Safety Guidelines during LNG Bunkering Operations.

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A brief outline

- Introduction
- Visualising the Bunkering
- Why we need “Controlled Zones”
- Explaining how to use those zones…
- What to do when a LNG fire does happen
- Summary and Conclusions (Q&A?)

Introduction

- The LNG industry has an excellent safety record!
- This has been achieved because there is a clear understanding of the **hazards** associated with LNG and how these can be **managed effectively**.
- As the maritime industry moves towards using LNG as a fuel, it is important that this knowledge is widely disseminated…

Introduction

- LNG is a boiling liquid which, because of its low storage temperatures (-140 to -160°C, depending on pressure), is continuously vaporising into gas (boil-off gas)…

- It will vaporise and rapidly pressurise a system to bursting point if left trapped between two valves without pressure relief.

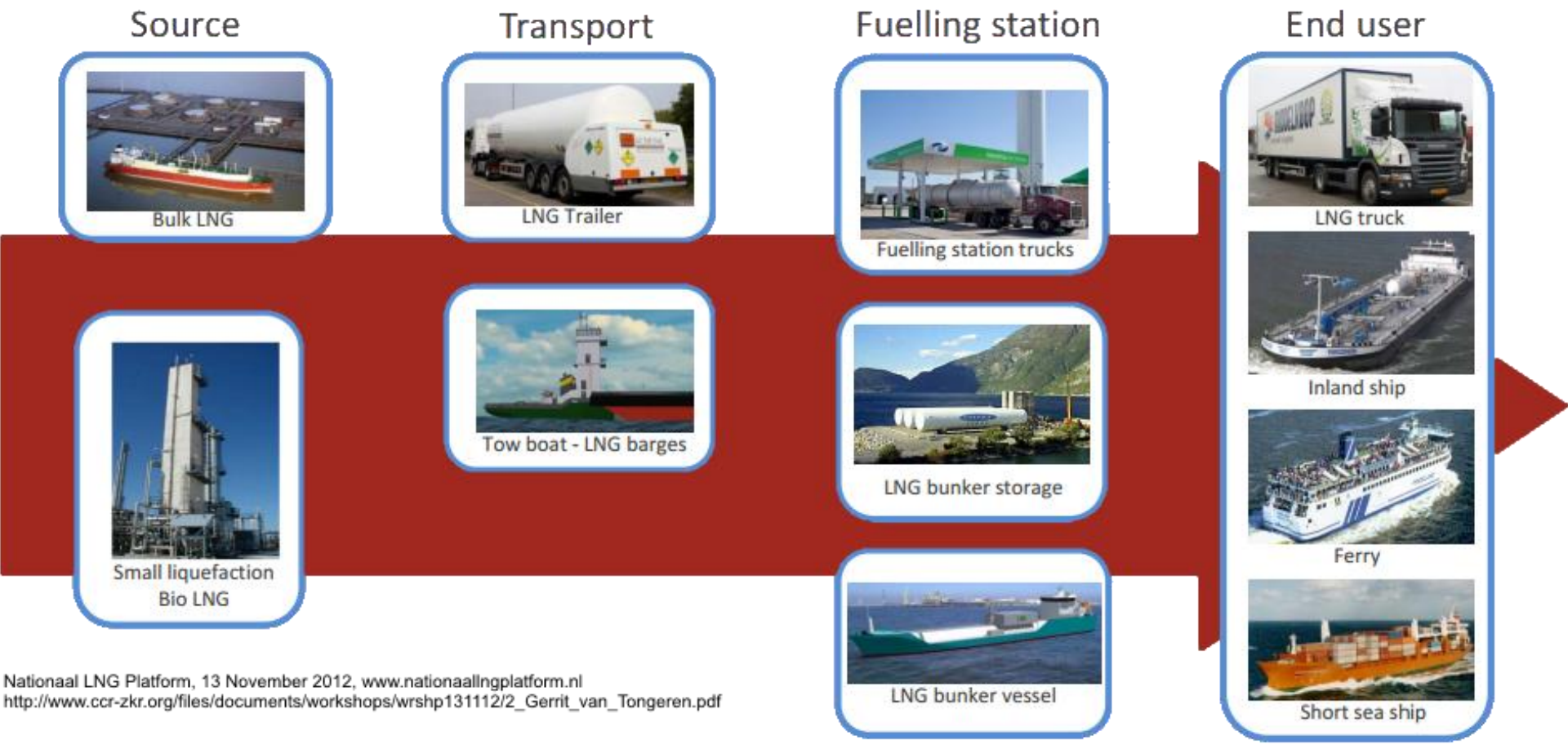
Introduction

- LNG spillage will damage ship quality steels in the area immediately around a spill; rapid cooling reduces the ductility of steel and its ability to support load, which can cause brittle fracture of a vessel's deck or of a steel component of a quayside.

- It may cause a Rapid Phase Transition (RPT) if it hits a water surface and boils so rapidly that an over-pressure situation occurs; an RPT is effectively a flameless explosion of "limited power"!!!

