

# European Train the Trainer Programme for Responders

Fuel Cells and Hydrogen Joint Undertaking (FCH JU) Grant Agreement Number 875089

# Deliverable D3.2 Short course for trainers

Lead authors: ENSOSP (Franck VERRIEST) CRISE (Eric MARANNE) Contributing authors: ULSTER UNIVERSITY (Lei XING) (Sile Brennan)

Version: 16/12/2021 Delivery date for internal review: 01/06/2021 Due date: 06/2021 Dissemination level: Public



Deliverable administration						
Work Package	WP3. Train the trainer programme					
N. and title	D3.2 Short c	ourse for trair	ners			
Туре	Report					
Status	Draft/Workin	g/ <b>Released</b>	Due	06/2021	Date	16/12/2021
Means of						
Comments						
	Development and revision					
Version N.	Date	Authors	S	Description		
1	13/04/2021	VERRIEST - MARANNE		1 <sup>st</sup> document draft		
2	01/06/2021	LECOMTE- VERRIEST		Deliverable for reviewers		or reviewers
3	22/06/2021	BRENNA	۹N	2 <sup>nd</sup> draft		raft
4	10/12/2021	STEFIC		Request for revision following periodic report		ision following report
5	16/12/2021	Brennan		Minor amendments and Project coordinator approval		nts and Project approval

#### Disclaimer

Despite the care that was taken while preparing this document the following disclaimer applies: the information in this document is provided as is and no guarantee or warranty is given that the information is fit for any particular purpose. The user thereof employs the information at his/her sole risk and liability.

The document reflects only the authors' views. The FCH JU and the European Union are not liable for any use that may be made of the information contained therein.

#### Acknowledgments

This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking under grant agreement No 875089. This Joint Undertaking receives support from the European Union's Horizon 2020 research and innovation programme, Hydrogen Europe and Hydrogen Europe research.



# Summary

This document describes the organisation of the "train the trainers" session which due to the ongoing pandemic was held remotely in June 2021 (21-25). This workshop was conceived as follows:

- Each morning session was dedicated to the theoretical courses directed by the University of Ulster. These represent an overall 12 courses of 45 minutes (9 hours of training in total).
- Each afternoon involves Virtual reality (VR) and operational training session. These exercises include 4 sequences of 8 operational situations.

This June session gathered the nominated 20 international expert trainers from 10 different European countries from the consortium, and included additional trainers and observers from outside the consortium, including representatives Asia and Australia. All with the common goal of delivering a harmonized hydrogen safety training at the European scale.

# **Keywords**

Train the trainer, operational training, virtual reality training, educational lectures

# **Table of contents**

Summary					
Keywords					
1. Virtual delivery					
2. Identification of trainers					
2.1 Fire and Rescue Instructor Prerequisites - essential					
2.2 Fire and Rescue Instructor Prerequisites - desirable					
3. Supporting materials before and after					
3.1 Materials for trainers during the course					
3.2 Materials for trainers after the course7					
4. Feedback from the course7					
5. Attendees					
6. "On-boarding" session					
7. Global organization of course7					
7.1 Educational lectures7					
7.2 Workshops7					
7.3 Planning					
7.3.1 Monday9					
7.3.2 Tuesday					
7.3.3 Wednesday					
7.3.4 Thursday					
7.3.5 Friday					
ANNEXE					

# 1. Virtual delivery

Due to the ongoing pandemic it was decided to deliver the 5-day training course virtually rather than postpone it indefinitely. The consortium acknowledge that this cannot replace the real hands-on operational or virtual reality training. However, it is hoped to give trainers sufficient introduction and materials for them to be able to discuss interventions and tactics with their trainees during national workshops, using the materials on the e-Platform. In addition, all trainers will be invited to undertake follow up training at ENSOSP in late 2021/early 2022 in advance of the national workshops. However, delivery of national training will not be dependent on this.

\* Amended in December 2021 to state that due to new restrictions as a result of the Omicron variant, the training has been further postponed to Spring 2022 if possible.

# 2. Identification of trainers

At least 2 trainers from each of 10 countries were identified in March 2021. The trainers all met a series of pre-requisites agreed by responders in the HyResponder consortium and given in the following section. All trainers:

- Meet the Fire and Rescue Instructor Prerequisites
- Should attend the virtual training the week of 21st 25th June 2021
- Engage with the teaching materials during and after this week, ideally helping with the review process
- Attend follow up operational training at ENSOSP late 2021/early 2022
- Deliver or assist with the delivery of a national event in 2022.

#### 2.1 Fire and Rescue Instructor Prerequisites - essential

- 1. Proven ability to undertake the teaching of courses using provided materials in organised modules to assess, guide and mentor including leading and conducting students in exercise and scenarios.
- 2. Able to present a credible professional standard of knowledge through educational, operational and professional awards and qualifications relative to the level of the students being instructed.
- 3. Physically able and capable of interpreting and applying operational skills founded in accepted national best practice standards of operational competency.
- 4. Have a demonstrable practical experience in operational response over five years
- 5. Have a developed understanding of leadership as crew and incident commander
- 6. Show the attitudes and behaviours required to create a learning environment that is supportive of students from diverse cultural, social and educational backgrounds.

7. Capable and competent with good verbal, numerical and written skills with an ability to communicate clearly

### 2.2 Fire and Rescue Instructor Prerequisites - desirable

- 1. Suitable and sufficient evidence of maintaining personal competence in current role
- 2. Undertaken a full range of operational tasks including first responder, emergency vehicle driver, breathing apparatus leader, extraction and hazmat operator
- 3. Demonstrates understanding of incident command and operational risk assessment
- 4. Are developing or have proven operational leadership and personnel management skills
- 5. Previously experienced in delivering a similar role as a FRS instructor or trainer
- 6. Skills that enable delivery of e-learning, virtual reality and blended learning
- 7. Understands the ethical and behavioural requirements needed to direct and work with students
- 8. Ability to build and improve teams, carry out post training debriefs, report and investigate
- 9. Welcoming attitude to promote a good learning experience

# 3. Supporting materials before and after

### 3.1 Materials for trainers during the course

A beta version of the HyResponder e-Platform (<u>https://hyresponder.eu/e-platform/</u>) was made available to trainers in time for the train the trainer course. The following materials were made available as of June 2021:

- Educational materials: stratified lecture documents, lecture slides (see Deliverable 2.2 for further details)
- Operational training: sequence documents with linked videos encompassing real scenarios and VR generated animations
- Virtual reality training: video content in support of the above and a document outlining the full capabilities of VR.
- EERG: whilst not yet the final version, it was agreed to make the updated EERG available for public input and trainer use
- e-Laboratory: The tools used in support of the educational lectures can be accessed by trainers.

### 3.2 Materials for trainers after the course

As outlined in Section 4, the feedback of the trainers will be taken on board and the supporting materials will be amended accordingly. This will include e.g. revised lectures and exercise sheets, and MOOCs as appropriate following analysis of trainer feedback.

# 4. Feedback from the course

Feedback on the course will be reviewed and presented in deliverable 3.3. The discussion and feedback sessions were recorded for analysis, comments in the meeting chat have been noted and the consortium will follow up with attendees as required. It is intended that the feedback is used to:

- Improve the training materials content and presentation
- Ensure that the materials provided on the e-Platform meet trainer needs
- Improve the e-Platform usability and design

# 5. Attendees

There were 52 registered attendees in addition to the presenters. These incorporated trainers from each of the 10 countries in the consortium (Austria, Belgium, Czech Republic, France, Germany, Italy, Norway, Spain, Switzerland, and the United Kingdom), additional trainers from Australia, Bulgaria, Croatia, Slovenia, Slovakia and Poland, and observers from Luxembourg, Canada and Japan.

# 6. "On-boarding" session

A short one-hour session was held with trainers two weeks prior to the course on the 8<sup>th</sup> of June 2021, the purpose of this meeting was to encourage engagement, to explain the HyResponder project and the training elements, and to help build the community.

# 7. Global organization of course

Each day, there are some educational lectures in the morning (9:15 to 12:15 - UK time) and workshops in the afternoon afternoons (13:00 to 15:15).

### 7.1 Educational lectures

The lectures are managed by Ulster University; a full overview of the materials can be found in Deliverable 2.2. In addition, full texts of all lectures and the glossary can be found on the HyResponder e-Platform. <u>https://hyresponder.eu/e-platform/</u>

### 7.2 Workshops

Each afternoon will be organised into two sequences mixing VR, Operational, Doctrine and EERGs presentation and each sequence (except the very first one), will follow the same architecture, given as a pedagogic example to the future trainers.

• Step 1: First a simple, direct incident will be proposed to the main virtual training room. The 'experts' of ENSOSP will present a simple situation as an introduction to the sequence focus. / 5 minutes duration max

• Step 2: 10 minutes will then be given to 4 separate working groups.

Separate rooms (or virtual rooms if videoconference) will be given to each group. Each group will be asked to identify threats, risks, immediate response, response set up, and basic commandment ideas. The trainers can organize the groups by thematic depending on the expected response (transit, size up the scene, rescue, exposure protection, ...). Opportunities to propose 2 possibilities of restitution for next step (step 3: restitution of the sub-groups):

- 1st possibility: each sub-group fully restores the situation from the taking into account of the event until the end of and the intervention
- 2nd possibility: each sub-group report part of the situation Taking into account of the event from the barracks until the arrival on the scene - Analysis of the situation - Conservatory measures - Operational implementation -....

Each group may be visited by an ENSOSP 'expert' during this discussion. We will encourage each group to mix different nationalities, hence to give space for internal group discussions.

