

# HyResponder

La sicurezza dei soccorritori in caso di intervento di soccorso con presenza di idrogeno

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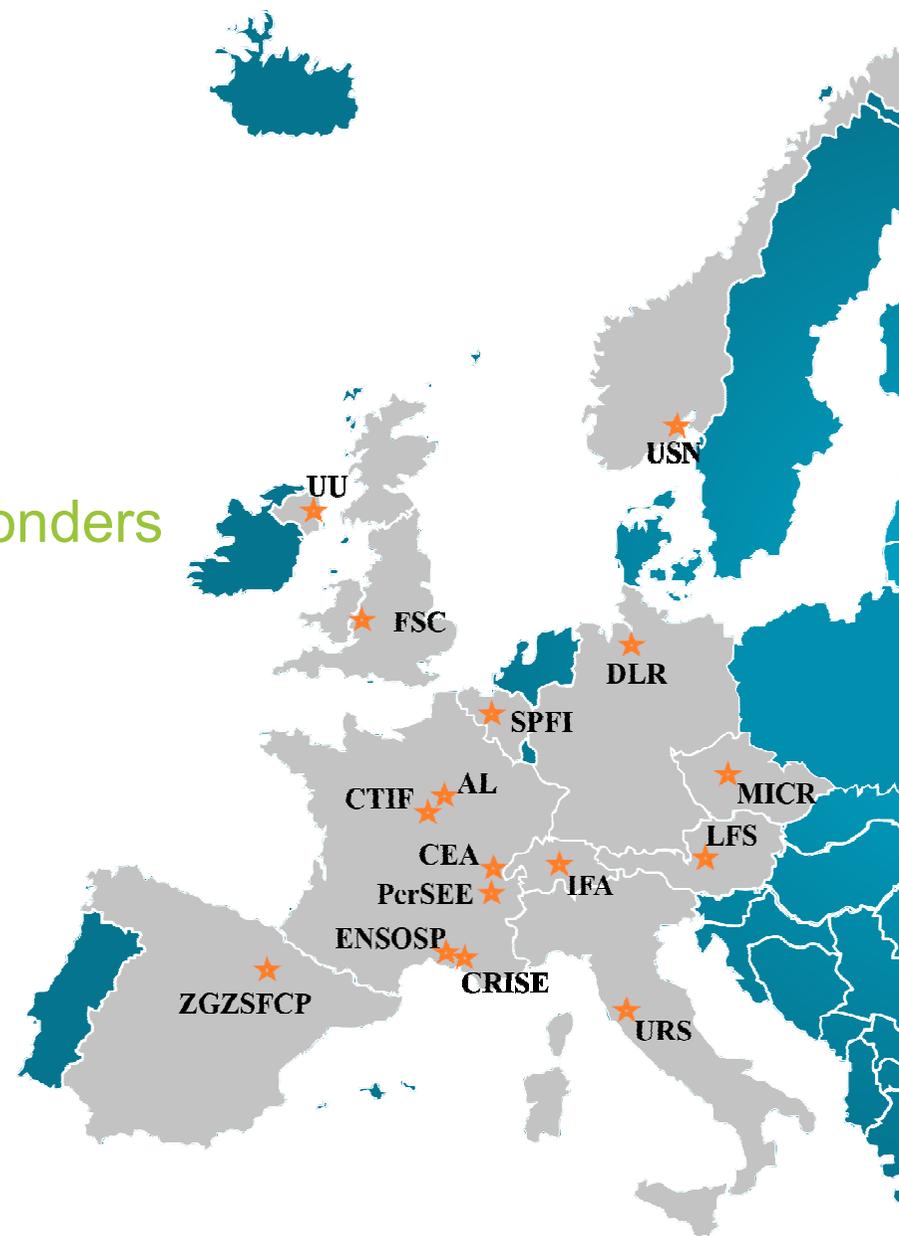
Sapienza Università di Roma

ISA, 10/12/2021



## Project Overview

- Call year: 2019
- Call topic: FCH-04-1-2019 - Training of Responders
- Project dates: 1/01/2020 -31/12/22
- % stage of implementation 08/12/2021: 64%
- Total project budget: €1M
- FCH JU max. contribution: €1M
- Other financial contribution: N/A
- Partners: 16 partners from 10 countries