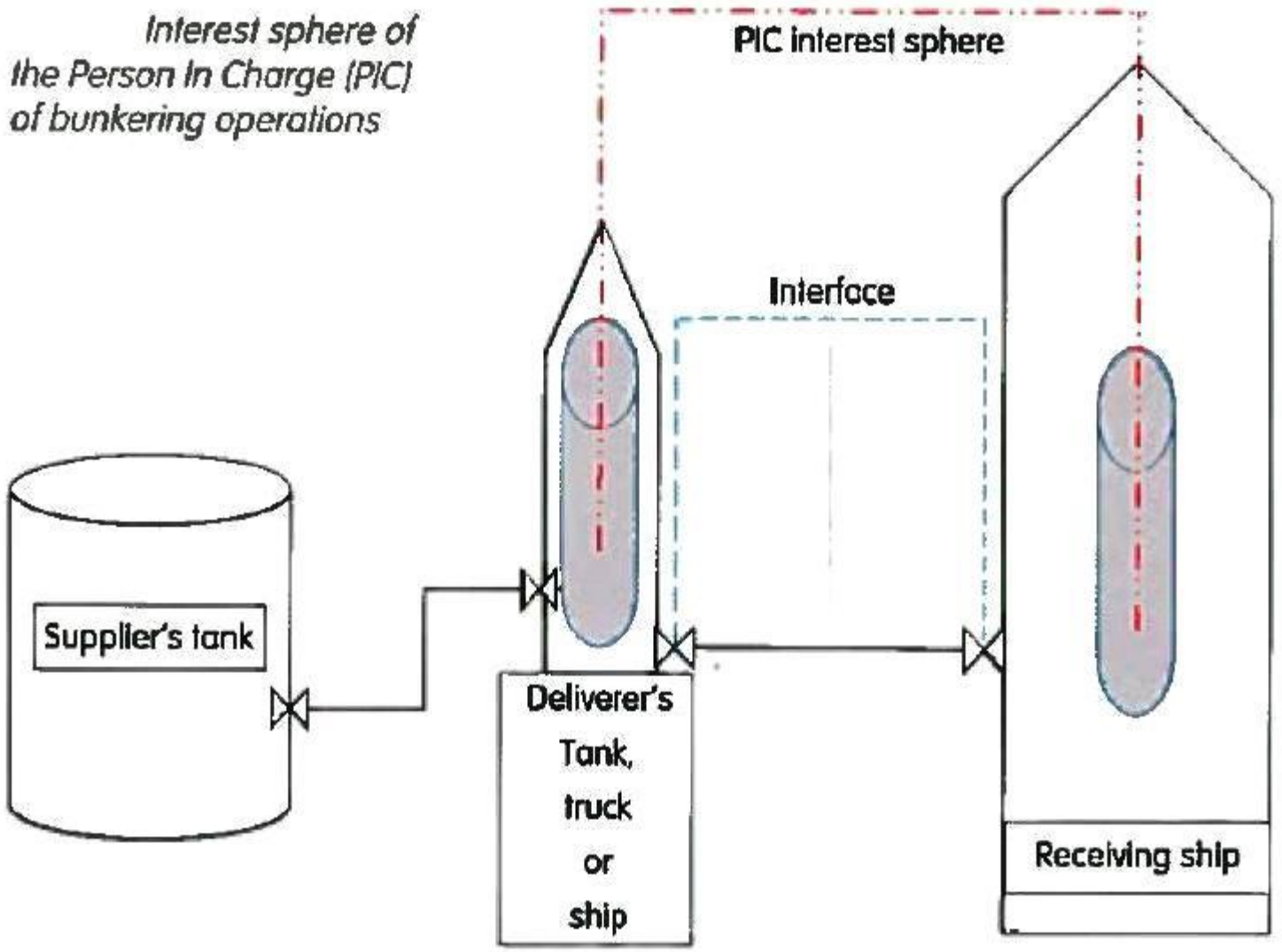
LNG Fuel Process

LNG Tank from Bulk to Tank

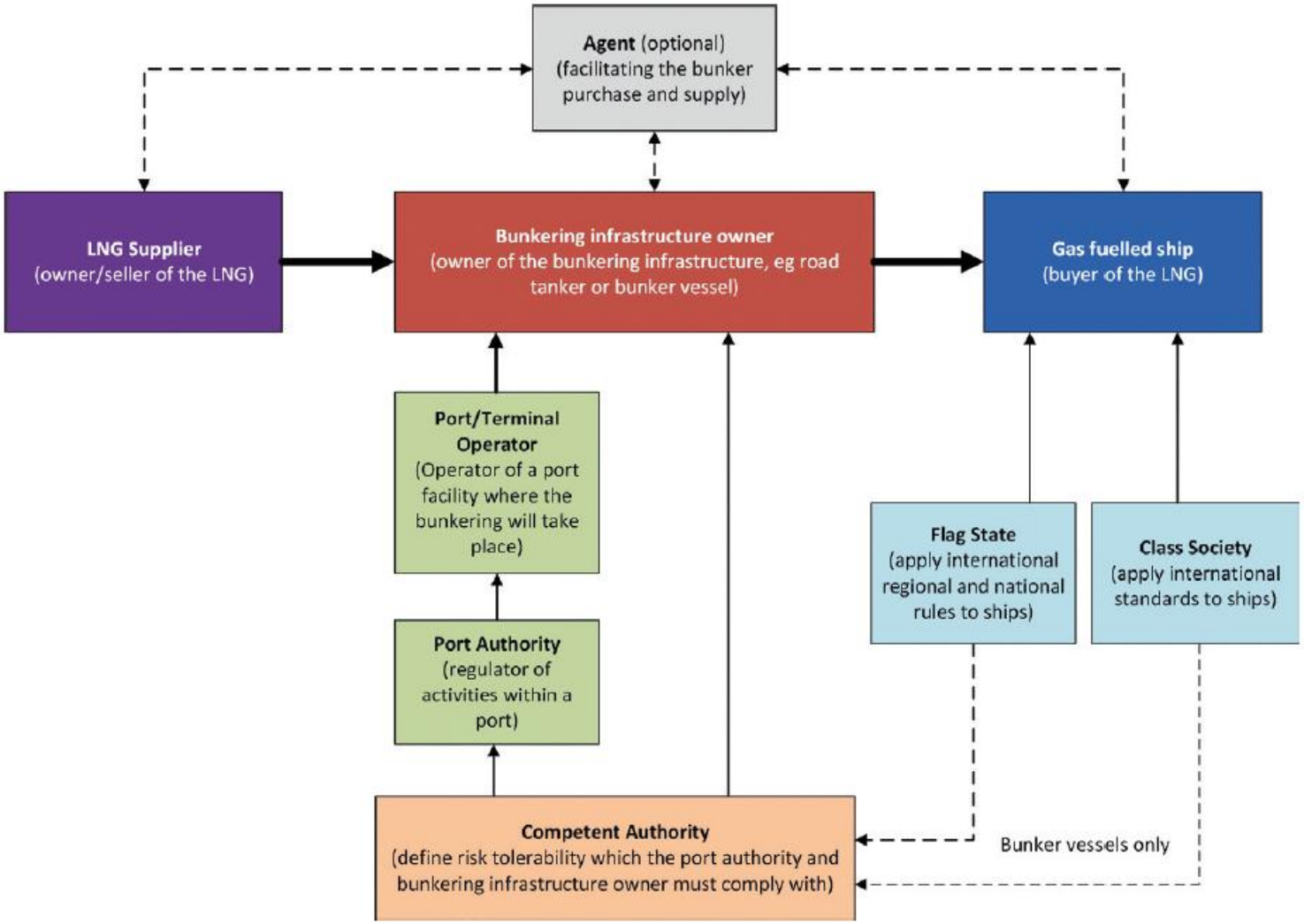


Nationaal LNG Platform, 13 November 2012, www.nationaallngplatform.nl
http://www.ccr-zkr.org/files/documents/workshops/wrshp131112/2_Gerrit_van_Tongeren.pdf

Visualizing the Bunkering



Stakeholders Involved?



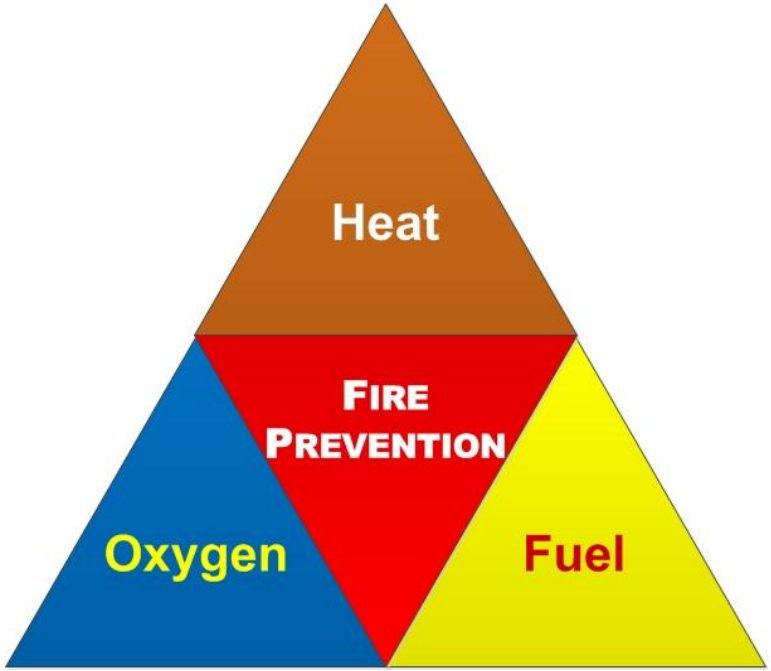
The Way Ahead

- One critical difference between LNG and other maritime fuels is that in the highly unlikely event of an accidental spillage, the hazard can extend some distance from the LNG installation because of the formation of a gas cloud.

- **Controlling the hazard** requires an understanding of the extent of the zone that might be affected and the measures that can be taken to reduce risks.

LNG Fire

- Fire Elements:
  - Fuel;
  - Air;
  - Source of Ignition!



First Commandment Handling LNG

Thou Shall Not Allow CH_4 To Mix With Oxygen

LNG Fire

Key Points to Remember:

- Methane (CH_4) like any other hydrocarbon is flammable.
- Flammable range 5 to 15% by volume in air.
- LNG does not burn!!!
- BUT, LNG vapor does burn.
  Also, the vapor could explode (if enclosed in a confined space)…