- Step 3: After these 10 minutes, all groups will rally the main conference room, to expose their proposals and ideas. ENSOSP 'experts' or 'H2 experts' from research or industry or ... will the debate the proposals, and, present EERG and doctrinal approaches, explained based on the exercise and feedbacks. This may be either an 'inverted classroom', where 'experts' will lead trainees to find themselves the EERG and doctrines (best induction and memorization strategy by far), or simply state the doctrine and EERG, depending on trainees' responsiveness. This step duration ought to be another 10 to 15 minutes.
- Step 4: Mixed within the last step or after it, ENSOSP will present two videos: one to picture the 'real' incident (as shoot on platform, a 'static video'), and another video presenting the 'doctrinal way' to handle the incident (this time a dynamic video, showing First responders actually tackling the incident). Finally, the trainers will read with the trainees the tactical sheet of the EERG in connection with the theme of the sequence
- Step 5: To finalize the sequence, another VR exercise will be proposed, as well as another separate group thinking, and proposals debriefing. Much faster this time. The idea here is to 'complexify' the incident with real life conditions, implying much more situational awareness, area analysis, and operational management skills. For example, if first exercise was a car burning in an open space, the second exercise will be a car burning in a dense urban area. The idea here is to further illustrate the current focus, to pinpoint important elements not to be oversighted or underestimated, and to anchor a bit more EERG and doctrine about this focus.

We evaluate a sequence duration to roughly one hour.

This means that each day will enable to develop two themes.

Details on the specific content is given in the following section.

# <u>Important</u>

- Lectures require 1 trainer.
- Practical training (sequence) requires 2 trainers + 1 additional trainer per group (between 5 and 8 trainers per training)

### 7.3 Planning

#### 7.3.1 Monday

Monday (UK time)					
09:15-10:00	Introduction to "Tra	Introduction to "Train the trainer" course: aim, objectives, structure			
10:00-10:25	Stratification appro	ach to teaching materials			
10:25-10:45	An introduction to	the e-Platform			
10:45-11:00	Feedback session				
11:00-11:15	Comfort break				
11:15-12:00	Lecture 1: Introduc	tion to hydrogen safety for responders			
12:00-12:15	Feedback session				
12:15-13:00	Lunch break				
13:00-13:45	Sequence 1.A - Introduction to training				
13:45-14:00	Feedback session				
14:00-15:00	Sequence 1.B - H2 equipment / Fuel cells				
E. Maranne, L. Lecomte	14:00-14:15	VR: Remote Power installation fire			
		Simple fire into a remote location of radio antenna power generator.			
		Situation analysis: 5 min			
		Return of the 4 sub-groups (2 min30 per sub group): 10 min			
L. Lecomte	14:15-14:30	Debriefing / Doctrine / EERG presentation (tactic n°19)			
L. Lecomte	14:30-14:45	Operational platform video of fuel cell fire - presentation of			
		intervention			
E. Maranne, L. Lecomte	14:45-15:00	VR: Fuel cell fire at production site into industrial estate, near H2			
		production line.			
15:00-15:15	Feedback session				

### Lecture 1: introduction to hydrogen safety for responders

The stratified content of each lecture and slides can be found here: https://hyresponder.eu/e-platform/training-materials/educational-training/

#### Sequence 1.A: Introduction

Presentation of VR for training the trainers, and introduction to uses of VR for training first responders. Following thematic will be somehow both examples of 'training the first responders' setups, as well as 'real first responders training', for the trainers not comfortable with Hydrogen issues. Basically, we want to ensure we address both needs at the same time, and present this choice to the audience.



EXERCISE SHEET



# PART n° 1.A VR Presentation

Day	1
Duration	0h45
Number of trainees	20

# Introduction to Virtual Reality and operational tactical reminder

Steps	Trainers	Topics	Pedagogic support	Duration	Teams
	ENSOSP CRISE	Training organization	CRISE & ENSOSP introduction	10'	Plenary session
			Presentation of the different phases		
			of the week's afternoon		
		EERG	EMERGENCY CALL MANAGEMENT	10'	
		presentation	The incident begins when the		
		and its use	emergency call arrives to the control		
			emergency services are usually over-		
			excited or terrorised. Despite this,		
			essential information must be		
			gathered:		
			Type of incident (electrical		
			fire etc.)		
			<ul> <li>Location of the incident</li> </ul>		
			<ul> <li>Number of persons killed,</li> </ul>		
			injured or threatened by the		
			incident		
			emergency answering service can		
			select the nearest available		
			emergency equipment and provide		
			useful advice to the person who		
			called:		
			As an example, if the emergency call		
			concerns an FC vehicle involved in a		
			fire in, the street the following steps		
			must be considered:		

	I
<ul> <li>Look for identification graphics placed on the exterior or interior of the vehicle to establish that FC or hydrogen is involved</li> <li>Make sure all the passengers can escape from the vehicle</li> <li>Turn-off the ignition key</li> <li>Provide first aid to the casualties in a safe area</li> <li>Try to extinguish the fire with a fire extinguisher if the fire is small</li> <li>Keep the members of general public away from the burning vehicle before the fire services arrive</li> </ul> Before leaving the fire station, the incident commander must choose a safe route to arrive at the incident ground, preventing the fire equipment to cross a flammable gas cloud, and make sure to arrive upwind.	
with a fire extinguisher if the fire is small	
Keep the members of	
general public away from	
the burning vehicle before	
Before leaving the fire station, the	
incident commander must choose a	
sale route to arrive at the incident	
equipment to cross a flammable gas	
cloud, and make sure to arrive	
upwind.	
FIRE AND RESCUE OPERATIONAL	
SEQUENCE Every fire and rescue operation follows	
the same "step-by-step" sequence on	
the incident field.	
Please note that those steps can be	
the real situation.	
1. RECOGNITION	
2. RESCUE	
3. PREPAREDINESS 4. INCIDENT SETTLEMENT	
5. PROTECTION	
6. CLEAR OUT	
OFFENSIVE AND DEFENSIVE	
TACTICS	
Offensive tactic: (or acting on	
danger sources)	

			-	
	This ta	actic aims to act very quickly on		
	the or	igin of the incident to prevent		
	it to p	roduce its effects.		
		<u>Advantages</u> : rapid		
		settlement of the incident, a		
		little area is concerned; the		
		required amount of		
		personnel and equipment is		
		limited		
		Drawbacks: risky for		
		firefighters, one shot is		
		available		
	Defen	sive tactic: (or acting on		
	dange	er flux and targets)		
	This ta	actic aims to act on the closest		
	area	of the incident preventing		
	those	effects from reaching an area		
	which	was not concerned		
	befor	ehand		
		Advantages: safer for crews		
		Drawbacks: it needs more		
		preparedness, the		
		settlement of the incident		
		takes a long time, and the		
		area finally concerned by the		
		incident is wider. Hydrogen		
		specificities in emergency		
		situations		
Presentat	ion of Benef	its of VR : report page 10 and	20'	
virtual	eality 11) of	deliverable 2.6		
use	, , , , , , , , , , , , , , , , , , , ,			

## Sequence 1.B: H2 equipment / Fuel cells

Simple H2 exercises, addressing incidents on H2 related devices, not involving directly H2 risks per se we want to first introduce H2 risk to trainees (trainers not familiar with H2).

Ecce Nationale Superiore des Officier de Capacita Participas	EXERCISE SHEET PART nº 1.B		Hy Responder
Day	1	· · · · ·	
Duration	1	h00	
Number of trainees	2	0	

# Simple fire of radio antenna power generator into a remote location

Steps	Trainers	Topics	Pedagogic support	Duration	Teams
1	ENSOSP	Operational	Remote power installation fire	5'	Plenary
	CRISE	theory			session
			Instructions to be given by the trainer:		
			<ul> <li>Analyse the situation</li> <li>List chronologically the preventive and operational actions you would take</li> </ul>		
2	ENSOSP	Collective	• TAKE USEFUL information ABOUT THE INCIDENT:	10'	Subgroups
		reflexion and proposal	Assure the precise incident location and the concerned power		
			Is this stationary power generation unit kwown by the fire service?		
			Witch part of the application is concerned by the incident? (Fuel cell, H2/O2 storage, photovoltaic panels, wind tubine)		
			Are there any person involved in the incident?		
			What happened?		
3	ENSOSP	Doctrine + EERG presentation	<ul> <li>SIZE UP THE SCENE</li> <li>Locate precisely dangerous areas, Emergency shutdown devices, valves, evaluate the amount of compressed gases present in the tanks.</li> <li>Has a leak occured? Is a leak still occuring?Which ones?</li> <li>Is the system delivering electricity?</li> <li>Is a technician present on the plant area?</li> <li>Look for the emergency fire and rescue plan.</li> </ul>	15'	Plenary session
			RESCUE Is there a victim?		
			• EXPOSURE PROTECTION As it is possible: Isolate (pressure, gas supply, electricity) energy production unit, fuel cell and storages (each one from the others)		
			• INCIDENT TREATMENT The fire concerns the Fuel cell Compartment. Push Emergency shutdown devices		

# EERG reference: Tactic n°19

			<ul> <li>Prevent the fire to spread to a uninvolved part of the plant with water spray curtains.</li> <li>FINAL INSPECTION</li> <li>Cool the wreckage as soon as no heat point is detected by the thermal imaging device.</li> <li>Repeatedly check H2 presence in the atmosphere.</li> <li>View of the full tactical sheet n°19</li> </ul>		
4 E	ENSOSP	« Operational platform presentation of intervention »	Operational video with responders emphasizing the points highlighted in step 3 above V 1-B-1	15'	Plenary session
5 C E	CRISE ENSOSP	VR: fuel cell fire at production site	<ul> <li>Fuel cell fire into industrial estate, near H2 production line <u>VR 1-B-2</u></li> <li>Wain points: <ul> <li>Use tools: thermal imaging camera + detectors H2, O2 and others if provided</li> <li>Use the technician knowledge</li> <li>look for the mergency fire and rescue plan.</li> <li>locate precisely dangerous areas, Emergency shutdown devices, valves,</li> <li>Photovoltaic panels</li> <li>Storage: evaluate the amount of compressed gases present in the tanks.</li> <li>each Team prepare 80 m of hoselines directly connected to the fire equipment pump</li> <li>Team 1: aims to cool the H2 tank to prevent pressure increase in the tanks</li> <li>Team 2: aims to extiguish the fire</li> </ul> </li> </ul>	15'	Plenary session

