ARISE

Ammonia Response In Sea Emergencies

JOINT INDUSTRIAL PARTNERSHIP FOR CONTROLED AMMONIA RELEASES AT SEA

PROJECT PRESENTATION FOR POTENTIAL SPONSORS

Cedre · INERIS maîtriser le risque pour un développement durable · YARA Yara Clean Ammonia · natural sciences .be · ONERA THE FRENCH AEROSPACE LAB · HSE Health and Safety Executive · INERIS Développement · IMT Mines Alès École Mines-Télécom · SINTEF

Maritime and Port Authority of Singapore (MPA)
66 476 abonnés
4 j • Modifié •

It was a historic moment when Fortescue, with the support of #MPA, government agencies, research institutes, and industry partners, successfully conducted the world's first use of #ammonia as marine fuel in the Port of #Singapore 👏 ...voir plus

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Part 1: The ARISE Project

PROJECT OVERVIEW

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Context – Objectives

LAURENT RUHLMANN (YCA)

Context and overall objective

- **Growing demand** for anhydrous ammonia as energy vector to decarbonise various industries
- Need to produce ammonia **from clean hydrogen sources.** (Methane with efficient CCS & renewable electricity with water electrolysis)
- Inherent geographical locations of these clean hydrogen sources will lead to **an increase in transportation of ammonia over long distances by sea**
- High potential for clean ammonia to be used as a marine fuel will **impact shipping industry and port risk profiles**
- Important **knowledge gap** on cold ammonia and sea water interaction leading to **inconsistent and unreliable spill consequence prediction**

Overall objective of project

Reduce the knowledge gap on cold ammonia and sea water interaction to improve related risk assessment exercise and accurately control impacted risk profiles.

Importance of new experimental data

- **Previous field-scale experiments** to understand behaviour of ammonia releases:

  - *A. Resplandy Tests in Mourmelon in 1967-68-69,*
  - *the US Desert Tortoise trials in the 1980s,*
  - *the Swedish FLADIS trials early 1993-94,*
  - *the French INERIS trials 1997-1999, and*
  - *the Jack Rabbit I trials in the 2010s*
  - *the Red Squirrel ammonia experiments onto water in Sept. 2022*

- Majority of experimental datasets only based on **pressurized ammonia releases on land**.
- Objective was to validate **consequence models relevant to land-based activities** and risk profile.
- Weakness in understanding **behaviour of ammonia spills onto and into sea water**.
- **Limited data available** for large-scale cold ammonia spills onto sea water.

Ammonia is very reactive with water and heat is generated when the two substances mix. While a significant amount of ammonia is absorbed by the water, at the same time the generated heat will increase the vaporization rate. The intense turbulence of the mixing process also generates aerosols, which affect the density of the toxic airborne cloud. These phenomena are not well understood and very few experimental data are available to characterize this interaction.

Need for reliable experimental data to enhance consequence modelling and risk assessment for release onto seawater

