

Call: NFRP-2019-2020
Topic: Innovation for Generation II and III reactors



Fracture mechanics testing of irradiated RPV steels by means of sub-sized specimens

Deliverable D6.8
Data Management Plan (DMP) – 1st version

Grant Agreement No: 900014
Contractual delivery date: Month 06
Actual delivery date: Month 06 (25/03/2021)
Lead beneficiary: P15 – UC



Grant Agreement No.	900014
Project full title	Fracture mechanics testing of irradiated RPV steels by means of sub-sized specimens (FRACTESUS)
Deliverable number	D6.8
Deliverable title	Data Management Plan (DMP) – 1 st version
Nature¹:	R
Dissemination level²:	PU
Work package number:	WP6
Work package leader:	Sergio Cicero
Author(s):	Sergio Cicero & Borja Arroyo
Keywords:	Data management, FAIR data, Data, Zenodo, OpenAire, Template, Fracture, Mini-CT, 0.16TC(T), Master Curve, Transition, KJc, ASTM E-1921, RPV, Sub-sized specimen, Open Access

The research leading to these results has received funding from the Euratom research and training programme 2020-2024 under grant agreement No 900014.

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¹ **Nature:** **R** -Document, report; **DEM** -Demonstrator, pilot, prototype; **DEC** -Websites, patent fillings, videos, etc.; **OTHER**; **ETHICS** -Ethics requirement; **ORDP** -Open Research Data Pilot; **DATA** -data sets, microdata, etc.

² **Dissemination level:** **PU** -Public; **CO** -Confidential, only for members of the consortium (including the Commission Services)

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1 Introduction

The FRACTESUS Data Management Plan (DMP) provides an overview of the data and information that will be collected throughout the project and shows the interaction and interrelation of the data- collecting activities within and between the Work Packages (WP's). The DMP outlines how data are to be handled both during the FRACTESUS project, and after the project is concluded. Its goal is to consider the many aspects of data management, metadata generation, data preservation, and analysis. This will lead to the data being well managed during the project development, and prepared for preservation in the future.

The DMP will lay out the procedure for data collection, storage, protection, retention and destruction of data, and confirmation that such data comply with national and EU legislation. This DMP aims at providing an effective framework to ensure comprehensive collecting and handling of the data used in the project, fulfilling the FAIR principles (see section 3). Thereby, FRACTESUS strives to comply with the Open Access (OA) policy of Horizon 2020.

This is the first version of the DMP (due date month 6) to be revised during the course of the project within Task 6.3 included in WP6 (led by the University of Cantabria, UC, P15 of FRACTESUS project). The DMP is a living document that will be adjusted to the specific needs of FRACTESUS throughout the project's runtime and will be adapted whenever appropriate (see section 7).

This plan will establish the measures for promoting the findings during FRACTESUS's lifecycle and will set the procedures for the sharing of data of the project addressing FAIR principle for research data (Findable, Accessible, Interoperable and Re-usable). The following document made use of the HORIZON 2020 FAIR DATA MANAGEMENT PLAN TEMPLATE and was written with reference to the Guidelines to FAIR data management in Horizon 2020 [1] and the GDPR (Regulation (EU) 2016/679).

2 Data summary

The main aim of the FRACTESUS project is to validate the use of **small-sized specimens to obtain reliable measurement of the resistance to fracture in nuclear materials**, in order for the nuclear industry to comply with the amended Nuclear Safety Directive. Measurement of fracture toughness using small-sized specimens has already been shown to be possible in both unirradiated and irradiated conditions. However, some effort is still required to achieve European regulatory acceptance of this approach by demonstrating its applicability to a suitably large database covering a wide variety of materials and irradiation conditions representative of long-term operation conditions [2].

The final **purpose of FRACTESUS data collection is to generate a large Open Access (OA) database of 0.16 C(T) fracture toughness results in different nuclear materials**, un-irradiated and irradiated, at different temperatures. This database will be used in the FRACTESUS project in order to **apply the Master Curve approach** (ASTM E-1921 [3]) and compare the results to other databases obtained by testing regular C(T) specimens. This database will be **useful for the whole EU community, and will be published in OA following FAIR principles** (see section 3), as specified in the FRACTESUS Open Access Procedure [4].

