Pre-normative research for safety of hydrogen driven vehicles and transport through tunnels and similar confined spaces

Fuel Cells and Hydrogen Joint Undertaking (FCH JU)
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Deliverable 7.5
Data Management Plan

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Summary

The D7.5 Data Management Plan (DMP) presents the first version of the plan. This document will be updated three times during the project development.

The HyTunnel-CS project will perform large amount of experimental work to study effect of mitigation systems on hydrogen release and dispersion in confined spaces, the thermal and pressure effects of hydrogen jet fires and their impact on structural integrity of tunnels and underground facilities, and the explosion prevention and mitigation.

This document sets the basis for the naming convention of the data, the edition, validation and storage of the data, and it also considers how to make data findable, openly accessible, interoperable, re-usable and where to allocate these experimental data.

Keywords

Data management plan, naming convention, experimental data, metafile

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Nomenclature and abbreviations

CEA	Commissariat a l'Energie Atomique et aux energies alternatives
CFD	Computational Fluid Dynamics
D	Deliverable
DMP	Data Management Plan
DMT	Data Management Team
DOI	Digital Object Identifier
DTU	Danmarks Tekniske Universitet
FCH JU	Fuel Cells and Hydrogen Joint Undertaking
FHA	Fundación para el Desarrollo de las Nuevas Tecnologías del Hidrógeno en Aragón
HSE	Health and Safety Executive
KIT	Karlsruher Institut fuer Technologie
NCSRD	National Center For Scientific Research "Demokritos"
ORD	Open Research Data
PS	Pro-Science – gesellschaft fuer wissenschaftliche und technische Dienstleistungen mbh
RCS	Regulation, Codes and Standards
SI	Système international (d'unités)
URS	Universita Degli Studi Di Roma La Sapienza
USN	Universitetet i Sorost-Norge
UU	Ulster University
WP	Work Package

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1. Data summary

The HyTunnel-CS Project aims to perform pre-normative research for the safety of hydrogen driven vehicles and transport through tunnels and similar confined spaces. The project objectives, between others, are:

- Generation of unique experimental data using the best European hydrogen safety research facilities and three real tunnels, and
- Development of new validated Computational Fluid Dynamics (CFD) and FE models for consequences analysis.

It is expected that large amount of experimental and modelling effort will be undertaken in the course of the project generating substantial amount of unique data.

This pre-normative research is finally aimed at producing recommendations for RCS for use of hydrogen vehicles in underground transportation systems to ensure that their expected penetration on the market as presented in several roadmaps, e.g. by the Hydrogen Council (Hydrogen Council, 2017), or by the FCH JU in 2019 (FCH JU, 2019), is safe. As long as the introduction of the hydrogen driven vehicles is promoted, safety concerns must be redefined not only for hydrogen driven vehicles, but also for interaction between different power technologies such as battery vehicles or internal combustion engine vehicles.

Data will be created in the core, phenomena-oriented work-packages (schematically presented in Figure 1):

- WP2 Effect of mitigation systems on hydrogen release and dispersion in confined spaces,
- WP3 Thermal and pressure effects of hydrogen jet fires and structural integrity,
- WP4 Explosion prevention and mitigation.