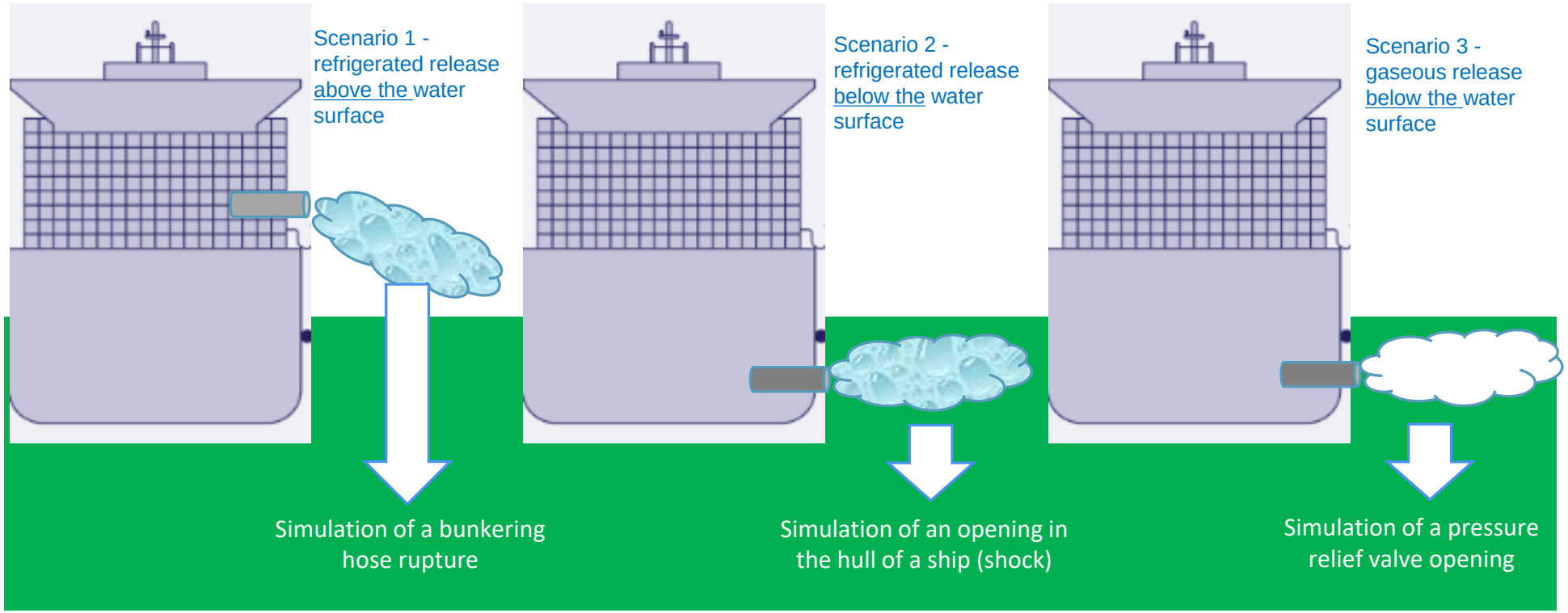
Operational objectives

The operational objectives of the project with full-scale experiments are

- **To establish test protocols and to perform full-scale releases** of cold liquid (refrigerated) ammonia onto seawater with different release scenarios
- To **test current and innovative detection and measurement technologies** in a sea environment (with involvement coast guards et governmental agencies)
- **To acquire the needed dataset** to upgrade consequence modelling tools capability and reliability (both for air and water dispersion)
- To identify potential response **techniques and strategies**
- To enable accurate **environmental impact assessment** (impact on sea life and recovery time and recommendations for response)

Scenarios for large-scale experiments

3 representative scenarios have been designed and will be carried out directly from a vessel transporting refrigerated ammonia.



ARISE benefits to ALL industry
Main deliverable

Actual consequences of this important knowledge gap

- Extreme inconsistency in spill scenario impact prediction
- Over conservative approach leading to unrealistic safety distances
- Impossibility to determine impact in sea environment
- Impossibility to design ad hoc mitigation strategies and systems
- Uncertainties in permit approval process from relevant authorities

Based on the field data acquisition, ARISE will deliver clear guidance to

- Perform consistent spill scenario impact prediction
- Define realistic conservative parameters
- Enable environmental impact study
- Establish mitigation strategies
- Support decision making steps in permit approval process

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Work plan overview - Test protocol – Measurement chain – Safety for the tests

OLIVIER GENTILHOMME (INERIS) & STÉPHANE LE FLOCH (CEDRE)