# Responder National networks

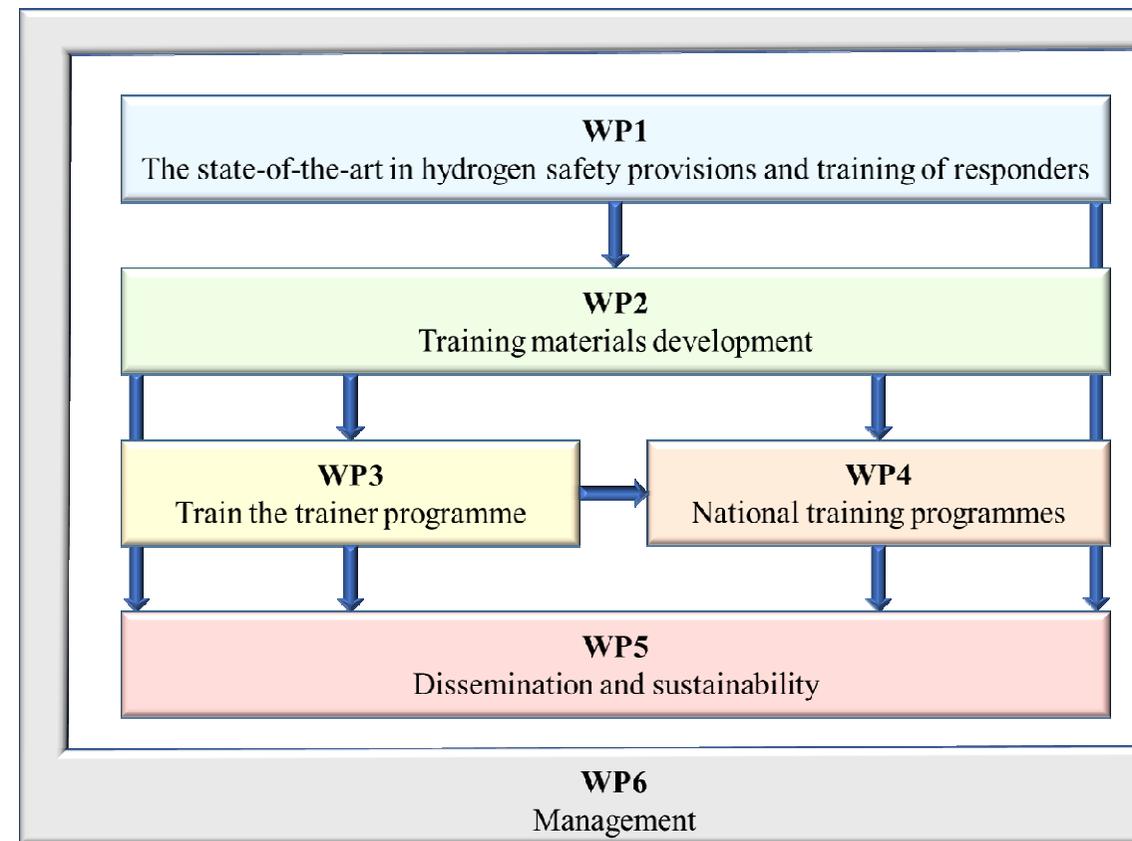
Country		Lead(s)	Language
France		ENSOSP and CEA	French
Austria		Landes-Feuerwehrschnle Tirol	German
Belgium		Centre of Expertise for Civil Security	Dutch
Spain		Zargoza Fire Academy (supported by FHa)	Spanish
Germany		DLR supporting Oldenburg Fire Service	
UK		University of Ulster, Fire Service College	English
Italy		Università degli Studi di Roma La Sapienza (supported by Italian National Fire Corps)	Italian
Switzerland		International Fire Academy	
Czech Republic		Ministry of the Interior of the Czech Republic	Czech
Norway		University of South Eastern Norway	Norwegian

★ Location of National Cluster Training Workshops



# Aim and work plan

- Develop and implement a sustainable train the trainer programme in hydrogen safety for responders throughout Europe
- Supporting the commercialisation of FCH technologies by informing the participation of responders in the initial permitting process, improving resilience and preparedness through enhanced emergency planning, and ensuring appropriate accident management and recovery





## Extended training package for trainers

- **Threefold** approach with all elements represented on new HyResponder **e-Platform**
  - 1. Operational training** (extended to include cryogenic spills)
  - 2. Educational training** (lectures revised, stratified and trialed)
  - 3. Virtual Reality training** (extended)
- Training is underpinned by the revised **European emergency response guide**
- A version of all training elements is in place and details are on the beta version of the HyResponder e-Platform

<https://hyresponder.eu/e-platform/>



# Stratification of educational training materials

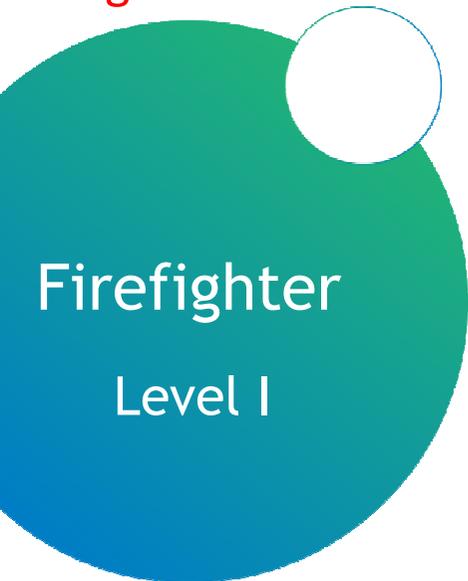
- Responder led identification of **four** learning levels across Europe aligned to EQF