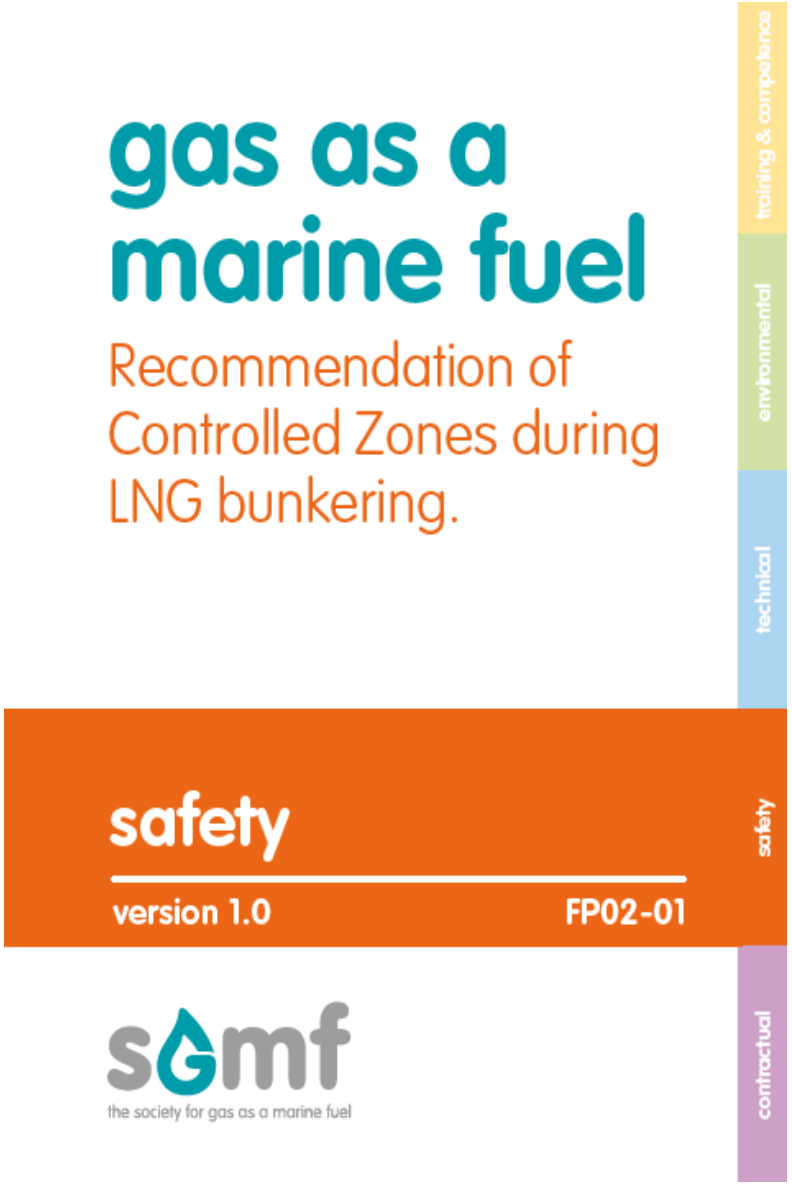
Why We Need Controlled Zones

- LNG and natural gas behave differently from traditional fuel oils when released into the air or onto water or land (vapour will disperse).

- As a result, safety precautions have to be assessed “differently” than for traditional bunkering operations.