Long experience of trials at sea

1981
More than 30 sea trials performed by Cedre with the support of the **French Navy**

2021
IPOMAC
Release of 6 HNS

2022
MANIFESTS
Release of 9 HNS and 1 vegetable oil
https://manifests-project.eu/

2023
C. NEST
Release of methanol and vegetable oil

2024
JIP ARISE
Qualification of the experimental dispositive

2025
JIP ARISE
Large scale experiment (refrigerated NH_3)

1981 : ECUMOIRE
1982 : CASTOR (Oil)
1983 : ECUMOIRE II (Oil)
1984 et 1985 : CASTOR 2 (Oil)
1986 : ECUMOIRE III (Oil)
1987 : ECUMOIRE IV (Oil)
1988 : ECUMOIRE V (Oil)
1989 : POLLUTMAR 1 (HNS)
1990 : Pollutmar II (HNS) & POLLUTMAR 3 (HNS)
1993 : Castor 2 et 3 (Oil) et Goémoniers 93 (Oil)
1994 : Ecumoire 6 (Oil)
1995 : Ecumoire 7 (Oil) et Kidour II (Oil)
1997 : Morskoul III (Oil) et Morskoul IV (Oil)
1999 : PALMOR 1 (Vegetable oil)
2001 : RAPSODI (Vegetable oil +HNS)
2005 : Depol 04 (Oil)
2006 : Dépol 05 (Oil)
2007-2008 : Depol 07 (Oil)
2009 : Clara II (HNS)
....

