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 7.13
Update 2 of Data Management Plan

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Disclaimer

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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 D7.13 is the second update of the DMP.

The HyTunnel-CS project will perform a 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 introduces to the project partners the final version of the metadata file, considering the inputs required in the ZENODO community to avoid overlaps. At the same time, the document presents the procedure to follow during the upload of the data.

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 that has and will be undertaken during the project will generate 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). 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.

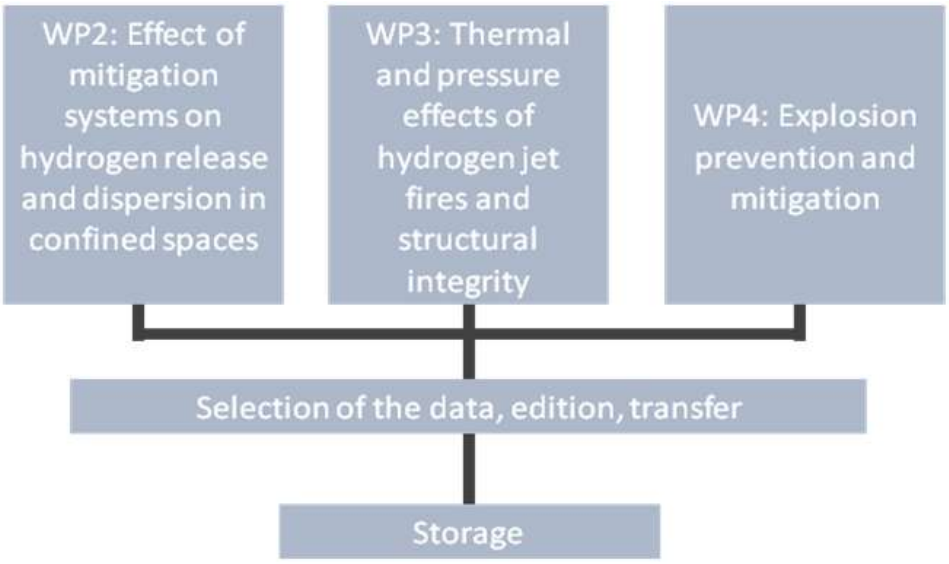

Figure 1. Relationship between WP and the DMP.

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 mainly focuses 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, example given 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.

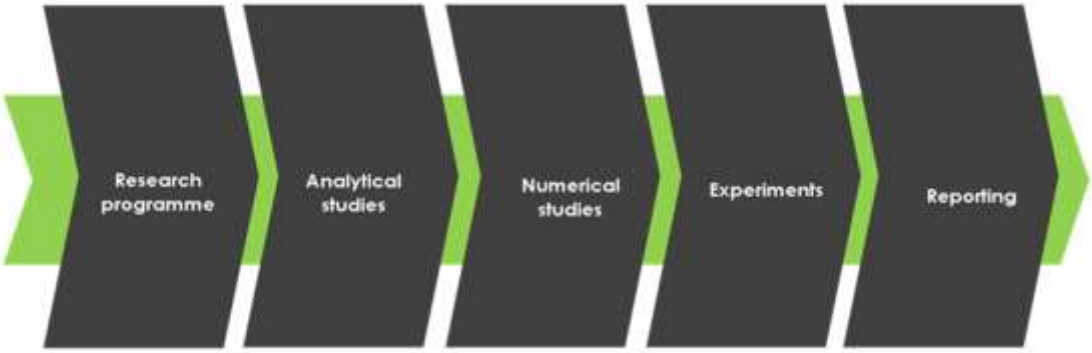

Figure 2. WP internal organisation.

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 number 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 present 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 to make data easily findable, the following naming convention presented in Figure 3 is purposed with 24 characters to identify data.