Vigile del fuoco

Capo Squadra

Funzionario di Guardia

Specialista

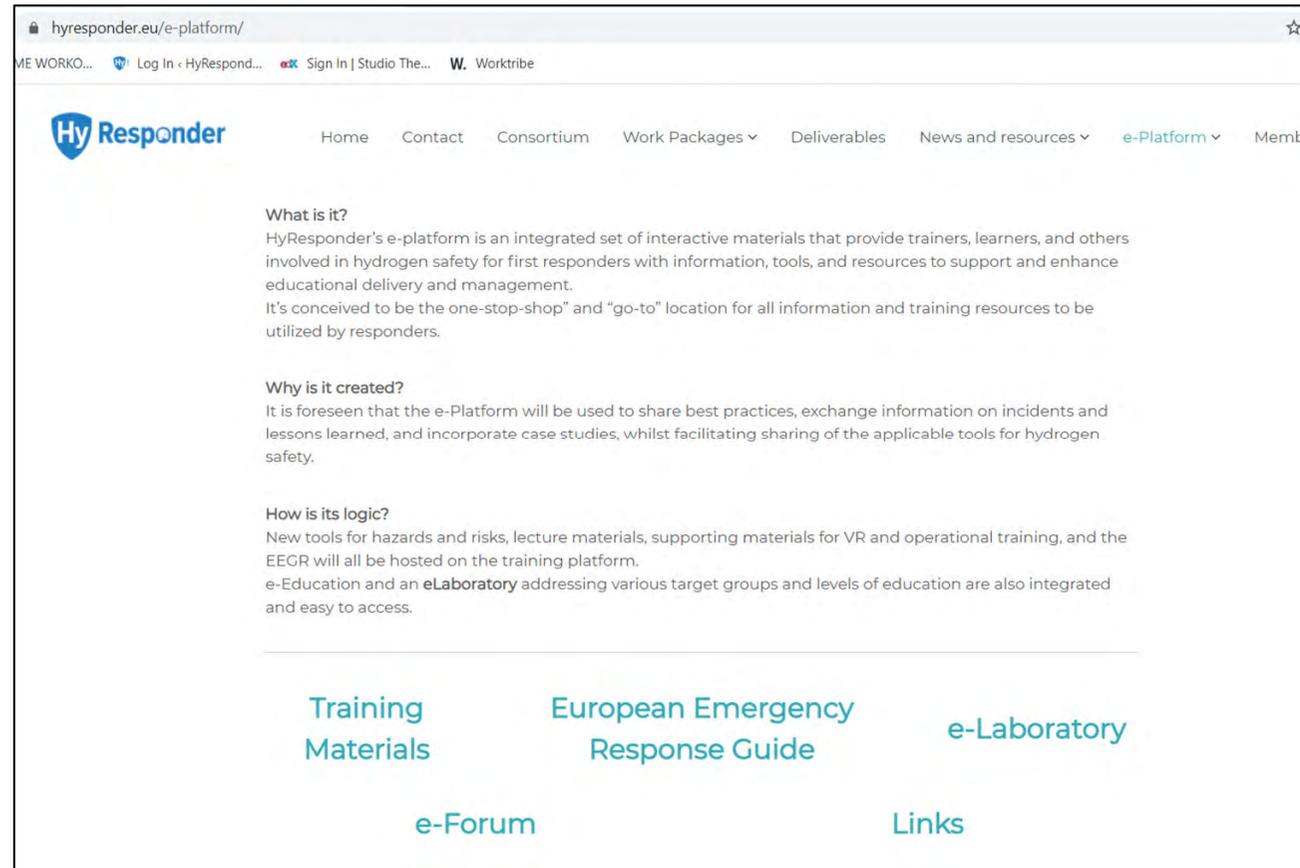


- Framework used as a basis to stratify the Lectures into up to 4 levels by responders
- Presentations at level 4
- Goal of developing a standardised training package and gaining recognition of the training

# HyResponder e-Platform



- Beta version
- Materials for trainers beyond HyResponder
- **Stratified lectures**
- Training sequences with operational videos
- Online tools
- EERG
- Translated materials will be available



<https://hyresponder.eu/e-platform/>

[< e-Platform](#)

## Training Materials

There is a threefold approach to training in HyResponder: educational training, operational training and virtual reality training. All elements form part of a training package and underpin the EERG. Supporting materials for each of these elements can be found on this Platform.