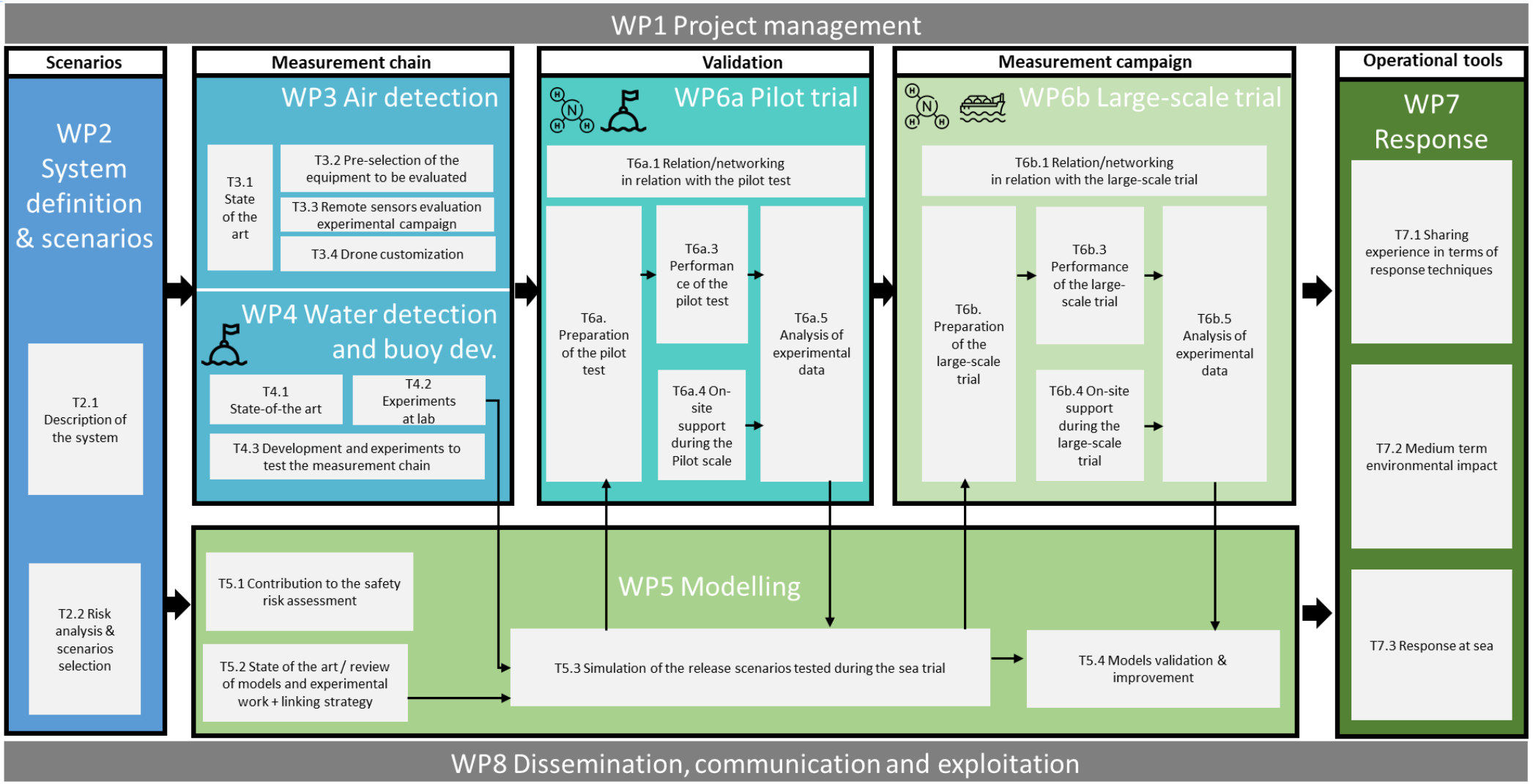
MARPOL Convention

Sea trials are performed **in compliance with international regulations** in force, especially the international convention for the prevention of pollution from ships 1973. Indeed article 2 of MARPOL Convention reminds that "release" does not include release of harmful substances for purposes of legitimate scientific research into pollution abatement or control.

Safety first!

- ✓ ARISE has the green light from the French Maritime authorities
- ✓ The experiment will be supervised by the French Maritime authorities and Navy's CEPPOL (Centre of Practical Expertise against pollution)
- ✓ A comprehensive safety assessment for each phase of the experiment will be established in collaboration between all ARISE consortium members and CEPPOL

WORK PLAN OVERVIEW



Main schedule of ARISE

2023

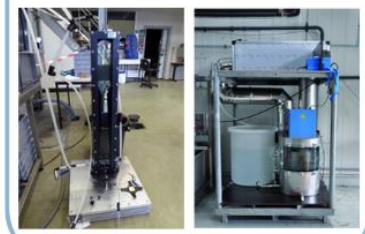
Desktop study

Cedre's facilities

2024

Behaviour of NH_3 at lab (Cedre)

- Dissolution
- Distribution between air & water

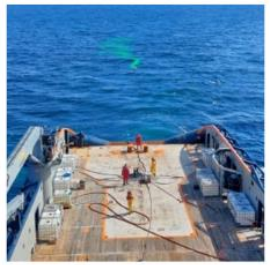


Select the most suitable sensors

- At INERIS, for the air
- At Cedre, for the water

Platform tested at sea

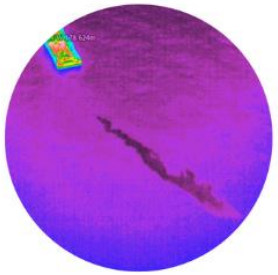
- Design the platform
- Test the platform in real condition



