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)
Grant Agreement Number 826193

Deliverable 7.8
Update 1 of Data Management Plan

Lead authors: FHA (A. Bernad)
Contributing authors: UU (D. Cirrone)
UU (D. Makarov)
USN (K. Vågsæther)
DTU (F. Markert)

Version: 200225
Delivery date for internal review: 31st January 2020
Due date: 28th February 2020
Dissemination level: Public

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

Deliverable administration					
Work Package	WP7. Management				
N. and title	D7.8 Update 1 of Data Management Plan (D37)				
Type	Report				
Status	Draft/Working/**Released**	Due	M12	Date	29-02-2020
Comments					

Development and revision			
Version N.	Date	Authors	Description
200130	30-01-20	A. Bernad (FHA)	1st draft for internal review
200224	24-02-20	D. Cirrone (UU) and F. Markert (DTU)	Comments from D. Cirrone (UU) and F. Markert (DTU)
200225	25-02-20	A. Bernad (FHA)	Final version

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 (JU) under grant agreement No 826193. The JU receives support from the European Union's Horizon 2020 research and innovation programme and United Kingdom, Germany, Greece, Denmark, Spain, Italy, Netherlands, Belgium, France, Norway, Switzerland.

Summary

The D7.5 Data Management Plan (DMP) presented the first version of the plan. This document will be updated three times during the project development. The present document D7.8 is the first update of the DMP.

The HyTunnel-CS project will perform large amount of experimental and computational 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 reviews the naming convention in order to clarify it to all the project partners. Moreover, this document works deeper in the H2020 principle of "as open as possible, as closed as necessary" and discusses the creation of the Data Management Team (DMT), a Zenodo community and the rules to transfer the data among partners in an easy and secure way.

Keywords

Update, data management plan, naming convention, experimental data, metafile

Table of contents

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*
FAIR	*Findable Accessible Interoperable Reusable*
FCH JU	*Fuel Cells and Hydrogen Joint Undertaking*
FE	*Finite Elements*
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*

List of figures

List of tables

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. Two important project objectives are:

- Generation of unique experimental data using the best European hydrogen safety research facilities and real tunnels, and
- Development of new validated Computational Fluid Dynamics (CFD) and Finite Elements (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 Regulation, Codes and Standards (RCS) for use of hydrogen vehicles in underground transportation systems to facilitate safe 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. The introduction of the hydrogen driven vehicles will set the beginning of a continuous task with the aim of redefining safety concerns not only for hydrogen driven vehicles, but also for the 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.

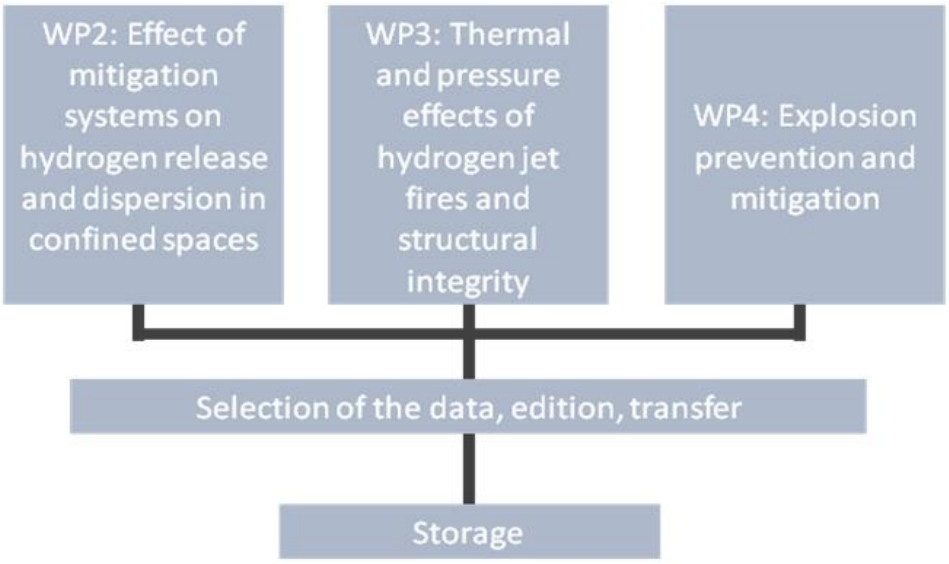

Figure 1. Relationship between WP and the DMP.

