CHALLENGES OF AMMONIA ENGINE CERTIFICATION

IMO Technical Seminar on the use of ammonia as marine fuel – 2026

SUMMARY

01.

Background – UR M78 Rev. 4

BACKGROUND

- **2030** to reduce total annual GHG by at least **20%,** compared to 2008
- **2040** to reduce total annual GHG by at least **70%,** compared to 2008
- **2050** to reach net-zero GHG emissions

- The 2023 IMO GHG Strategy promotes the uptake of zero or near-zero GHG emission technologies, fuels and/or energy sources
- **Ammonia (NH_3)** is a zero-carbon fuel that, alongside hydrogen and methanol, has been identified as a **potential marine fuel to reduce GHG emissions** from international shipping

- This creates immediate **regulatory pressure** on **engine manufacturers** to demonstrate compliance through appropriate design assessment, testing and certification

BACKGROUND

HD HYUNDAI HEAVY INDUSTRIES | ENGINE & MACHINERY

WÄRTSILÄ

WIN GD

WinGD Achieves next Ammonia Milestone with First X72DF-A Engine Approval

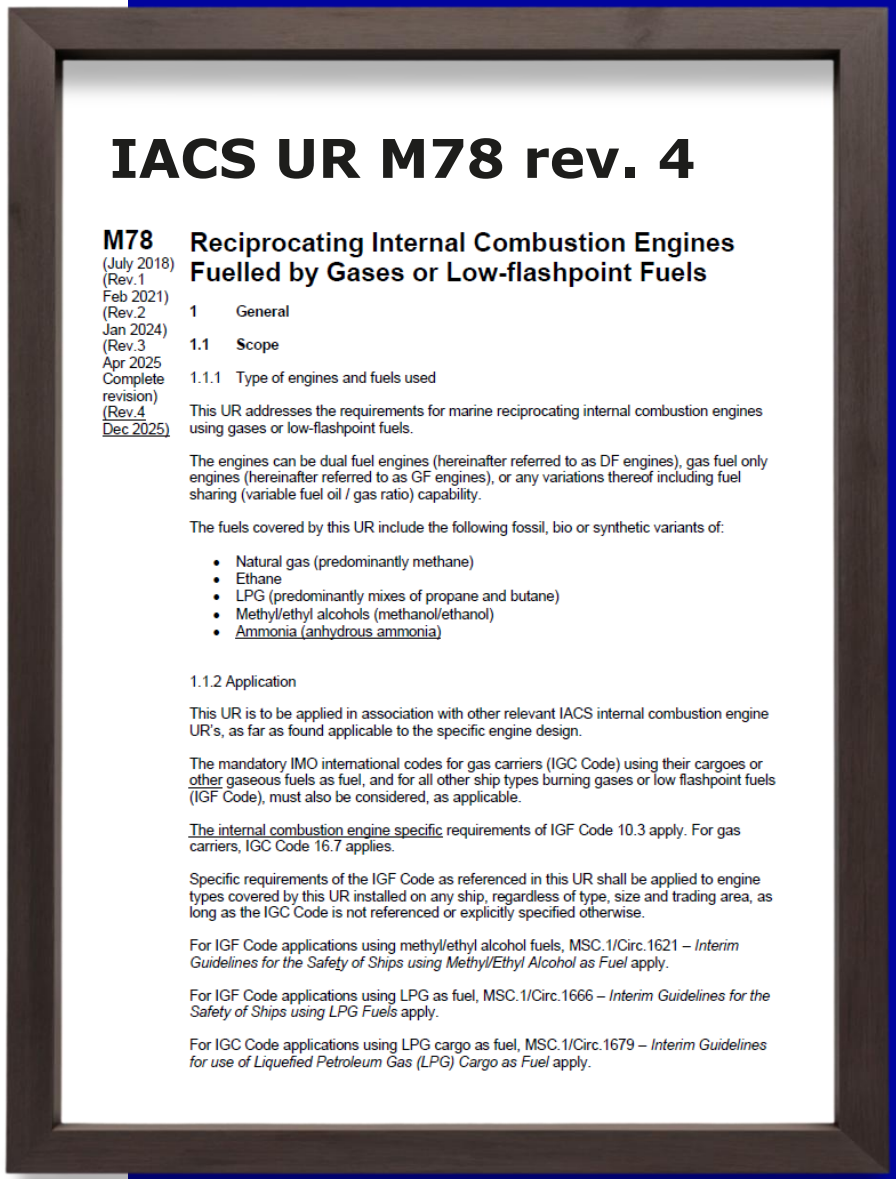
Everllence

Successful Type Approval Test Continues ME- LGIA's Seamless Development

UNIFORMLY IMPLEMENTED BY IACS SOCIETIES

July 2027

Engine makers agree to apply UR M78 ***before*** *the application date*



IACS UR M78 rev. 4

M78
(July 2018)
(Rev.1 Feb 2021)
(Rev.2 Jan 2024)
(Rev.3 Apr 2025 Complete revision)
(Rev.4 Dec 2025)

Reciprocating Internal Combustion Engines Fuelled by Gases or Low-flashpoint Fuels

1 General

1.1 Scope

1.1.1 Type of engines and fuels used

This UR addresses the requirements for marine reciprocating internal combustion engines using gases or low-flashpoint fuels.

