Implementation of International Standards for Maritime Hydrogen Fuel Cells

H_2@ Ports Workshop

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Outline

- Recent interest in using hydrogen and fuel cells for vessel power and propulsion
- Application of the IGF Code to hydrogen and fuel cells
- U.S. implementation of IGF Code and other standards for hydrogen fuel cell vessel projects

Hydrogen Fuel Cell Powered Passenger Ferry

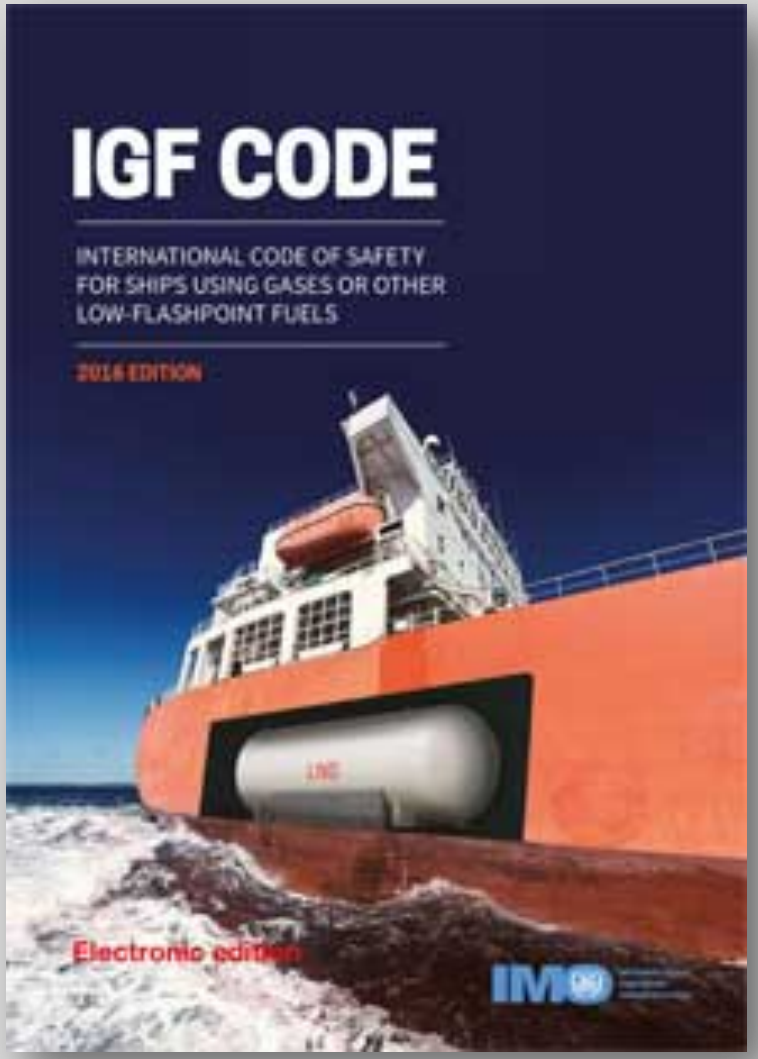
- Aluminum catamaran
- 70′ / 21 m LOA
- 84 passenger (reconfigurable)
- 22 knot top speed
- 2x 300 kW electric motors
- 360 kW PEM fuel cell
- 100 kWh Li-ion battery
- H_2: 264 kg @ 250 bar

IGF Code Development

International Code of Safety for Ships Using Gases or Other Low-Flashpoint Fuels (IGF Code)

Timeline / Key Milestones:

- May 2004: Norway proposes development of international standards for gas-fuelled ships
- Jun 2009: IMO adopts "***Interim Guidelines on Safety for Natural Gas-Fuelled Engine Installations on Ships***"
- Jun 2015: ***IGF Code*** adopted at MSC 95
- Jan 2017: ***IGF Code*** entered into force



Safety Considerations

- **Fuel System**
  - Machinery space configuration
  - Tank placement
  - Tank & piping requirements
- **Gas Detection**
  - System certification
- **Hazardous Locations**
  - Classification of areas
  - Electrical equipment
- **Fire Protection**
  - Installed firefighting systems
  - Fire detection

Options for Alternative Design

2.3 Alternative design

2.3.1 This Code contains functional requirements for all appliances and arrangements related to the usage of low-flashpoint fuels.