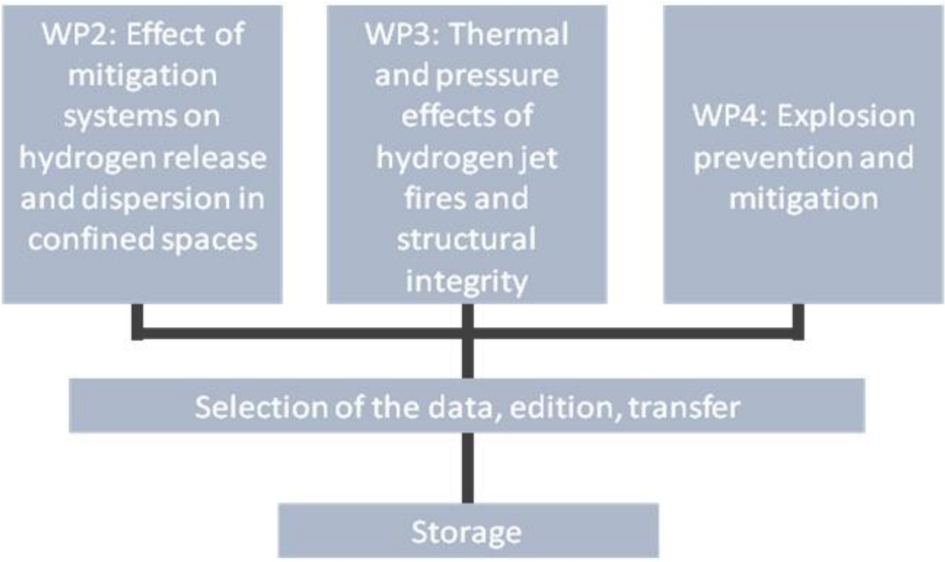

Figure 1. Relationship between WP and the DMP.

To perform the pre-normative research, the strategy to follow for each specific WP is to study relevant physical phenomena in extensive experimental campaign, which is followed by the development and validation of engineering tools and numerical models. The research data will be created in both these activities.

The DMP will mainly focus on the primary experimental data collected in studies of hydrogen releases, ignitions, jet fires, deflagrations and mitigation of hydrogen accidents. The generated experimental data will be digitised, documented and stored in accordance with Guidance to the Rules on Open Access to Scientific Publications and Research Data in Horizon 2020.

The experimental data will be used to validate the numerical simulations performed in the project. Storage and open access to the data generated in numerical simulations, e.g. by CFD, is considered as well.

The DMP is developed aiming at typical format of data storage like CVS file format, though convention for the stored data should accommodate the need to document wide range of experimental conditions, recording devices, controlled variables, model input and output parameters, etc.

Each phenomena-oriented work-package is organised as it is presented in

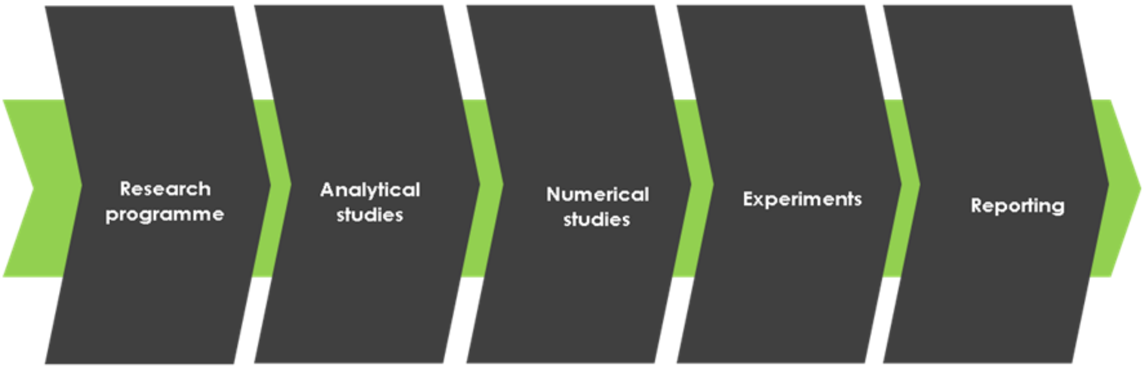

Figure 2.

