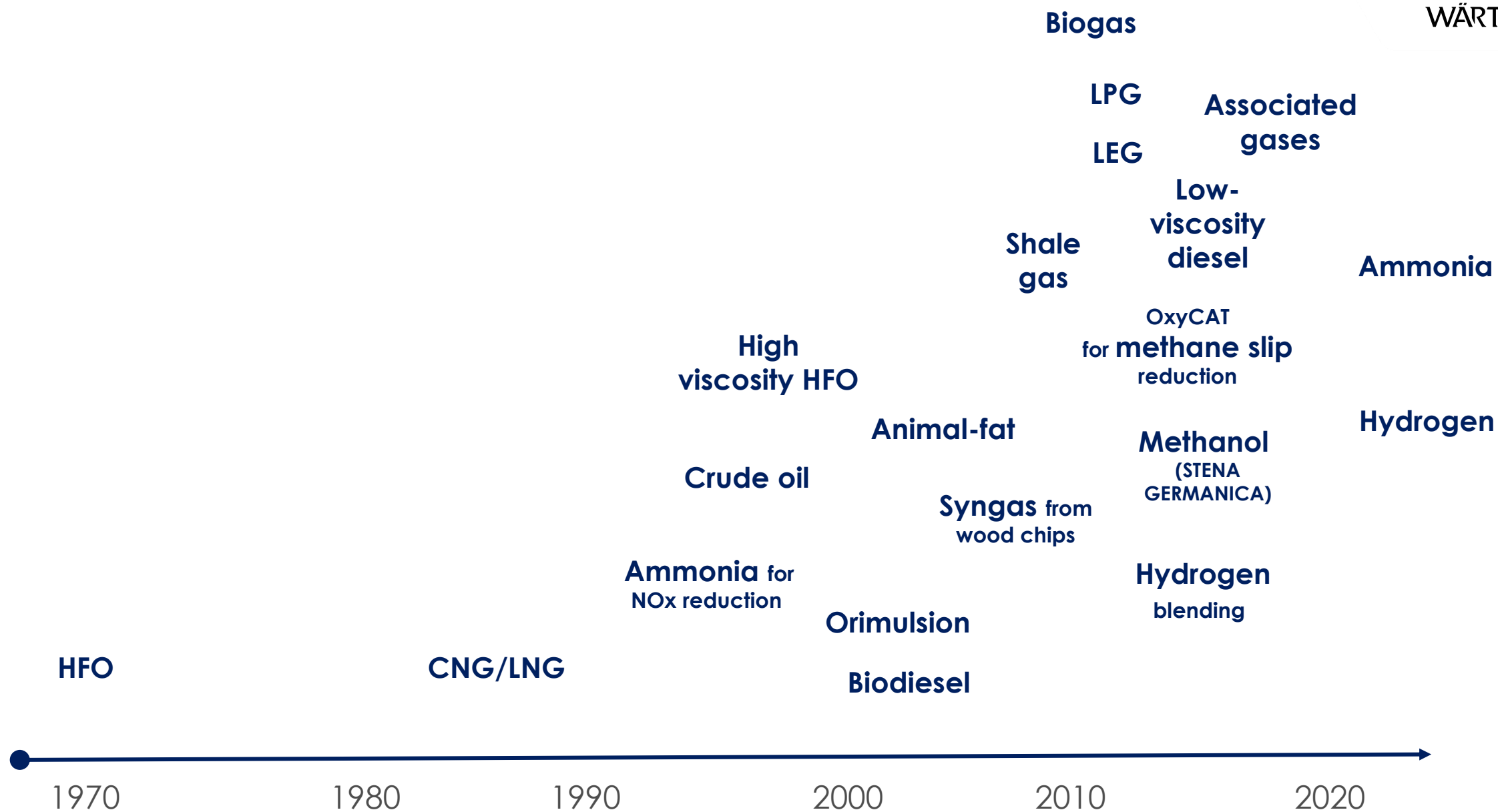


BSM Ammonia Day Hamburg 6th of March 2025

Fredrik Lindfors

Project Manager Sustainable Fuels & Decarbonisation | Research & Technology Development
Wärtsilä R&D and Engineering



Ammonia engine concept to Product: advancing from industrial chemical to zero-carbon ship fuel through R&D and collaboration