The engines can be dual fuel engines (hereinafter referred to as DF engines), gas fuel only engines (hereinafter referred to as GF engines), or any variations thereof including fuel sharing (variable fuel oil / gas ratio) capability.

The fuels covered by this UR include the following fossil, bio or synthetic variants of:

- Natural gas (predominantly methane)
- Ethane
- LPG (predominantly mixes of propane and butane)
- Methyl/ethyl alcohols (methanol/ethanol)
- Ammonia (anhydrous ammonia)

1.1.2 Application

This UR is to be applied in association with other relevant IACS internal combustion engine UR's, as far as found applicable to the specific engine design.

The mandatory IMO international codes for gas carriers (IGC Code) using their cargoes or other gaseous fuels as fuel, and for all other ship types burning gases or low flashpoint fuels (IGF Code), must also be considered, as applicable.

The internal combustion engine specific requirements of IGF Code 10.3 apply. For gas carriers, IGC Code 16.7 applies.

Specific requirements of the IGF Code as referenced in this UR shall be applied to engine types covered by this UR installed on any ship, regardless of type, size and trading area, as long as the IGC Code is not referenced or explicitly specified otherwise.

For IGF Code applications using methyl/ethyl alcohol fuels, MSC.1/Circ.1621 – *Interim Guidelines for the Safety of Ships using Methyl/Ethyl Alcohol as Fuel* apply.

For IGF Code applications using LPG as fuel, MSC.1/Circ.1666 – *Interim Guidelines for the Safety of Ships using LPG Fuels* apply.

For IGC Code applications using LPG cargo as fuel, MSC.1/Circ.1679 – *Interim Guidelines for use of Liquefied Petroleum Gas (LPG) Cargo as Fuel* apply.

MAIN TOPICS

Risk analysis

Concept of **off-engine** and **on-engine** systems. Interactions in between those system