To perform the pre-normative research, the strategy to follow for each specific WP is to study relevant physical phenomena in an 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 CSV or Excel 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.

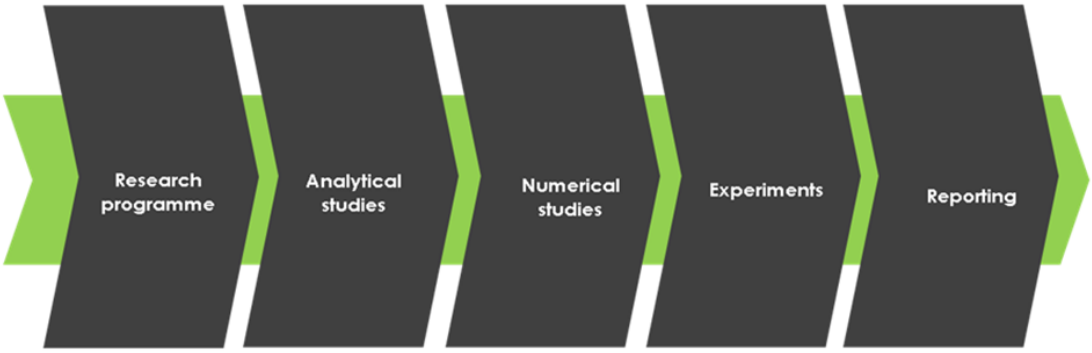

Figure 2. WP internal organisation.

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).

Due to the enormous size of the whole data, the number of experimental series and the amount of tests involved in some of the experimental series, only the results of representative cases and scenarios may be uploaded. This decision will be applied when the tests presents good repeatability.

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.

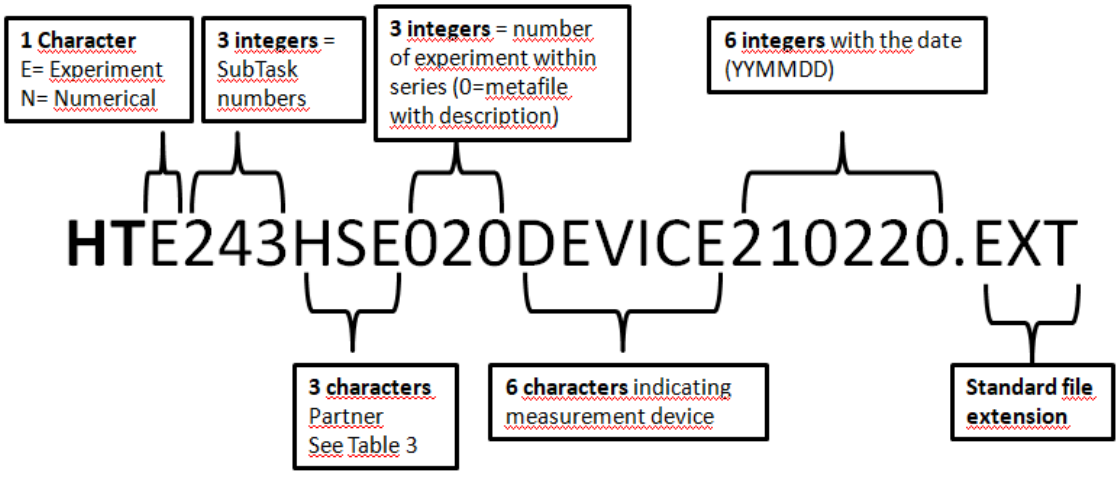

Figure 3. Naming convention.

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 and the partner who has performed the experiment. 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 following 3 integers 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, and which should be valid for all different tests that belongs to the experiment.

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 notations 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 of the data, considering that any change that has been introduced in the data needs to be explained in the metafile.

Example given:

Experiments of Dynamics of H2 release and dispersion in a tunnel (subtask 2.4.3 performed by HSE). Assuming that the experiment will be performed on the 20 of February of 2021 (example date based on the information presented in D 2.1 (Venetsanos, 2019)) and that the final solution is to use fast thermal conductivity sensors and oxygen deficiency sensors, the naming convention will be:

Metadata file: Valid for the 27 experiments and with the information of Table 5 filled accordingly.