2020

First engine tests with ammonia blends



2022

Industry collaboration for solution validation



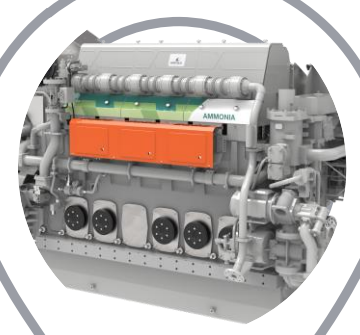
2023

Technical concept ready



2024

First ammonia engine order



2025

First ammonia engine deliveries

KATAPULT - DEMO 2000 – NH3 DF Engine Demonstration project at Stord



2020 - 2023

PARTNERS

**SUSTAINABLE
ENERGY** | NORWEGIAN
CATAPULT
CENTRE

 **Forskningsrådet**

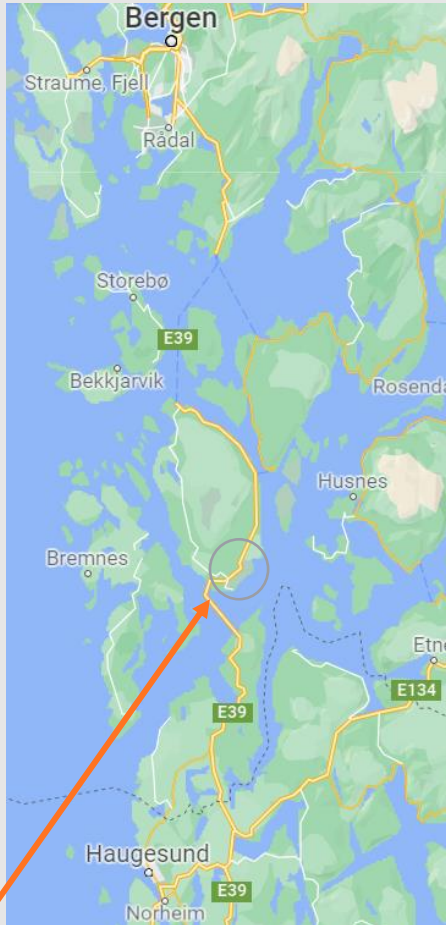
 **REPSOL**

 | **Knutsen OAS
Shipping**

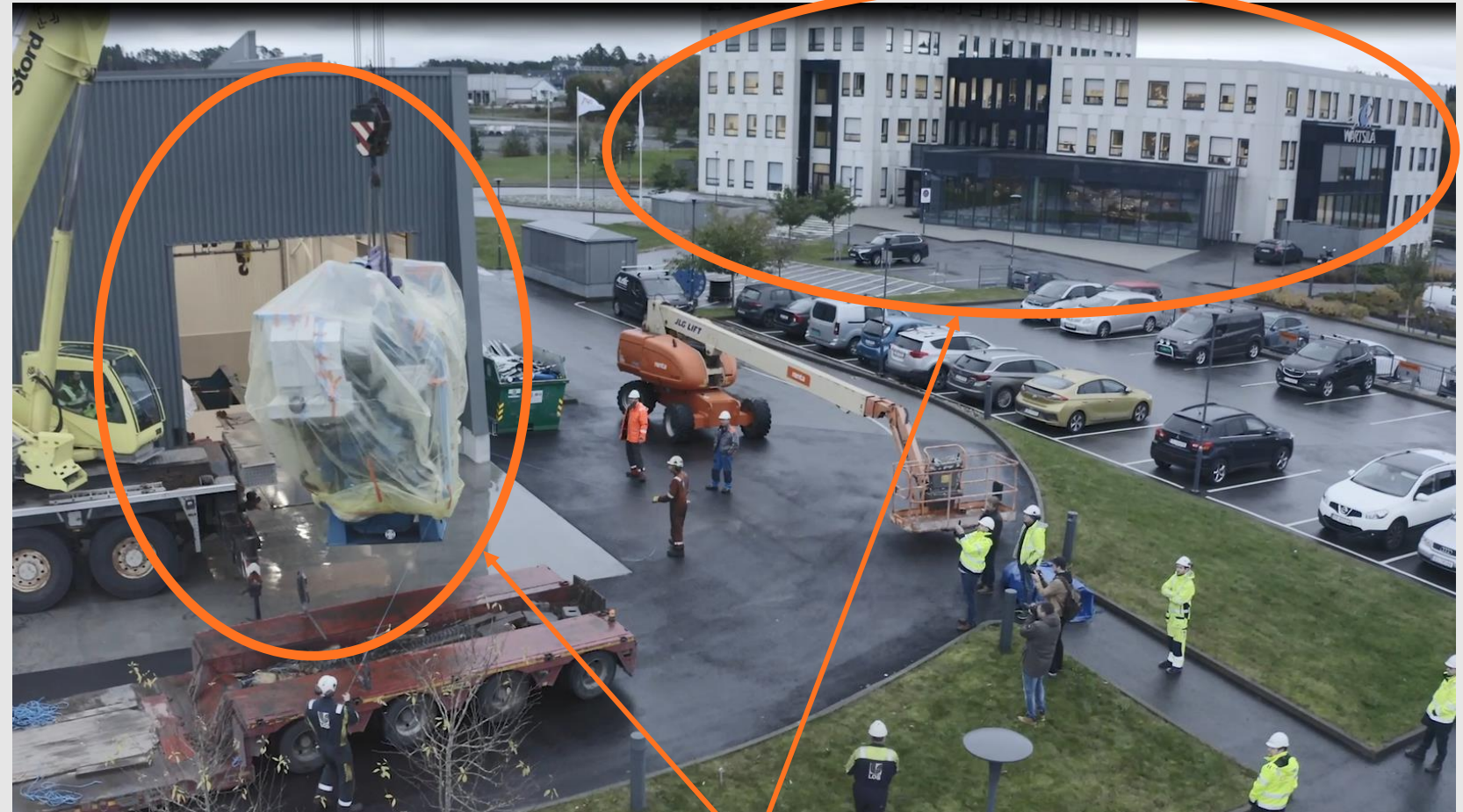
equinor 


WÄRTSILÄ

Katapult Test Centre Stord

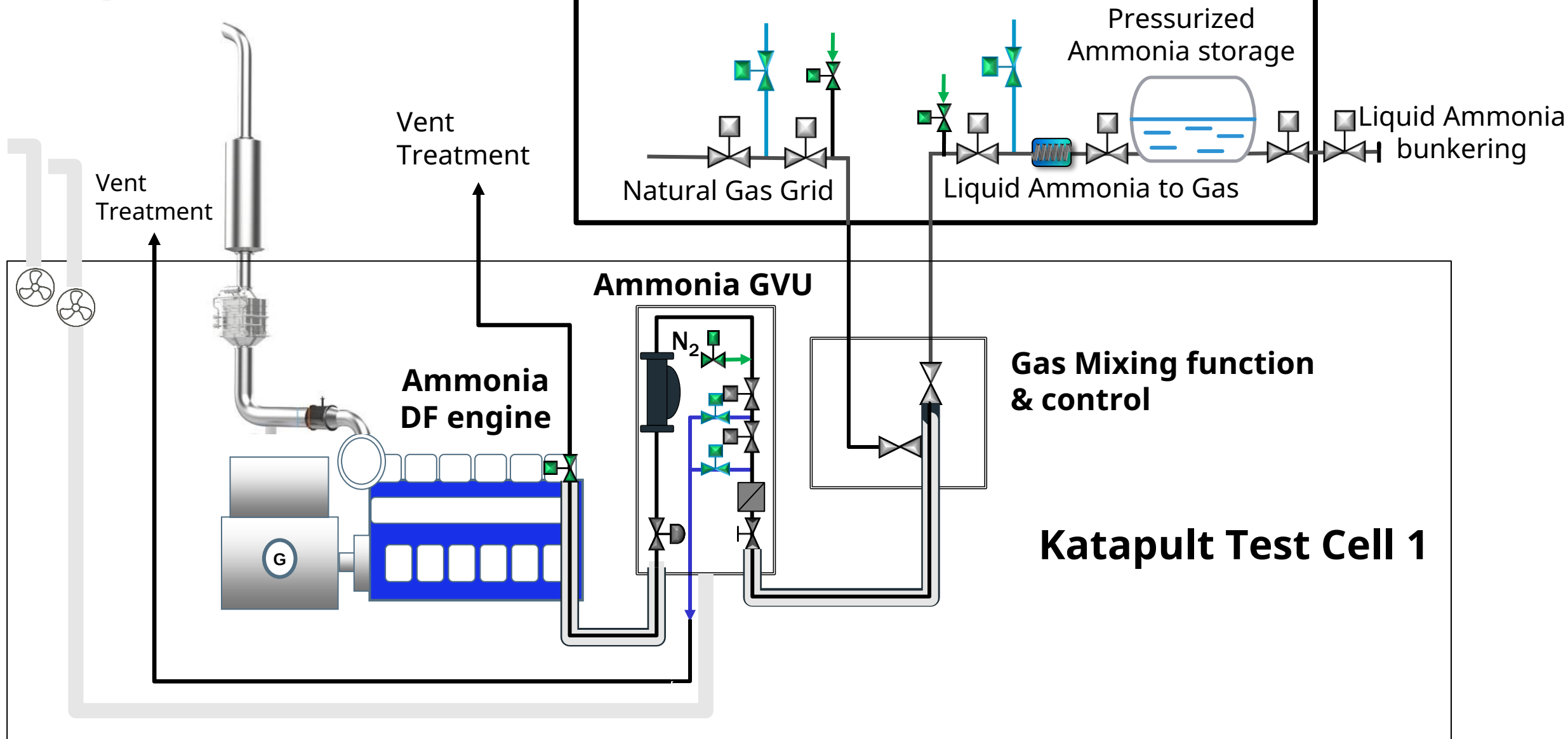


Heiane, Stord



Test Centre is next to Wärtsilä Stord Office

Enables testing of Ammonia Engine concept on Ship level (from liquid bunkering to exhaust after treatment)



KATAPULT TESTING CONTINUATION MARCH 2025



Tests ongoing for over 24 months and rolling:

