Clean Hydrogen Partnership

European Hydrogen Safety Panel (EHSP)

# Statistics, lessons learnt and recommendations from the analysis of HIAD 2.0 database

Jennifer Wen, Marta Maroño, Pietro Moretto, Ernst-Arndt Reinecke, Pratap Sathiah, Etienne Studer, Elena Vyazmina, Daniele Melideo, **Iñaki Azkarate**

**European Hydrogen Safety Panel (EHSP)**

**18 May 2022**


EUROPEAN PARTNERSHIP

EHEC 2022 EUROPEAN HYDROGEN ENERGY CONFERENCE

AeH2 ASOCIACIÓN ESPAÑOLA DEL HIDRÓGENO

# Background

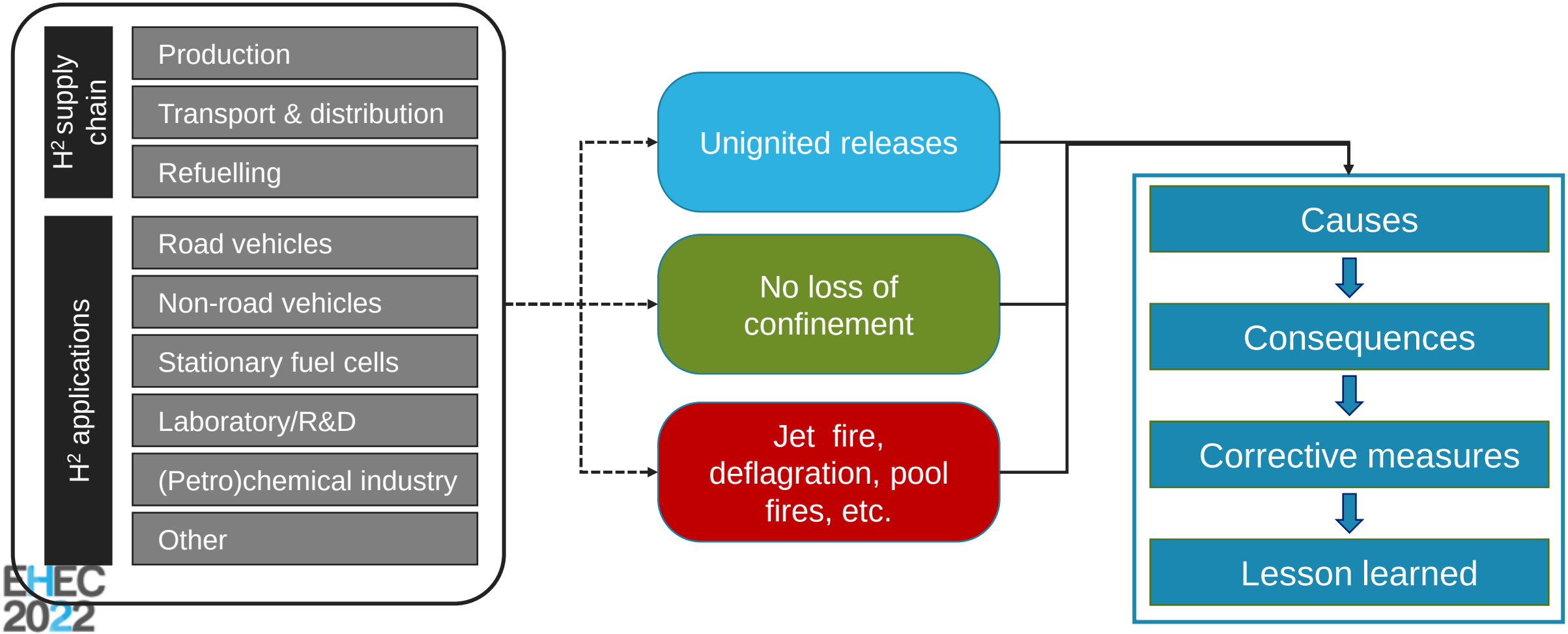
## HIAD

- The Hydrogen Incidents and Accidents Database (HIAD) was firstly developed within the HySAFE Network of Excellence by the Joint Research Centre of the EC (JRC) .
- Updated by JRC as HIAD 2.0 in 2016.
- Since its launch in 2017, the EHSP has been working closely with JRC to enlarge and improve HIAD 2.0.