Remote Power installation fire File VR 1-B-1

### *EERG: tactic sheet n°19*

	Stationary power generation ur	nit (SPGU)					
Hydrogen-based energy storage system (H2ESS)							
<u>Tactic n° 19</u>	Tactic n° 19 FIRE						
	·						
	AT THE FIRE STATION						
TAKE USEFUL informa							
• assure the precise in	ncident location and the concerned power						
• is this stationary por	wer generation unit kwown by the fire service?						
• Does a firefighting p	plan exists? take it in the fire equipment and read it	on the road.					
witch part of the appl tubine)	ication is involved in the incident? (Fuel cell, H2/O2	storage, photovoltaic panels, wind					
• are there any person	n involved in the incident?						
<ul> <li>what happened?</li> </ul>							
<ul> <li>Investigate the pres</li> </ul>	ence of hydrants inside and around the unit						
WEATHER CONDITION	1S						
• wind direction and v	wind speed						
ITINERARY							
choose a safe itinerar	y:						
<ul> <li>do not cross an ever</li> </ul>	ntual explosive gas cloud						
• do not reach scene	from below (if possible arrive downwind)						
<ul> <li>anticipate the need</li> </ul>	of a hydrant						
TAKE FOLLOWING TO	OLS (if availble use drone UAV – use ATEX device):						
Gaseous hydrocarbo	on dectector,						
H2 detector							
O2 detector							
<ul> <li>Thermal imaging car</li> </ul>	mera						
Wear fully protectiv	e equipment including breathing apparatus						
	ARRIVAL ON SCENE						
ARRIVAL :							
<ul> <li>Choose a safe way t and make sure to arriv</li> </ul>	• Choose a safe way to get to the incident ground, preventing the fire equipment to cross a flammable gas cloud, and make sure to arrive upwind.						
• Stop the fire equipment between 50 and 100 meters (55 - 110 yd) before the incident.							
If a wind turbine is co of the environment w	If a wind turbine is concerned, stop at a distance of twice the height of the wind turbine. Realise a complete check of the environment with termal image camera.						
away from a possibl	away from a possible ignited flammable liquid leak progression.						
Approach objects ta	• Approach objects taking into account possible ignition of leaking H2.						
• Engage the pump ar	nd connect the fire truck to a hydrant.						
• Deploy and arm a he	ose-lise for safety or for a primary attack						
SAFETY AREA							
15							

if H2/O2 storage is concerned:

• Set up a safety area for the public beyond a radius of 500 meters (550 yd)

if a wind turbine is concerned:

• Set up a safety area for the public beyond a radius of twice the height of the wind turbine .

if fuel cell or electrical devices is concerned:

• Set up a safety area for the public between a radius of 50 and 100 meters (55 - 110 yd)

• Ensure that unauthorized/untrained personnel do not enter the hazardous area

SIZE UP THE SCENE

• BY QUESTIONNING THE WITNESSES, TECHNICAL STAFF OF THE SPGU/H2ESS AND OBSERVATION, ANSWER THE FOLLOWING QUESTIONS :

o Is someone injured? Threatened?

o what has happened?

o witch part of the application is concerned by the incident? (Fuel cell, H2/O2 storage, photovoltaic panels, wind tubine...)

o Has a leak occurred? Is a leak still occurring?Which ones?

is the system delivering electricity?

Is a technician present on the plant area?

Check for possibility H2 in confined spaces

look for the emergency fire and rescue plan.

locate dangerous areas, Emergency shutdown devices and valves.

evaluate the amount of compressed gases present in the tanks.

o Demand extra support if necessary

RESCUE

Humans' rescue overrides all other considerations.

Be equiped with PBE.

If a human is threatened or concerned by the Fire :

• Team 1 : extract the victim(s) from the danger zone by any possible means

• Team 2 : Protect the action of Team 1 with the armed fire hose-line

evacuate the passengers in the opposite direction of the wind (or in worst case as far as possible in the direction of wind).

#### EXPOSURE PROTECTION

• evacuate adjacent buildings

• Prevent the fire from spreading to uninvolved buildings

note that a SPGU is supposed to produce electricity as soon as it is no longer supplied by the electrical network. So it is necessary to stop the electrical production of the SPGU before any other action by Pushing Emergency shutdown devices.

Isolate (pressure, gas supply, electricity) energy production unit, fuel cell and storages (each one from the others).(figure 33)

Check and note every ESD or valve turned off on the emergency plan.

• Repeatedly check H2 presence in the atmosphere.

INCIDENT TREATMENT

3 cases are possible:

The fire concerns the photovoltaic panels or wind turbine area.

Push Emergency shutdown devices

prevent the fire to spread to a uninvolved part of the plant with water spray curtains. put the fire out. The fire concerns the Fuel cell Compartment. Push Emergency shutdown devices prevent the fire to spread to a uninvolved part of the plant with water spray curtains. do not open the FC compartment. The fire concerns the storage area (high stakes level situation ) Push Emergency shutdown devices prevent the fire to spread to a uninvolved part of the plant with water spray curtains. put the fire out with an offensive Fire attack: each Team prepare 80 m of hoselines directly connected to the fire truck • Team 1: aims to cool the H2 tank to prevent pressure increase in the tanks • Team 2: aims to extinguish the fire. If the fire concerns an ignited H2 leak, the only safe way to put out the fire is to close the appropriate valve. The primary action of the incident commander is to prevent pressure increase in the tanks, he checks the efficacy of the cooling. Mind that H2 storages are equipped with Pressure release devices that may open and close several times depending on the pressure inside the tank. Mind that violent reactions are possible between water and burning materials Mind that water will be polluted during extinction Try to contain polluted water In there is no identified stake: consider if it is safe to let the unit burn, take necessary precautions **FINAL INSPECTION** • Cool the unit as soon as a heat point is detected by the thermal imaging device. • Repeatedly check H2 presence in the atmosphere.

Take necessary precautions to prevent reigniting : establish a regular monitoring of the unit (fire guard)

Operational video presentation of intervention File V 1-B-1

Fuel cell fire at production site File VR 1-B-2

#### 7.3.2 Tuesday

Tuesday (UK time)					
09:15-10:00	Lecture 2: Propertie	Lecture 2: Properties of hydrogen relevant to safety			
10:00-10:15	Feedback session				
10:15-11:00	Lecture 3: Hydrogen	1 Storage			
11:00-11:15	Feedback session				
11:15-11:30	Comfort break				
11:30-12:15	Lecture 4: Compatibility of hydrogen with different materials				
12:15-12:30	Feedback session				
12:30-13:15	Lunch break				
13:15-14:15	Sequence 2.A - Ignit	ed Gaseous leaks			
E. Maranne, L. Lecomte	13:15-13:30 VR: Leak on the H2 feeding of a forklift station in a storage area.				
L. Lecomte	13:30-13:45Debriefing / Doctrine / ERG presentation (tactic n°2)				
L. Lecomte	13:45-14:00 Operational platform video of leak - presentation of intervention				

E. Maranne, L. Lecomte	14:00-14:15	VR: Ignited leak on the storages of a solar production site.
14:15-15:15	Sequence 2.B - Vehi	cles fires
E. Maranne, L. Lecomte	14:15-14:30	VR: Single car burning in open grounds
L. Lecomte	14:30-14:45	Debriefing / Doctrine / EERG presentation
L. Lecomte	14:45-15:00	Operational platform video of vehicle fire - presentation of intervention
E. Maranne, L. Lecomte	15:00-15:15	VR: Several cars (multi-energy) incident in tunnel
15:15-15:30	Feedback session	

#### Lectures 2, 3 and 4:

Lecture 2: Properties of hydrogen relevant to safety

Lecture 3: Hydrogen storage

Lecture 4: Compatibility of hydrogen with different materials

The stratified content **of each lecture and** slides can be found here: <u>https://hyresponder.eu/e-platform/training-materials/educational-training/</u>

Sequence 2.A: Ignited Gaseous leaks Cf. exercise sheet part n°2.A



# Leak on the H2 feeding of a forklift station in a storage area

Day	2
Duration	1h00
Number of trainees	20

#### EERG reference: Tactic n°2

Steps	Trainers	Topics	Pedagogic support	Duration	Teams
1	ENSOSP		Situation explanation (context) of simple	5'	Plenary
	CRISE		gaseous leak:		session
			VR 2-A-1		

			Provide guidance to the trainees on what they		
2	ENSOSP	Collective reflexion and proposal	<ul> <li>should observe</li> <li>Trainees' observations and their related operational proposals</li> <li>Main points: <ul> <li>assure the precise incident location,</li> <li>type of vehicle concerned,</li> <li>what happened.</li> </ul> </li> </ul>	10'	Subgroups
3	ENSOSP	Operational theory Doctrine + EERG presentation	<ul> <li>SIZE UP THE SCENE</li> <li>witch part of the application is concerned by the incident? (Fuel cell, H2/O2 storage, photovoltaic panels, wind tubine)</li> <li>Has a leak occured? Is a leak still occuring?Which ones?</li> <li>Set up a safety area for the public beyond a radius distance of 100 meters (110 yd)</li> <li>Look for the mergency fire and rescue plan.</li> <li>Locate precisely dangerous areas, Emergency shutdown devices, valves,</li> <li>RESCUE</li> <li>Is there a victim?</li> <li>If a human is threatened or concerned by the gas leak:</li> <li>Team 1: extract the victim(s) from the danger zone by any possible means (extraction tool : use the method implemented in the country). A pumpoperated system might be safer than a battery-operated, however pump should be in safe zone and respect the distance with the car.</li> <li>Team 2: stretch a fire hoseline to protect the action of the Team 1 in case of an ignition of the cloud</li> <li>EXPOSURE PROTECTION</li> <li>Use only necessary personnel.</li> <li>Turn off the ignition key.</li> <li>Press the fuel cell (or Hydrogen system in general) emergency shutdown device</li> <li>INCIDENT TREATMENT</li> </ul>	15'	Plenary session