~ 750 running hours on Ammonia

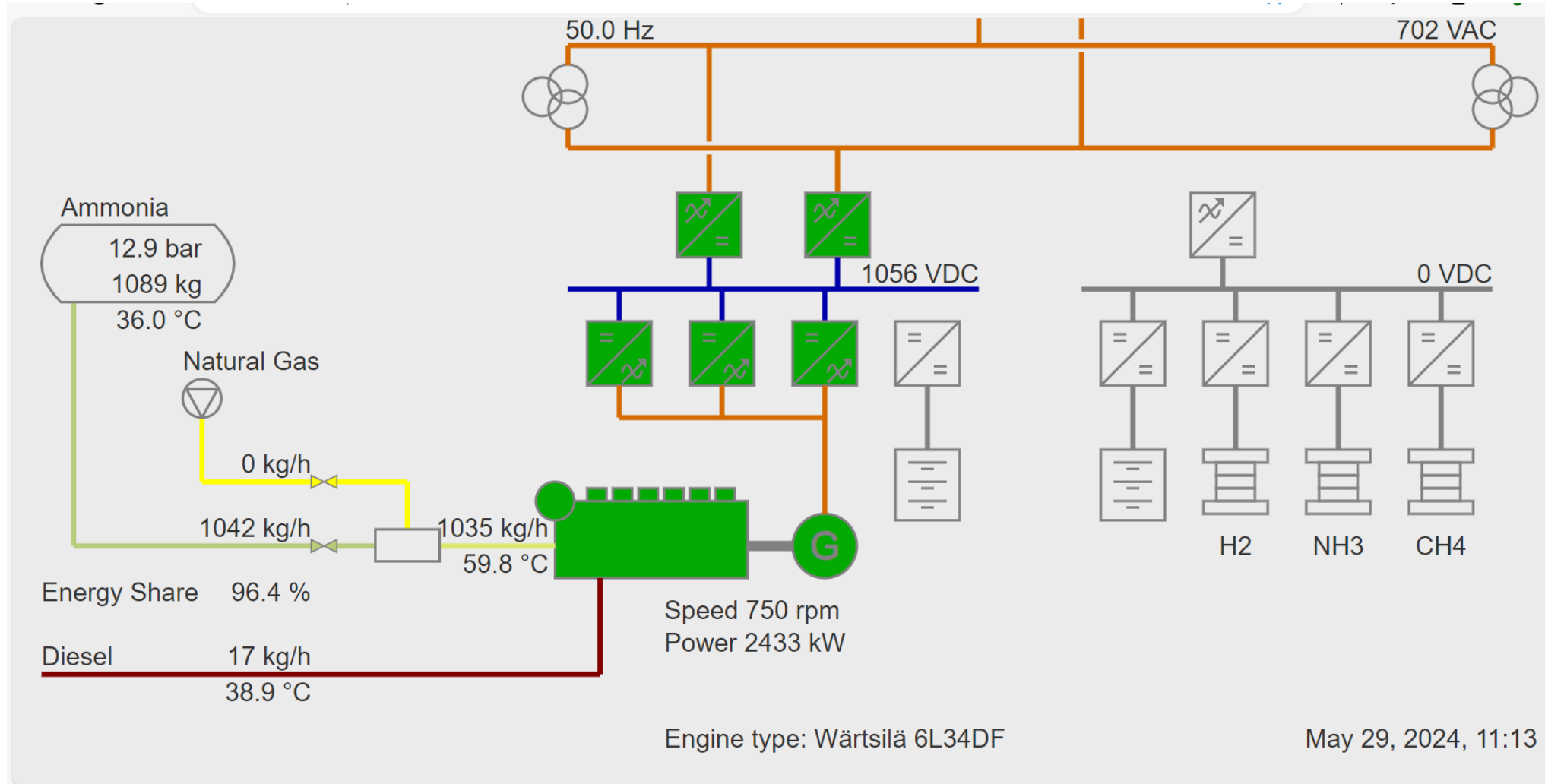
Ammonia Gas Mode
Energy share testing

Dynamic operation

NH₃ / NO_x Catalyst and
N₂O Catalyst
technology testing

Emissions analyser
technologies

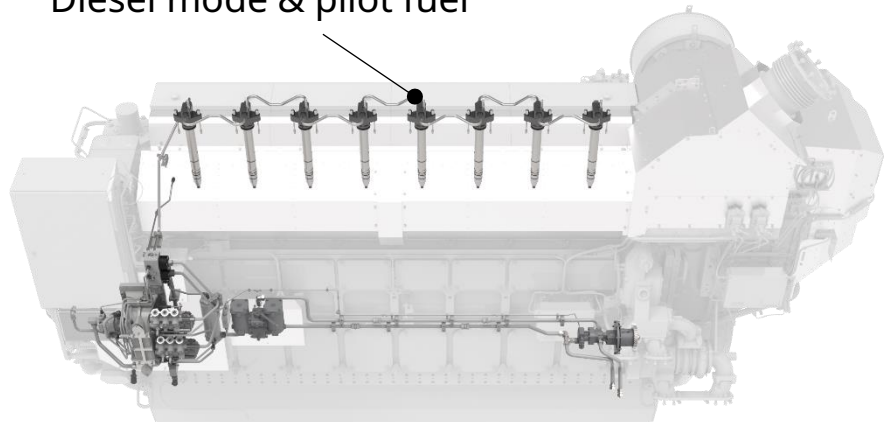
Ammonia operation at Stord



Wärtsilä 25 Ammonia engine



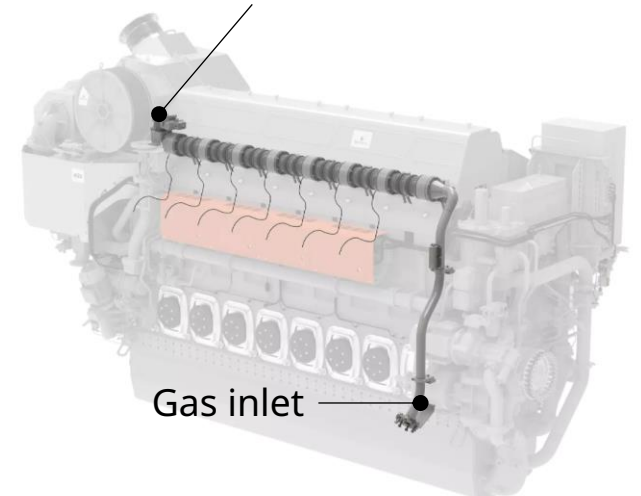
Diesel mode & pilot fuel



Gas admission valve on cylinder head unit



De-gassing outlet



Gas inlet

NOR - Aftertreatment System

Optimized for both ammonia mode and diesel mode

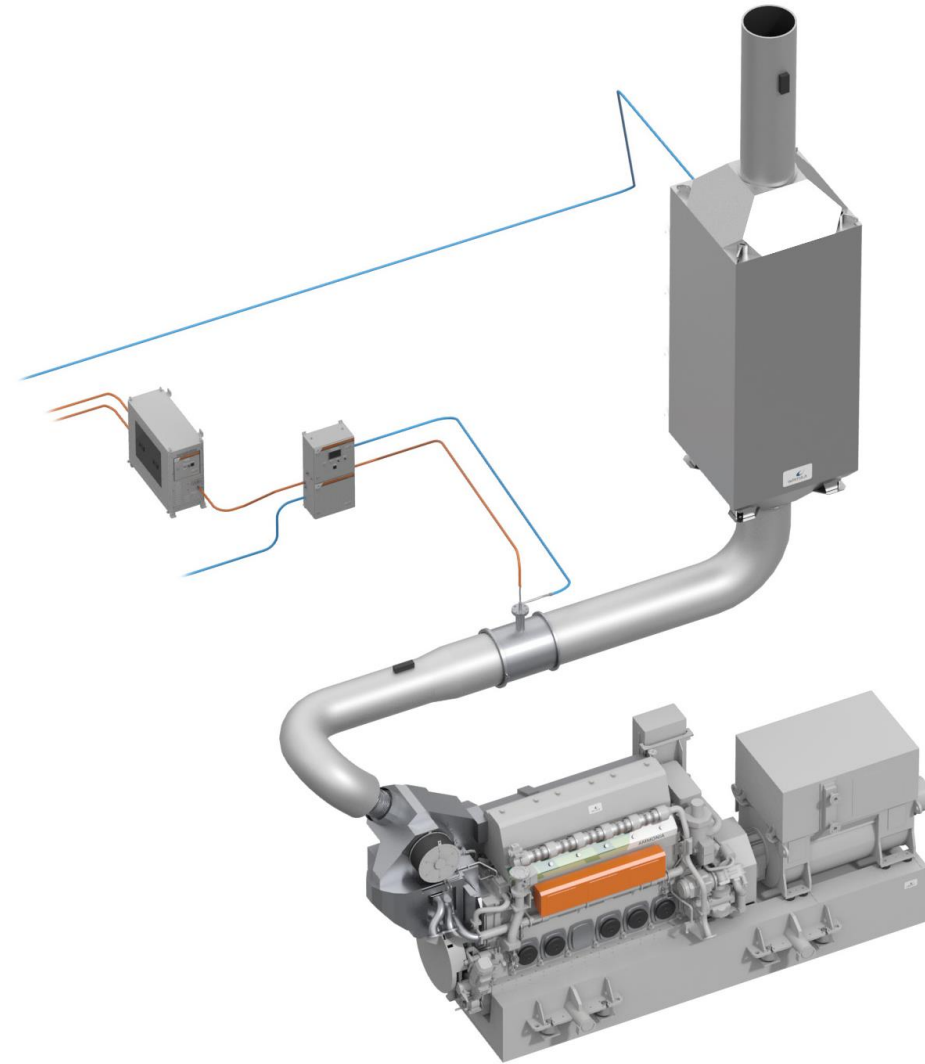
The NOR system consist of a mixing unit, reactor with catalyst elements and auxiliary system for dosing and control

Common automation platform for engine and NOR system

Continuous emission measurements for control purposes

Reactor equipped with automatic soot blowing

For engine conversion cases, evaluation of possible installed NOx Reducer evaluated on case by case basis



Marine Product Development – Ammonia



Current Status► Current Plan► Ambition

Technology Development
Developing combustion technologies, fuel systems, automation systems and safety features to operate on sustainable fuels

Product Development
Applying technologies to specific product types

Industrialised Solution
Decarbonise the marine industry with portfolio of engines running on sustainable fuel applications

Product Development
First Ammonia engine to be delivered within 2025.

Roadmap of Development¹⁾
Indicated product timelines remain subject to change

At Which Time
Ammonia is available with supporting infrastructure to meet customer demand and these fuels are economically viable

Edition: 6.1 January 2025		Pre 2023	2023				2024				2025				2026				2027				2028			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Ammonia ²⁾	W25					Ⓢ																				
	W31														Ⓢ											
	W34																									

Timeline not yet defined.³⁾

Ⓢ Sales Release ⓓ First New Build Delivery

1) Disclaimer: Subject to sufficient technology progression and quality, while ensuring maximum safety in these developments, the following indications in development have been made. It should be noted that both engine model and timeline remain subject to change based on market demand and other influencing factors.

2) Ammonia as main fuel, diesel (biodiesel) as pilot fuel.

3) Retrofit package is under planning. Sales release and first delivery dates are dependent on results from on-going technology tests. Tentative plans indicate a sales release not earlier than 2027.