2025

Large scale experiment

- French Navy
- National authorities



Data analysis and evaluation

- Modelling
- Potential response techniques
- Communication

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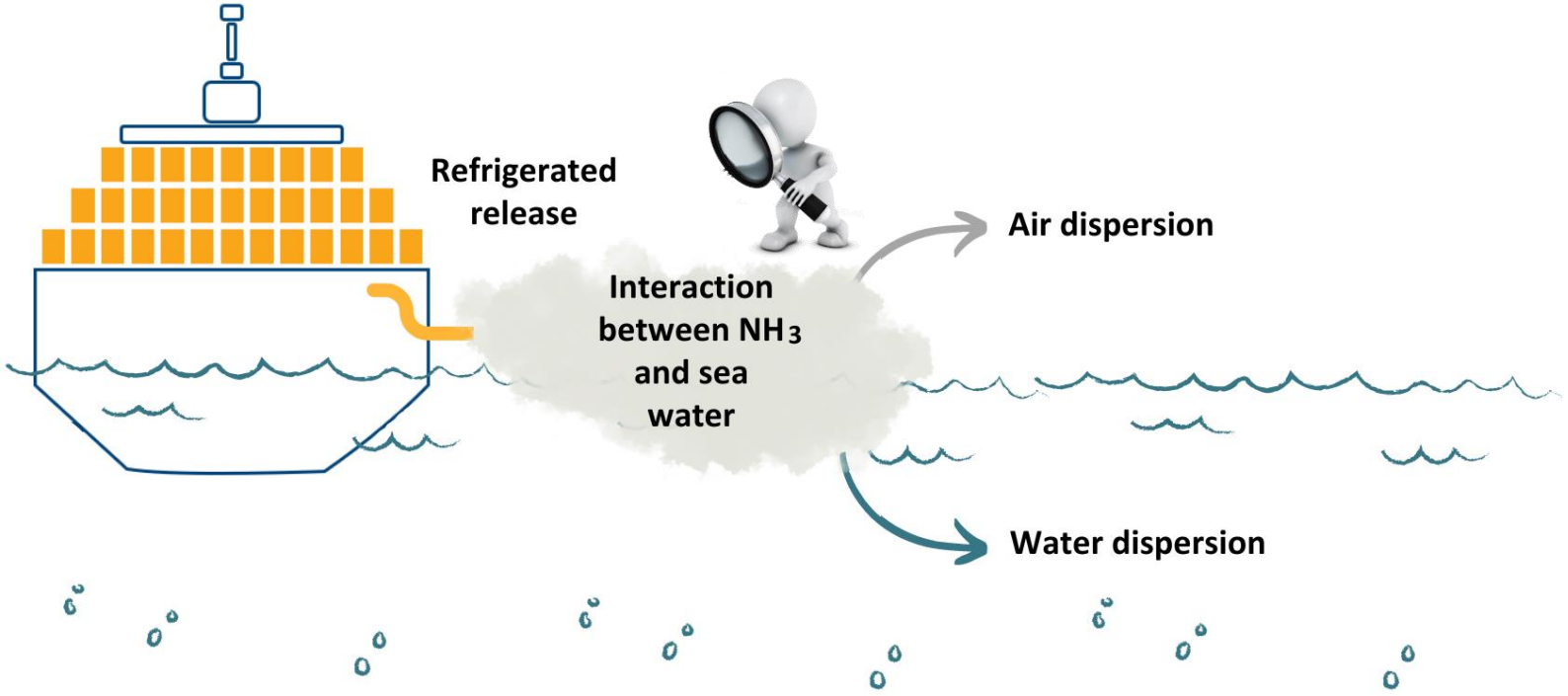
What do we want to focus on?

Current targeted release conditions :

- *Refrigerated NH_3 release*
- *Released mass flow rate = 100 kg/s*
- *Orifice diameter = 200 mm*
- *Height = 8 m above the sea (and -1 m below)*
- *Release duration = 30 s*



Examples of technical questions that need to be addressed :

- *What is the partition ratio between water and air ?*
- *What is the penetration depth of the cold ammonia ?*
- *Depending on the heat transfer between the cold ammonia and the sea water, how cold is the resulting toxic cloud ? Impact on the gas dispersion and on the safety distances.*
- *How much dissolved ammonia is diluted in the water ?*

Attention should be paid to…

Metrology to meet our objectives

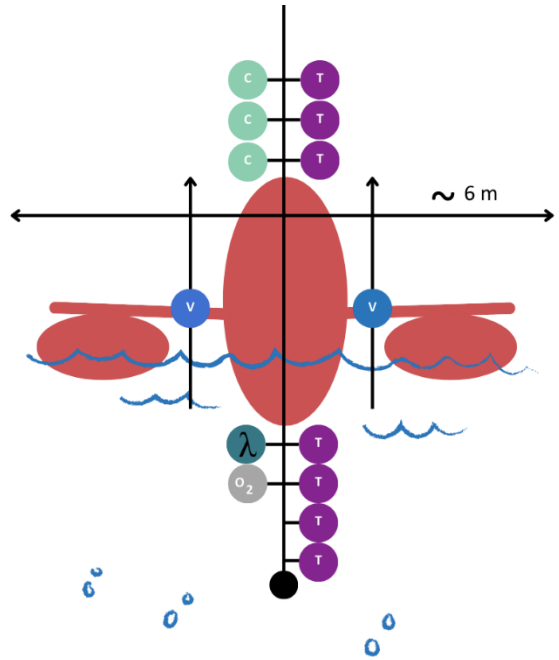
Guaranty of feasibility to ensure that everything is working properly during the large-scale trials