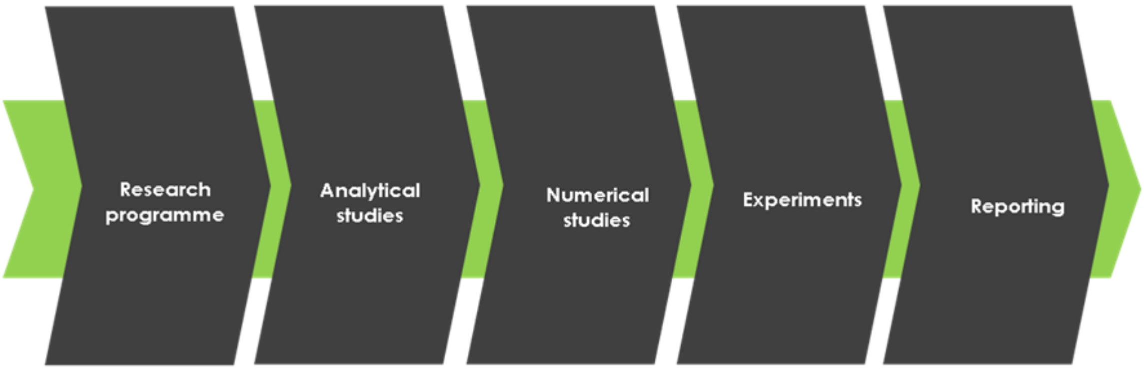

Figure 2. WP internal organisation.

The experiments will be performed by the partners as presented in Table 1.

Work Package	Partner
WP2	HSE, USN, PS
WP3	CEA, HSE, DTU, USN, PS
WP4	KIT, HSE, CEA, PS, USN

Table 1. Partners involved in the experiments per WP.

It is envisaged that a single dataset may have a typical size of 10 GB, based on the experience of partner KIT and PRESLHY FCH-JU funded project. It is expected that the overall size of the stored data can reach 2 TB (Jordan, 2018).

2. FAIR data responder

2.1 Making data findable, including provisions for metadata

As it has been explained previously, the amount of data generated during the HyTunnel-CS project development is considerable. Experimental and numerical data will be mainly produced by the project partners presented in Table 2.

Abbreviation	Name
CEA	Commissariat a l'Energie Atomique et aux energies alternatives
DTU	Danmarks Tekniske Universitet
HSE	Health and Safety Executive
NCSRD	National Center For Scientific Research "Demokritos"
KIT	Karlsruher Institut fuer Technologie
PS	Pro-Science – gesellschaft fuer wissenschaftliche und technische Dienstleistungen mbh
URS	Universita Degli Studi Di Roma La Sapienza
USN	Universitetet i Sorost-Norge
UU	University of Ulster

Table 2. Project partners involved in data production.

Looking for a simplified data processing and in order to make data easily findable, the following naming convention presented in Figure 3 is purposed with 24 characters to identify data.

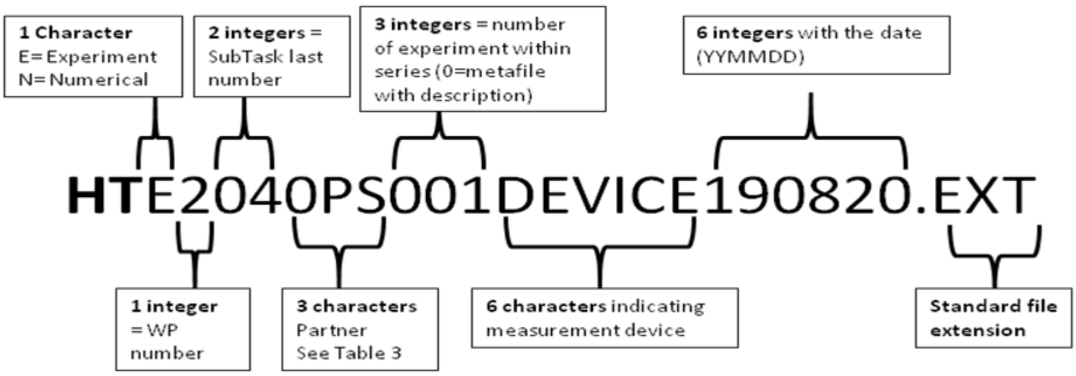

Figure 3. Naming convention.

The 2 characters HT aims to identify the HyTunnel-CS project origin of the data. The third character, which is a letter, aims to identify if the data comes from a numerical analysis (N) as a simulation, or comes from an experiment (E), e.g. a record from a pressure sensor mounted in a wall.

The following six characters aim to represent the WP, the specific subtask inside the experiment Task and the partner who has experimented. The abbreviation for each partner is presented in Table 3.

Abbreviation	Naming convention
CEA	CEA
DTU	DTU
HSE	HSE
NCSRD	NCS
KIT	KIT
PS	0PS
URS	URS
USN	USN
UU	0UU

Table 3. Naming convention per project partner.