Sources of HIAD 2.0:

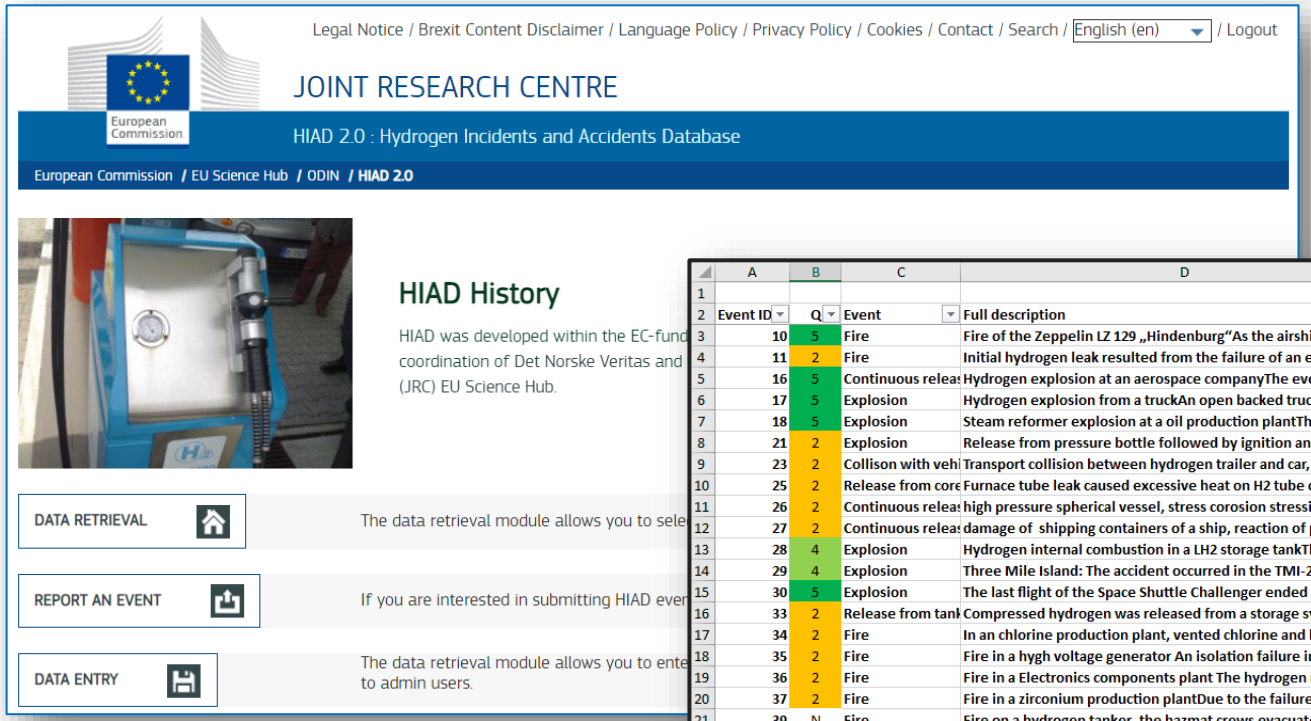
- public, from scientific literatures, news.
- Other public not hydrogen-specific databases such as ARIA (Analysis, Research and Information on Accidents, F), SEVESO (Eu), eMARS (Eu), US CSB, NTSB, OHS, national nuclear authorities, etc.

# HIAD 2.0 Database structure



# How to access HIAD

While HIAD 2.0 database is offline due to maintenance, those who need to access the information should contact pietro.moretto@ec.europa.eu