Wärtsilä 25 engine data

	Wärtsilä 25		Wärtsilä 25DF		Wärtsilä 25 Ammonia	
Cylinder bore (mm)	250		250		250	
Piston stroke (mm)	340		340		340	
Nom speed (rpm)	900	1 000	900	1 000	900	1 000
Power / cyl. (kW)	345	375	315	345	280	305
BMEP (MPa)	2.72	2.70	2.52	2.48	2.24	2.19
6L power (kWm)	2 070	2 250	1 890	2 070	1 680	1 830
7L power (kWm)	2 415	2 625	2 205	2 415	1 960	2 135
8L power (kWm)	2 760	3 000	2 520	2 760	2 240	2 440
9L power (kWm)	3 105	3 375	2 835	3 105	2 520	2 745
Application	DM, DE, AUX		DE, AUX	DM, DE, AUX	DE, AUX	





The world's first ammonia-fuelled in-service ship

After the fuel conversion, Viking Energy is to start operating on ammonia in 2026.



Eidesvik offshore

Copyright: © Peter Tubaas/Vestland Media

Ammonia as fuel: advancing from industrial chemical to zero-carbon ship fuel through R&D and collaboration



2019-

Training:
Internal &
External



2020-

Material and
combustion
testing



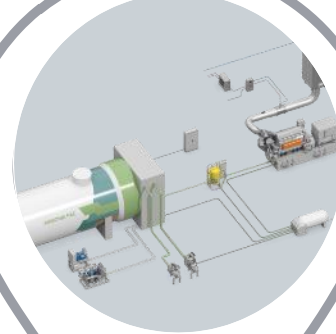
2020-

Hazids and
Hazops



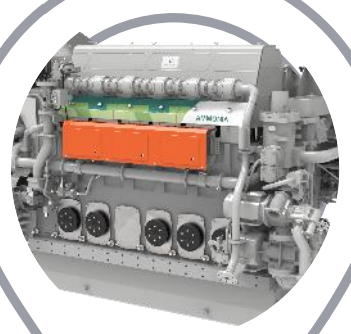
2020-

Safety systems
Training



2020-

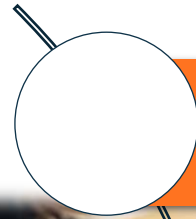
System design



2021-

Engine
operation

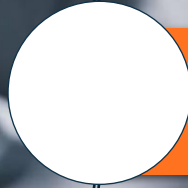
Areas for Cooperation and Development since 2019



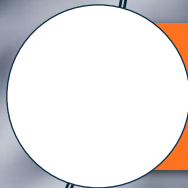
Legislation (Pilot projects, AIP, concept studies)



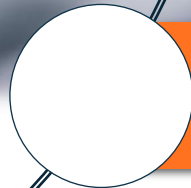
Systems (tank system, fuel handling, engine, exhaust and after treatment, etc.)



Training and Competence (Industry and lessons learnt)