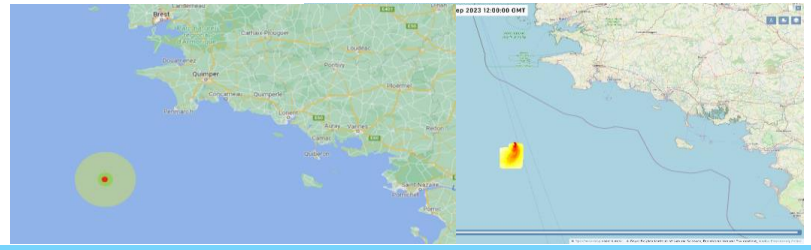
Ensure the **safety** of the trial

- *In situ* : distinction between the close field and the far field
  - In the close field : gas concentration, temperature (water + air), water conductivity, dissolved NH_3, videos… to understand the interaction between the refrigerated NH_3 and the sea water
  - In the far field : gas concentration, temperature (water + air) to follow the toxic cloud
- Remotely :
  - Air monitoring (aircraft, drone…)
  - Surface monitoring (FTIR equipment…)

  } *To visualise the toxic cloud*

- Medium
  - Medium-scale experiments are scheduled to demonstrate that :
    - ⟶ The selected cameras can be entitled for the large-scale tests
    - ⟶ The buoys and the measurement chain are working properly





Experimental protocol - 2024

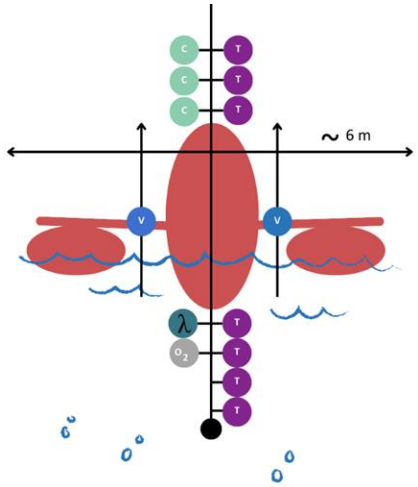
To test the measurement chain

April 2024

Assessment of the deployment and buoyancy of mats equipped with sensors

June 2024

Assessment of measurement chain with **ammonia gas** release



<u>Water sensors & Air sensors</u>

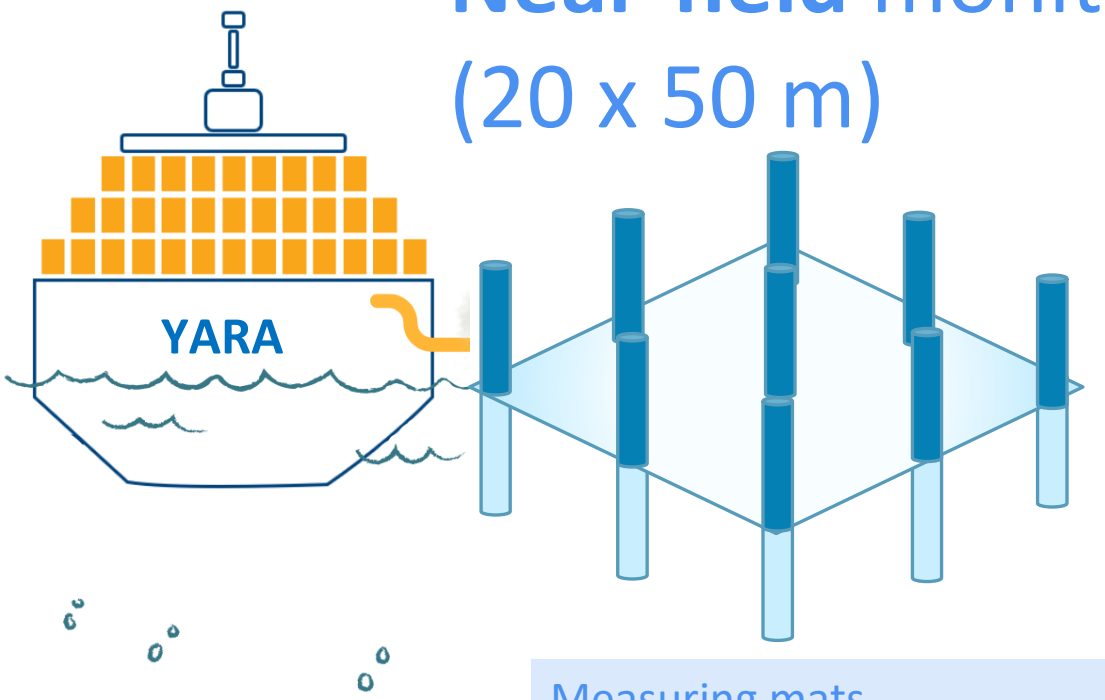
- ✓ NH_3 / NH_4
- ✓ Conductivity, dissolved O_2
- ✓ Temperature (air and water)
- ✓ Camera