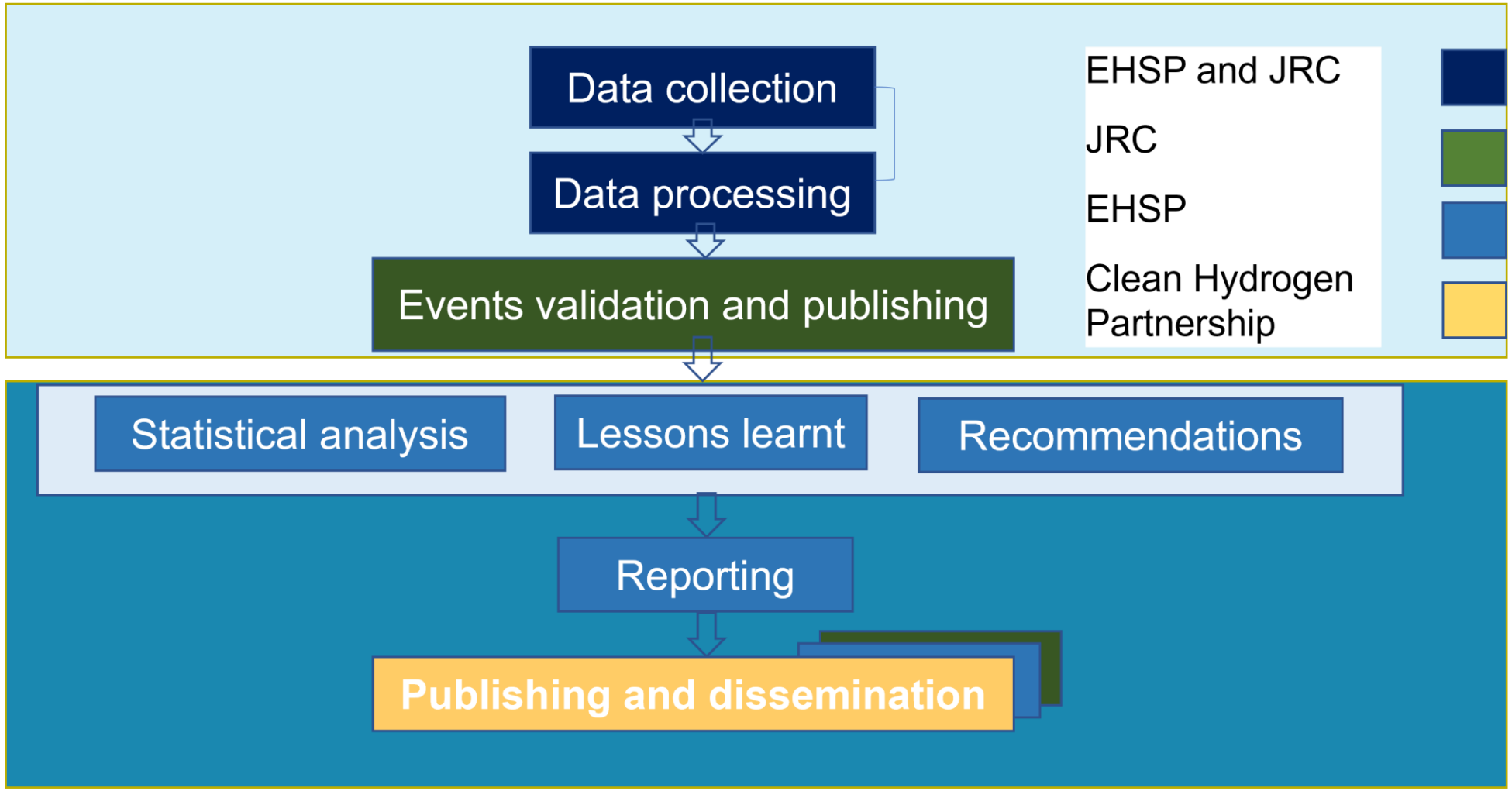



Since 2021 not accessible online, but via an Excel file

| | A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | |
| 2 | Event ID | Q | Event | Full description | Classification | Physical consequences | Application sta | Systems involv | Region | Country |
| 3 | 10 | 5 | Fire | Fire of the Zeppelin LZ 129 „Hindenburg“As the airship approached | Hydrogen system initiating event | Jet Fires and Explosions | Non-Road vehicle | zeppelin, gas stor | | UNITED STATES |
| 4 | 11 | 2 | Fire | Initial hydrogen leak resulted from the failure of an elbow welded c | Hydrogen system initiating event | Jet Fires and Explosions | Chemical/Petroch | Failure of a 2-inch | | UNITED STATES |
| 5 | 16 | 5 | Continuous releas | Hydrogen explosion at an aerospace companyThe event occurred in | Hydrogen system initiating event | Unignited Hydrogen Releas | Chemical/Petroch | support buildings | | UNITED STATES |
| 6 | 17 | 5 | Explosion | Hydrogen explosion from a truckAn open backed truck was deliverir | Hydrogen system initiating event | Jet Fires and Explosions | Hydrogen transpo | Industrial pressur | | SWEDEN |
| 7 | 18 | 5 | Explosion | Steam reformer explosion at a oil production plantThe event occurr | Hydrogen system initiating event | Jet Fires and Explosions | Chemical/Petroch | steam reformer | | CANADA |
| 8 | 21 | 2 | Explosion | Release from pressure bottle followed by ignition and perhaps fast | Hydrogen system initiating event | Jet Fires and Explosions | Hydrogen transpo | Compressed hydr | | PEOPLE REPUBLIC |
| 9 | 23 | 2 | Collison with vehi | Transport collision between hydrogen trailer and car, without hydro | Non-Hydrogen system initiating event | No Hydrogen Release | Road vehicle | gaseous hydroger | | |
| 10 | 25 | 2 | Release from core | Furnace tube leak caused excessive heat on H2 tube causing rupture | Hydrogen system initiating event | Unignited Hydrogen Releas | Chemical/Petroch | hydrogen pipeline | | UNITED STATES |
| 11 | 26 | 2 | Continuous releas | high pressure spherical vessel, stress corosion stressing by hydogen | Hydrogen system initiating event | Unignited Hydrogen Releas | Chemical/Petroch | high pressure spe | | GERMANY |
| 12 | 27 | 2 | Continuous releas | damage of shipping containers of a ship, reaction of phosphorpentc | Hydrogen system initiating event | Unignited Hydrogen Releas | Non-Road vehicle | high pressure sph | | CANADA |
| 13 | 28 | 4 | Explosion | Hydrogen internal combustion in a LH2 storage tankThe accident occ | Hydrogen system initiating event | Jet Fires and Explosions | Laboratory / R&D | liquid hydrogen ci | | FRANCE |
| 14 | 29 | 4 | Explosion | Three Mile Island: The accident occurred in the TMI-2 reactor (the pl | Hydrogen system initiating event | Jet Fires and Explosions | Chemical/Petroch | | | UNITED STATES |
| 15 | 30 | 5 | Explosion | The last flight of the Space Shuttle Challenger ended 73 seconds afte | Hydrogen system initiating event | Jet Fires and Explosions | Non-Road vehicle | external fuel tank | | |