Robust and safe operation on vessels and power plants



Fuel availability and cost of operation

Legislation



Basic design of Ammonia fuelled Ammonia Carrier



GLOBAL
MARITIME
FORUM

Unleashing the
potential of the global
maritime industry

Mærsk Mc-Kinney Møller Center
for Zero Carbon Shipping

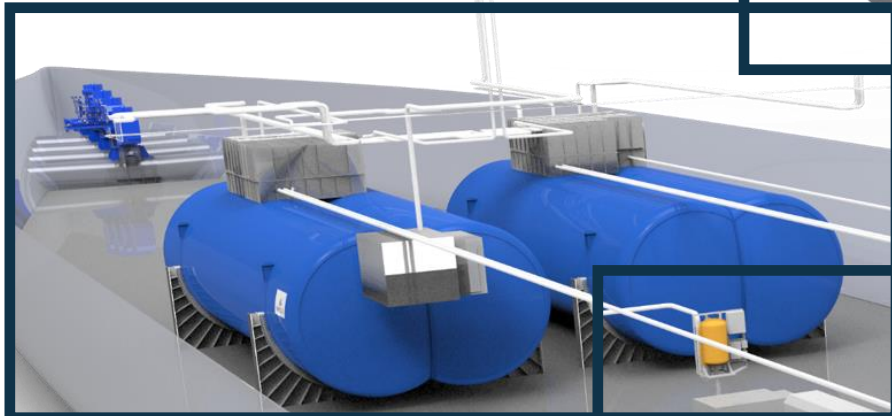


Knowledge grows

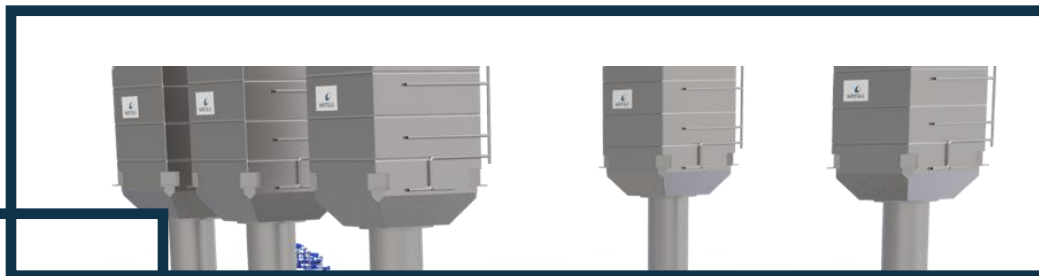


Systems

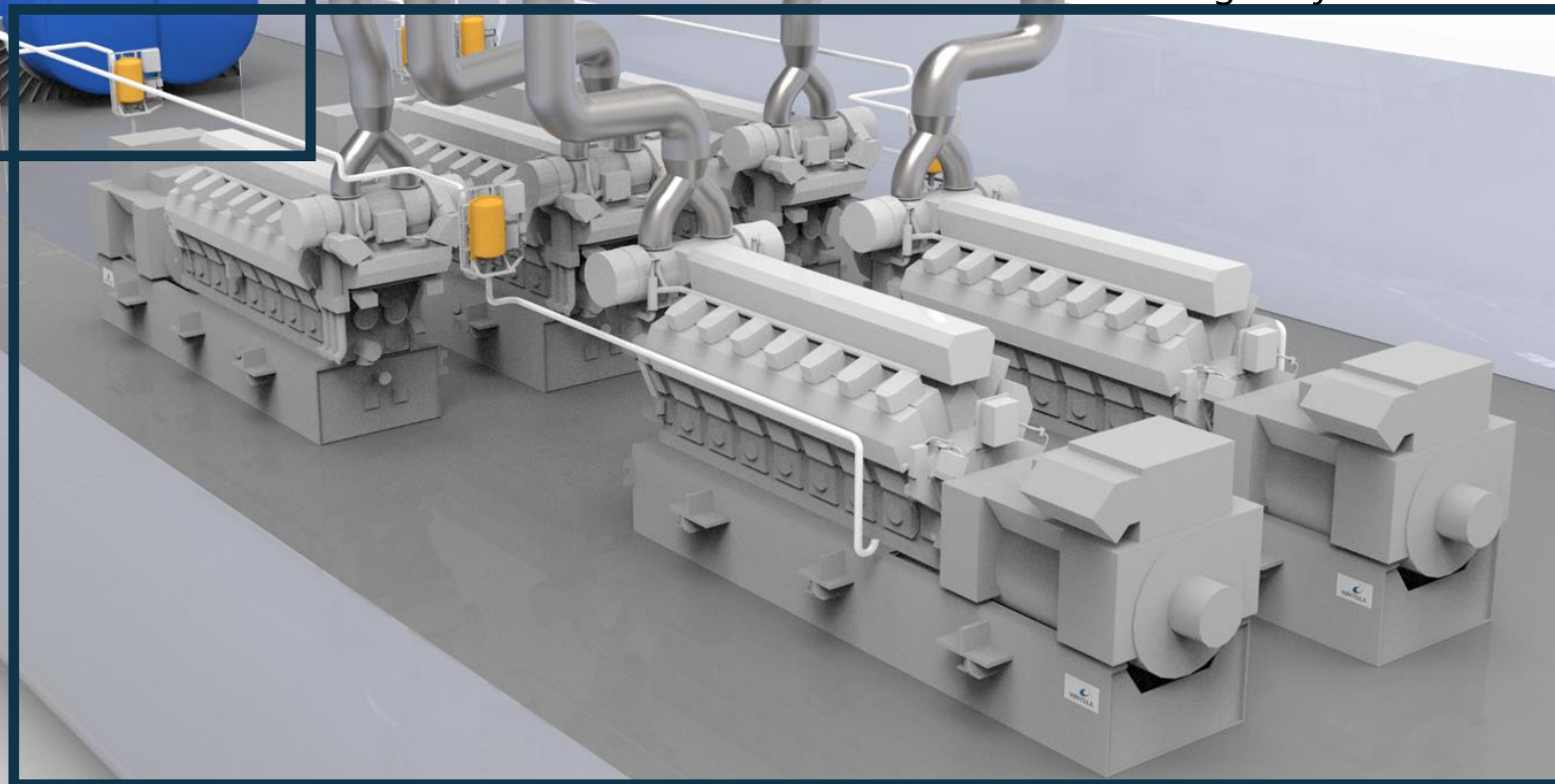
Fuel supply system



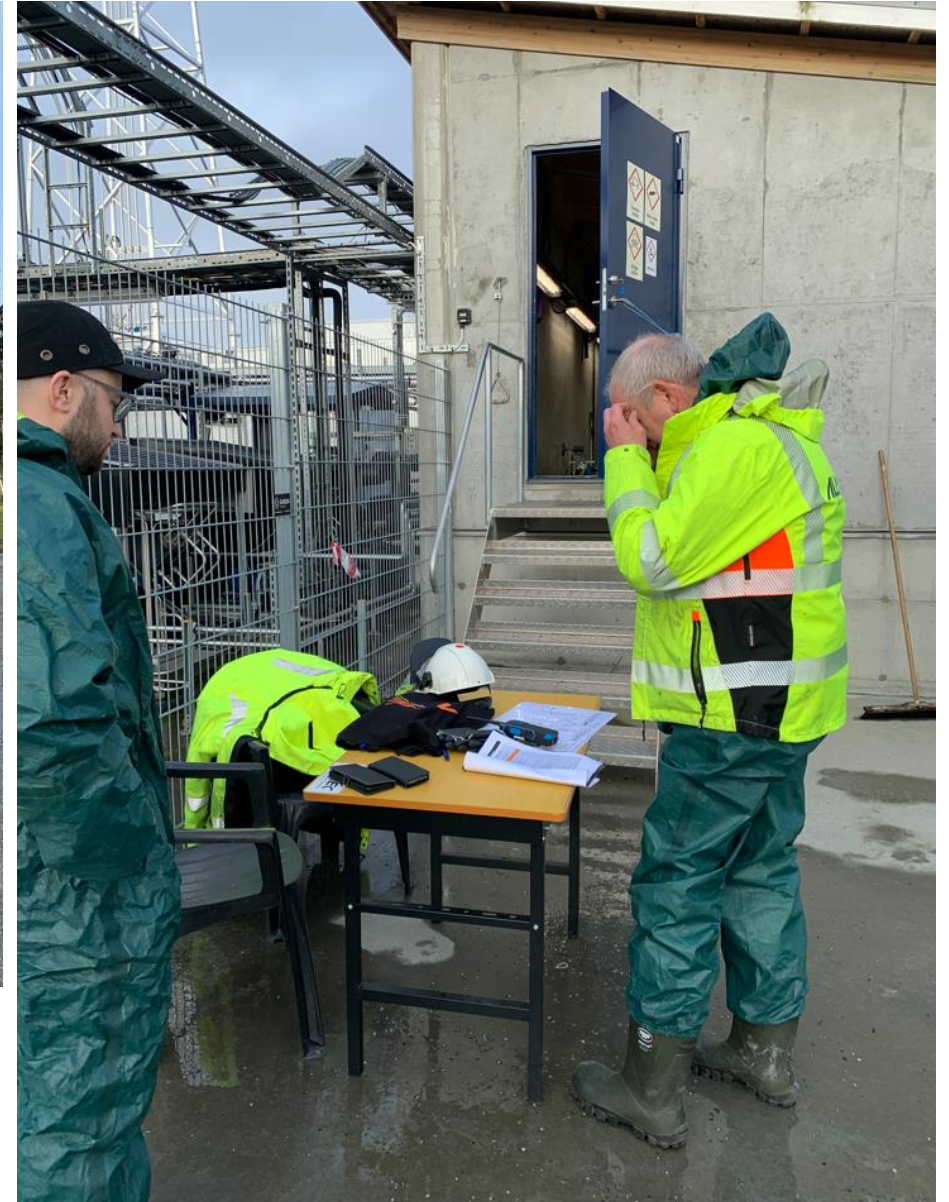
Aftertreatment system



Engine system



Training and Competence



Ammonia filling operations since 2022

Robust and Safe Operation

Safety test with ammonia engine for classification purpose