			Push Emergency shutdown devices		
			prevent the fire to spread to a uninvolved part of the plant with water spray curtains.		
			If H2 leak continues after the protection step , close H2 valve as close as possible of the H2 tank.		
			If it is not possible to reach a H2 valve, allow H2 to leak safely until the tank is empty.		
			• FINAL INSPECTION Repeatedly check H2 presence in the atmosphere.		
			View of the full tactical sheet n°2		
4	ENSOSP	Operational platform	Operational video: non ignited H2 flare and emphasize the points made earlier.	15'	Plenary session
		of intervention	V2-A-2		
5	CRISE ENSOSP	Ignited leak on the storages of a solar production site		15'	Plenary session

Main points:	
<ul> <li>Main points: <ul> <li>Use tools: thermal imaging camera + detectors H2, O2 and others if provided</li> <li>Use the technician knowledge</li> <li>look for the emergency fire and rescue plan.</li> <li>locate precisely dangerous areas, Emergency shutdown devices, valves,</li> <li>Photovoltaic panels</li> <li>Storage: evaluate the amount of compressed gases present in the tanks.</li> <li>each Team prepare 80 m of hoselines directly connected to the fire equipment pump</li> </ul> </li> </ul>	
• Team 1: aims to cool the H2 tank to prevent pressure increase in the	
• Team 2: aims to extiguish the fire	
Ensure that unauthorized/untrained personnel	
do not enter the hazardous area	
- Final inspection	

#### Leak on the H2 feeding of a forklift station in a storage area. File VR 2-A-1

#### EERG: tactic sheet n°2

# FC CAR/FC FORKLIFT

Ta	<u>ctic</u>	n°	2

# H2 LEAK WITHOUT FIRE

#### AT THE FIRE STATION

TAKE USEFUL information ABOUT THE INCIDENT:

- assure the precise incident location,
- type of vehicle concerned,
- what happened.

WEATHER CONDITIONS

• wind direction, + wind speed.

ITINERARY:

choose a safe itinerary:

- do not cross an eventual explosive gas cloud,
- do not reach scene from below,
- anticipate the need of a hydrant.
- TAKE FOLLOWING TOOLS (if available use drone UAV use ATEX device).
- Gaseous hydrocarbons dectector, H2 detector, O2 detector,
- Thermal imaging camera.

#### ARRIVAL ON SCENE

ARRIVAL:

• Choose a safe way to get to the incident ground, preventing the fire equipment to cross a flammable gas cloud, and make sure to arrive upwind.

• Stop the fire equipment between 50 and 100 meters (55 - 110 yd) before the incident. Away from a possible ignited flammable leak progression.

• Engage the pump and connect the fire equipment to a hydrant.

SAFETY AREA:

For a CAR and FORKLIFT: Set up a safety area for the public beyond a radius distance of 100 meters (110 yd)

• For a BUS: Set up a safety area for the public beyond a radius of 200 meters (220 yd)

• Ensure that unauthorized/untrained personnel do not enter the hazardous area

#### SIZE UP THE SCENE

IF A PERSON IS INSIDE THE HAZARDOUS AREA:

ENGAGE THE RESCUE OPERATIONS (conduct rescue operation with back up of charged water line).

IF NO ONE IS INSIDE THE HAZARDOUS AREA:

• Answer the following questions:

o Which type of vehicle is involved?

o What happened?

o Has a loud hissing sound being hared before the FR arrive?

Vehicle identification:

H2 car may be identified by FCHV Fuel Cell Hybrid Vehicle graphics (figure 3)

Confirm the safety area with the H2 detector .

If H2 is detected, refine the safety area.

o Demand extra support if necessary

Check if high temperature points exist on the vehicle by using thermal camera (more than 150°C/302°F). Check for possible ignition source.

#### RESCUE

Humans' rescue overrides all other considerations (a water mist might also be used in this situation of a leak with no fire)

If a human is threatened or concerned by the gas leak:

• Team 1: extract the victim(s) from the danger zone by any possible means (extraction tool : use the method implemented in the country). A pump-operated system might be safer than a battery-operated, however pump should be in safe zone and respect the distance with the car.

• Team 2: stretch a fire hoseline to protect the action of the Team 1 in case of an ignition of the cloud.

Evacuate the passengers in the opposite direction of the wind, if impossible as far as possible in the wind direction.

#### EXPOSURE PROTECTION

• Use only necessary personnel.

- Evacuate adjacent buildings.
- If the vehicle is in a building, prevent H2 accumulation by operating wide ventilation of the building.
- Open the doors and hoods (if present).
- Set the hand-brake and wedge the vehicle.
- Turn off the ignition key.

• Press the fuel cell (or Hydrogen system in general) emergency shutdown device (buses and forklift) For Buses, an Emergency shutdown device is generaly located near the driver seat, on the left-hand side and another is on fuel cell in "engine" compartment, located at the back of the bus.

• Do not operate any other electrical breaker to avoid creation of electrical spark (during extraction be aware of high voltage).

- Repeatedly check H2 presence in the atmosphere.
- Refine safety area.

 $\bullet$  Check if high temperature points exist on the vehicle by using thermal camera (more than 150°C/302°F).

INCIDENT TREATMENT

• If H2 leak continues after the protection step , close H2 valve as close as possible of the H2 tank.

• If it is not possible to reach a H2 valve, allow H2 to leak safely until the tank is empty. Deploy a water curtain with monitor.

#### FINAL INSPECTION

• After a last H2 atmospheric control, make sure that the vehicle or the wreckage is evacuated by authorized personnels (idealy by manufacturer).

*Operational video on platform.* File V 2-A-2

Ignited leak on the storages of a solar production site File VR 2-A-2

Sequence 2.B Vehicles fires Cf. exercise sheet part n°2.B

	EXERCISE	
ENSOSP	SHEET	Hy Responder
core indicade superieure des Unicies de Sapeus-rampies	PART n° 2.B	
	Vehicles fire	

Day	2
Duration	1h00
Number of trainees	20

# Single car burning in open grounds

EERG reference: Tactics n°3

Steps	Trainers	Topics	Pedagogic support	Duration	Teams
1	ENSOSP		Explanation of context:	5'	Plenary
	CRISE		Video V 2B1		session
			The second second		
			in the second		

					[]
			Provide guidance to the trainees on what they should observe (i.e. characteristic of the flame)		
2	ENSOSP	Collective reflexion and proposal	Trainees' observations and their related operational proposals Main points: • assure the precise incident location, • type of vehicle concerned, • what happened.	10'	Subgroups
3	ENSOSP	Operational theory Doctrine + EERG presentation	<ul> <li>SIZE UP THE SCENE</li> <li>Is someone threatened by the fire? Where?</li> <li>How many vehicles are involved in the fire?</li> <li>How many of these vehicles are powered by H2 or by another compressed flammable gas?</li> <li>Has a loud hissing sound being heared?</li> <li>Where can be H2 overpressure valve be localized in the vehicle?</li> <li>Did the TPRD activate? Is the flame produced?</li> <li>RESCUE</li> <li>Is there a victim?</li> <li>If a human is threatened or concerned by the gas leak:</li> <li>Team 1: extract the victim(s) from the danger zone by any possible means (extraction tool : use the method implemented in the country). A pump- operated system might be safer than a battery-operated, however pump should be in safe zone and respect the distance with the car.</li> </ul>	15'	Plenary session

			Team 2: stretch a fire hoseline to protect the action of the Team 1 in case of an ignition of the cloud		
			• EXPOSURE PROTECTION Use only necessary personnel. Turn off the ignition key. Press the fuel cell (or Hydrogen system in general) emergency shutdown device		
			<ul> <li>INCIDENT TREATMENT</li> <li>Push Emergency shutdown devices prevent the fire to spread to a uninvolved part of the plant with water spray curtains.</li> <li>If H2 leak continues after the protection step , close H2 valve as close as possible of the H2 tank.</li> <li>If it is not possible to reach a H2 valve, allow H2 to leak safely until the tank is empty.</li> </ul>		
			• FINAL INSPECTION Repeatedly check H2 presence in the atmosphere. View the full tactical sheet n°3		
4	ENSOSP	Operational platform presentation of intervention	Operational video and emphasize the points made earlier. V 2-B-2	10'	Plenary session
5	CRISE ENSOSP	Several cars (multi- energy) incident in tunnel	VR scenario n° MSP IUV INC – Light-duty vehicle fire (LPG) VR 2-B-2	15'	Plenary session