| 16 | 33 | 2 | Release from tank | Compressed hydrogen was released from a storage system due to th | Hydrogen system initiating event | Unignited Hydrogen Releas | Chemical/Petroch | hydrogen storage | | UNITED STATES |
| 17 | 34 | 2 | Fire | In an chlorine production plant, vented chlorine and hydrogen, auto | Hydrogen system initiating event | Jet Fires and Explosions | Other | chlorine electroly | | UNITED STATES |
| 18 | 35 | 2 | Fire | Fire in a hygh voltage generator An isolation failure in starter coil of | Hydrogen system initiating event | Jet Fires and Explosions | Chemical/Petroch | hydrogen pipe, hi | | UNITED STATES |
| 19 | 36 | 2 | Fire | Fire in a Electronics components plant The hydrogen release of a de | Hydrogen system initiating event | Jet Fires and Explosions | Other | hydrogen supply l | | UNITED STATES |
| 20 | 37 | 2 | Fire | Fire in a zirconium production plantDue to the failure of a exhaust s | Hydrogen system initiating event | Jet Fires and Explosions | Other | hydrogen exhaust | | UNITED STATES |
| 21 | 39 | N | Fire | Fire on a hydrogen tanker, the hazmat crews evacuated the workers | Hydrogen system initiating event | Jet Fires and Explosions | Chemical/Petroch | Hydrogen tanker | | UNITED STATES |
| 22 | 40 | 5 | Explosion | Hydrogen-air explosion in an ammonium plant.This resulted in the c | Hydrogen system initiating event | Jet Fires and Explosions | Chemical/Petroch | hydrogen vessel, | | NORWAY |
| 23 | 43 | A | ntinuous releas | Hydrogen release from a road truck transporting liquid hydrogen | Hydrogen system initiating event | Unignited Hydrogen Releas | Hydrogen transpo | vent system, LH2- | | UNITED STATES |
| 24 | 44 | 5 | Explosion | Hydrogen explosion and fire in a petrochemical complex. The explo | Hydrogen system initiating event | Jet Fires and Explosions | Chemical/Petroch | litol benzene onv | | CANADA |
| 25 | 46 | 2 | Fire - hydrogen | Lightning caused fires at plant near Hamburg after igniting a hydrog | Hydrogen system initiating event | Jet Fires and Explosions | Chemical/Petroch | Ventilation pipe | | GERMANY |
| 26 | 47 | 3 | Explosion | An explosion occurred involving a COY Microbiological Anaerobic Cl | Hydrogen system initiating event | Jet Fires and Explosions | Laboratory / R&D | microbiological ar | | |
| 27 | 49 | 2 | Explosion | Explosion at chemical plant in Akita Prefecture involving hydrogen k | Hydrogen system initiating event | Jet Fires and Explosions | Chemical/Petroch | | | JAPAN |
| 28 | 51 | 2 | Explosion | Explosion at Shreveport refinery involving hydrogen injured a work | Hydrogen system initiating event | Jet Fires and Explosions | Chemical/Petroch | | | UNITED STATES |
| 29 | 52 | 4 | Explosion | Hydrogen explosion in a unit of a nuclear power plant.The explosior | Hydrogen system initiating event | Jet Fires and Explosions | Chemical/Petroch | reactor cooling sy | | |
| 30 | 53 | 2 | Explosion | 3 workers were injured in the hydrogen explosion | Hydrogen system initiating event | Jet Fires and Explosions | Chemical/Petroch | - | | FINLAND |

EHEC 2022
EUROPEAN HYDROGEN ENERGY CONFERENCE
EUROPEAN PARTNERSHIP

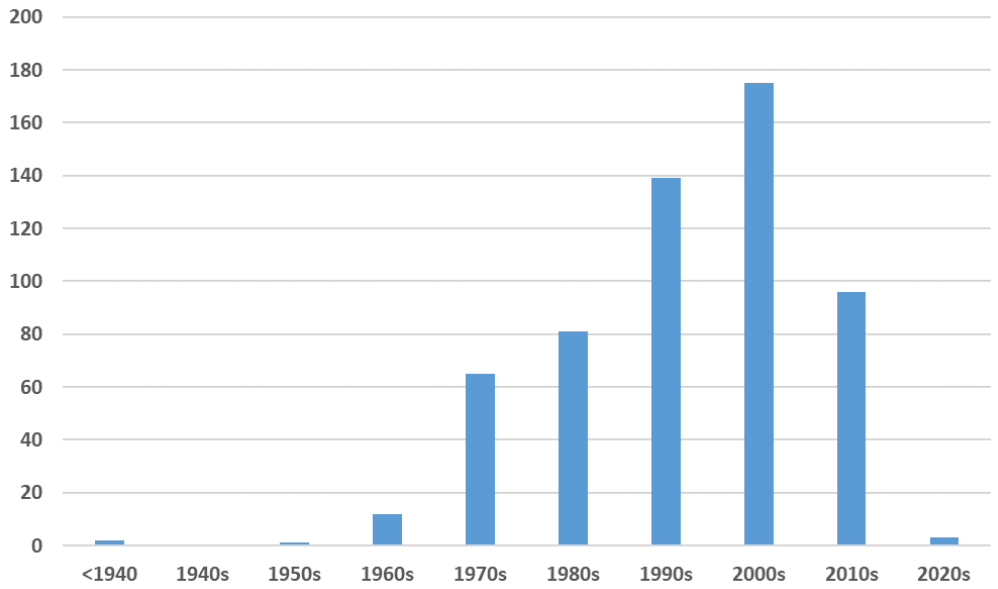
# Overview of the data collection and assessment process