Teknisk Ukeblad February 2024



System overview

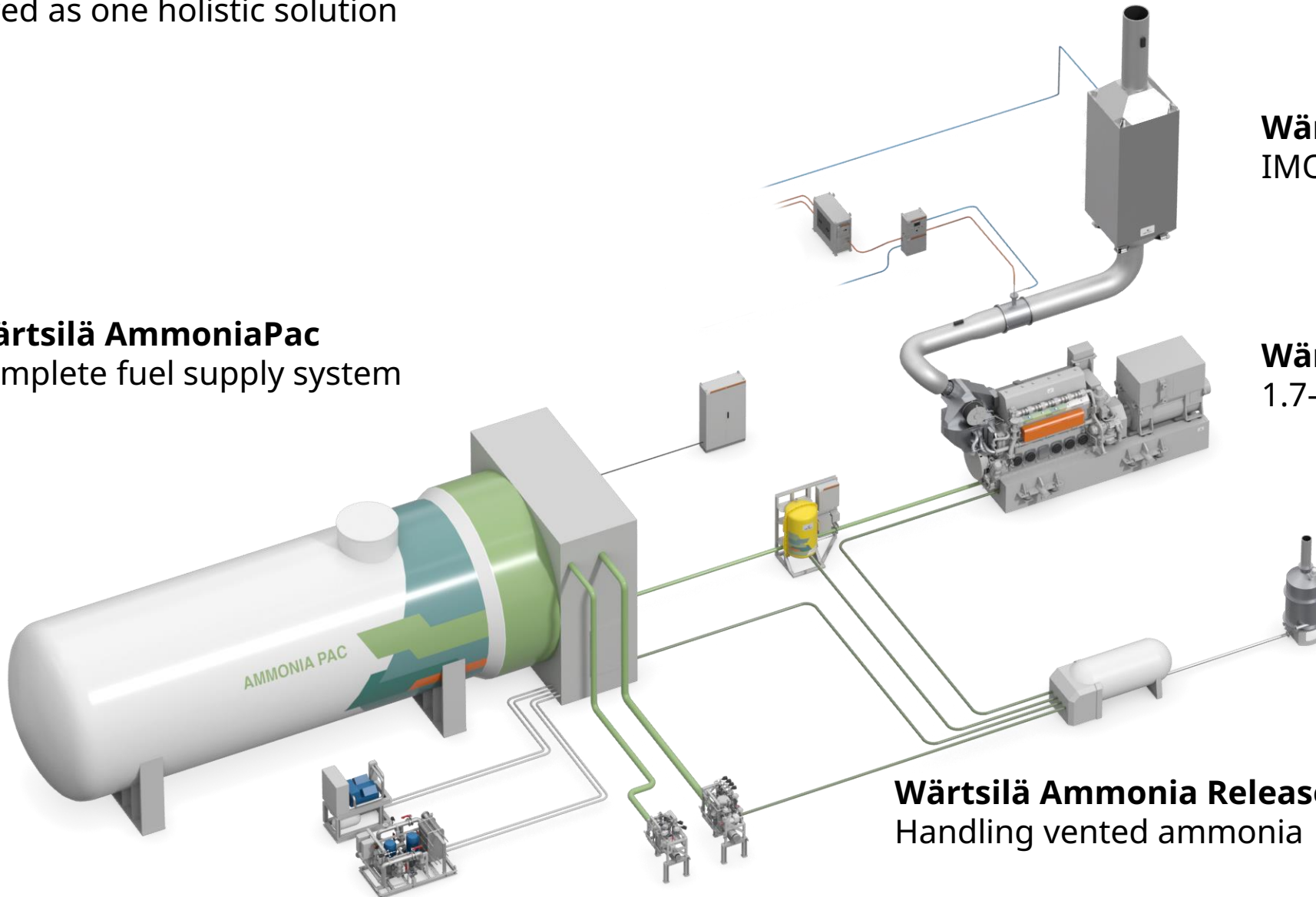
Engineered as one holistic solution

Wärtsilä AmmoniaPac
Complete fuel supply system

Wärtsilä NOx Reducer
IMO Tier II / Tier III

Wärtsilä 25 Ammonia
1.7-2.7MW

Wärtsilä Ammonia Release Mitigation System
Handling vented ammonia



AmmoniaPac – fuel supply system

Based on the well proven LNGPac design - a safe and user-friendly system for both operators and service personnel

Type-C Ammonia fuel storage tank(s)

- Single shell in carbon steel or stainless steel
- 20 bar(g) design pressure
 - Bunker Ammonia at any temperature
 - Unlimited holding time without auxiliary systems
- 9 bar(g) design pressure