### Vehicle fire on platform File V 2-B-1

Single car burning in open grounds File VR 2-B-1

*EERG: tactic sheet n°3* 

	FC CAR/FC FORKLIFT					
Tactic n° 3	FIRE					
	AT THE FIRE STATION					
TAKE USEFUL information	ABOUT THE INCIDENT:					
<ul> <li>assure the precise incide</li> </ul>	ent location					
<ul> <li>type of vehicle concerned</li> </ul>	ed					
<ul><li>what happend?</li></ul>						
WEATHER CONDITIONS						
<ul> <li>wind direction</li> </ul>						
<ul> <li>wind speed</li> </ul>						
ITINERARY						
choose a safe itinerary:						
<ul> <li>do not cross an eventua</li> </ul>	l explosive gas cloud					
<ul> <li>do not reach scene from</li> </ul>	n below					
<ul> <li>anticipate the need of a</li> </ul>	a hydrant					
TAKE FOLLOWING TOOLS	(if availble use drone UAV – use ATEX device):					
<ul> <li>Gaseous hydrocarbons of</li> </ul>	dectector, H2 detector, O2 detector					
<ul> <li>Thermal imaging camera</li> </ul>	3					
	ARRIVAL ON SCENE					
ARRIVAL:						
<ul> <li>Choose a safe way to ge and make sure to arrive up</li> </ul>	t to the incident ground, preventing the fire equipment to cross a f pwind.	lammable gas cloud,				
<ul> <li>Stop the fire equipment ignited flammable leak pro</li> </ul>	t between 50 and 100 meters (55 - 110 yd) before the incident, awa ogression.	ay from a possible				
• Engage the pump and co	onnect the fire equipment to a hydrant.					
SAFETY AREA						
• CAR and FORKLIFT: Set up a safety area for the public beyond a radius of 100 meters (110 yd)						
• BUS: Set up a safety area for the public beyond a radius of 200 meters (220 yd)						
<ul> <li>Ensure that unauthorized/untrained personnel do not enter the hazardous area.</li> </ul>						
SIZE UP THE SCENE						
IF A PERSON IS INSIDE THE HAZARDOUS AREA :						
ENGAGE RESCUE OPERATIONS						
<ul> <li>answer the following questions:</li> </ul>						

o Is someone threatened by the fire? Where?

o How many vehicles are involved in the fire?

o How many of these vehicles are powered by H2 or by another compressed flammable gas?

o Has a loud hissing sound being heared before the FR arrive?

Where can be H2 overpressure valve be localized in the vehicle?

Did the TPRD activate? Is the flame produced?

o Demand extra support if necessary

Vehicle identification:

H2 car may be identified by FCHV Fuel Cell Hybrid Vehicle graphics (figure 3).

RESCUE

Humans' rescue overrides all other considerations.

If a human is threatened or concerned by the Fire :

• Team 1: extract the victim(s) from the danger zone by any possible means (figure 10). Be equiped with PBE.

• Team 2: stretch a fire hoseline to protect the action of the Team 1 to

evacuate the passengers in the opposite direction of the wind (or in worst case as far as possible in the direction of wind).

#### EXPOSURE PROTECTION

• Use only necessary personnel

- Evacuate adjacent buildings
- Prevent the fire from spreading to a uninvolved vehicle(s) or building(s)
- Move ajacent non involved vehicles by any way possible (driving, towing, pushing, etc)

• If the vehicle is in a building, prevent combustion gases and H2 accumulation by operating wide ventilation of the building.

If possible and safe:

- Open the doors and hoods (if present)
- Set the hand-brake on
- Wedge the vehicle
- Turn off the ignition key (during extinguishing be aware of high voltage).
- Press the fuel cell emergency shutdown device (buses and forklifts)

For Buses, an Emergency shutdown device is generaly located near the driver seat on left side and another is on fuel cell in "engine" compartment, located at the back of the bus

• Repeatedly check H2 presence in the atmosphere (preventive measure).

• Refine safety area.

• Repeatedly check H2 tanks temperature with thermal imaging device.

#### INCIDENT TREATMENT

In case of High stakes level situation :

Operate an offensive Fire attack: (figures 8-9)

each Team prepare 80 m of hoselines directly connected to the fire equipment pump (figure 4). Be equiped with PBE.

• Team 1: aims to cool the H2 tank. This prevents the Thermal Pressure Release Device to operate.

• Team 2: aims to extinguish the vehicle fire.

The teams avoid passing through danger angles. (figures 5-6-7)

Mind that violent reactions are possible between water and burning materials

as soon as possible, wedge the vehicle.

Mind that water will be polluted during extinction (especialy if battery is damaged.) operate its containement with adequate equipment.

In there is no identified stake:

evaluate the opportunity to let the vehicle burn safely.

FINAL INSPECTION

• Cool the wreckage as soon as no heat point is detected by the thermal imaging device.

• After the last H2 atmospheric control, make sure that the vehicle or the wreckage is evacuated by authorized personnels (idealy by the manufacturer).

### Operational platform video of vehicle fire and presentation of intervention File V 2-B-2

Several cars (multi-energy) incident in tunnel File VR 2-B-2

#### 7.3.3 Wednesday

Wednesday (UK time)	Wednesday (UK time)				
09:15-10:00	Lecture 5: Liquefied	Lecture 5: Liquefied hydrogen			
10:00-10:15	Feedback session				
10:15-11:00	Lecture 6: Harm crit	eria for people and property			
11:00-11:15	Feedback session				
11:15-11:30	Comfort break				
11:30-12:15	Lecture 7: Unignited	hydrogen releases outdoors and their mitigation			
12:15-12:30	Feedback session				
12:30-13:15	Lunch break				
13:15-14:15	Sequence 3.A Liquid Hydrogen				
EM, LL	13:15-13:30	VR: Sphere feed pipe leak in industrial storage (puddle)			
LL	13:30-13:45	Debriefing / Doctrine / EERG presentation part 2.6			
LL	13:45-14:00	Video of liquid hydrogen spread phenomena			
EM, LL	14:00-14:15	VR: LH2 trailer incident in commercial area (LH2 dump)			
14:15-15:15	Sequence 3.B Transp	portation			
EM, LL	14:15-14:30	VR: H2 train fire in countryside			
LL	14:30-14:45	Debriefing / Doctrine / EERG presentation tactic sheet n°7			
LL	14:45-15:00	Operational platform presentation of intervention			
EM, LL	15:00-15:15	VR: H2 Bus Fire downtown			
15:15-15:30	Feedback session				

#### Lectures 5, 6 and 7:

Lecture 5: Liquefied hydrogen

Lecture 6: Harm criteria for people and property

Lecture 7: Unignited hydrogen releases outdoors and their mitigation

The stratified content **of each lecture and** slides can be found here: <u>https://hyresponder.eu/e-platform/training-materials/educational-training/</u>

#### Sequence 3.A Liquid Hydrogen Cf. exercise sheet part n°3.A



Day	3
Duration	1h00
Number of trainees	20

# Sphere feed pipe leak in industrial storage (puddle)

### Part n°2 of EERG: LH2 (focus on 2.6: hazardous phenomena)

Steps	Trainers	Topics	Pedagogic support	Duration	Teams
1	ENSOSP CRISE		Explanation of the context: VR 3-A-1 For the context: VR 3-A-1 For the context: Provide guidance to the trainees on what they should observe (i.e. characteristic of the leak)	5'	Plenary session
2	ENSOSP	Collective reflexion and proposal	Trainees' observations and their related operational proposals Main points: • assure the precise incident location, • type of vehicle concerned, • what happened.	10'	Subgroups
3	ENSOSP	Operational theory Doctrine + EERG presentation	<ul> <li>SIZE UP THE SCENE</li> <li>Is someone threatened by the leak? Where?</li> <li>Liquid cryogenic release</li> <li>unignited release: with cryogenic burns and/or anoxia in confined spaces</li> <li>ignited release:</li> <li>with immediate ignition inducing a jet fire</li> <li>with delayed ignition inducing a direct flammable cold cloud and a potential unconfined vapour cloud explosion or a cryogenic liquid pool followed by a</li> </ul>	15'	Plenary session

			flammable cloud due to hydrogen vaporization • RESCUE Is there a victim? Evaluate cryogenic burns and anoxia risks • EXPOSURE PROTECTION Use only necessary personnel. • INCIDENT TREATMENT prevent the fire to spread to a uninvolved part of the plant with water spray curtains. Close H2 valve as close as possible of the H2 tank. If it is not possible to reach a H2 valve, allow H2 to leak safely until the tank is empty. • FINAL INSPECTION Repeatedly check H2 presence in the atmosphere. View the part 2.6 of EERG		
4	ENSOSP	Operational platform presentation of intervention	Operational video and emphasize the points made earlier. V 3-A-2	5'	Plenary session
5	CRISE ENSOSP	LH2 truck incident in commercial area (LH2 dump)	VR 3-A-2	15'	Plenary session

Leak on the LH2 on platform. File V 3-A-1

#### Sphere feed pipe leak in industrial storage (puddle) File VR 3-A-1

### EERG part n°2.6: hazardous phenomena

#### 2.6. Hazardous phenomena

For liquid on-board hydrogen storage, the main feared events are:

- Liquid cryogenic release
  - o unignited release:
- with cryogenic burns and/or anoxia in confined spaces
  - $\circ \quad \text{ignited release:} \quad$
- with immediate ignition inducing a jet fire
- with delayed ignition inducing a direct flammable cold cloud and a potential unconfined vapor cloud explosion or a cryogenic liquid pool followed by a flammable cloud due to hydrogen vaporization
- Mechanical rupture of the tank inducing a blast wave
- 2.6.1. Potential consequences

2.6.1.1. Release without ignition

As previously said, in case of release without ignition, the main risks for first responders are cryogenic burns and/or anoxia.

Appropriate individual protection can protect the first responders against these damages.

2.6.1.2. Release with immediate ignition

In case of release with immediate ignition, a jet fire is induced, having thermal effects as hazardous consequences.

Release flowrates were calculated with e-laboratory tool applying Helmholtz free energy based equation of state, and horizontal jet fire characteristics and consequences are based on Schefer approach.