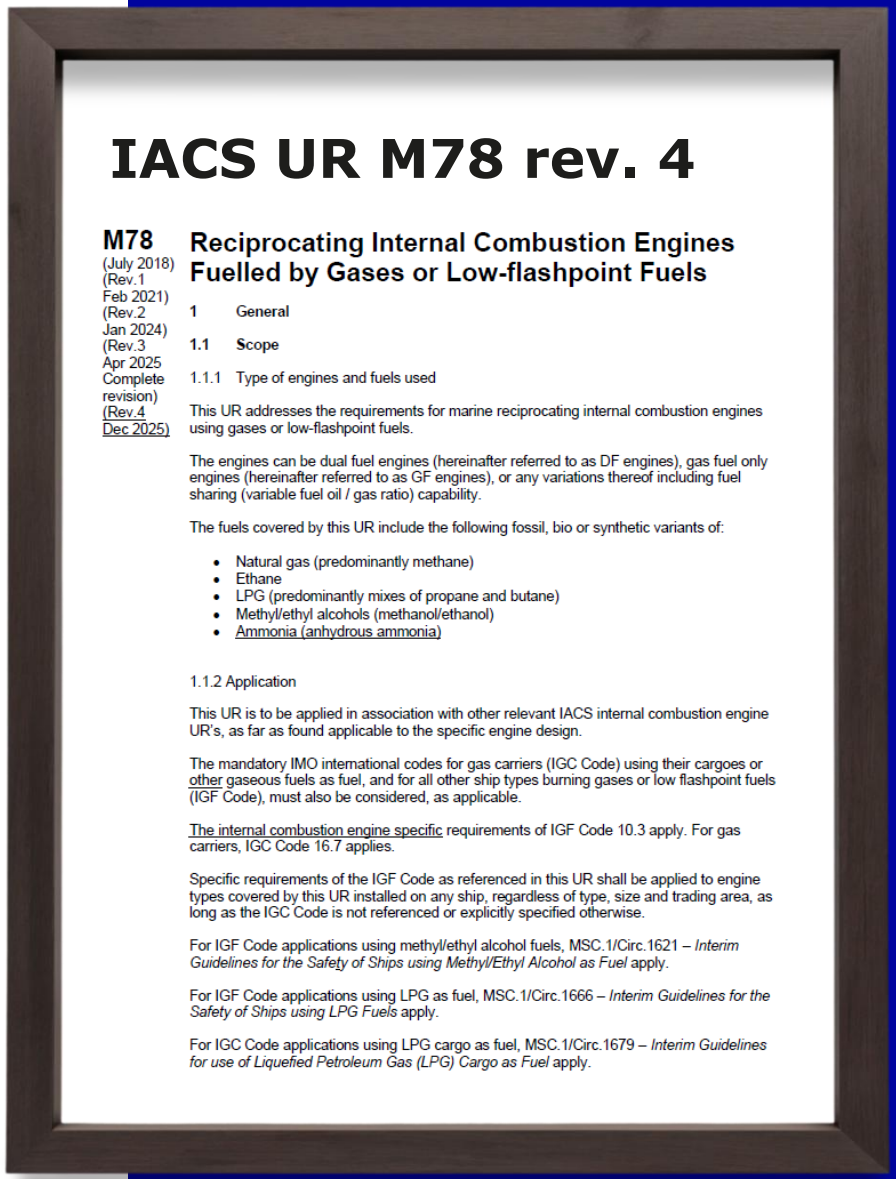
Hazard potential of **toxic releases**

Crankcase

Crankcase **under pressure ventilation**

Exhaust gases

Maximum **110 ppm** ammonia concentration in *normal operation*