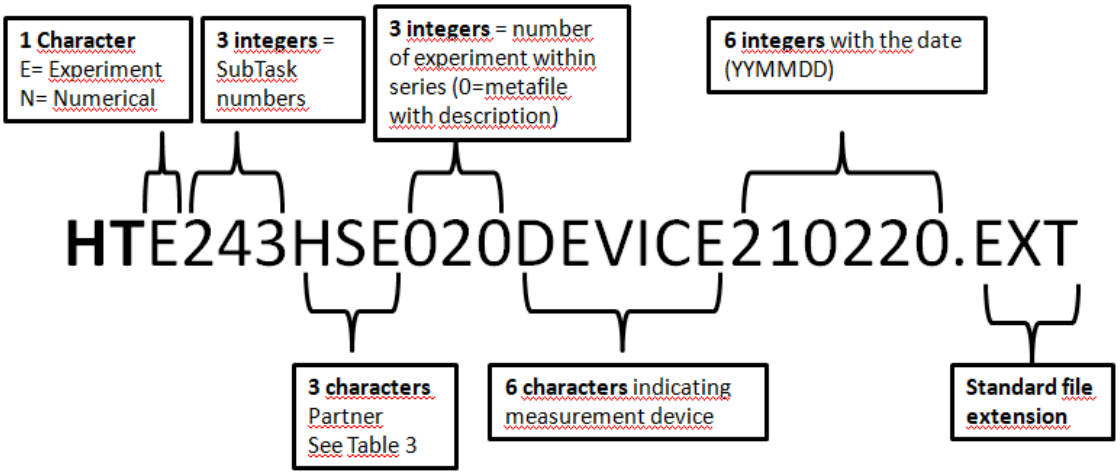

Figure 3. Naming convention.

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), example given 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 same data file, as the case of different sensors measuring in the same experiment and all the information presented in the same file, 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.

Moreover, if the metafile is covering different measures, with different devices for an experiment, the six characters for the metafile must be “MIXED_” and in the metafile description, this information must be presented.

The individual indicator should follow the abbreviations presented in Table 4 when possible replacing the XX for two numbers example given 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 hydrogen 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 (if data from different sensor is presented together in the same file):

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_210220.xls

All data must 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.

<table>
<tr><th>Field</th><th>Possible information</th></tr>
<tr><td>Summary</td><td>Category (Physical phenomena category)
Experiment type
Experiment name
Keywords
Draft drawing or simple description of the facility
Short description</td></tr>
<tr><td>Data file name</td><td>Based on the Figure 3 D7.13
It can be presented as a table if several experiments are uploaded together. Example given:

<table><tr><td>Concentration data (Excel worksheet)</td><td>Pressure data (txt document)</td></tr><tr><td>HTE242USN00002CONC190621</td><td>HTE242USN00002PRESS190621</td></tr></table>
If several experiments, all the separated files should be uploaded as a .zip
Example given:

HTE242USN0000XPRESS.zip which contains the different pressure data for different experiments.</td></tr>
<tr><td>Author</td><td>The main author and contributors
The relevant agencies attending the experiment
FROM XX XX XX TO XX XX XX
The place of the experiment</td></tr>
</table>

Field	Possible information
	The data provider (the person providing the experiment to database)
Experimental setup	Write the name of the Deliverable where it appears and if it is public, provide the link. If it is CO report, please, present a drawing of the 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
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 **All this information may be presented as a table if needed to present it in a clear way**
Experimental data	**Description** - Measurement procedures, quantities, errors, the format of the data file and description for each data file **Experiment data** - The result or experiment data collected under different conditions. (It may be presented as a Figure of an experiment with representative response)
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

Field	Possible information
	- 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
Acknowledgements	The data presented is part of the experimental results of HyTunnel-CS The project HyTunnel-CS 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

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 HyTunnel-CS community at 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.

Note: If all the files are going to be uploaded in a folder, the folder must be compressed using the .zip format. The file must have the same name.

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 separators 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.

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, because data will be introduced in the HyTunnel-CS community at 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: HyTunnel-CS community at ZENODO

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.