### Educational Training

### Operational Training

### Virtual Reality Training

Lecture 1: [Introduction to hydrogen safety for responders](#)

Lecture 2: [Properties of hydrogen relevant to safety](#)

Lecture 3: [Hydrogen storage](#)

Lecture 4: [Compatibility of hydrogen with different materials](#)

Lecture 5: [Safety of liquefied hydrogen](#)

Lecture 6: [Harm criteria for people and property](#)

Lecture 7: [Unignited hydrogen releases outdoors and their mitigation](#)

Lecture 8: [Ignition sources and prevention of ignition](#)

Lecture 9: [Hazard distances from hydrogen flames and firefighting](#)

Lecture 10: [Dealing with hydrogen explosions](#)

Lecture 11: [Confined spaces](#)

Lecture 12: [Hydrogen refuelling stations & infrastructure](#)

[< Training materials](#)

## Operational Training

How to use these materials:



1. The summary video sheet with embedded video links
2. The European Emergency Response Guide (EERG)
3. The exercise sheet.

### 1. Fuel cell equipment

1. V1-B-1 Operational video
2. VR 1-B-1 Simple fire of radio antenna power generator into a remote location
3. VR 1-B-2 Fuel cell fire into industrial estate, near H2 production line

### 2. Ignited gaseous leaks

1. V 2-A-2 Operational video
2. VR 2-A-1 Leak on the H2 feeding of a forklift station in a storage area
3. VR 2-A-2 Ignited leak on the storages of a solar production site

### 3. Vehicles fires

1. V 2-B-2 Operational video
2. V 2-B-1 Single car burning in open grounds
3. VR 2-B-1 Single car burning in open grounds
4. VR 2-B-2 Several cars (multi-energy) incident in tunnel

### 4. Liquid hydrogen

1. V 3-A-2 Operational video
2. VR 3-A-1 Sphere feed pipe leak in industrial storage (puddle)
3. VR 3-A-2 LH2 truck incident in commercial area (LH2 dump)