According to the **general common testing protocols exposed in FRACTESUS deliverable D.6.9: "Testing protocols and reporting formats"** [5], the partners will perform fracture tests in the following scenarios:

- General characterization of the materials (tensile, hardness, ...)
- Standard fracture characterization on 1T C(T) specimens of the materials.
- **0.16T C(T)** specimens **fracture toughness** tests on **un-irradiated RPV** steels in the transition region.
- **0.16T C(T)** specimens **fracture toughness** tests on **irradiated RPV** steels and other materials.
- Supporting experiments based on small specimen test techniques (in-kind)

Each FRACTESUS test will be equally treated, and will generate **two types of results**:

- **Non-digital results:** will simply consist of the **remains of the tested specimens**. As their preservation during the time in optimal condition may be difficult, and any other use apart from the **surface fracture observation and fractography analysis is not foreseen, these two tasks will be performed immediately after the tests, which will be part of the digital results**. However, the remains of the tested specimens will be preserved in as good condition as possible in the partners' facilities during the project development, but will be then eliminated.
- **Digital results:** will consist of the direct data derived from the test, which are **load (N) and load-line displacement (mm)**, as well as the main outputs of the test: **image of the fracture surface, testing temperature, initial crack length** (measured in the fracture surface), **material properties, and fractography**, among others.

As specified in FRACTESUS deliverable D.6.9 [5], the corresponding partner will generate as a result, **from each one of the aforementioned tests, a testing PDF report** file (obtained by filling a supplied Excel format and converting it into PDF) containing all the digital results obtained. This PDF file, in addition to the remains of the tested samples, will be **the only result** to be considered for subsequent analysis. It will consist of two sheets (obtained from the two tabs of the aforementioned Excel format) and will have an approximate **expected size of around 1Mb per test**:

- **Raw data and calculations sheet:** will contain the direct data derived from the test, which are load (N) and load-line displacement (mm).
- **Data summary sheet:** will show the main outputs of the test in one sheet, including: a picture of the fracture surface, testing temperature, initial crack length (measured in the fracture surface), material properties, and fractography, among others.

Additionally, a **separate file with data necessary for Master Curve calculations** (not adjusted K_{Jc} , W , B , a_0 , stable crack extension, S_{VS} , E , test temperature, etc) **should be delivered for each data set generated in singular mini-C(T) tests for the particular material**. This information will be collected into an Excel format table (supplied by WP6) and then converted into a PDF, which will have an approximate **expected size of around 1Mb** per data set. It will serve also as a test index of each material characterized.

All mini-C(T) experimental data included in the FRACTESUS **database will have its origin within the partners' experimental programs** during the project development. However, **the re-use of existing Master Curve data for large specimen testing** from prior research might be also necessary for mini-C(T) results comparison. Its origin is in already published documents (publications /reports). Recalculations of the results based on this data (e.g. in accordance to the newest standard version) might be also necessary.

Tests results and the aforementioned data sets allocation (see section 4) will rely on Zenodo [6] and OpenAire [7], treating all test results in the same way, no matter their type. **Each test file or data set file will first be uploaded to Zenodo [6], where it will be linked to a corresponding DOI [8], and then linked to FRACTESUS project in OpenAire [7].**

3 FAIR data

In line with the EU's guidelines, **FRACTESUS will follow FAIR principle for research data** (Findable, Accessible, Interoperable and Re-usable). The FRACTESUS project policy is to be as open access (OA) as possible, so all test results, data generated, publications, etc will be totally open. However, in agreement with [2], part of the deliverables will be OA, but another part of them will be just restricted to the consortium. This section provides a detailed description of how to achieve FAIR data in order to ensure their understanding by the partners of the consortium.

3.1 Making data findable

Metadata is data on the research data themselves, which is useful for other researchers to find and understand how data is located in a repository. In the cases where large numbers of different results are incorporated to a repository (see section 4) this is essential. In the case of the FRACTESUS project, as the data generated will basically consist of fracture test results on standard and 0.16T C(T) specimens (also some other conventional characterization tests), their identification will be given by following naming conventions and the assignation of a Digital Object Identified (DOI) [8] to each data. There is also another type of data, consisting of published papers, which will also be systematically named and associated to a DOI.