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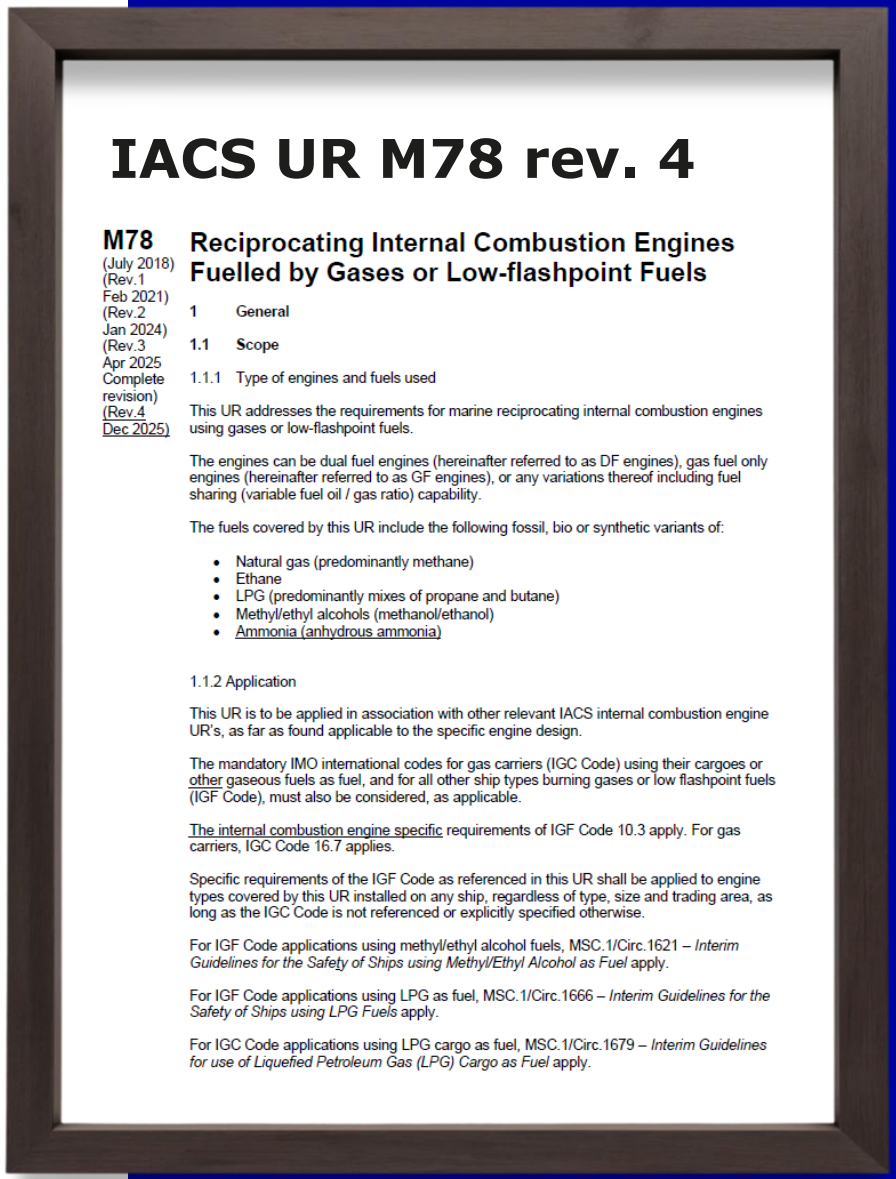
IGF VS IGC

For IGF
MSC.1/Circ.1687. applicable
110 ppm Alarm
220 ppm treated by ARMS

For IGC
MSC.1/Circ.1679 applicable

