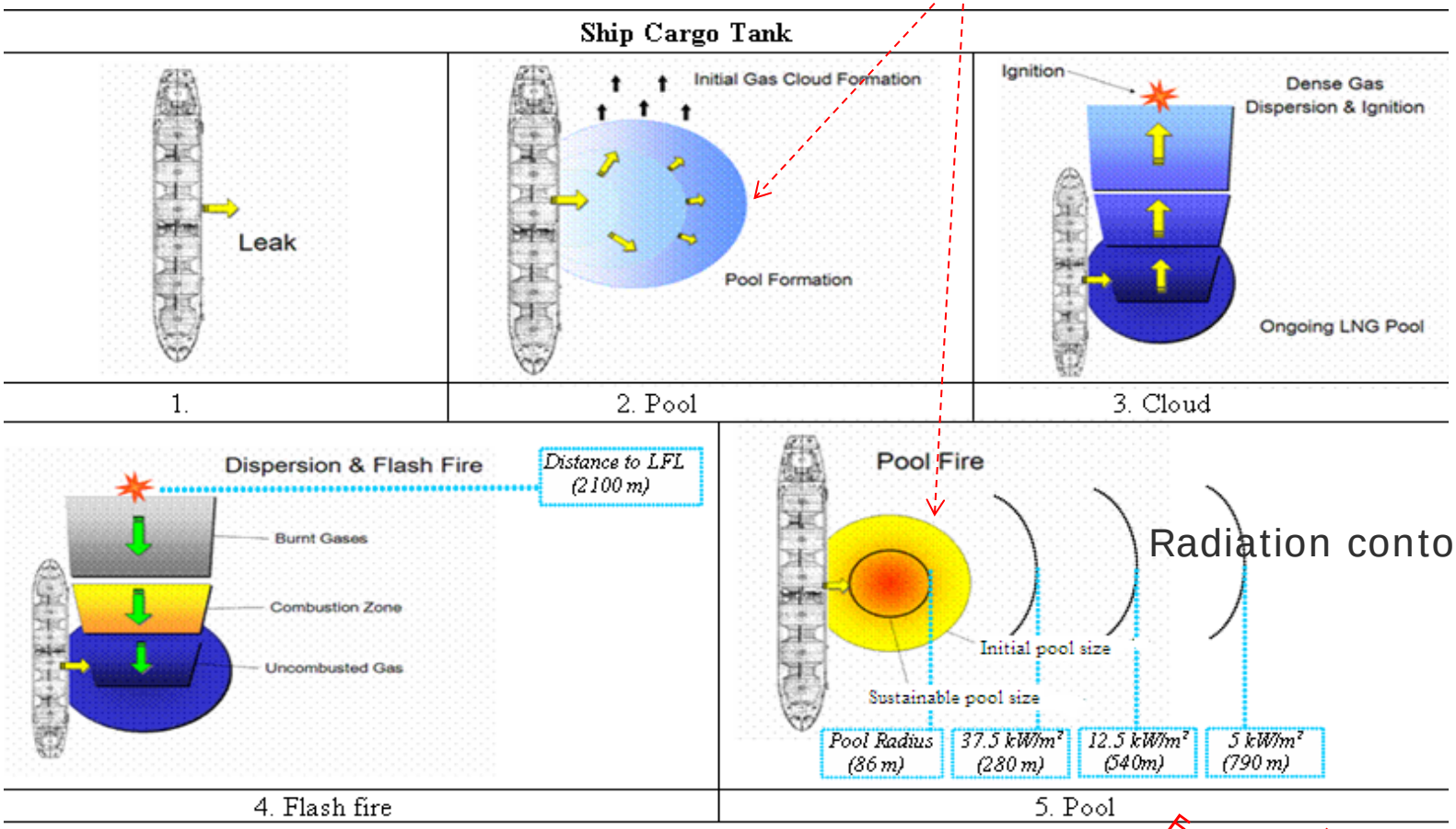


Risk assessments - required on different levels and in different phases of the system development



Key Element in the risk assessment is determining the Safety Zone

PHAST: Models the Gas Cloud & Pool Fire



Radiation contours

Escape Way

Lifeboat

Sunny Day: 1 kW/m2

Conclusion

- 4 Types of LNG Bunkering
- 3 Functional Requirement
  - Safe Design & Operation
  - Safety Management System
  - Risk Management
- 3 Layers of Defence
- Compatible Safety Management System
- Training of Personnel
- Risk Management
  - Deterministic
  - QRA

QUESTIONS?

NAVIGATING COMPLEXITY

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SAFER, SMARTER, GREENER

PLANNED BUNKERING LOCATIONS

DNV·GL