Based on the advantages that it presents, the use of ZENODO has been 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 has created a community on ZENODO (HyTunnel CS | ZENODO) which is the main repository for making datasets publicly available, and to link these datasets with the project in a clear and proper way. Data from USN has been already published in the community.

Responsible for the data management in HyTunnel-CS project is the partner FHa, which is the contact partner of the community, 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 in accordance with this deliverable, quality assurance of the data, metadata and metafile preparation and the upload to ZENODO and its link with the HyTunnel-CS community 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 must 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 accept the data in the Community. The partner can contact the DMT as many times as needed in order to clarify or solve issues or doubts always **before** the upload to ZENODO.

1. **Data uploading procedure:** The main author/contributor to the experiment/simulation/tool once the quality of the experiments is confirmed and the information has been discussed within the frame of the project, prepares the data and the metadata file for the upload.

   The data that is going to be uploaded must follow the naming convention and the author must prepare the metadata file following this deliverable. It is important that the data uploaded, and the metadata does not content failures or mistakes, as far as **there is no possibility to change it or to correct them once it has been uploaded**.

   Contacting during this stage to the DMT is suggested if any doubt appears.

2. The main author registers in ZENODO to be able to upload the files.

3. The main author uploads the data. During the upload, when filling the fields, the HyTunnel-CS community must be selected. The language must be 'English'. The author must ensure that the access rights are selected properly and the that the funding corresponds to the Grant Agreement No: 826193