### 5. Transportation

1. VR 3-B-1 H2 train fire in countryside
2. VR 3-B-2 H2 Bus Fire downtown

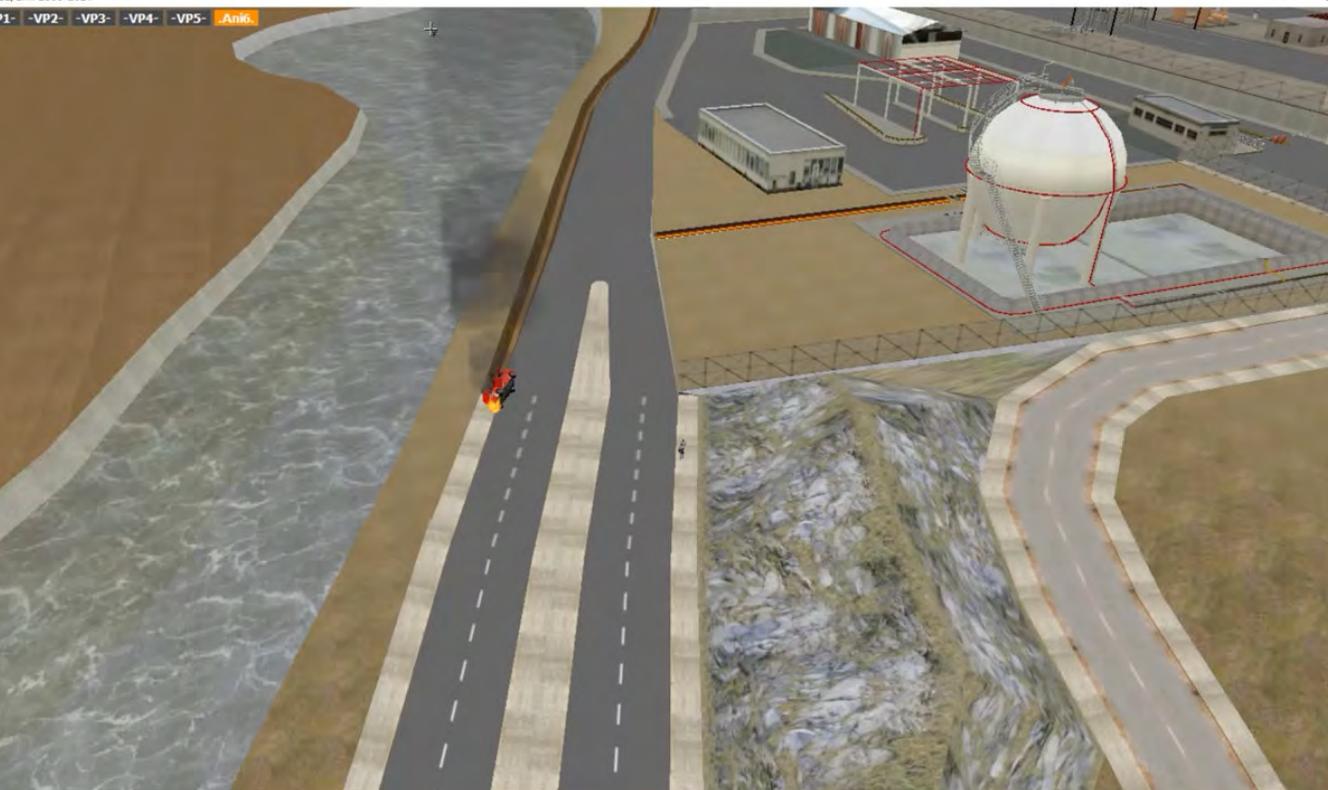
### 6. Small storage

1. V 4-A-2 Operational video
2. VR 4-A-1 Bottle rack dispersion (dismantled rack and leak)
3. VR 4-A-2 Dismantled H2 trailer on motorway

### 7. Explosion in a fuel cell enclosure

1. VR 4-B-2 Explosion in a FC container

SE/EMI 2000-2021



o link : <https://www.youtube.com/watch?v=bKRACelt3xc> 

	<b>VIDEO SHEET</b>	
	<b>PART n° 2.B</b> <b>Vehicle fire</b>	

## Single car burning in open grounds

EERG reference: Tactics n°3

Video support	Topic (explanation for trainers to trainees)	Main points
<p>Single car burning in open grounds Video VR 2B1 Video link : <a href="https://youtu.be/bKRACelt3xc">https://youtu.be/bKRACelt3xc</a></p>  <p>Video V 2B1 Video link : <a href="https://youtu.be/twHBaFB7iVM">https://youtu.be/twHBaFB7iVM</a></p> 	<p>VR situation with vehicle on road.</p> <p>One realistic experience into ENSOSP. Provide guidance to the trainees on what they should observe</p>	<p>Trainees must remark the position of the car and analyse the situation</p> <p>Trainees must make a focus on the sound and the flame of the leak</p> <p>What is the TPRD location?</p> <p>Approximately how long does the leak last?</p>
<p>Operational video with responders V 2-B-2 Video link : <a href="https://youtu.be/NF3to8EPUj8">https://youtu.be/NF3to8EPUj8</a></p> 	<p>Demonstration of intervention to extinguish a fire in a H2 car</p>	<p>Use tools: thermal imager camera + detectors H2, CO and others if provided</p> <p>Each Team prepare hoses directly connected to the fire equipment pump</p> <p>The chef guides his teams</p>
<p>Several cars (multi-energy) incident in tunnel VR 2-B-2 Video link : <a href="https://youtu.be/cz9p1SBwyHc">https://youtu.be/cz9p1SBwyHc</a></p> 	<p>You go with your team into a tunnel for a traffic accident. What do you do during transit, when you arrive at the scene (information gathering) and How do you intervene in safety conditions?</p>	<p>Having a analyze of global situation</p> <p>Locate precisely dangerous areas, Emergency shutdown devices, valves</p>



Video link : <https://youtu.be/lwHBaFB7iVM>



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More Info mail to : [specialized.training@ensosp.fr](mailto:specialized.training@ensosp.fr)



