



**Fuel Recycle and Experimentally Demonstrated
Manufacturing of Advanced Nuclear Solutions for Safety
Project Number: 101060800**




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Data Management Plan

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Summary

This document describes the Data Management Plan (DMP) to be implemented within the European Horizon Project Fuel Recycle and Experimentally Demonstrated Manufacturing of Advanced Nuclear Solutions for Safety (FREDMANS). Large amount of experimental and numerical data will be generated during the fouryears of project duration. The DMP outlines the conditions for data preservation, adherence to FAIR principles, publication, and makes a distinction between potentially sensitive or confidential information and open access data.

Keywords

Data Management Plan, FAIR, public, dataset

1. DESCRIPTION OF FREDMANS PROJECT

1.1 Objective of the project

FREDMANS aims to increase safety and efficiency in both nuclear power production as well as the recycling of spent fuel. Changing from oxide fuel to a more fissile dense material with higher thermal conductivity can enhance both safety of operation and the economic impact of nuclear power.

At the same time, a transition to a greener society with respect to both the generation and usage of electricity will drastically increase consumption of finite materials. Generation is predicted to increase by 16-20 times, in particular as electrification replaces the direct use of fossil fuels for heating and transportation. The nuclear industry can mitigate their part of the resource use through the recycling of spent nuclear fuel. This can enhance the actual power output by about 100 times.

However, today there has been no full industrial demonstration of the complete recycling of nuclear fuel, although one time recycling, including of plutonium, has been used on large scale for many years e.g., in France. The model fuel is nitride fuel. It may be more energy efficient/economically advantageous to recycle not only the fissile material, but also the required isotopically enriched N-15 that is otherwise currently a costly raw material.

The project sets objectives that address the overall goals of the SET plan, SNETP and EERA JPNM SRA to answer the specific aims of this call relating to the safety of advanced fuels and their recyclability, in particular nitrides highlighted in the call.

We will prove that advanced fuels are a viable option for industrial use that can enhance the safety, sustainability and economics of nuclear power operation.

1.2 Project structure

The FREDMANS project consists of seven work packages (WP).

The work packages are: Advanced Manufacturing, Recyclability, Waste Management, and Industrial Applications. Across all these WPs, the crucial aspect of safety is held in high focus. As the real safety of future nuclear systems is achieved through well educated people, an extensive Training & Education work package is included.

WP 1 is the evaluation of novel fuel production methods, which are optimised for the refabrication.

WP 2 is bridging the fabrication of the advanced and innovative nuclear fuels and the new waste fractions disposal which might result through recyclability and sustainability of material after production.

WP 3 will investigate waste management methods for the handling of advanced fuel materials.

The objectives of WP4 are to identify industrially scalable manufacturing methods for UN fuel, based on input from WP1, elaborate concept designs, safety assessments, cost estimates for fuel factory and pilot plant and for the treatment plant.

WP 5 objective is to support the exchange of knowledge and practical experience among the community and future researchers. It is primarily addressed to MSc and PhD students, as main target group, but also teachers and other members of the community will benefit from the activities and measures in the area of education/training and mobility carried on by FREDMANS project.

WP6 and WP7 deal with the project management, communication and ethics requirements.

2. Background of the Data Management Plan and definitions

2.1 Background

This document presents the FREDMANS Data Management Plan (DMP).

According to the EC, Open access (OA) refers to the practice of providing online access to scientific information that is free of charge to the end-user and reusable. 'Scientific' refers to all academic disciplines. In the context of research and innovation, 'scientific information' can mean:

- peer-reviewed scientific research articles (published in scholarly journals);
- research data (data underlying publications, curated data and/or raw data).

The rationale is that data management is not a goal itself, but a way that leads to knowledge discovery and innovation, and to subsequent data and knowledge integration and reuse. Therefore, projects must aim at improving and maximising access to and reuse of research data generated, while balancing openness and protection of scientific information, commercialisation and Intellectual Property Rights, privacy concerns, etc.

DMPs are a key element of good data management. As part of making research data findable, accessible, interoperable, and reusable (FAIR), a DMP should include information on the data life cycle:

- the handling of research data during and after the project,
- what data will be collected, processed or generated,
- what methodology and standards will be applied,
- whether data will be shared/made open and how,
- how data will be curated and preserved.