MSC.1/Circ.1702 interim guideline for use of ammonia cargo as fuel removes the 110, 220 ppm and refers to engine safety concept.



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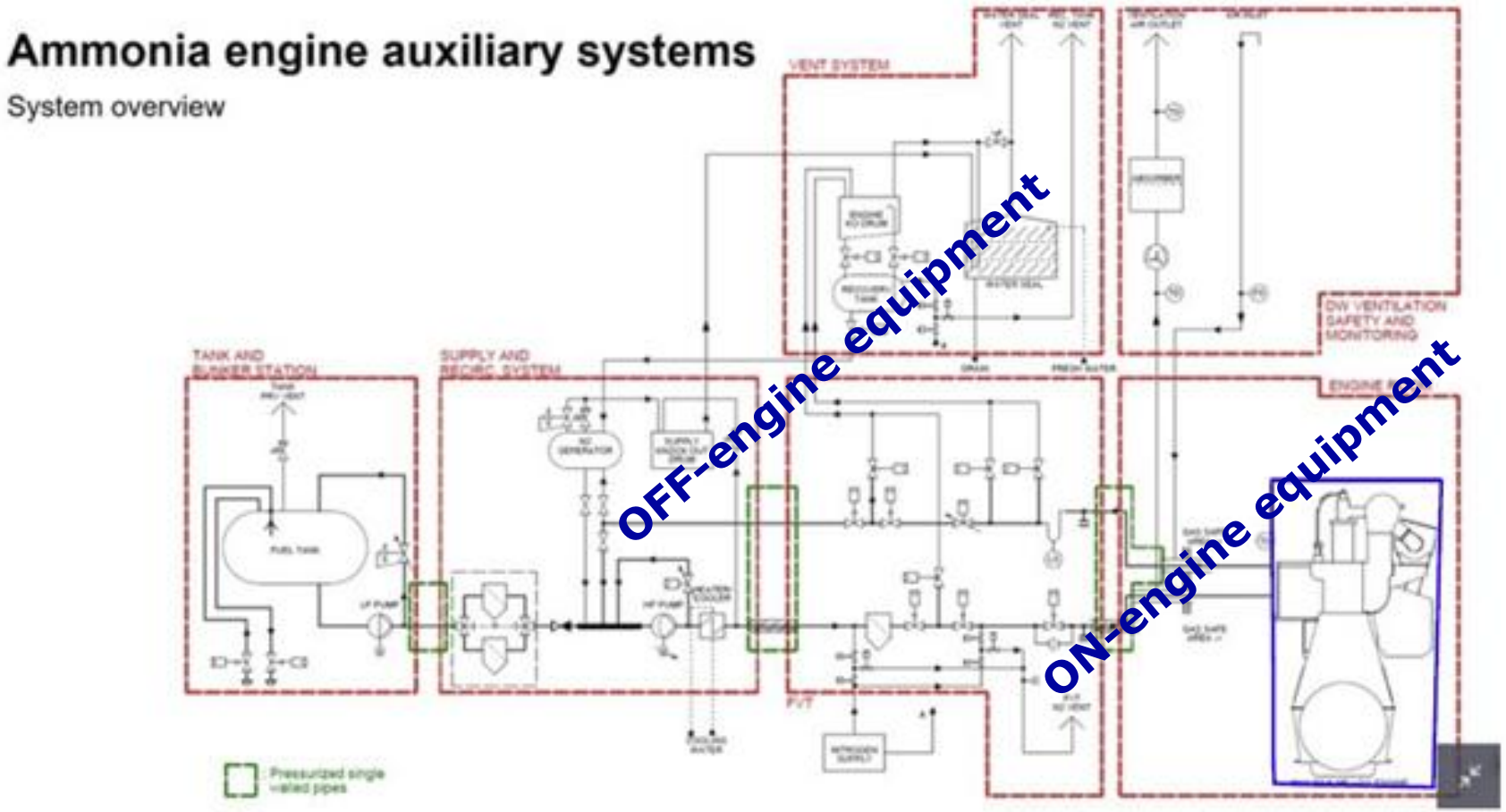
02.