Hydrogène Hydrogène / Hydrogen Jet Fire

Video link : <https://youtu.be/NE3tpRFPUjs>



	<b>VIDEO SHEET</b>	
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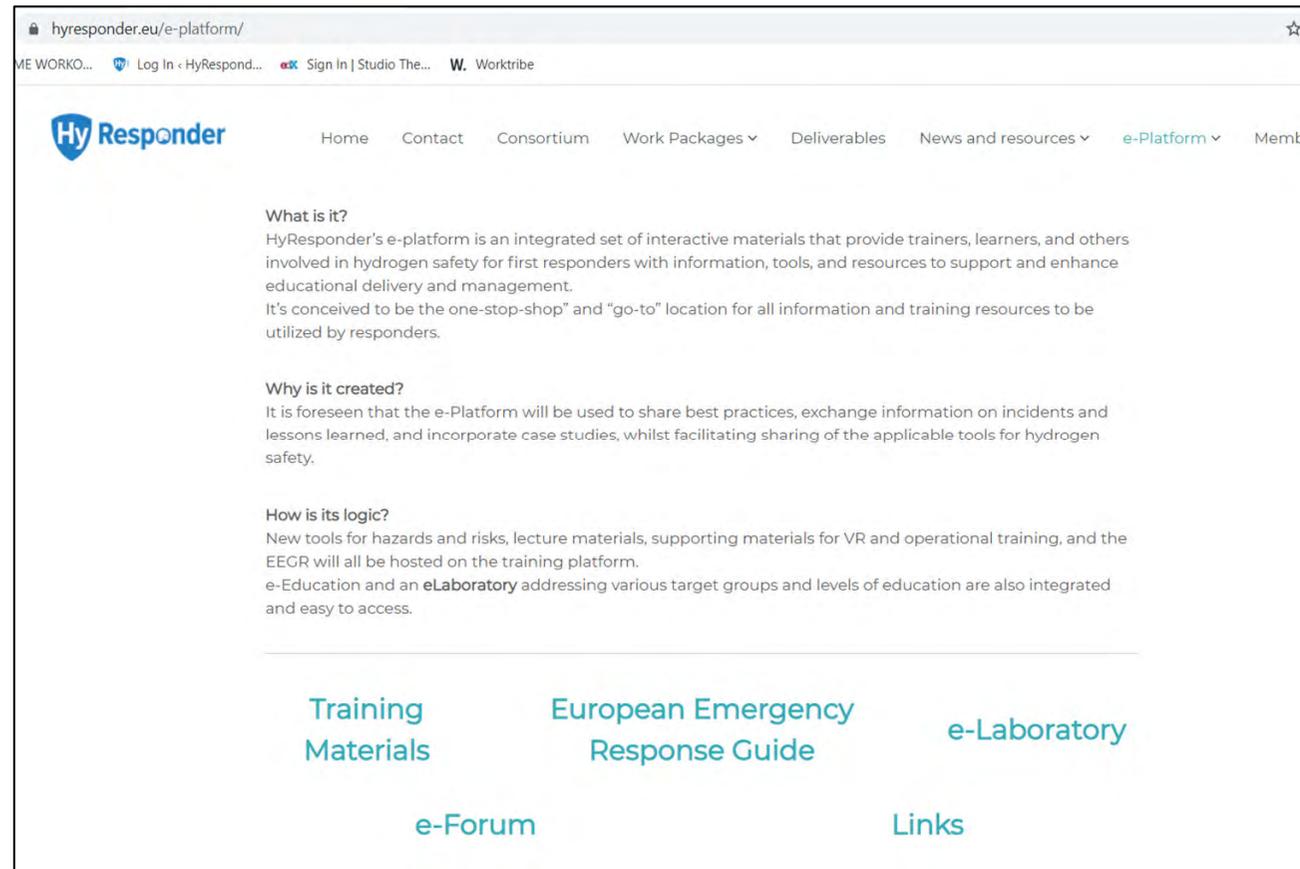
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# Hy Responder

Hy Responder is a virtual laboratory enabling to apprehend the behaviour of hydrogen from a physical and safety prospective

Today e-Laboratory is made of more than 20 e-tools which will expand with additional contributors.

Hy Responder works essentially by simulations. Each tool requires input parameters and computes results.

There is a form online to sign up to the

Hy Responder laboratory: <https://hyresponder.eu/e-laboratory/>

## e-laboratory

Jet parameters model

Similarity law for concentration decay in hydrogen expanded and under-expanded jets and unignited jet hazard distance

Effect of buoyancy on decrease of hazard distance for unignited releases

Flame length correlation and three hazard distances for jet fires

Calculation of fireball diameter for rupture in a fire of a stand-alone and an under-vehicle hydrogen storage tanks