Release	Release Storage		Thermal effects			
diameter	pressure	flowrate	Flame length	3 kw.m <sup>-2</sup>	5 kw.m <sup>-2</sup>	8 kw.m <sup>-2</sup>
0.1 mm	1 bar	8.7·10 <sup>-6</sup> kg.s <sup>-1</sup>	0.1 m	< 0.1 m	< 0.1 m	< 0.1 m
1 mm	1 bar	8.7·10 <sup>-4</sup> kg.s <sup>-1</sup>	0.8 m	0.9 m	0.8 m	0.7 m
2 mm	1 bar	3.5·10 <sup>-3</sup> kg.s <sup>-1</sup>	1.5 m	1.7 m	1.5 m	1.4 m
4 mm	1 bar	1.4·10 <sup>-2</sup> kg.s <sup>-1</sup>	3.1 m	3.8 m	3.3 m	3 m

Table 13: Thermal effects for	jet fires considering	different pressures and	d release diameters
-------------------------------	-----------------------	-------------------------	---------------------

Table 14: Separation distances for jet fires considering different pressures and release diameters

Release	Storage	Thermal effects				
diameter	pressure	Flame length	No harm	Pain threshold	3 <sup>rd</sup> degree burns	
0.1 mm	1 bar	0.1 m	0.4 m	0.3 m	0.2 m	
1 mm	1 bar	0.8 m	2.8 m	2.4 m	1.6 m	
2 mm	1 bar	1.5 m	5.3 m	4.5 m	3 m	
4 mm	1 bar	3.1 m	10.9 m	9.3 m	6.2 m	

#### 2.6.1.3. Release with delayed ignition

For release with delayed ignition, an unconfined vapor cloud explosion is considered (UVCE). A flammable cloud is formed and its ignition induces a blast wave with overpressure effects as hazardous consequences, decreasing with the distance from ignition point.

Overpressure distances were calculated with the TNO Multi-Energy approach, considering a level 5; choice is done regarding hydrogen flowrate and considering the phenomenon in free field without or with small congestion.

Release is considered horizontal and ignition point is taken at 10%-H<sub>2</sub> in the axis of the release.

	Release	Storage	Hydrogen mass	Overpressure effects			
d	diameter	pressure		20 mbar	50 mbar	140 mbar	200 mbar
	0.1 mm	1 bar	2.5·10 <sup>-8</sup> kg	0.3 m	0.2 m	< 0.2 m	< 0.2 m

2.6 m

5.3 m

10.5 m

1.5 m

3 m

6 m

1 m

2 m

4 m

0.9 m

1.8 m

3.6 m

Table 15: Overpressure effects for UVCE considering different pressures and release diameters

#### 2.6.1.4. Mechanical rupture of the storage tank

1 bar

1 bar

1 bar

1 mm

2 mm

4 mm

In order to evaluate maximum hazardous distances, an engulfing fire is considered on a stand- alone cryogenic tank (type I) at maximum working pressure. The rupture pressure is 1.9 times the maximum liquid pressure.

Table 16: Overpressure effects due to tank burst considering different tank volumes

2.5·10<sup>-5</sup> kg

2.0.10<sup>-4</sup> kg

1.6·10<sup>-3</sup> kg

Tank volume	Maximum	Overpressure effects				
	pressure	20 mbar	50 mbar	140 mbar	200 mbar	
0.5 m <sup>3</sup>	13 bar	32 m	16 m	7 m	5 m	
1 m <sup>3</sup>	13 bar	41 m	20 m	9 m	6 m	
15 m <sup>3</sup>	13 bar	100 m	50 m	22 m	15 m	

LH2 trailer incident in commercial area (LH2 dump) File VR 3-A-2

Sequence 3.B Transportation Cf. exercise sheet part n°3.B

Ede National Suppliers de Oficies of Superstructure	<b>EXERCICE</b> <b>SHEET</b> PART n° 3.B – Transportation	<b>Hy Responder</b>
Day	3	
Duration	1h00	
Number of trainees	20	

# H2 train fire in countryside

# EERG reference: Tactic sheet n°7

Steps	Trainers	Topics	Pedagogic support		Teams
1	ENSOSP		Explanation of context:	5'	Plenary
	CRISE		VR 3-B-1		session
			Provide guidance to the trainees on what they		
			should observe		
2	ENSOSP	Collective reflexion and	Trainees' observations and their related operational proposals	10'	Subgroups
		proposar	• assure the procise incident location		
			• assure the precise incluent location,		
			• type of venicle concerned,		
2	ENGOGD	Operational		15'	Dlonory
5	LINSUSF	theory	• SIZE OF THE SCENE	15	richary
		Doctrine +	IF A PERSON IS INSIDE THE		50551011
		EERG	HAZARDOUS AREA ENGAGE		
		presentation	RESCUE OPERATIONS : Humans'		
		1	Rescue overrides all other considerations		
			, then answer the following questions		
			Is someone threatened by the fire? Where?		
			How many vehicles are involved in the fire?		
			How many of these vehicles are powered by H2		
			or another compressed flammable Gaz?		
			Find the FR arrive?		

Demand extra support if necessary Vehicle identification, H2 car may be identified by FCHV Fuel Cell Hybrid Vehicle badgesflammable cloud due to hydrogen vaporization	
<ul> <li>RESCUE</li> <li>Is there a victim?</li> <li>Team 1: extract the victim(s) from the danger zone by any possible means (extraction tool : use the method implemented in the country).</li> <li>A pump-operated system might be safer than a battery-operated, however pump should be in safe zone and respect the distance with the car.</li> <li>Team 2: stretch a fire hoseline to protect the action of the Team 1 in case of an ignition of</li> </ul>	
the cloud • EXPOSURE PROTECTION Press the fuel cell emergency shutdown device For trucks, trains and ships: safety data sheets or on-board rescue sheet Repeatedly check H2 presence in the atmosphere Refine safety area Repeatedly check H2 tanks temperature with thermal imaging device	
<ul> <li>INCIDENT TREATMENT         In case of high stakes level situation, operate an offensive fire attack, each team prepare 80 m of hoselines directly connected to the fire engine pump         Team 1: aims to cool the H2 tank and so doing prevent Thermal Pressure Release Device to operate         Team 2: aims to extiguish the vehicle fire         According to the size of the event and the vehicle affected, adapt the plan of action by engaging additional teams. Reminder : keep the strategy of a two teams engagement.     </li> </ul>	
Teams should avoid passing through danger angles (close to the storage zone of the vehicle : on the roof for Buses and Trains / same as cars for Trucks).	

			Mind that violent reactions are possible between water and burning materials as soon as possible, wedge the vehicle Mind that water will be polluted during extinction (especialy if battery is damaged.), operate its containement If there is no identified stake, evaluate the opportunity to let the vehicle burn safely. Be aware that FCH can burn for a long period. prevent the fire to spread to a uninvolved part of the plant with water spray curtains. Close H2 valve as close as possible of the H2 tank. If it is not possible to reach a H2 valve, allow H2 to leak safely until the tank is empty. • FINAL INSPECTION Cool the wreckage as soon as no heat point is detected by the thermal imaging device After a last H2 atmospheric control, make sure that the vehicle or the wreckage is evacuated by authorized personnels (idealy manufacturer) Repeatedly check H2 presence in the atmosphere		
4	CDICE		view the full factic sheet n° / of EERG	157	DI
4	CRISE ENSOSP	H2 Bus Fire downtown	VR scenario n°3-B-2 Key point:	15'	Plenary session

H2 train fire in countryside File VR 3-B-1

FERG: tactic	sheet n°7				
ELRO. were	FC BUS / FC TRUCKS / FC TRAINS	Hy Responder			
Tactic n° 7	FIRE				
	AT THE FIRE STATION				
TAKE USEFUL information	on ABOUT THE INCIDENT				
<ul> <li>Assure the prec</li> <li>Are there any p</li> <li>Type of vehicle</li> <li>What happened</li> </ul>	ise incident location (may include using vehicle tracking) erson involved in the incident? concerned with manufacturer's emergency response gui I?	dance			
WEATHER CONDITIONS					
Wind direction					
• Wind speed •	e itinerary				
<ul> <li>Do not cross an eventual explosive gas cloud</li> <li>Do not reach scene from bellow</li> <li>Anticipate the need of a hydrant</li> </ul>					
<ul> <li>Gaseous hydrod</li> <li>H2 detector</li> <li>O2 detector</li> <li>Thermal imagin</li> </ul>	<ul> <li>Gaseous hydrocarbons detector</li> <li>H2 detector</li> <li>O2 detector</li> </ul>				
- mermarmagin	ARRIVAL ON SCENE				
ARRIVAL					
<ul> <li>Choose a safe w and make sure f</li> <li>Stop the fire ap</li> <li>Away from a po</li> <li>Engage the pum</li> <li>SAFETY AREA</li> </ul>	vay to get to the incident ground, preventing the fire ap to arrive upwind pliance between 50 and 100 meters before the incident ssible ignited flammable liquid leak progression up and connect the fire appliance to a hydrant	pliance to cross a flammable gaz cloud,			
<ul> <li>CAR and FORKLIFT Set up a safety area for the public beyond a radius of 100 meters</li> <li>BUS, truck, train, ship:Set up a safety area for the public beyond a radius of 200 meters</li> <li>Ensure that unauthorized/untrained personnel do not enter the hazardous area</li> </ul>					
		an answer the following questions			
<ul> <li>Is someone three</li> <li>How many vehi</li> <li>How many of the</li> </ul>	<ul> <li>A PERSON IS INSIDE THE HAZARDOUS AREA, ENGAGE RESCUE OPERATIONS then answer the following questions</li> <li>Is someone threatened by the fire? Where?</li> <li>How many vehicles are involved in the fire?</li> <li>How many of these vehicles are powered by H2 or another compressed flammable Gaz?</li> </ul>				
36					

• Has a loud hissing sound been eared before the FR arrive? o Demand extra support if necessary

Vehicle identification, H2 car may be identified by FCHV Fuel Cell Hybrid Vehicle badges

RESCUE

Humans' Rescue overrides all other considerations

Engage rescue as a conventional accident with hazmat support, if a human is threatened or concerned by the fire Be equiped with PBE.