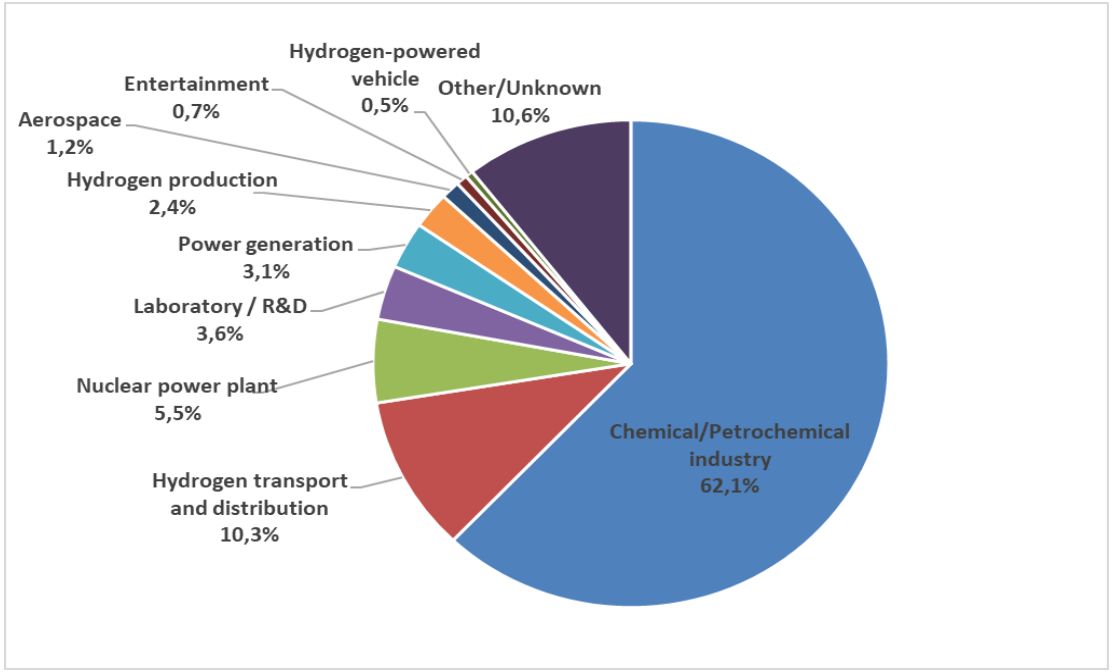
# Results from the statistics analysis (1)

The analysis reported here is based on the 706 incidents, which were in the database as of May 2021. A total of 576 of these events were considered to be statistically relevant and formed the basis for the statistical analysis to inform lessons learned and recommendations.