Risk assessment & Safety concept

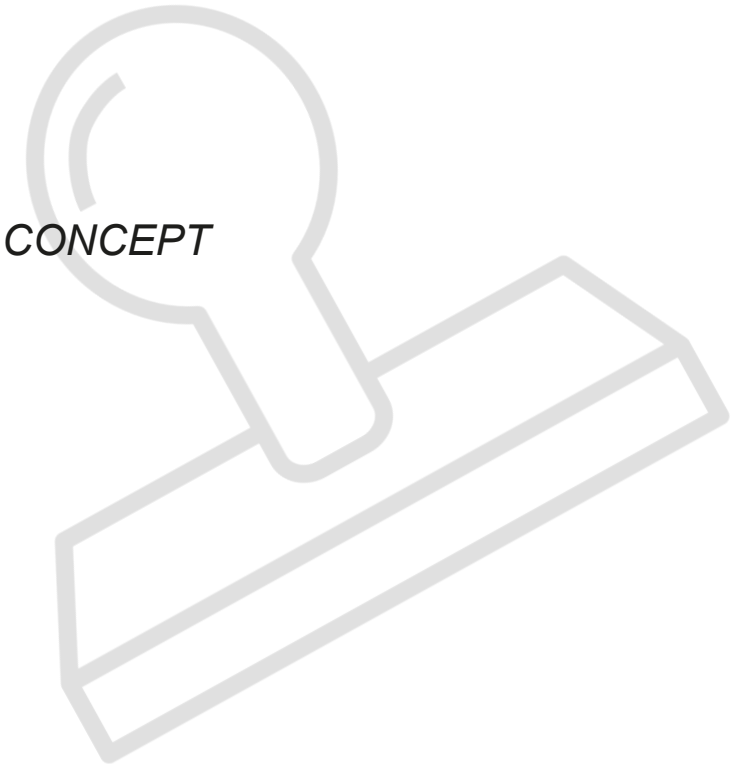
HIGH COMPLEXITY OF NH3 ENGINES



RISK ASSESSMENT

prevent direct release of ammonia to atmosphere

SAFETY CONCEPT

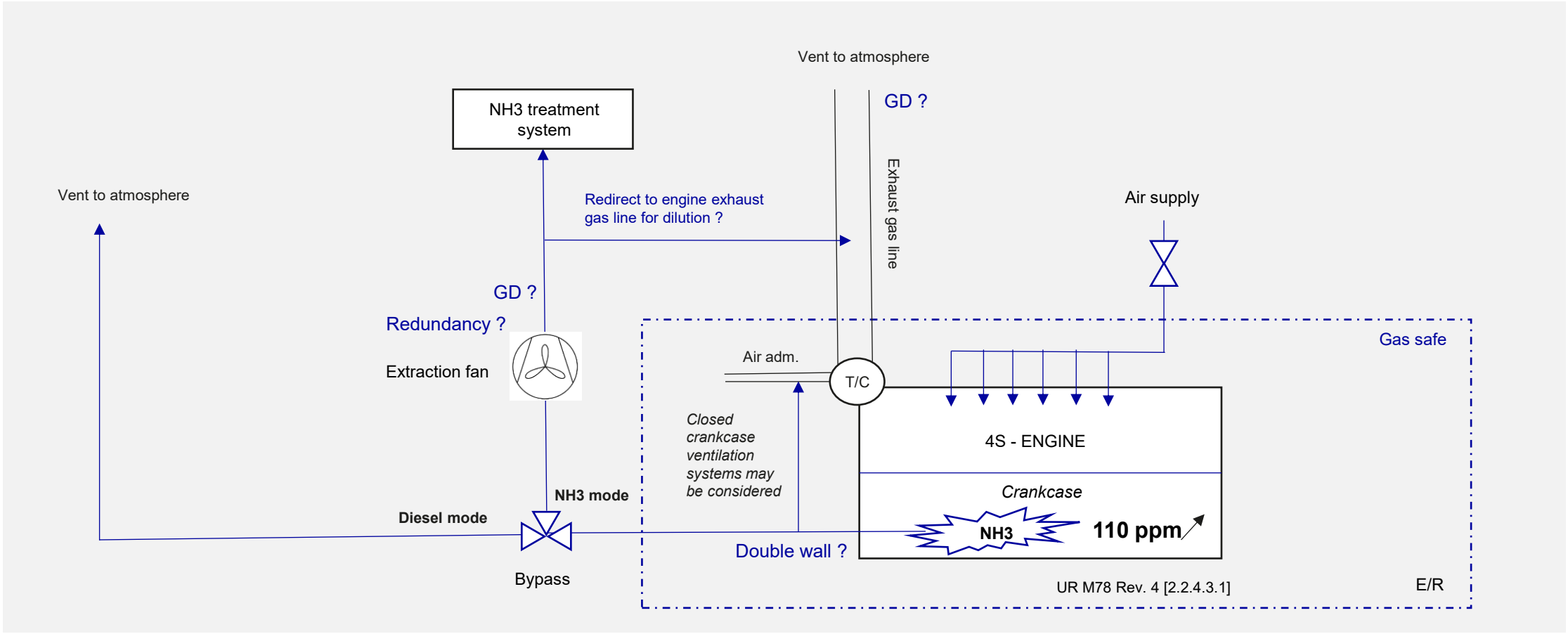


Cover the off- and on-engine equipment

03.

Crankcase & Lub Oil

CRANKCASE


Vent to atmosphere
NH3 treatment system
GD ?
Exhaust gas line
Vent to atmosphere
Redirect to engine exhaust gas line for dilution ?
Air supply
GD ?
Redundancy ?
Extraction fan
Gas safe
Air adm.
T/C
Closed crankcase ventilation systems may be considered
4S - ENGINE
Crankcase
NH3 mode
Diesel mode
NH3
110 ppm
Double wall ?
Bypass
UR M78 Rev. 4 [2.2.4.3.1]
E/R

ENGINE LUB OIL

01

- *Ammonia absorption by the lub oil shall be analysed and documented*
- The risks of ammonia vapor emissions from oil circuits (centrifugal separators, used oil boxes, box vents, pipes) should be analyzed.
- The corresponding concentrations in the vapors present in the lub oil tank and vent pipes should be evaluated

02

- It is recommended by some engine makers to have a separate gas detector above LO separator, in case of failure in LO separator.
- Sludge from LO separor shall be treated as toxic, since it will contain ammonia-water.