2.3.2 Fuels, appliances and arrangements of low-flashpoint fuel systems may either:

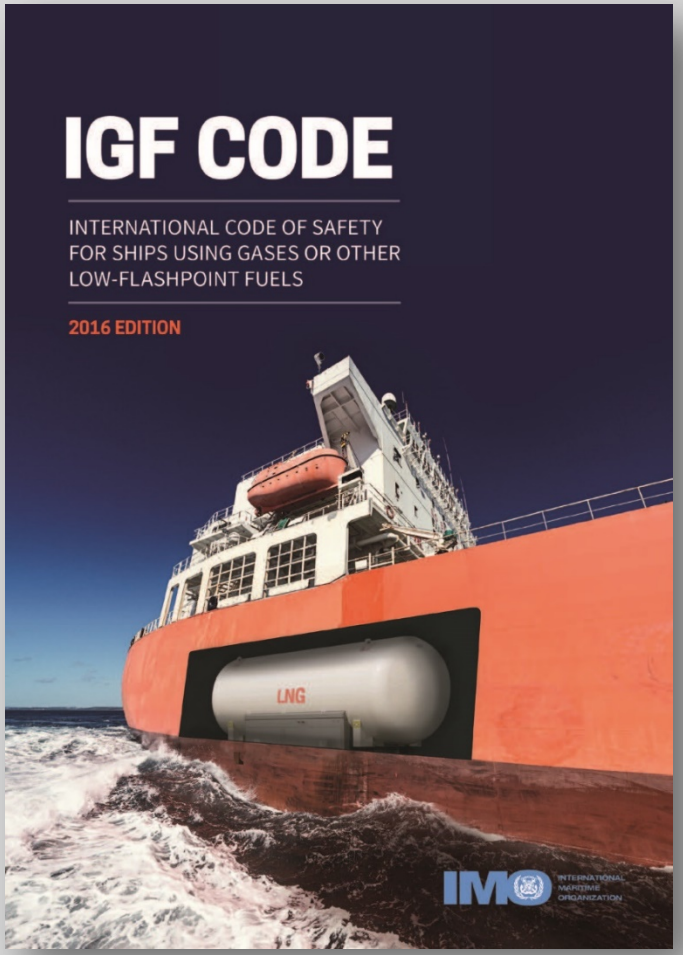
.1 deviate from those set out in this Code, or

.2 be designed for use of a fuel not specifically addressed in this Code.

Such fuels, appliances and arrangements can be used provided that these meet the intent of the goal and functional requirements concerned and provide an equivalent level of safety of the relevant chapters.

2.3.3 The equivalence of the alternative design shall be demonstrated as specified in SOLAS regulation II-1/55 and approved by the Administration. However, the Administration shall not allow operational methods or procedures to be applied as an alternative to a particular fitting, material, appliance, apparatus, item of equipment, or type thereof which is prescribed by this Code.