Blast wave from high-pressure tank rupture without and with combustion

Adiabatic and isothermal model of blowdown of storage tank dynamics

Pressure peaking phenomenon for unignited releases

Pressure peaking phenomenon for ignited releases

Mitigation of uniform mixture deflagration by venting technique

Mitigation of localised non-uniform mixture deflagration by venting

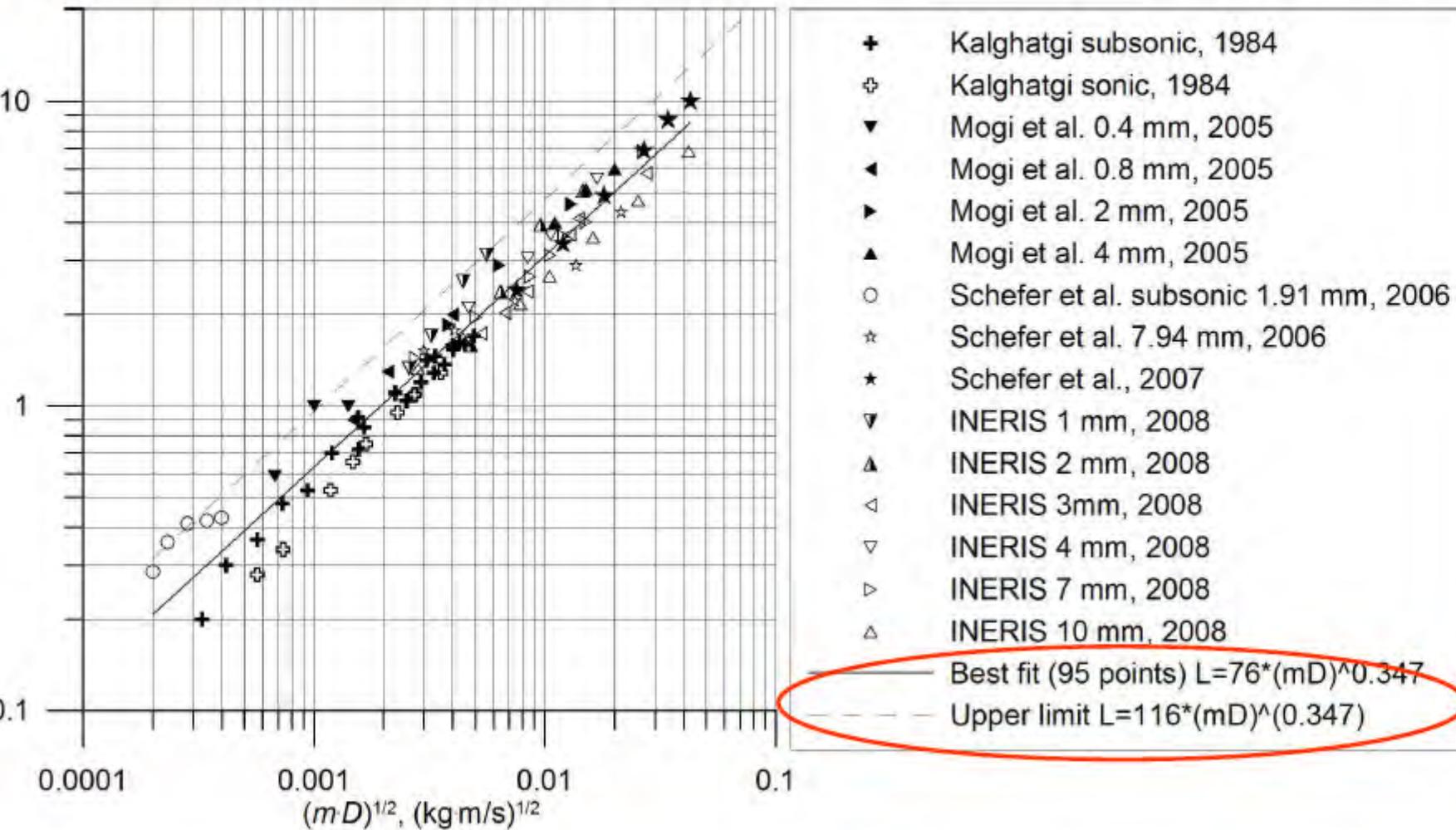
Upper limit of hydrogen inventory in closed space

Passive ventilation in an enclosure with one vent: uniform hydrogen concentration

Forced ventilation system parameters

The Abel-Noble EOS to calculate CGH2 mass in a volume at particular pressure and density

The dimensional correlation (2009)