03

- This topic shall be analysed on the engine **Safety concept**
- This topic shall be indicated on the **Engine product guide** and installation planning instruction to customer.

04.

Double wall piping & HP NH3 pump in E/R

DOUBLE WALL PIPE ARRANGEMENT

Case of Everllence double wall piping for ME-LGIA

Deviation about parameter monitoring of gas ammonia detection level inside the enclosure of NH3 fuel double wall pipes as per MSC Circ. 1687 Table 1

It is a pure alternative design process and therefore applicable on a case-by-case basis validated by the Flag

Equivalent level of safety

- **DESIGN**
- **TYPE APPROVAL TEST**

EQUIVALENT LEVEL OF SAFETY

Case of Everllence double wall piping for ME-LGIA

DESIGN

HAZARD EVALUATION LETTER

Everllence proposal is based on the following design:

Detection **5500 ppm (Alarm)**
shutdown **11000 ppm**

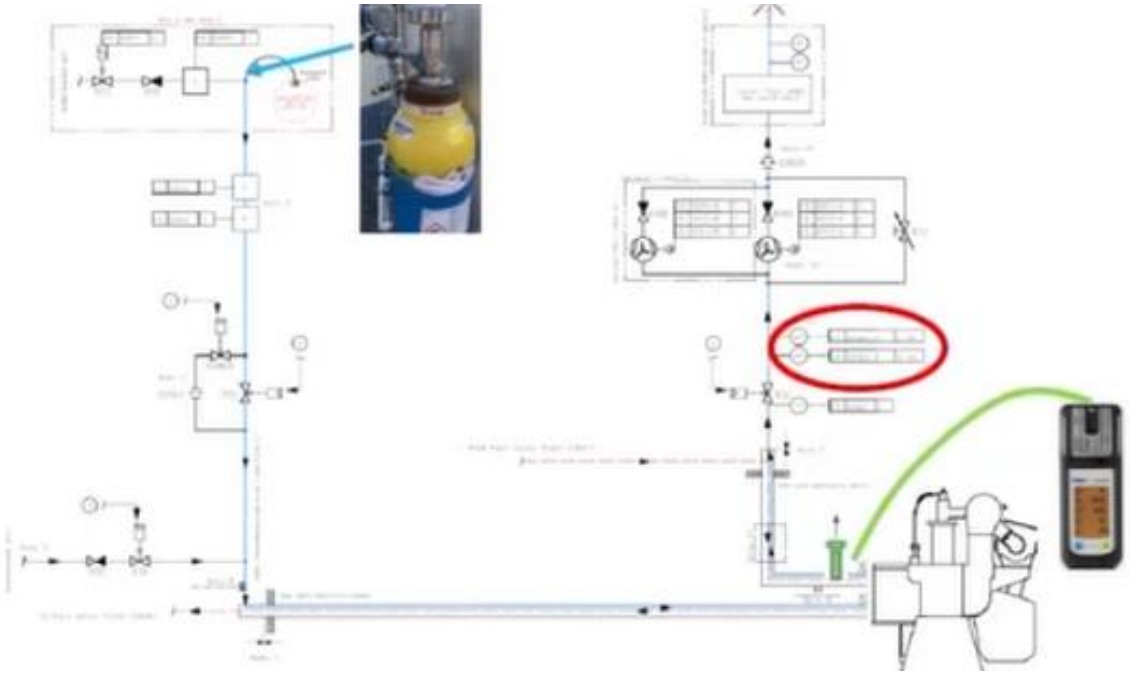
Everllence design is based on many hours of testing, running experience from critical testing and maintenance