## Years



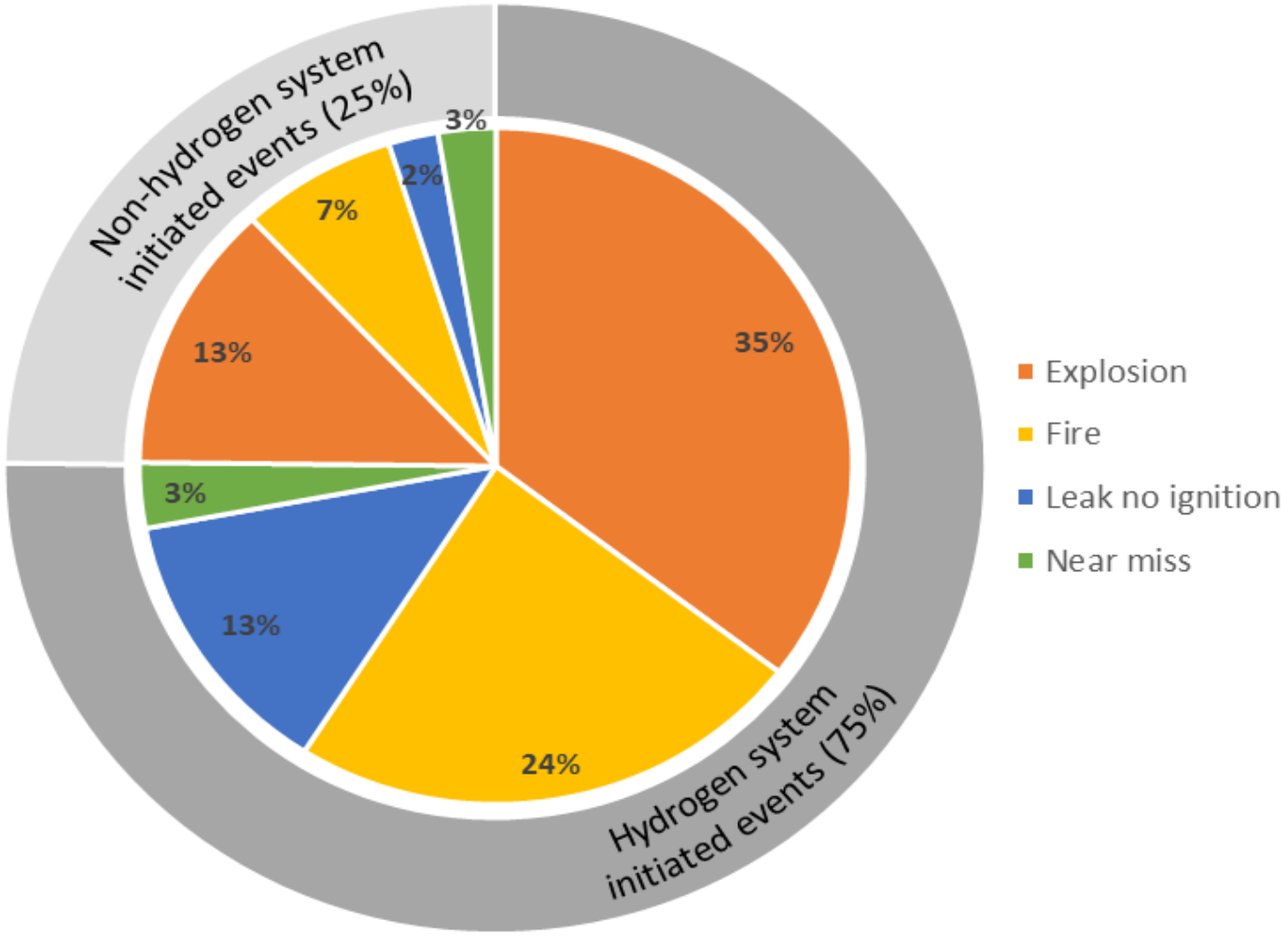

## Industrial sectors




EHEC 2022
EUROPEAN HYDROGEN ENERGY CONFERENCE
EUROPEAN PARTNERSHIP

Co-funded by the European Union

# Results from the statistics analysis (2)

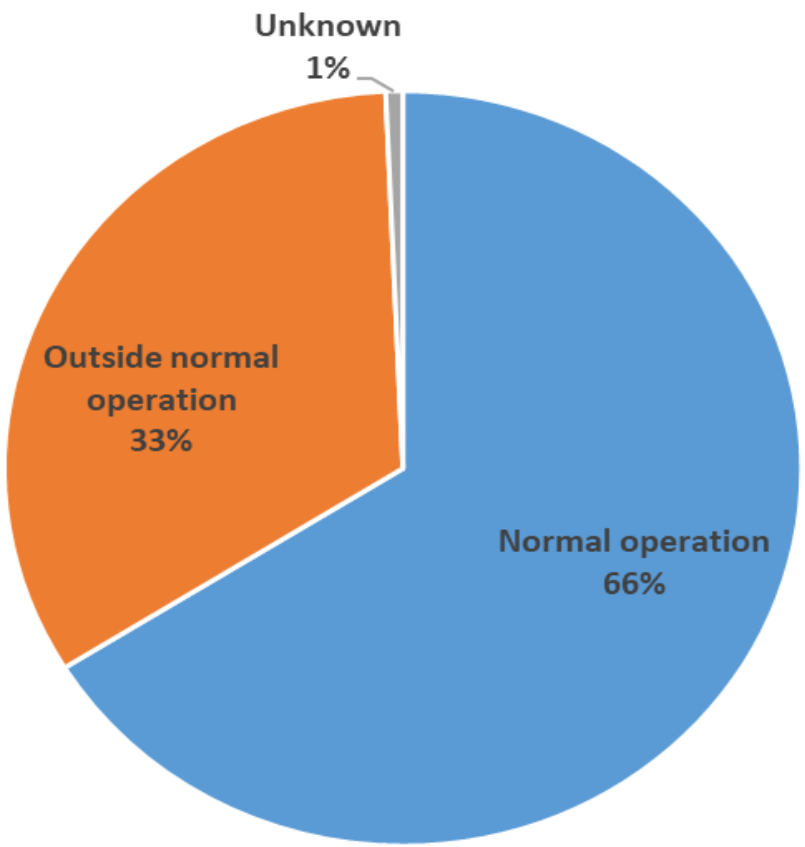




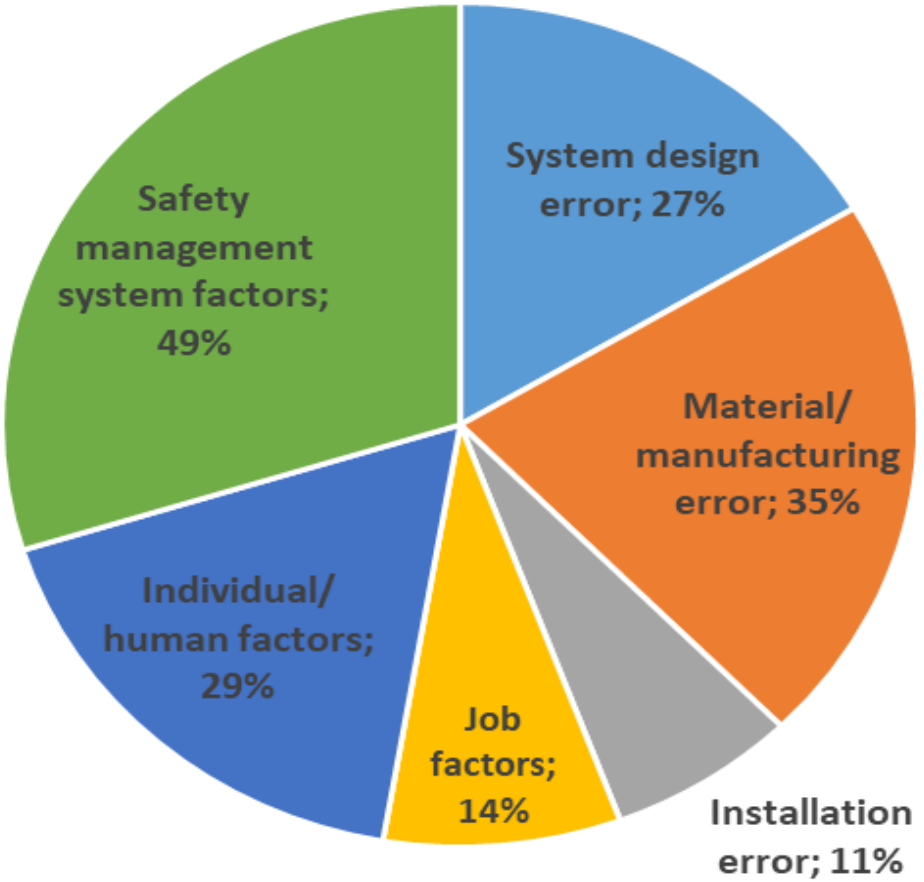

Co-funded by the European Union

# Results from the statistics analysis (3)

## Operational mode




## Causes (multiple entries per incident possible)




Co-funded by the European Union

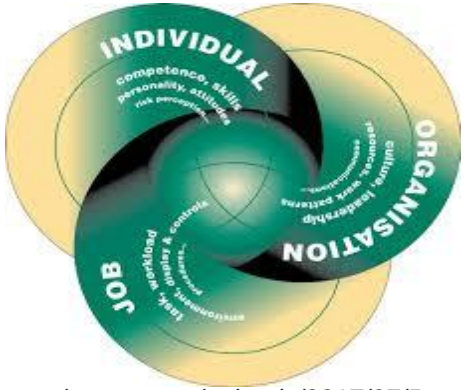
# Lessons learnt

The lessons learnt are grouped into the following four main categories:

- System design
- System manufacturing, installation, and modification
- Human factors
- Emergency response

# Lessons learnt related to human factor

- Lack of regular maintenance or inspection, special attention for safety devices during maintenance
- Reoperation after repair
- Individual/human factors, lack of clear instructions
- Reusing tanks or pipes previously containing flammable liquid or gas without thorough purging