Good prediction for high and low pressure jets for small deluge jets

Flame length correlation and three hazard distances for jet fires

Flame length correlation and three hazard distances for jet fires

URL: <https://elab.hysafer.ulster.ac.uk>

Login: HyResponderTrainer

Password: safetyfirst

Pressure in reservoir  
 Pa

Temperature in reservoir  
 K

Orifice diameter  
 m

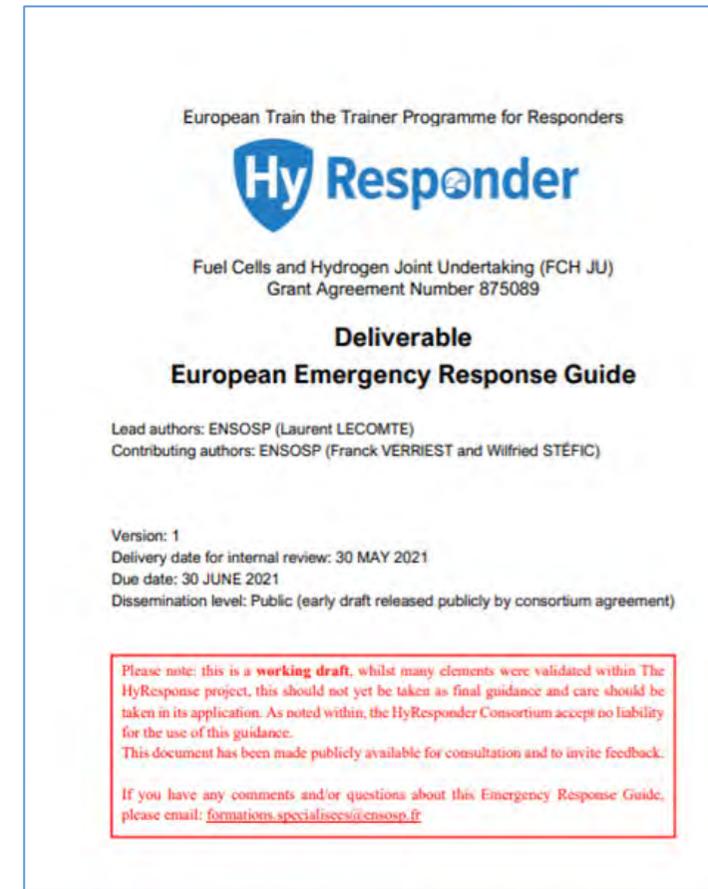
Ambient pressure  
 Pa

Ambient temperature  
 K

Name	Symbol	Value
H2 pressure in reservoir	$p_1$	2e+7
H2 temperature in reservoir	$T_1$	293
Orifice diameter	$d_3$	0.003
Ambient pressure	$p_4$	1.01325e+5
Ambient temperature	$T_{atm}$	293
Flame length	$L_F$	6.259
No harm (70°C) separation distance	$X_{70}$	21.9065
Pain limit (5 mins, 115°C) separation distance	$X_{115}$	18.777
Third degree burns (20 sec, 309°C) separation distance	$X_{309}$	12.518

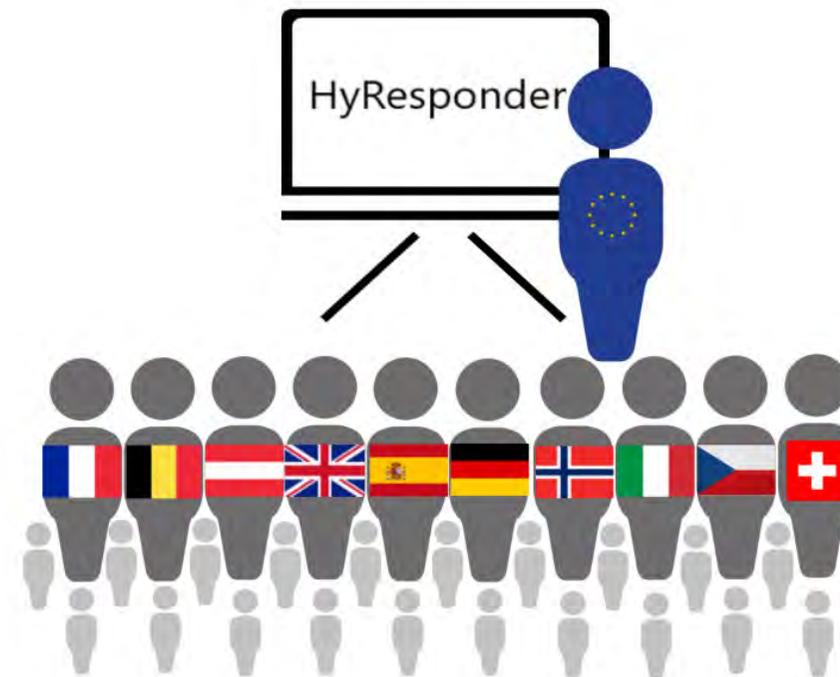
# Revised European Emergency Response Guide

- HyResponse EERG updated
- Guide intended to be used by emergency response personnel, both by front-liners and commanders
- Revisions include events related to LH2
- Multiple contributions from the wide consultation
- Open to public input
- <https://hyresponder.eu/e-platform/european-emergency-response-guide/>



# Train the trainer activities

- Virtual training for trainers from 10 partner countries plus SAB  
June 2021 clear limitations for operational and virtual reality training
- Unique approach to manage online delivery “training sequences”
- Trainers now ready to introduce national training in 2022
- Hands-on training planned for February 2022 at ENSOSP



# Plan for National training activities

- Plan in place for training in 10 countries over 2022  
In Italy scheduled on March 2022
- Trainers will introduce the **translated** training  
Czech, Dutch, English, French,  
German, Italian, Norwegian, & Spanish
- Translated materials will be available in  
advance of the training
- Contact us to find out more!

★ Location of National Cluster Training Works



# Know more & get involved

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**Project coordinator**

**Dr Síle Brennan**

Email: [sl.brennan@ulster.ac.uk](mailto:sl.brennan@ulster.ac.uk);

**<https://hyresponder.eu/>**

# Responder

This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking (JU) under grant agreement N° 101017787. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the United Kingdom, France, Austria, Belgium, Spain, Germany, Italy, Czechia, Switzerland, Norway



FUEL CELLS AND HYDROGEN  
JOINT UNDERTAKING



University



The French Academy for Fire, Rescue and Civil Protection Officers



ESCUELA DE BOMBEROS



DLR

Deutsches Zentrum  
für Luft- und Raumfahrt  
German Aerospace Center



International  
Fire  
Academy



Institute of  
Networked Energy Systems



SAP  
UNIVERS



European Hydrogen Train the Trainer Programme for Responders