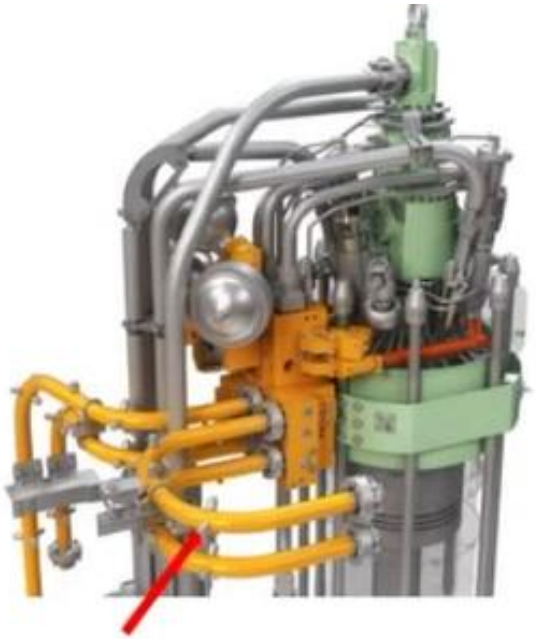
EQUIVALENT LEVEL OF SAFETY

Case of Everllence double wall piping for ME-LGIA

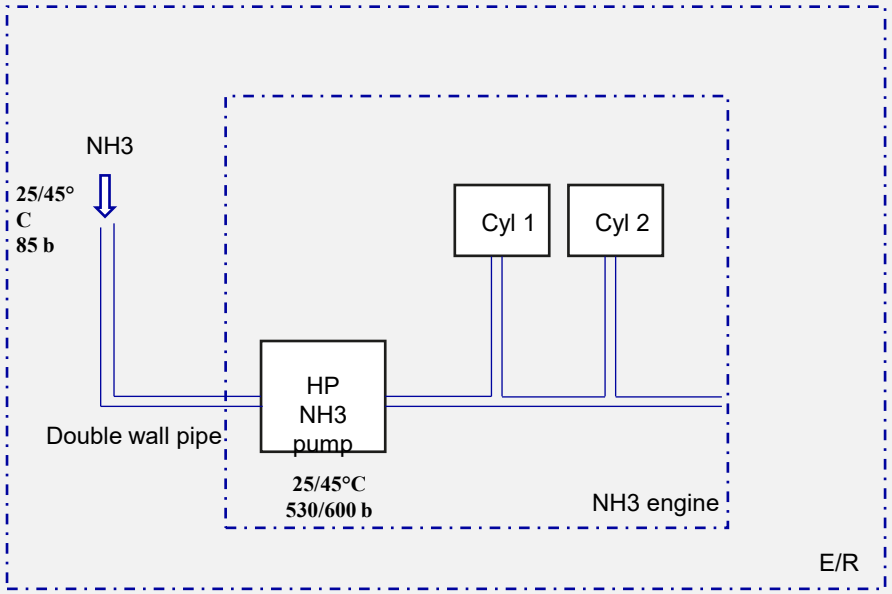
TYPE APPROVAL TEST

Safety demonstrated during Type Approval Test





NH3 FUEL BOOSTER PUMP LOCATED OUTSIDE THE FUEL PREPARATION ROOM



NH3 HP pump installed on engine room, as a of pressure boosting unit

Injection pumps ?

- Independent secondary barrier
- Leakage detection
- Mechanical failures of the fuel pump shall not compromise both the inner and outer barriers
- gas detection alarm

Classification approval under Flag acceptance ?

Note: IACS Draft GF23 - Arrangements of fuel pumps in **methyl/ethyl alcohol** fuelled vessels -
Injection pumps increasing the fuel pressure for the cylinders are accepted as part of the engine system and are therefore accepted to be located outside the fuel preparation room

05.

Stage A – Internal tests

STAGE A – INTERNAL TESTS

01

Ammonia engine is **not a mature technology** Innovative product

02

It is essential that the engine makers **communicate well in advance with classification** societies about the internal test results to inform about any remarks or observations noted during the internal test and the overhaul inspection which may impact the type approval certification

03

IACS UR M71 Stage A requirements shall be updated to **consider innovative engine and low maturity** of this type of product to ensure that the engine is internally tested by the maker with a sufficient cummulative running hours to check the design robustness of main critical engine components (ie. Injection).

06.

Conclusion

WRAP-UP

Ammonia engines technology as well as ammonia regulations shall be regularly improved based on experience and feedback

Engine makers and classification societies have to collaborate closely together

Alternative design shall be considered well in advance on the engine design assessment and validated during the type test

Engines Type Approval Certification is a critical safety milestone for zero-carbon maritime propulsion

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