• Team 1: extract the victim(s) from the danger zone by any possible means. A path must have been identified by thermal camera due to the multiples directions possibility of the TPRD or obstacles which would deflect the natural direction of the flame.

• Team 2: stretch a fire hoseline to protect the action of the team 1

According to the size of the event and the vehicle affected, adapt the plan of action by engaging additional teams. Reminder : keep the strategy of a two teams engagement.

Evacuate the passengers in the opposite direction of the wind (or in worst case as far as possible in the direction of wind).

#### EXPOSURE PROTECTION

Use only necessary personnel

Evacuate adjacent buildings

Prevent the fire from spreading to a uninvolved vehicle(s) or building(s)

Move ajacent non involved vehicles by any way possible (driving, towing, pushing...)

If the vehicle is in a building, prevent combustion gases and H2 accumulation by operating wide ventilation of the building

Open the doors and hoods (if present)

Set parking brake

Wedge the vehicle

Turn off the ignition key

Press the fuel cell emergency shutdown device

- For buses, an emergency shutdown device is generally located near the driver seat on left side and another is on fuel cell in "engine" compartment, located at the back of the bus.
- For trucks, trains and ships: safety data sheets or on-board rescue sheet

Repeatedly check H2 presence in the atmosphere Refine safety area

Repeatedly check H2 tanks temperature with thermal imaging device

INCIDENT TREATMENT

In case of high stakes level situation, operate an offensive fire attack, each team prepare 80 m of hoselines directly connected to the fire engine pump

• Team 1: aims to cool the H2 tank and so doing prevent Thermal Pressure Release Device to operate

• Team 2: aims to extiguish the vehicle fire

•

According to the size of the event and the vehicle affected, adapt the plan of action by engaging additional teams. Reminder : keep the strategy of a two teams engagement.

Teams should avoid passing through danger angles (close to the storage zone of the vehicle : on the roof for Buses and Trains / same as cars for Trucks).

Mind that violent reactions are possible between water and burning materials as soon as possible, wedge the vehicle

Mind that water will be polluted during extinction (especialy if battery is damaged.), operate its containement

If there is no identified stake, evaluate the opportunity to let the vehicle burn safely. Be aware that FCH can burn for a long period.

#### FINAL INSPECTION

• Cool the wreckage as soon as no heat point is detected by the thermal imaging device

• After a last H2 atmospheric control, make sure that the vehicle or the wreckage is evacuated by authorized personnels (idealy manufacturer)

#### H2 Bus Fire downtown File VR 3-B-2

#### 7.3.4 Thursday

Thursday (UK time)				
09:15-10:00	Lecture 8: Ignition so	Lecture 8: Ignition sources and prevention of ignition		
10:00-10:15	Feedback session			
10:15-11:00	Lecture 9: Hazard di	stances from hydrogen flames		
11:00-11:15	Feedback session			
11:15-11:30	Comfort break			
11:30-12:15	Lecture 10: Dealing	with hydrogen explosions		
12:15-12:30	Feedback session			
12:30-13:15	Lunch break			
13:15-14:15	Sequence 4.A Small storage			
EM, LL	13:15-13:30	VR: Bottle rack dispersion (dismantled rack and leak)		
LL	13:30-13:45	Debriefing / Doctrine / EERG presentation tactic sheet n°9		
LL	13:45-14:00	Operational platform video of trailer - presentation of intervention		
EM, LL	14:00-14:15	VR: Dismantled H2 trailer on motorway		
14:15-15:15	Sequence 4.B Explosion FC container			
EM, LL	14:15-14:30	VR: Explosion in fuel cell container (remote station)		
LL	14:30-14:45	Operational debriefing		
EM, LL	14:45-15:15	Slot free for discussion on preceding topic		
15:15-15:30	Feedback session			

#### Lectures 8, 9 and 10:

Lecture 8: Ignition source and prevention of ignition Lecture 9: Hazard distances from hydrogen flames Lecture 10: Dealing with hydrogen explosions

The stratified content **of each lecture and** slides can be found here: <u>https://hyresponder.eu/e-platform/training-materials/educational-training/</u>

Sequence 4.A Small storage Cf. exercise sheet part n°4.A

ENSOSP	EXERCICE SHEET	Hy Responder
core realizione apprintere des criscers de approprioripies	PART n° 4.A –	
	Small storage	
Day	4	

Day	4
Duration	1h00
Number of trainees	20

# Bottle rack dispersion (dismantled rack and leak)

### EERG reference: Tactic n°9

Steps	Trainers	Topics	Pedagogic support	Duration	Teams
1	ENSOSP		Explanation of context	5'	Plenary
	CRISE		VR 4-A-1		session
			Provide guidance to the trainees on what they		
_		~ 11 1	should observe		~ 1
2	ENSOSP	Collective	Trainees' observations and their related	10'	Subgroups
		reflexion	operational proposals		
		and	Main points:		
		proposal	✓ assure the precise incident location,		
			✓ type of vehicle concerned,		
			✓ what happened		

3	ENSOSP	Operational	SIZE UP THE SCENE	15'	Plenary
		theory	Is someone injured? Threatened?		session
		Doctrine +	Which Type is the involved vehicle? If available		
		EERG	and not excessively time consuming use google		
		presentation	lens to help identify.		
			Has a leak occured? Is a leak still occuring?		
			Is a part of the truck damaged?		
			Is the trailer dismanteled? Is there a loss of		
			cargo?		
			Check energies present in the involved vehicle		
			(tank type, refueling hole type, vehicle		
			registration papers)		
			Does a flammable liquid leak exists?		
			Operate H2 detector		
			View the safety data sheet (if available and not		
			excessively time consuming).		
			• RESCUE		
			Engage rescue as a conventional accident.		
			Adapt and engage rescue following		
			conventional national and european tactics.		
			Humans' rescue overrides all other		
			considerations.		
			EVERIDE DE CECTION		
			• EXPOSURE PROTECTION		
			Repeatedly check H2 presence in the		
			atmosphere. If H2 is detected apply H2 leak		
			tactic.		
			Check if high temperature points exist on the		
			vehicle by using thermal camera (more than		
			150°C/302°F)		
			stretch a fire noseline to protect the action of		
			If available, prioritize the use of non-sparking		
			tools.		
			INCIDENT TREATMENT		
			check and close every H2 value on the trailer		
			with the protection of an armed hoseline.		

			If no H2 leak and no sign of fire is detected : at all times keep H2 measuring active. DO NOT: • cut or crush H2 lines • damage H2 tanks If there is a loss of cargo or if the trailer is damaged, inspect individualy each cylinder contact the transport company hotline to evacuate safely the cylinders • FINAL INSPECTION After a last H2 atmospheric control, make sure that the vehicle or the wreckage and the cargo is evacuated by authorized personnels (idealy transport company). Secure the environment : if possible, move tanks and other tank vehicles out of the area of activity. Consider and organise the safety precautions needed while salvage and towing View the full tactic sheet n°9 of EERG		
4	ENSOSP	Operational platform presentation of intervention	V 4-A-2	10'	Plenary session
5	CRISE ENSOSP	Dismantled H2 trailer on motorway	Emphasize the points made earlier. VR 4-A-2	15'	Plenary session

Bottle rack dispersion (dismantled rack and leak) File VR 4-A-1

*EERG: tactic sheet n°9* 

	H2 trailer			
	NO LEAK NO FIRE			
	(technical alarm, work accident, road trafic accident)			
	AT THE FIRE STATION			
TAKE USEFUL inform	ation ABOUT THE INCIDENT:			
• Assure the precise	incident location (may include vehicle tracking)			
Are there any perso	on involved in the incident?			
<ul> <li>Type of trailer concerned? Size, cargo? Is if full or empty? Search for manufacturer's emergency response guidance</li> <li>Is the cargo dismanteled?</li> <li>See Twitterfacebook or other channel of information to find real-time nicture</li> </ul>				
WEATHER CONDITIONS				
<ul> <li>wind direction</li> </ul>				
<ul> <li>wind speed</li> </ul>				
Use a weather	er app like <u>https://www.weather-forecast.com</u>			
ITINERARY				
choose a safe itinera	ry :			
<ul> <li>do not cross an even</li> </ul>	entual explosive gas cloud			
<ul> <li>do not reach scene</li> </ul>	from below			
<ul> <li>anticipate the need</li> </ul>	d of a hydrant			
TAKE FOLLOWING TO	OOLS (if availble use drone UAV – use ATEX device):			
Gaseous hydrocarb	ons dectector,			
H2 detector				
U2 detector     Thermal imaging of				
Inermai imaging ca     Moor fully protoctiv	amera			
Additional resources	· Check ISO 17840 / EBG 2020 (Guide 115)			
Additional resources	ARRIVAL ON SCENE			
ARRIVAL :				
Choose a safe way	to get to the incident ground, preventing the fire equipment to cross a flammable gas cloud,			
and make sure to arr	ive upwind.			
• Stop the fire equip	ment between 50 and 100 meters (55 - 110 yd) before the incident.			

- away from a possible ignited flammable liquid leak progression.
- Approach objects taking into account possible ignotion of leaking H2
- Engage the pump and connect the fire equipment to a hydrant.