<u>Each buoy will be equipped with</u>

- ✓ Batteries (2 days)
- ✓ Internal memory for storing sensor data

Experimental protocol - 2025

Near-field monitoring (20 x 50 m)

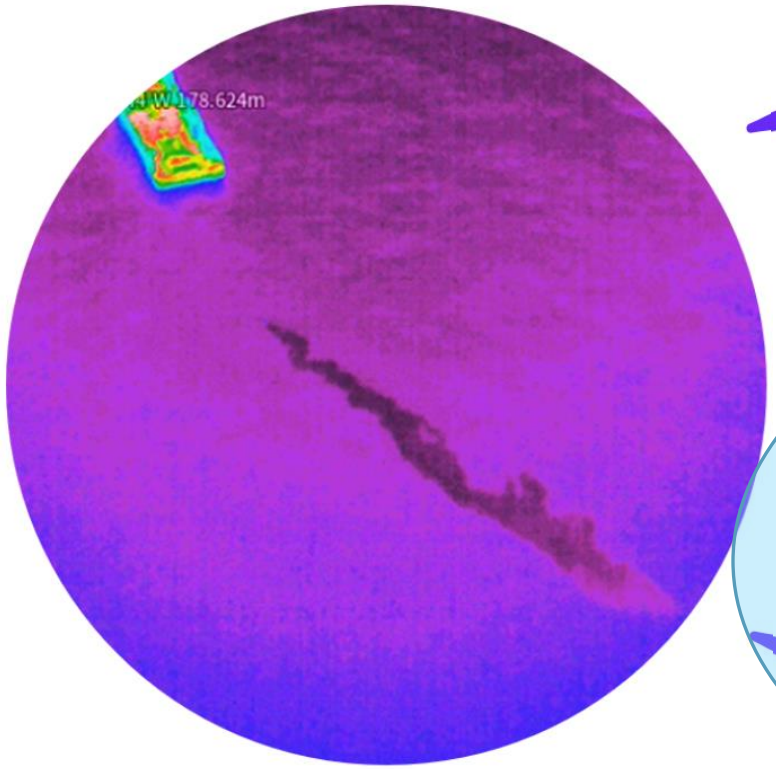


Measuring mats
- ✓ 3 m above de sea surface
- ✓ 3 m below de sea surface

Far-field monitoring independent mats

- ✓ 10 additional mats will be deployed
- ✓ Able to drift depending on swell and currents (gas cloud drift tracking)
- ✓ GPS positioning

Opportunity will be taken



Satellite (?), coastguards aircrafts for pollution tracking (FRA, SPN, BEL, GBR and +++)

Surface monitoring

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Water monitoring: *in situ* (Conductivity, temperature, Dissolved O_2 …) & sampling (drone)

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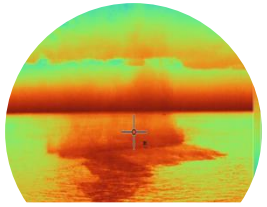
Results and expected impact – planning

STÉPHANE LE FLOCH (CEDRE)

Expected results

Improved knowledge of the fate of cold ammonia at the water interface

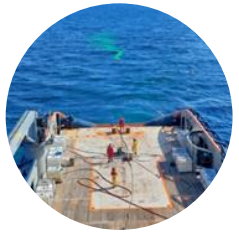


Detection technology: evaluate **sensors currently used** by national authorities and **evaluation of new sensors** for monitoring cold ammonia in air and water