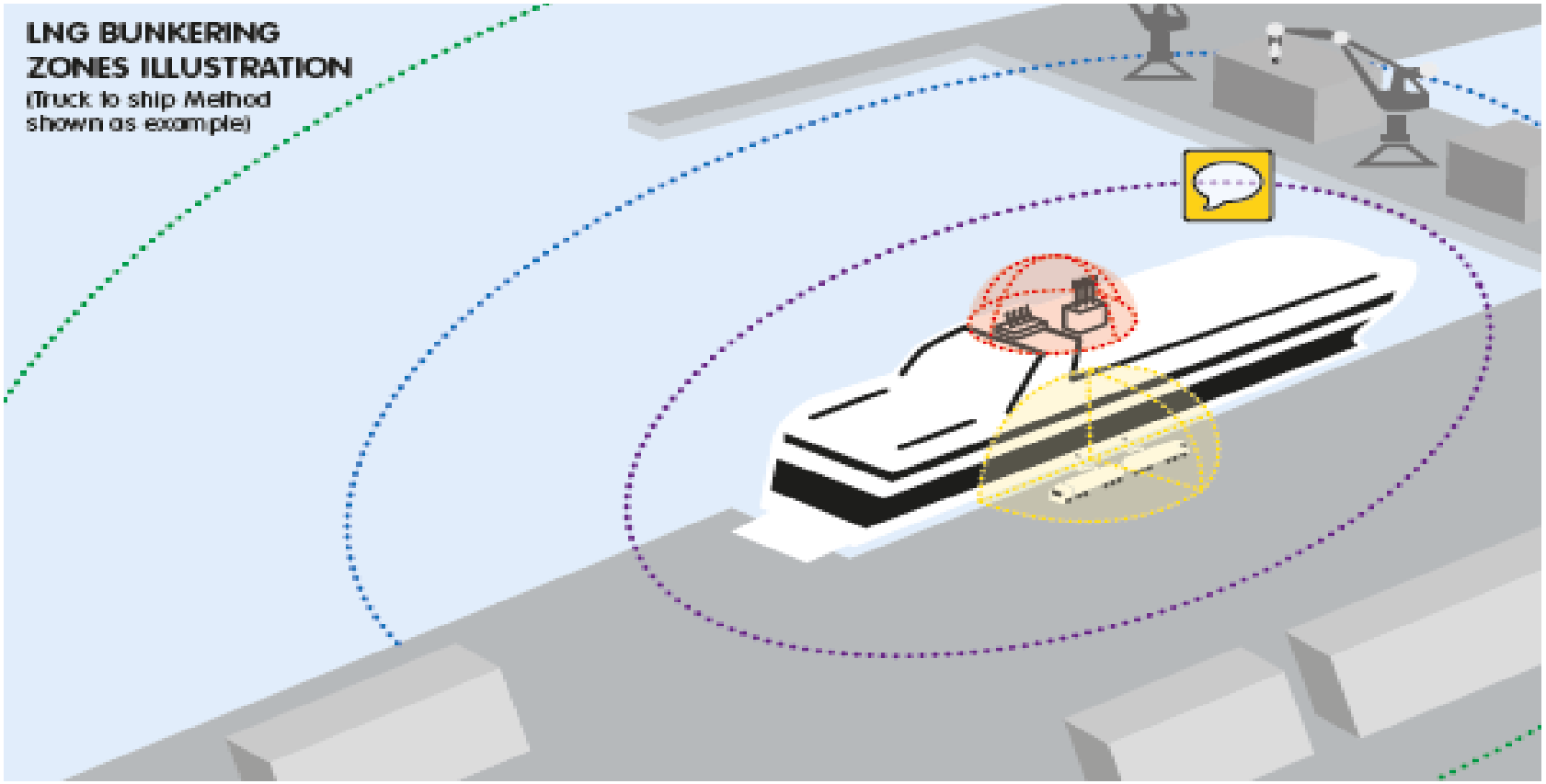
- **Simple Solution:** Controlled zones around the bunkering infrastructure of an LNG supplier and gas-receiving ship to facilitate the safe transfer of LNG during bunkering.

Controlling the Risks?



Controlled Zones...

Five controlled zones are defined below and shown in the Figure.



Hazardous Zone

- The Hazardous Zone is a three-dimensional space in which a combustible or explosive atmosphere can be expected to be present frequently enough to require special precautions for the control of potential ignition sources.
  - Hazardous zones are always present, but addressed via appropriate design techniques and safety practices.
  - Hazardous zones must be defined for all components of the LNG bunkering system by their respective owners. These components can include gas-fuelled ships, bunker vessels, road tankers and terminals.

Potential Ignition Sources?

- Ignition sources are normally assumed to be electrical equipment (including mobile/cell phones and high-power radio and radar) but can also include:
  - static electricity generated by the pumping of liquids or the loading of cargoes using conveyor belts;
  - naked flames from welding, paint stripping and people smoking;
  - vehicles (particularly gasoline/petrol-fuelled) delivering to a vessel or boarding a ferry.

Design and Safety Practices…

Examples of special precautions required to limit the probability of ignition sources coming into the hazardous area include:

- using intrinsically safe equipment, which cannot spark;
- prohibiting people from bringing ignition sources within the area.

Safety Zone

- The Safety Zone can be defined as the three-dimensional envelope of distances inside which the majority of leak events occur and where, in exceptional circumstances, there is a recognised potential for a leak of natural gas or LNG to harm life or damage equipment/infrastructure.

- The zone is temporary by nature, **present only during bunkering**. It may extend beyond the gas-fuelled ship/LNG road tanker/bunker vessel, interconnecting pipework, and so on, and will be larger than the Hazardous Zone.