 - Bunker mainly refrigerated Ammonia
 - Limited holding time (15/21 days) without auxiliary systems

Tank connection space

- Contains pump based fuel processing system
- Delivers gaseous ammonia at ~9 bar(g) to GUV
- Double manhole enclosure and integrated airlock enables safe installation below deck



AmmoniaPac – fuel supply system (cont.)

Bunkering and vapor return skids

- Sizes up to DN100 available, larger upon request
- Based on standard skid design from LNGPac

Subcooling unit

- Provides cooling of Ammonia in the storage tank
- Enables unlimited holding time for 9 barg tank system

Heating media system

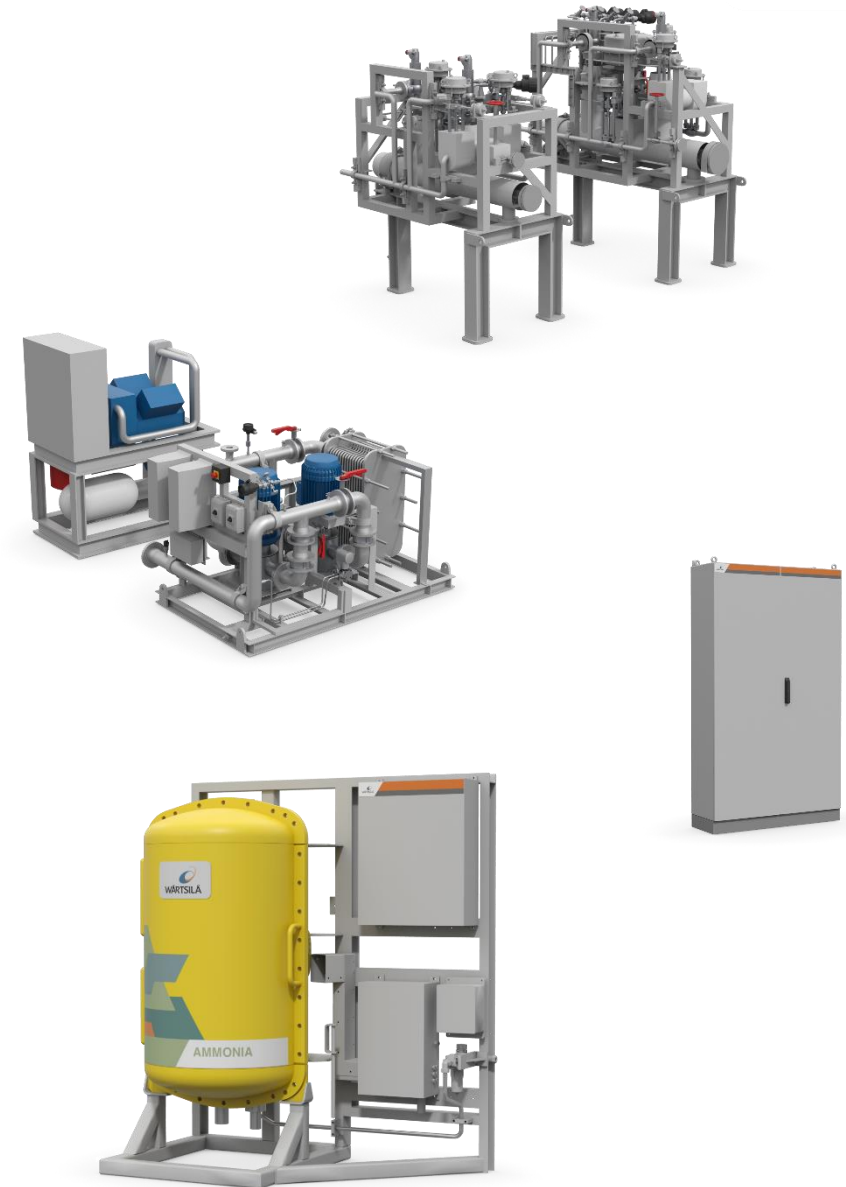
- Provides heat for vaporization and heating of the Ammonia fuel