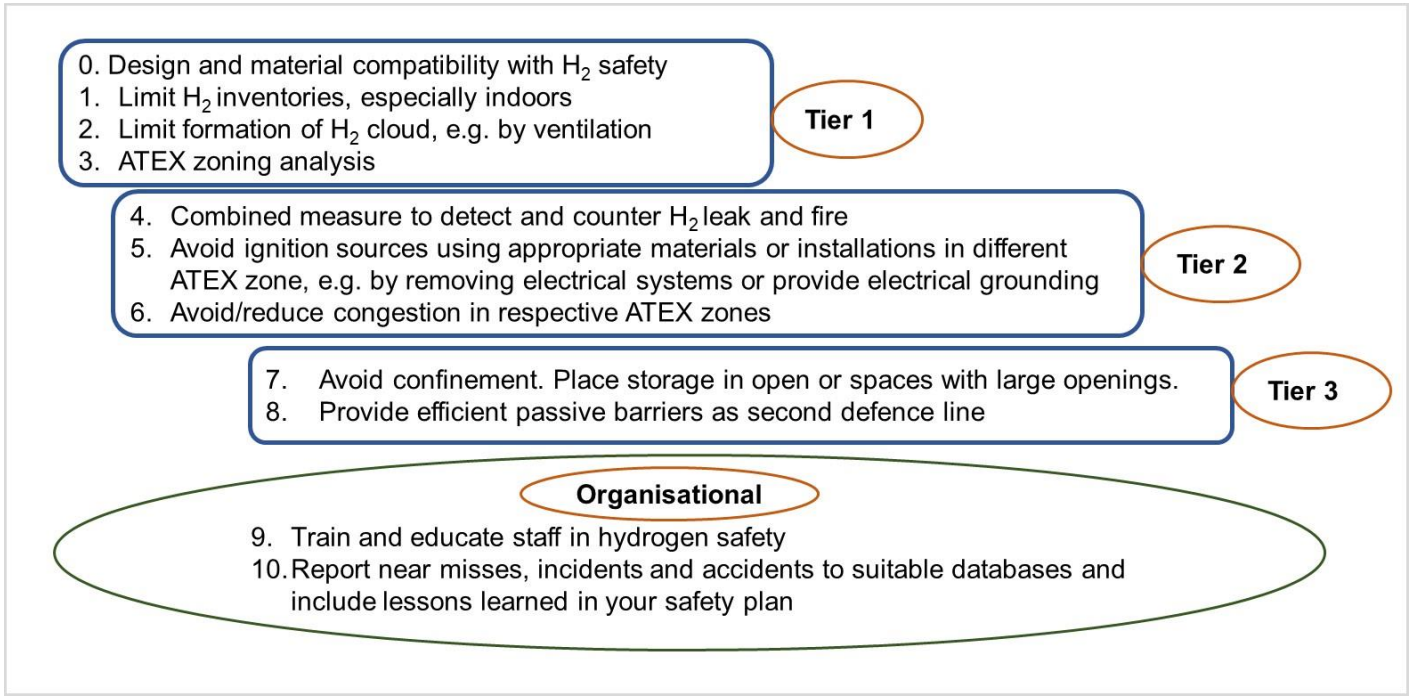


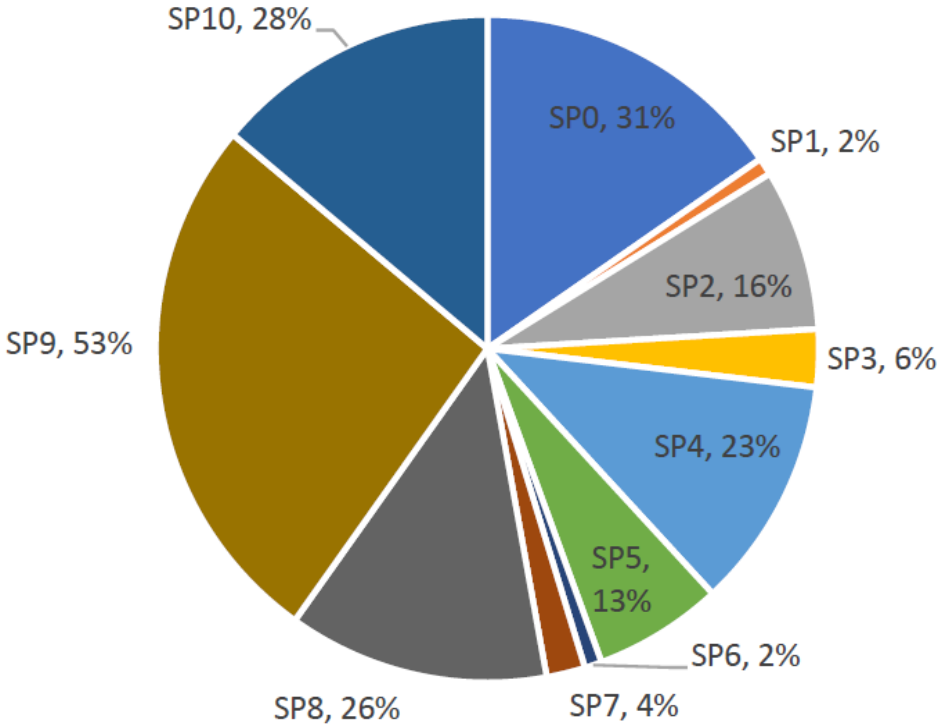

*https://www.ciobacademy.org/wp-content/uploads/2017/07/Root-Cause-Analysis-2018.pdf*

Definition of Health and Safety Executive (HSE)

Co-funded by the European Union

# Statistics related to EHSP identified safety principles (SP#)




*https://www.fch.europa.eu/sites/default/files/documents/Safety_Planning_Implementation_and_Reporting_for_EU_Projects-Final.pdf*

# THANK YOU!

The report from the analysis can be found at
https://www.fch.europa.eu/sites/default/files/documents/Lessons%20learnt%20from%20HIAD%202.0-Final.pdf

A paper based on the analysis was presented at the International Conference on Hydrogen Safety 2021 and awarded the best paper prize.

A modified version of the above paper has been published in the International Journal of Hydrogen Energy in Gold Open Access. It can be downloaded free at the following link:

https://reader.elsevier.com/reader/sd/pii/S0360319922012976?token=B67B5AC502387E7B7CE7CC15DABAE2731A101F1BEF7D7A2DEDBF4B0DE060A2CD430485A0C110D758A00ADE1D884ADF5D&originRegion=eu-west-1&originCreation=20220414145607


EHEC 2022
EUROPEAN HYDROGEN ENERGY CONFERENCE
EUROPEAN PARTNERSHIP

Co-funded by the European Union