The 3 integers which are after present which is the experiment or simulation number inside the series. Note that the value 000 is reserved for the metafile which is explained below.

The characters in DEVICE aim to codify the measurement device. If the data comes from numerical analysis, these characters must be "NUMANA". If data comes from experiments, general examples for the abbreviations may be, but not limited to, the abbreviations presented in Table 4.

Measurement device	Abbreviation
Pressure sensor	PRESXX
Temperature sensor	TEMPXX
Video Camera	VIDEXX
High Speed Video Camera	HSVCXX
Concentration sensor	CONCXX
Flow meter sensor	FLMTXX

Table 4. General abbreviations

If there is more than one source of data that is presented in the data file, as the case of different sensors measuring in the same experiment, these six characters must be "MIXED_" and in the header line of the data file, an individual identification for the source of data must be presented.

The individual indicator should follow the abbreviations presented in Table 4 when possible replacing the XX for two numbers e.g. FLMT02. Detailed information about each source of data must be presented in the metafile presented in Table 5. Metafile fields and explanation (*if numerical simulation results will be included on the data repository).Table 5, with its individual abbreviation.

The date is the last editing date, considering that any change that has been introduced in the data needs to be explained in the metafile.

The data files must be linked with a metafile (in a standard format such as .pdf) containing the information about the experiment or the numerical simulation, if the latter is included in the data repository. An example of exhaustive information on a dataset that may be introduced in the metafile is presented in Table 5.

Field	Possible information
Summary	Category (Physical phenomena category) Experiment type Experiment name Keywords Draft drawing or simple description of the facility Short description
Data file name	Based on the Figure 3
Author	The main participants The relevant agencies attending the experiment The experiment date and time The place of the experiment The data provider (the person providing the experiment to database)
Experimental setup	Components of the experimental facilities Boundary geometry - The type of the boundary (source, velocity, pressure, etc.) - The size of such special boundary (can be given in the later facility drawing) - The location of the special boundary (can be given in the later facility drawing) Instrumentations - Detailed information about the measurement devices, with its identification and position in the experiment (can be given in the later facility drawing) The mutable variables in the facility (as sometimes, geometry may also be a mutable factor in experiment) - The destructible boundary and parameter of the boundary - The mutable geometry in the facility Drawing of the facility
Objective of the experiment	Experiment goals - What detailed physical phenomena are planned to be studied by the experiment originally
Experimental procedure	Initial condition - Gas species and their ratio, initial pressure, initial temperature, initial velocity, turbulence parameters Boundary condition - Some experiments have special boundary conditions such as the source of the gas, velocity inlet or outlet and pressure boundary Descriptions - Preparation of the experiment, experiment procedure, experiment phenomena, theoretical analysis and conclusions
Experimental data	Description - Measurement procedures, quantities, errors, the format of the data file and description for each data file Experiment data - The final result, experiment data collected under different conditions. Figure Video
Performed simulation*	Author Validation code Mathematical treatments Governing equations

Field	Possible information
	- The transportation equations used to describe the gas dynamics Chemical models - The models used to simulation the chemical reaction Boundaries - Numerical method used to simulate the boundary Calculation domain - Calculation domain geometry - Grid structure and resolution - Figures of the domain Initial and boundary conditions Physical properties Validation dataset Validation results - Figures, graphs - Conclusions
Comments	Changes in the data and explanation of the changes if applicable. Analysis of the experiment Validation made
Reference	From the participants or a third party (if it is involved) the reports and papers published including: - Reports or papers about the repeatability of the experiment (with its Digital Object Identifier (DOI) if applies)

Table 5. Metafile fields and explanation (*if numerical simulation results will be included on the data repository).

2.2 Making data openly accessible

The access to the selected final data is envisaged via the webpage of the project (at least until five years after the project finalisation) or via ZENODO, a repository linked with the OpenAIRE project developed by CERN that is open for all type of data. Access to both databases is supported by any web browser. To access to the metafile, only a .pdf reader is needed.