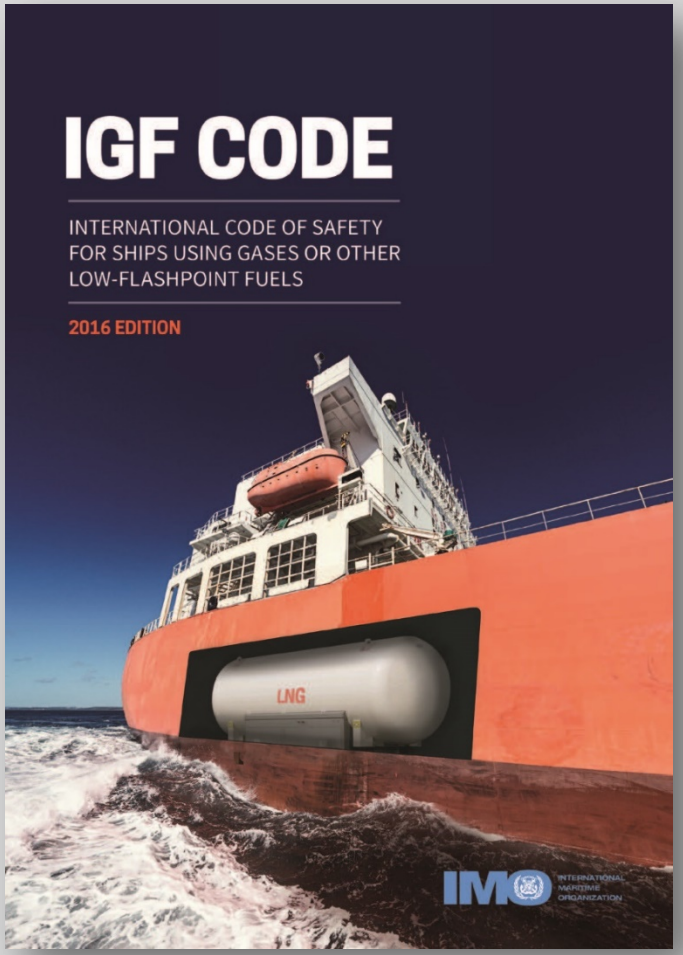
Applying IGF Code to Hydrogen & Fuel Cells



Hydrogen v/s Natural Gas

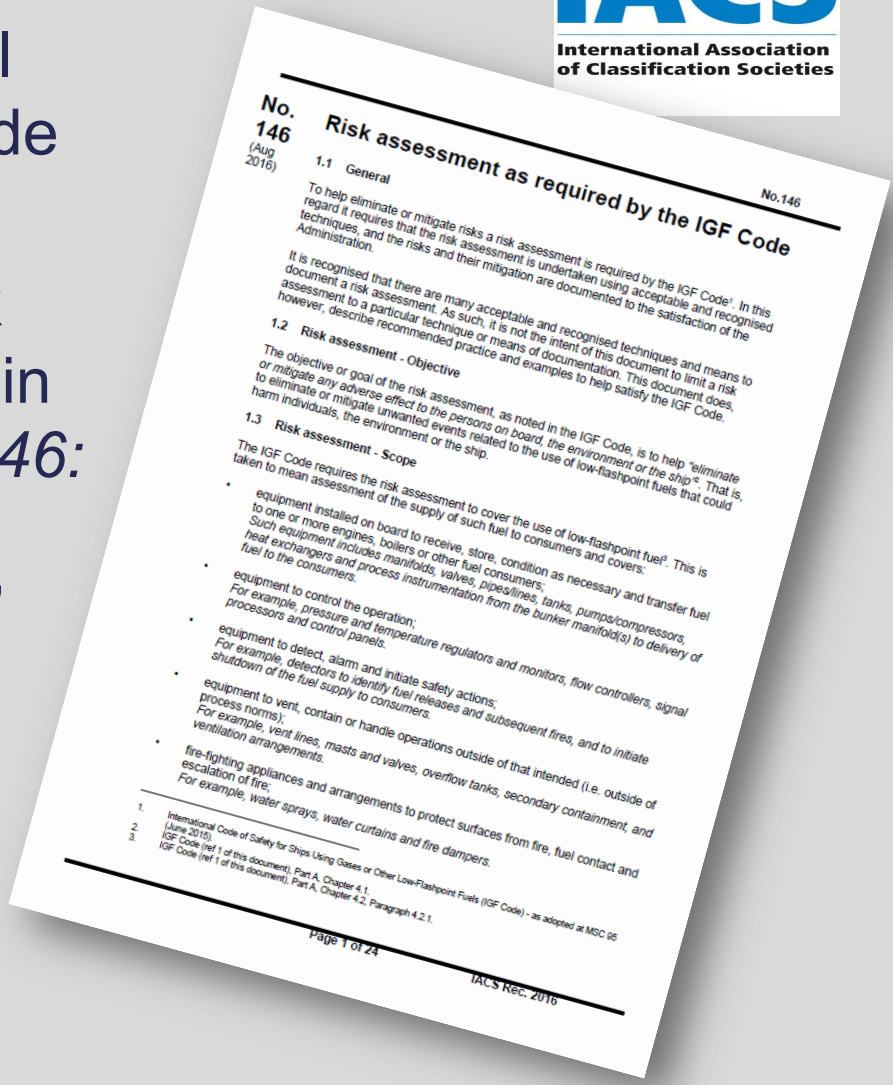
- characteristics & risks are similar
- differences are known and well-documented