<ul> <li>Deploy and arm a hose-line for safety of for a primary attack</li> </ul>			
Only absolutely necessary staff on site . Explore the surroundings : e.g. tanks, Hydrogen Station etc. with a view of			
the domino effect.			
SAFETY AREA			
<ul> <li>Set up a safety area for the public beyond a radius of 50 - 100 meters (55-110 yd)</li> </ul>			
<ul> <li>Ensure that unauthorized/untrained personnel do not enter the hazardous area</li> </ul>			
<ul> <li>Check for possible ignition sources, consider static electricity</li> </ul>			
SIZE UP THE SCENE			
• BY QUESTIONNING THE WITNESSES AND OBSERVATION, ANSWER THE FOLLOWING QUESTIONS :			
o Is someone injured? Threatened?			
o Which Type is the involved vehicle? If available and not excessively time consuming use google lens to help			
identify.			
o what has happened?			
o Has a leak occured? Is a leak still occuring?			
o Is a part of the truck damaged?			
o Is the trailer dismanteled? Is there a loss of cargo ?			
o Demand extra support if necessary			
• Check energies present in the involved vehicle (tank type, refueling hole type, vehicle registration papers)			
• does a flammable liquid leak exists?			
• operate H2 detector			
View the safety data sheet (if available and not excessively time consuming).			
RESCUE			
Engage rescue as a conventional accident. Adapt and engage rescue following conventional national and european			
tactics.			
Humans' rescue overrides all other considerations.			
EXPOSURE PROTECTION			
Use only necessary personnel			
• Set parking brake			
Wedge the vehicle.			
• Turn off the ignition key			
• Repeatedly check H2 presence in the atmosphere. If H2 is detected apply H2 leak tactic.			
• Check if high temperature points exist on the vehicle by using thermal camera (more than 150°C/302°F)			
• Stretch a fire hoseline to protect the action of other teams			
If available, prioritize the use of non-sparking tools.			
INCIDENT TREATMENT			
• Check and close every H2 valve on the trailer with the protection of an armed hoseline.			
• If no H2 leak and no sign of fire is detected :			
Proceed and act as in an usual road trafic accident and by the corresponding extrication guidelines. At all times			
keep H2 measuring active.			
DO NOT:			
cut or crush H2 lines			
damage H2 tanks			
If there is a loss of cargo or if the trailer is damaged, inspect individualy each cylinder			

Contact the transport company hotline to evacuate safely the cylinders

Grant Agreement No: 875089 D3.2 HyResponder "Short course for trainers"

#### FINAL INSPECTION

• After a last H2 atmospheric control, make sure that the vehicle or the wreckage and the cargo is evacuated by authorized personnels (idealy transport company).

Secure the environment : if possible, move tanks and other tank vehicles out of the area of activity.

Consider and organise the safety precautions needed while salvage and towing

Operational platform video of dismantled trailers - presentation of intervention File V 4-A-2

Dismantled H2 trailer on motorway File VR 4-A-2

Sequence 4.B Explosion in fuel cell container Cf. exercise sheet part n°4.B



Day	1
Duration	1h00
Number of trainees	20

### **Explosion in a FC container**

#### EERG reference: Tactic n°19

Steps	Trainers	Topics	Pedagogic support	Duration	Teams
1	ENSOSP CRISE	Operational theory	VR 4-B-1 VR	5'	Plenary session
2	ENSOSP	Collective reflexion and proposal	• TAKE USEFUL information ABOUT THE INCIDENT: assure the precise incident location and the concerned power	10'	Subgroups

			is this stationary power generation unit kwown by the fire service? Does a firefighting plan exists? take it in the fire equipment and read it on the road. witch part of the application is concerned by the incident? (Fuel cell, H2/O2 storage, photovoltaic panels, wind tubine) are there any person involved in the incident? what happened?		
3	ENSOSP	Doctrine + EERG	<ul> <li>SIZE UP THE SCENE</li> <li>witch part of the application is concerned by the incident? (Fuel cell, H2/O2 storage, photovoltaic panels, wind tubine)</li> <li>Has a leak occured? Is a leak still occuring?Which ones?</li> <li>is the system delivering electricity?</li> <li>Is a technician present on the plant area?</li> <li>look for the emergency fire and rescue plan.</li> <li>locate precisely dangerous areas, Emergency shutdown devices, valves,</li> <li>evaluate the amount of compressed gases present in the tanks.</li> <li>Demand extra support if necessary         <ul> <li>RESCUE</li> <li>Is there a victim?</li> <li>EXPOSURE PROTECTION</li> <li>As it is possible:</li> <li>Isolate (pressure, gas supply, electricity)</li> <li>energy production unit, fuel cell and storages</li> <li>(each one from the others)</li> <li>INCIDENT TREATMENT</li> <li>the fire concerns the Fuel cell Compartment.</li> <li>Push Emergency shutdown devices</li> <li>prevent the fire to spread to a uninvolved part of the plant with water spray curtains.</li> <li>do not open the FC comparment.</li> <li>FINAL INSPECTION</li> </ul> </li> <li>Cool the wreckage as soon as no heat point is detected by the thermal imaging device.</li> <li>Repeatedly check H2 presence in the atmosphere.</li> <li>View of the full tactical sheet n°19</li> </ul>	15'	Plenary session
4	CRISE ENSOSP		Main points: - Use tools: thermal imaging camera + detectors H2, O2 and others if provided - Use the technician knowledge	15'	Plenary session

	<ul> <li>look for the mergency fire and rescue plan.</li> <li>locate precisely dangerous areas, Emergency shutdown devices, valves,</li> <li>Photovoltaic panels</li> <li>Storage: evaluate the amount of compressed gases present in the tanks.</li> <li>each Team prepare 80 m of hoselines directly connected to the fire equipment pump</li> <li>Team 1: aims to cool the H2 tank to prevent pressure increase in the tanks</li> <li>Team 2: aims to extinguish the fire Final inspection</li> </ul>		
--	--	--	--

Explosion in fuel cell container File VR 4-B-1

### EERG TACTIC SHEET n°19 cf p.15

*EERG: general discussion about operational approach Free slot for discussion on preceding topics or else* 

### 7.3.5 Friday

Friday (UK time)			
09:15-10:00	Lecture 11: Confined spaces		
10:00-10:15	Feedback session		
10:15-11:00	Lecture 12: Hydrogen refuelling stations and infrastructure		
11:00-11:15	Feedback session		
11:15-11:30	Comfort break		
11:30-12:15	Overview of terminology		
12:15-12:30	Feedback session		
12:30-13:15	Lunch break		
13:15-14:00	National specificities and feedback		
14:00-14:30	Round-table discussion and closure of the event.		

### Lectures 11 and 12:

Lecture 11: Confined spaces Lecture 12: Hydrogen refuelling stations and infrastructure Only lectures on Friday, but:

- Broaden work done in the preceding days in the scope of national trainings: what can be done, how, with which material, guidelines, how to share and gain experience with no VR and no Op platform, How to, etc.
- Discussions in this scope relative to VR

Same thing in the frame of operational platform.

### ANNEXE n°1

### Sequence of sequences

Day	PART N°	SEQUENCE	VIRTUAL REALITY SIMPLE EXERCISE (CRISE - ENSOSP)	REAL PHENOMENA VIDEOS (ENSOSP)	OPERATIONAL VIDEOS (ENSOSP)	Tactic sheet	VIRTUAL REALITY EXERCISE (MORE COMPLEX) (CRISE - ENSOSP)
	1.A	Presentation VR	Introduction Virtual Reality and operational tactical reminder				
Monday	1.B	Equipment fuel cell	Simple fire into a remote location of radio antenna power generator	х	х		Fuel Cell fire into industrial estate, near H2 production line.
Tuesday	2.A	lgnited gaseous leak	Leak on the H2 feeding of a forklift station in (or out?) a storage area	х	х		Ignited leak on the storages of a solar production site
	2.B	Vehicles fire	Single car burning in open grounds	Х	х		Several cars (multi-energy) incident in tunnel
Wednesday	3.A	Liquid Hydrogen	Sphere feed pipe leak in industrial storage (puddle)	х	х		LH2 trailer incident in commercial area (LH2 dump)
	3.B	Transportation	H2 train fire in countryside				H2 Bus Fire downtown
Thursday	4.A	Small storage	Bottle rack dispersion (dismantled rack and leak)	х	х		Dismantled H2 trailer on motorway
	4.B		Explosion in fuel cell container (remote station)	х			NONE PLANNED, WE KEEP THIS SLOT FREE FOR DISCUSSION ON PRECEDING TOPICS OR ELSE
Friday		Feedback	<ul> <li>No sequence but:         <ul> <li>Broaden work done in the preceding days in the scope of national trainings: what can be done, how, with which material, guidelines, how to share and gain experience with no VR and no Op platform, How to, etc.</li> <li>Discussions in this scope relative to VR</li> <li>Same thing in the frame of operational platform</li> </ul> </li> </ul>				

Videos of the proposed VR scenarios will be available in the Training Kit, along with 'making of' videos shot during the pedagogic setup in ENSOSP

#### ANNEXE n°2

#### Detail about the timing pedagogic situation

Group: 20 trainees Sub-groups: 4 trainees per sub-group Duration per exercise: 1h00 maxi

VIRTUAL REALITY EXERCISE (SIMPLE) (0h15) Situation analysis: 5 min Return of the 4 sub-groups: 10 min

<u>OPERATIONAL THEORY (0h15)</u> Adjustment points about EERG tactics: theoretical + operational

Reminder:

- Operational organization
- Analysis of the intervention area

- ....

<u>REAL PHENOMENA AND OPERATIONAL VIDEOS (0h15)</u> Video of the phenomena Video of the operational practice Comments and additional information during the video

VIRTUAL REALITY EXERCISE (MORE COMPLEX) (0h15) Situation analysis: 5 min Return: 10 min