HTE243HSE000MIXED_210220.pdf

Datasheet: Assuming that the file is saved in an Excel file and the test is the number 20 out of the 27 that are planned based on section 5.3.10 of the D 2.1 (Venetsanos, 2019)

HTE243HSE020MIXED_200620.xls

All data must be linked be linked with its respective 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

Field	Possible information
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 - The transportation equations used to describe the gas dynamics Chemical models - The models used to simulate 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) - Reference to the intermediate report from the HyTunnel-CS project where the experiment has been presented.

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

2.2 Making data openly accessible

HyTunnel CS aims to use the H2020 principle of "as open as possible, as closed as necessary" meaning that the default approach is to make datasets public but maintaining confidential data covered.

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,").

It is recommended that metafile should not 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.) 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 only be made available after their quality and validity have been ensured. The objective of the project should be maintaining these data as long as possible available.

Based on the project development evolution, only data which has been ensured will be uploaded. The data will be stored in the private Members Area of the project until it is agreed to uploaded to the open repositories by the Data Management Team (**DMT**). Due to it, it is not expected an upload to open repositories of the data prior to M16 of the project.

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. As part of this dissemination, the project partners who aim to disseminate the datasheets must make sure that they provide repository address and basic access instructions.

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, 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, based on the fact that data will be 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 to the Members Area and it is responsibility of the project partners conducting and involved in the experimental series/simulation**.**

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. Due to it, the use of the webpage as the primary repository will not increase the price of the webpage and it is expected to be used as first internal repository of information.

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.

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."):

- **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.

HyTunnel-CS will create a community on Zenodo which will be the main repository for making datasets publicly available, and to link these datasets with the project in a clear and proper way.

Responsible for the data management in HyTunnel-CS project is the partner FHa with the collaboration of the project coordination team. A **DMT** is purposed and its composition is formed by a representative member from FHa and a representative member from UU.

The data selection, data edition, quality assurance of the data, metadata and metafile preparation is responsibility of the partners conducting/involved in the experimental series/ simulation and the guidelines established in the last version available of the DMP of the project have to be followed.

The **DMT** will check that these indications presented in the last version of the DMP of the project have been implemented properly through edition and will upload the data to the open repository once it has been agreed.

4. Data security

4.1 Prevention of data loss and data recovery

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 project who performed the experimental series/computation will be encouraged to create copies of the data in their computers or their company/university own repository if available.

The experimental data will be stored also in the Members Area of the project and the tasks leaders are also encouraged to store result data in the server of their company. With this action, the data will not be lost.

4.2 Secure storage and transfer of sensitive data

Until a dataset is not fully finalised and ready for publication, the platform for information exchange between the project partners is the HyTunnel-CS Members Area. If there is no restriction on sensitive data and there is consensus among the dataset contributors, other data exchange systems as email, are also allowed.

In case of restricted data, HyTunnel-CS Members Area will be used as the private repository and the information will be classified as confidential.

References

Venetsanos, 2019. Deliverable D2.1 Detailed research programme on unignited leaks in tunnels and confined space.

FCH JU, 2019. Hydrogen Roadmap Europe, A Sustainable Pathway for the European Energy Transition. FCH JU, Belgium.

Hydrogen Council, 2017. Hydrogen scaling up. A sustainable pathway for the global energy transition. (Roadmap). Hydrogen Council.

Jedicke, O., Ren, K., Kotchourko, A., Shentsov, V., Makarov, D., Keenan, J., Molkov, V., Baraldi, D., Tolias, I., Giannissi, S., Venetsanos, A., Coldrick, S., Slater, S., Verbecke, F., Duclos, A., n.d. Critical Analysis and Requirements to Physical and Mathematical Models (Deliverable No. 2.2), SUpport to SAfety ANalysis of Hydrogen and Fuel Cell Technologies.

Official download of VLC media player, the best Open Source player - VideoLAN [WWW Document], n.d. URL https://www.videolan.org/vlc/ (accessed 7.26.19).

Zenodo - Research. Shared. [WWW Document], n.d. URL http://help.zenodo.org/features/ (accessed 7.26.19).