AmmoniaPac Control and Automation System

- PLC-based control system with independent safety system
- Same platform as LNGPac with fully remote operation

Gas Valve Unit (GVU-ED)

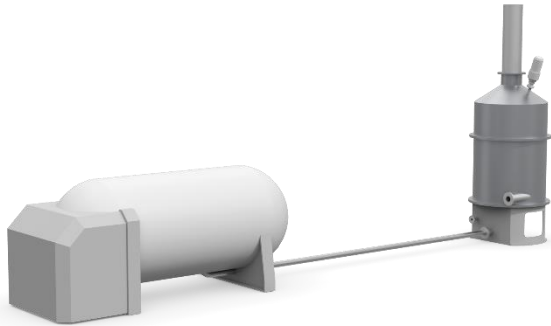
- Filters and regulates the gas pressure to each engine according to load requirement
- Can also be integrated into the TCS (Tank Connection Space)



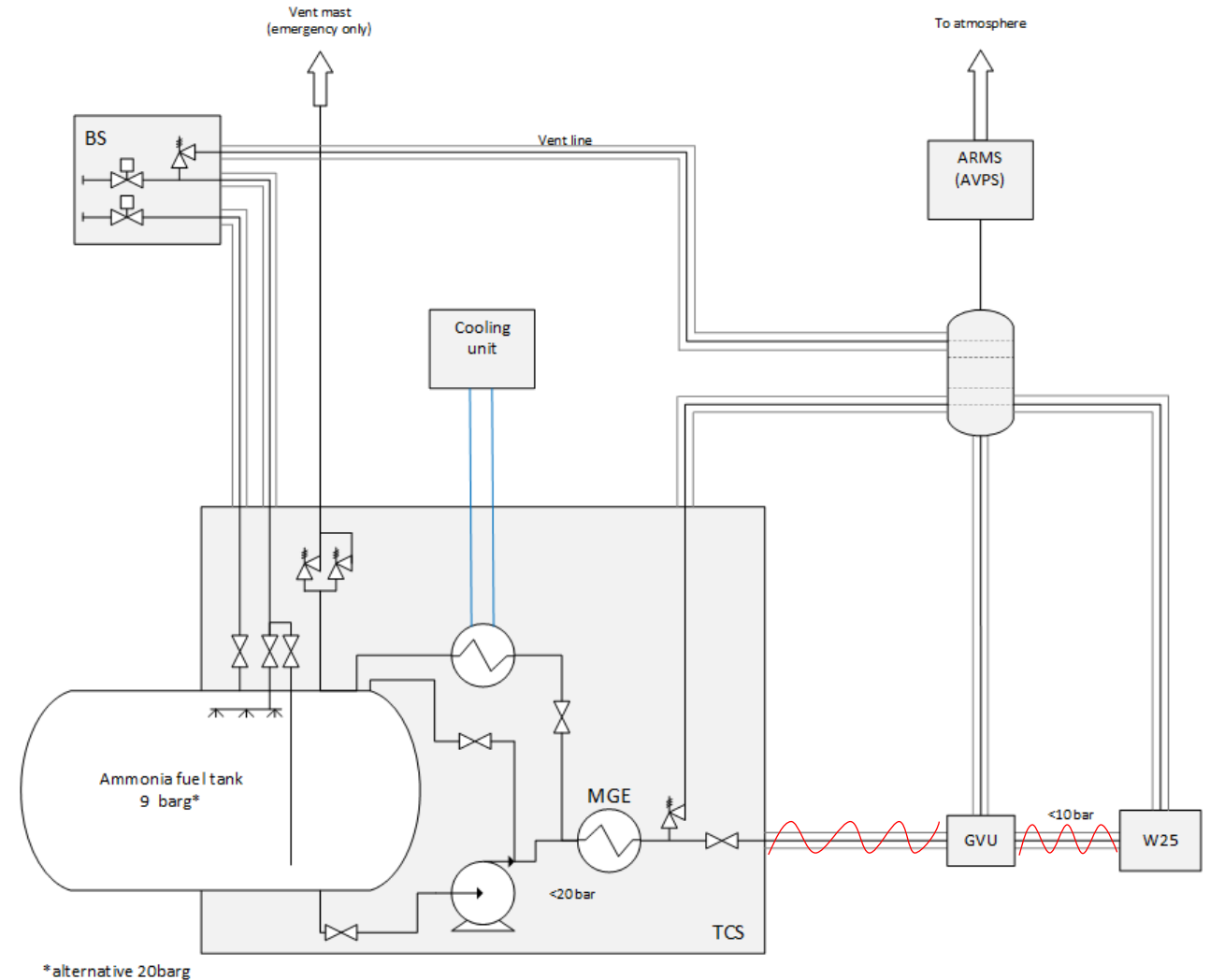
AmmoniaPac – fuel gas supply system (cont.)

Wärtsilä Ammonia Release Mitigation System (WARMS)

- All vented Ammonia from the system is led to the ARMS collection tank (except tank PRVs)
- The collected gas is burned off in the burner, resulting in practically zero emissions
- Uses ammonia as pilot fuel to avoid additional CO₂ emissions



Heating added on fuel piping to GVU and engine to keep Ammonia from condensing







WÄRTSILÄ