Safety Zone

The purpose of the Safety Zone is to minimise the likelihood of harm to people and damage to equipment by:

- controlling leaks and spills;
- avoiding ignition and a subsequent fire or explosion;
- excluding non-essential people (to avoid additional injuries or deaths in the event of an accident);
- protecting essential staff through the use of PPE (to minimise the likelihood of injury or death in the event of an accident)!

Personal Protective Equipment

- PPE used MUST facilitate working:

Safety Zone

The Safety Zone should always be under the control of the Person In Charge (PIC). Its size will depend on:

- the design of the LNG bunkering infrastructure/gas-fuelled ship;
- the configuration of the LNG transfer system;
- the duration, flow-rate and pressure of the potential leak source;
- weather conditions and ambient temperature;
- the layout of the location where spills could occur.

Monitoring & Security Area

- The Monitoring & Security Area is defined as the three-dimensional space inside which activities (including people and vehicle movements) need to be identified and monitored to ensure that they do not affect the safety of the bunkering operation by encroaching on the Safety Zone of the gas-fuelled ship, quayside or LNG bunkering infrastructure.

- **Its primary purpose is to prevent impacts from the actions of people not involved in the bunkering process**.

Monitoring & Security Area

- The Monitoring & Security Area will always be larger than the Safety Zone.

- As the reasons for the Monitoring & Security Area are many and wide-ranging, it is unlikely that it will be possible to define or justify the size of the Monitoring & Security Area by calculation.

- It should be considered as a contingency on, or factor to, the Safety Zone; **this area is only relevant during bunkering (Activate/Mark?)**.

Marine Exclusion Zone

The purpose of the Marine Exclusion Zone is to protect the bunkering vessel from other marine traffic, primarily by defining minimum distances and speeds for passing vessels.

Definition of the Marine Exclusion Zone is for each port to decide and implement in port rules, based on specific port and ship studies (Local Notices to Marines/Port Regulations).

All ships and bunker vessels must comply with these rules in the normal way.

External Zone

In some jurisdictions – for example, much of Europe – an External Zone is required (Local government, or intervention at the State level).

A port cannot influence how the general public behaves outside the port area so the risk level outside must be kept low.

This zone is defined by the level of risk general members of the public can be exposed to, based on local regulatory requirements or socio-political norms…

LNG Fire

- Types of LNG Fires:
  - Flash Fire/Vapor Cloud Fire;
  - Jet;
  - Pool;
  - BLEVE;
  - Rapid Phase Transition?

Leak Behaviour

Gas clouds formed by leaking LNG can travel significant distances before they ignite.

The Safety Zone is defined by the maximum distance the gas evaporating from a pool of LNG or from a pressurised LNG release can subsequently be ignited, based on possible hole sizes…

On this basis, the delayed ignition of a gas cloud causing a flash fire is argued to be the event that defines the safety distance.

Leak Behaviour

Many factors determine how far a gas cloud will spread and remain within flammable limits. The parameters considered by SGMF include:

- LNG transfer flow rate, temperature and pressure;
- hole size;
- different orientations of leaks – vertically, horizontally and downwards;
- various climatic conditions around wind speed, climatic stability, ambient temperature and humidity;

Leak Behaviour

- a range of LNG compositions and physical properties;
- different geometries/topographies for releases over land and sea and at different elevations;
- various durations of release (depending on the type of emergency shut-down system)…

SGMF has created a model called Bunkering Area Safety Information for LNG (BASiL) to estimate the size of the Safety Zone based on the extent of the gas cloud to 100% Low Flash Level (LFL).

The BASiL model is available on SGMF's website (www.sgmf.info).

LNG Firefighting Procedures

- A rough guide:
  - Isolate and contain the source of the fire.
  - Cool surfaces under radiation or encroaching flames with water.
  - Control and extinguish fire with **appropriate** equipment.

Summary and Conclusions

- LNG Bunkering is a very safe procedure; associated risks are “mitigated” by ZONES…
- Any type of incident can be successfully managed/resolved if the basic principles are well understood.
- Prevention is crucial, with measures such as using the proper/right type of equipment and training in all available scenarios holding a pivotal role.
- Plan in advance and conduct training drills!!!

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