Files containing single tests results in the data repository will be structured by using a name convention consisting of: **"PROJECT-NAME"_"material"_"test-type"_"specimen-type"_"temperature°C"_"test-number"_"document-extension"** ; examples:

FRACTESUS_73W_KJc_0.16TC(T)_-125°C_1.pdf
FRACTESUS_SA508_KJc_1TC(T)_20°C_2.pdf
FRACTESUS_15Kh2MFAA_Fracture_SPT_-50°C_1.pdf
FRACTESUS_A533B_Tensile_φ10_0°C_1.pdf

Files containing data sets (table of results in a whole material) in the data repository will be structured by using a name convention consisting of: **"PROJECT-NAME"_"material"_"test-type"_"specimen-type"_"document-extension"** ; examples:

FRACTESUS_73W_KJc_0.16TC(T).pdf
FRACTESUS_SA508_KJc_1TC(T).pdf
FRACTESUS_15Kh2MFAA_Fracture_SPT.pdf
FRACTESUS_A533B_Tensile_φ10.pdf

Example keywords will be modified as the project advances. For the moment, **keywords such as the following are related to the FRACTESUS project: fracture, mini-CT, 0.16TC(T), Master Curve, Transition, KJc, ASTM E-1921, RPV, Sub-sized specimen, Open Access, ...**

File versioning is not contemplated, as it is intended to upload each data once all concerns about it are solved and the final version is made available to the public.

3.2 Making data openly accessible

All data published in FRACTESUS will be openly accessible. Firstly, it will be stored and organized in a database by the owners (Sharepoint or personal computers of the partners) and then transferred to Zenodo [6] and linked to OpenAire [7] (see section 4 for more details) where it will be available and totally OA. The data will be periodically uploaded to Zenodo [6] as the project advances.

No special tools are needed to access or read data. Zenodo [6] and OpenAire [7] are open databases accessible from any **internet connection** public, private or institutional. The data are produced in a common electronic document format, **PDF (.pdf)**.

There will be no restrictions to accessing data, which will be Open Access once processed, at Zenodo [6] (<https://zenodo.org/>) and OpenAire [7] (<https://www.openaire.eu/>).

3.3 Making data interoperable

Common vocabulary employed in the fracture mechanics field will be used in the datasheets as well as in the data-naming convention, in order to assure a quick indexing and retrieval of relevant data. Keywords and their synonyms and/or associated words can also be employed for subject headings of data. Also, the vocabulary included in the regularly used standards, such as **ASTM E-1921** [3] may be used.

In order to ensure interoperability, all datasets will use the same standards for data creation.

3.4 Increase data re-use (through clarifying licenses)

Licensing will not be applicable for FRACTESUS data, as all data will be **completely open access (OA)** and freely reusable. **No embargo period** is contemplated, except in the cases of green open access papers (see FRACTESUS OA procedure [4]) which will be residually used for this project's publications.

The data produced and/or used in the project will be useable by third parties, during the project development as well as at least 10 years after the end of the project (see section 4) with no restriction, as OA and maximum diffusion is one of the project goals.

Quality assurance will be treated, if necessary, yearly during the project coordination meetings, in order to maintain the standards of the project's data management.

4 Allocation of resources

Data management in FRACTESUS is included as task T6.3 of WP6, led by the University of Cantabria (UC), who will be responsible for data management. UC has allocated a part of the overall WP6 budget and person-months to these activities. WP6 is responsible for FAIR data management, and the open access (OA) publication procedure [4].



All data from the FRACTESUS project will be published in OA: from scientific journal papers and conference proceedings to test data. The research data needed to validate the results presented in each scientific publication must be published at the same time as the publication. Gold-OA will be preferably employed if possible; as the non-OA journal embargo period is rarely under six months, this type of Green-OA communications will not be of common use in the project. **In the FRACTESUS OA procedure [4], the steps for OA publishing** during the project can be found defined in detail.

As specified in FRACTESUS OA procedure [4], costs related to OA to research data are eligible as part of the Horizon 2020 grant. A limited OA budget in the FRACTESUS Project is included within the University of Cantabria (P-15) budget for peer-review papers.

The FRACTESUS project will have data archived in Zenodo [6], which does not impose any requirements on format, size, access restrictions or license and is not restricted to one funder, or one nation; it is free to use for all research outputs from across all fields. Then, **the project will be included in OpenAIRE [7]**, which is a partnership of (currently) more than 50 institutions, all working to shape and implement effective OA and Open Science policies. OpenAIRE aims to establish an open and sustainable scholarly communication infrastructure responsible for the overall management, analysis, manipulation, provision, monitoring and cross-linking of all research outcomes.

During the project, **data will be uploaded to Zenodo [6] and linked to the OpenAire [7] project** regularly, as new results are submitted by the partners. As these resources are considered to be safe, no regular back-ups are planned; however, all data will be additionally internally stored in the project private sharepoint, managed by SCK-CEN.