Being videos a possible type of uploaded data or even explanatory metadata, the recommended software for playing these videos is the Open Source VLC media player (“Official download of VLC media player, the best Open Source player - VideoLAN,” n.d.).

It is recommended that metafile should include embedded videos as it increases hugely file size. Instead the metafile may contain representative video frames - grabbed and introduced as figures.

As far as data is open, there will be no need to ascertain the identity of the person who accesses the data.

2.3 Making data interoperable

To ensure data interoperability, the use of standard file formats is expected.

The partners from the HyTunnel-CS project will use SI base units from any measured quantity. This implies the use of metre (m) for length, seconds (s) for time, kilogram (kg) for mass, Ampere (A) for electric current and Kelvin (K) for temperature. Decimal separator will be "." and no thousand separator shall be used.

If necessary, the unit conversion must be performed before transferring the data into the repository.

The HyTunnel-CS project will use the terminology from the D2.2 Critical Analysis and Requirements to Physical and Mathematical Models (Jedicke et al., n.d.) from the SUSANA project (Grant agreement FCH-JU-325386)

2.4 Increase data re-use (through clarifying licences)

There is no expected embargo period. Nevertheless, data will be only made available as long as its quality and validity have been previously ensured and the objective of the project should be maintaining these data as long as possible available. Due to it, it is not expected until the M16 of the project when the first part of the data will be uploaded.

All the data that goes to the database is free of use without restriction from third parties. To ensure this re-usability of the data, the license model should be selected as much open as possible, considering **CC BY license Creative Commons** as a possibility.

This type of license allows the highest accessibility to the data. The user may redistribute, translate and use the data for publication in academic or commercial activities, provided that appropriate credit is given to the author (BY) and that modifications to the publication made by the user are clearly indicated.

Moreover, data will be widely disseminated through the project dissemination activities and scientific publications, to increase its re-use.

Once the data will be uploaded on the storage service or webpage of the project, they will be available for at least five years after the formal end of the project, or protracted as long as the webpage is operative. After this period, the webpage contents will be migrated to another platform, potentially it may be IA HySafe or Net-Tools project (Grant Agreement 736648) websites.

Additionally, provided that data are introduced in the ZENODO repository, the data will remain re-usable as long as the repository operates.

Data quality assurance is included prior to the uploading process to the repository and its definition should be addressed after the creation of the **data management team (DMT).**

As long as the studies conducted throughout the project will use the experimental data that will be deposited in the future, the results are expected to be further checked prior to the upload. There is no extra review for the data later than the 28/02/2022.

3. Allocation of resources

The data management of the HyTunnel-CS project is expected to be free. Firstly, the use of the webpage as the primary repository will not increase the price of the webpage.

Added to it, the use of an Open repository for data as ZENODO, will allow maintaining the data as long as the repository is open and free of charge.

Responsible for the data management in HyTunnel-CS project is the partner FHa with the collaboration of the project coordination team. A **DMT** nevertheless is purposed and its formation should be defined in the 2nd project meeting.

This **DMT** will be responsible of the data selection, edition and quality assurance, and for the metadata and metafile preparation.

The use of ZENODO should be strongly considered as far as it has some benefits as the ones presented in its webpage ("Zenodo - Research. Shared.," n.d.):

- **Citeable**: Uploads get a DOI.
- **Funding**: Identify grants for research funded by the European Commission via OpenAIRE.
- **Flexible licensing**: Allowing uploading data under a variety of different licenses.
- **Safe**: As far as the research data introduced in ZENODO is stored in the CERN´s own same cloud infrastructure as CERN's Large Hadrons Collider research data.
- **Retention period**: Items will be retained for the lifetime of the repository. This is currently the lifetime of the host laboratory CERN, which currently has an experimental programme defined for the next 20 years at least.
- **Volume and size limitations**: Total files size limit per record is 50GB. Higher quotas can be requested and granted on a case-by-case basis.

4. Data security

The data will be produced as long as the project is ongoing. The data storage will be done periodically during the project with the DMP reviews. To save data properly, the members of the **DMT** will be encouraged to create copies of the data in their computers or their company/university own repository if available.

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