Improved modelling tools to predict the fate of cold ammonia in the marine environment (air and water)

Improved risk assessment methodology for safer use of liquid ammonia in the marine industry & Drafting of guidelines for the responders, the industries and for IMO and EMSA

Impacts



Release of cold ammonia at sea for **the first time**, opportunity to carry out a **large-scale study**

Assess possible **response techniques** and **strategies**

Ammonia leak at Jurong food factory's chiller room

Enabling **environmental assessment** of the short / medium / long term **impact on marine life** and recovery period needed

Contribution to the safe and accelerated of the **transformation of the maritime industry** in order to reach **IMO Net Zero target in 2050**

Key principles for the dissemination

Results will be **fully public** and **open access**: guidelines, scientific papers, YouTube videos, social media posts…

A guidance document will be drafted by the consortium and communicated to IMO and EMSA and +++

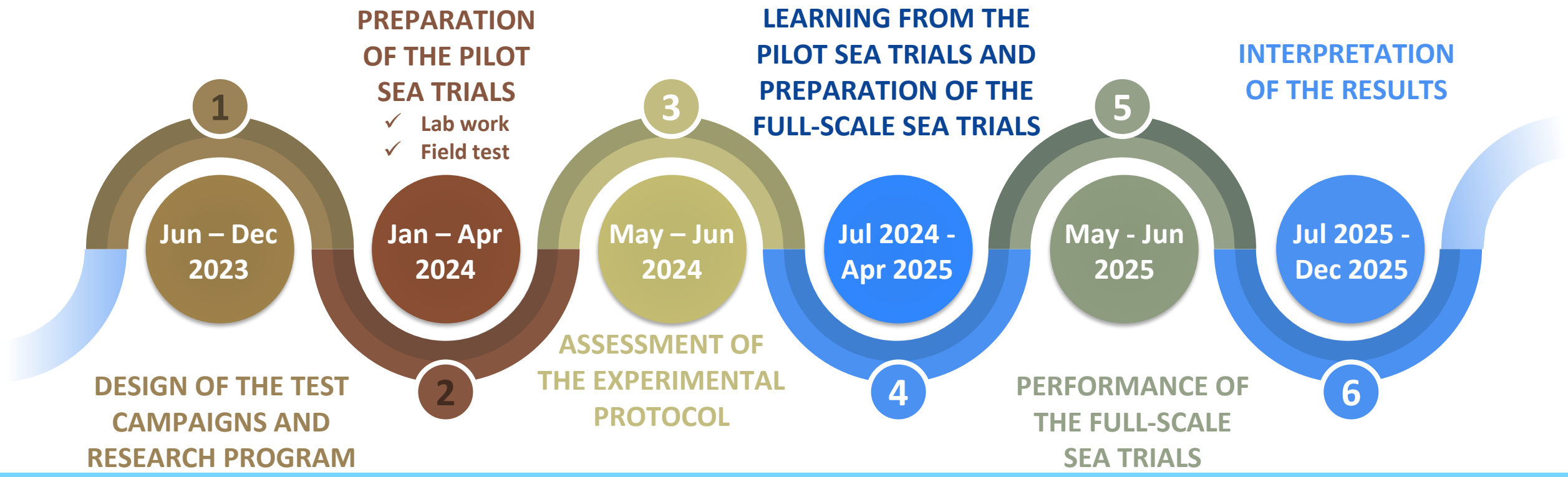
Regular workshops with sponsors will be organized along the project to share information on the progress

A symposium will be organized end of 2024 and end of 2025 to present the results to the stakeholders (sponsors and invited participants)

Implementation - Planning

Duration: from **January 2023** to **December 2025**

Key milestones:



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Questions & Answers

Contact

CHRISTOPHE.LOGETTE@CEDRE.FR

STEPHANE.LE.FLOCH@CEDRE.FR

OLIVIER.GENTILHOMME@INERIS.COM

OLIVIER.SALVI@INERIS-DEVELOPPEMENT.COM

LAURENT.RUHLMANN@YARA.COM

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