WP6 will be in charge of long-term preservation. Resources, associated costs and potential value, as well as how data will be kept beyond the project and how long, will be discussed by the whole consortium during General Assembly meetings. In the first instance, given that OA data publishing will rely on Zenodo and OpenAire, which are free of charge, it is intended to preserve OA data in these repositories during a period of at least 10 years after the end of the project. If any of the aforementioned databases, Zenodo or OpenAire, is put out of use or transformed into a different tool, WP6 will be in charge of migrating data to the substitutional/equivalent tool (if it is not done automatically).

5 Data security

For the duration of the project, and prior to the data upload to the aforementioned repositories, datasets will be stored in the responsible partner's storage system, as well as in the project private sharepoint. Every partner is responsible for ensuring that the data are stored safely and securely and in full compliance with European Union data protection laws. Once the data have been uploaded to the repository, and even after the completion of the project, all the responsibilities concerning data recovery and secure storage will go to the repository storing the dataset. The data will be stored in **Zenodo [6] and OpenAire [7], which are certified and reliable repositories for long term data preservation and curation.**

FRACTESUS will use methods that emphasize easy access and extended contact and trust-building among partners. All data files will be transferred via secure internet connections, avoiding the use of USB flash

drives. Files will be labeled in a systematically structured way, in order to ensure the coherence of the final dataset.

6 Ethical aspects

No specific ethical issues have been identified: good research ethics is a major topic for the consortium of this project. Good research ethics means taking great care to prevent any situation where sensitive information could get misused. Furthermore, all processes of data generation and data sharing have to be documented and approved by the consortium.

The FRACTESUS partners will comply with the ethical principles which state that all activities must be carried out in compliance with ethical principles, including the highest standards of research integrity, as set out, for instance, in the European Code of Conduct for Research Integrity including, in particular, avoiding fabrication, falsification, plagiarism or other research misconduct, and applicable international, EU and national law (in particular, EU Directive 95/46/EC).

No personal data will be treated during the research or technical development of the project. However, the dissemination activities such as workshops and training seminars (WP6 responsibility) or project meetings and general administration (WP1 and/or WP7 responsibility), participation in which is on a voluntary basis, may involve the use of personal data. **An Informed Consent Form will be handed out to any individual participating in FRACTESUS workshops or other activities which may lead to the collection of data** which will subsequently be used in the project. The individuals will be informed comprehensively about the intended use of the information collected from them and must agree to the data collection for this scientific purpose with their active approval in the form of a written consent. Data collection, storage, protection, retention and destruction will be carried out through the intranet system of the project: Sharepoint.

FRACTESUS non-EU partners will also rigorously follow the ethical standards and guidelines of Horizon 2020, regardless of the country in which the research is carried out. Activities carried out outside the EU will be executed in compliance with the legal obligations in the country where they are carried out, with an extra condition that the activities must also be allowed in at least one EU Member State. Data will be transferred between a non-EU country and countries in the European Union to allow for joint analyses and storage of all data in the common database.

7 Schedule for updates

The first version of the DMP will be issued on M06; then the following month after each General Assembly meeting (yearly), an updating of the document will be performed, if required. In any case, at the end of the project a final revised and updated version will be issued. This is the current DMP schedule for updates:

		PROJECT MONTH NUMBER																																																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48		
		2020				2021												2022												2023												2024									
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		
General Assembly				X												X												X													X										
DMP UPDATE				X												X												X													X										X



8 Other issues

No other issues to report at this time.

9 References

[1] European Commission, Participant Portal H2020 Online Manual, (accessed on March 11th, 2021) https://ec.europa.eu/research/participants/docs/h2020-funding-guide/cross-cutting-issues/open-access-data-management/data-management_en.htm

[2] Grant Agreement number 9400014 - FRACTESUS, NFRP-2019-2020, 2020.

[3] ASTM E1921 - 20, "Standard Test Method for Determination of Reference Temperature, T_0 , for Ferritic Steels in the Transition Range", ASTM International, Subcommittee E08.07, 2020.

[4] "How to publish in FRACTESUS project - Open Access Procedure", FRACTESUS Consortium (grant number 900014), Work package leader report, WP6, UC/PR N°15, 2020.

[5] "Testing protocols and reporting formats", FRACTESUS Consortium (grant number 900014), Deliverable D6.9, WP6, UC/PR N°15, (S.Cicero, B.Arroyo & G. Díaz), 2021.

[6] Zenodo open-access repository (accessed on March 11th, 2021), <https://zenodo.org>

[7] OpenAire project (accessed on March 11th, 2021), <https://www.openaire.eu/>

[8] Digital Object Identifier (DOI) system, (accessed on March 11th, 2021), <https://www.doi.org>