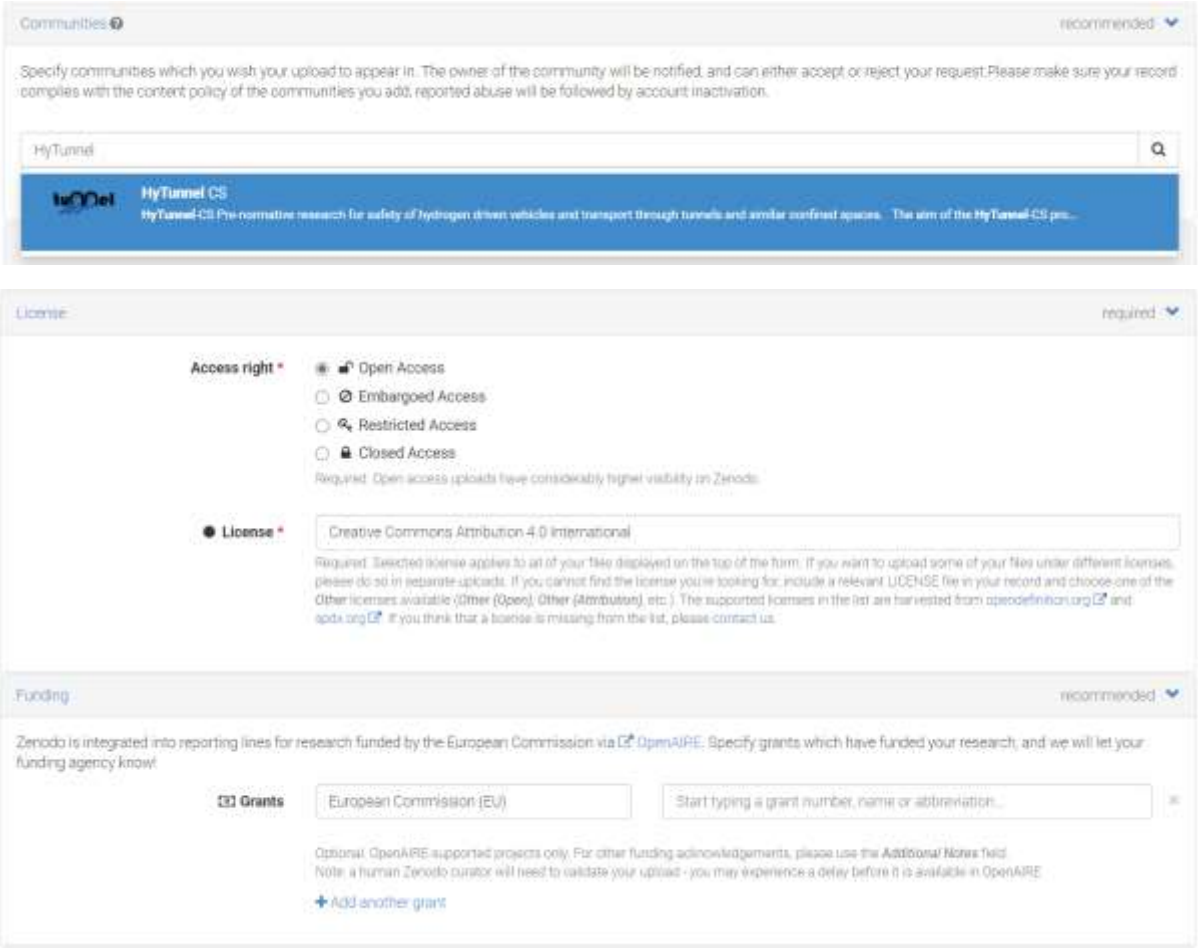

Figure 4. Uploading details example.

4. The main author checks all the fields that may be applicable in the ZENODO uploading portal, example given if the data has related publications the DOI can be

included to link both data and paper, etc. Some of this fields can be modified after the publication.

5. When all the information has been filled accordingly, the author must submit it. Then, the data is available in ZENODO.

6. Once the data is available in ZENODO, FHa will receive a request to allow the data to be part of the HyTunnel-CS community. If the metadata and the fields in the submission are correct, FHa will accepts the request and the data will be finally available in the ZENODO community as Figure 5 presents:

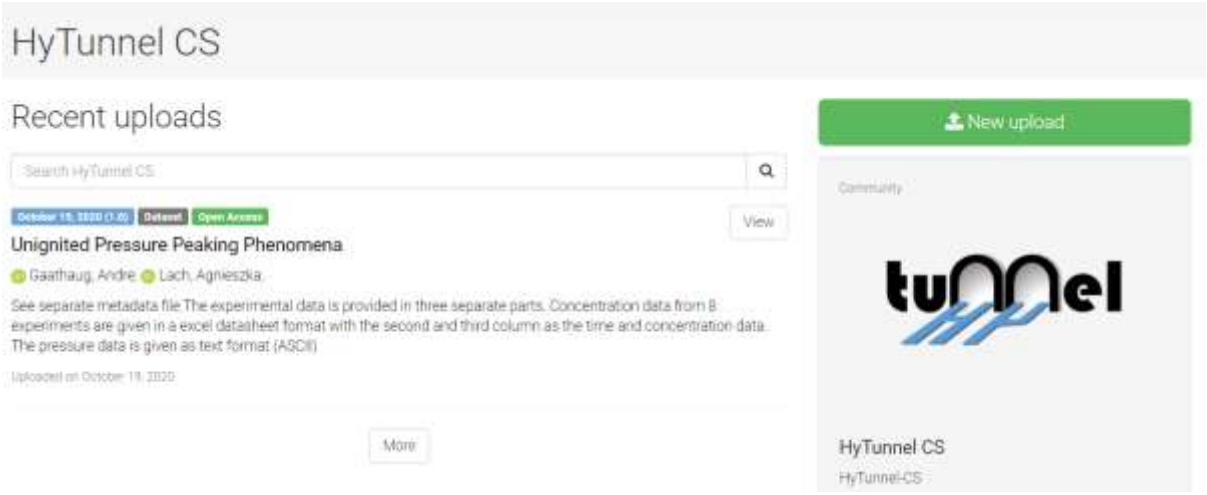

Figure 5. Final view of the upload in the HyTunnel CS community at ZENODO.

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.

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