Applying IGF Code to Hydrogen & Fuel Cells



- Risk assessment for vessel design required by IGF Code
- Additional guidance on risk assessments are provided in *IACS Recommendation #146: "Risk Assessment as Required by the IGF Code" (Aug 2016)*

IACS
International Association of Classification Societies



No. 146 (Aug 2016)

Risk assessment as required by the IGF Code

No.146

1.1 General

To help eliminate or mitigate risks a risk assessment is required by the IGF Code[1]. In this regard it requires that the risk assessment is undertaken using acceptable and recognised techniques, and the risks and their mitigation are documented to the satisfaction of the Administration.

It is recognised that there are many acceptable and recognised techniques and means to document a risk assessment. As such, it is not the intent of this document to limit a risk assessment to a particular technique or means of documentation. This document does, however, describe recommended practice and examples to help satisfy the IGF Code.

1.2 Risk assessment - Objective

The objective or goal of the risk assessment, as noted in the IGF Code, is to help "*eliminate or mitigate any adverse effect to the persons on board, the environment or the ship*". That is, to eliminate or mitigate unwanted events related to the use of low-flashpoint fuels that could harm individuals, the environment or the ship.

1.3 Risk assessment - Scope

The IGF Code requires the risk assessment to cover the use of low-flashpoint fuel[2]. This is taken to mean assessment of the supply of such fuel to consumers and covers:

- equipment installed on board to receive, store, condition as necessary and transfer fuel to one or more engines, boilers or other fuel consumers;
  Such equipment includes manifolds, valves, pipes/lines, tanks, pumps/compressors, heat exchangers and process instrumentation from the bunker manifold(s) to delivery of fuel to the consumers.
- equipment to control the operation;
  For example, pressure and temperature regulators and monitors, flow controllers, signal processors and control panels.
- equipment to detect, alarm and initiate safety actions;
  For example, detectors to identify fuel releases and subsequent fires, and to initiate shutdown of the fuel supply to consumers.
- equipment to vent, contain or handle operations outside of that intended (i.e. outside of process norms);
  For example, vent lines, masts and valves, overflow tanks, secondary containment, and ventilation arrangements.
- fire-fighting appliances and arrangements to protect surfaces from fire, fuel contact and escalation of fire;
  For example, water sprays, water curtains and fire dampers.

1. International Code of Safety for Ships Using Gases or Other Low-Flashpoint Fuels (IGF Code) - as adopted at MSC 95 (June 2015).
2. IGF Code (ref 1 of this document), Part A, Chapter 4.1.
3. IGF Code (ref 1 of this document), Part A, Chapter 4.2, Paragraph 4.2.1.

Design Basis: Equivalency to U.S. Federal Regulations

Equivalent level of safety to requirements in Title 46 Code of Federal Regulations

- U.S. Federal Regulations do not address:
  - hydrogen as a vessel fuel
  - use of fuel cells for vessel power
- Need to establish equivalency to design standards in Title 46, Code of Federal Regulations (CFR) - Shipping
  - Design Basis providing framework of standards & requirements
  - Vessel specific / case-by-case
  - Draw from standards such as IGF Code, ASME, ASTM, IEC & Class Society Rules

Thank You!

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