While open access to research data has become applicable by default in Horizon Europe, the Commission acknowledges that there could be good reasons to keep the research data confidential.

2.2 Definitions

Before explaining the consortium strategy in terms of Data Management, several terms must be defined:

- **Data:** Data refers to unstructured facts and figures, which are not organised in any way and which provide no further information regarding patterns, context, etc. For instance, data on production, demand, results from technical tests and so on, is unstructured data.
- **Information:** For data to become information, it must be contextualized, categorized, calculated and condensed. Information thus paints a bigger picture; it is data with relevance and purpose. It may convey a trend in the environment, or perhaps indicate a pattern of sales for a given period of time.
- **Knowledge:** Knowledge is closely linked to doing and implies know-how and understanding. The knowledge possessed by every individual is a product of his/her experience and encompasses the norms by which he/she evaluates new inputs from his/her surroundings. For instance, knowledge is related to the know-how acquired in R&D projects, commercial activities or the expertise that is inherent to each partner.

This present DMP will mainly deal with how the data will be managed and will mention the links with knowledge. Below are some further definitions, concerning data:

- **Data codebook:** A codebook is an essential document that informs the data user about the study, data file(s), variables, categories, etc., that make up a complete dataset. The codebook may include a dataset's record layout, list of variable names and labels, concepts,

categories, cases, missing value codes, frequency counts, notes, universal statements, and so on.

- **Dataset:** a dataset is a collection of data. Most commonly a data set corresponds to the contents of a single database table, or a single statistical data matrix, where every column of the table represents a particular variable. The data set lists values for each of the variables, such as height and weight of an object, for each member of the dataset. The dataset may comprise data for one or more members, corresponding to the number of rows.

2.3 Versions of the Data Management Plan

According to the EU's guidelines regarding the DMP (European Commission¹, 2022), the document may be updated, if necessary, during the project lifetime. The minimum requirement is that the DMP is updated at least for each periodic evaluation of the project. The DMP is intended to be a living document in which information can be made available on a finer level of granularity through updates as the implementation of the project progresses. The DMP should, therefore, have a clear version number and include a timetable for updates.

3. FREDMANS data

3.1 Open Science

Open access to scientific publications

The beneficiaries must ensure open access to peer-reviewed scientific publications relating to their results. In particular, they must ensure that:

- at the latest at the time of publication, a machine-readable electronic copy of the published version or the final peer-reviewed manuscript accepted for publication, is deposited in a trusted repository for scientific publications
- immediate open access is provided to the deposited publication via the repository, under the latest available version of the Creative Commons Attribution International Public Licence (CC BY) or a licence with equivalent rights; for monographs and other long-text formats, the licence may exclude commercial uses and derivative works (e.g. CC BY-NC, CC BY-ND) and
- information is given via the repository about any research output or any other tools and instruments needed to validate the conclusions of the scientific publication.

Beneficiaries (or authors) must retain sufficient intellectual property rights to comply with the open access requirements. Metadata of deposited publications must be open under a Creative Commons Public Domain Dedication (CC 0) or equivalent, in line with the FAIR principles (in particular machine-actionable) and provide information at least about the following: publication (author(s), title, date of publication, publication venue); Horizon Europe or Euratom funding; grant project name, acronym and number; licensing terms; persistent identifiers for the publication, the authors involved in the action and, if possible, for their organisations and the grant. Where applicable, the metadata must include persistent identifiers for any research output or any other tools and instruments needed to validate the conclusions of the publication.

Only publication fees in full open access venues for peer-reviewed scientific publications are eligible for reimbursement.

Research data management

The beneficiaries must manage the digital research data generated in the action ('data') responsibly, in line with the FAIR principles and by taking all of the following actions:

- establish a data management plan ('DMP') (and regularly update it) Associated with document Ref. Ares (2022)4053005 - 31/05/2022 12
- as soon as possible and within the deadlines set out in the DMP, deposit the data in a trusted repository; if required in the call conditions, this repository must be federated in the EOSC in compliance with EOSC requirements
- as soon as possible and within the deadlines set out in the DMP, ensure open access — via the repository — to the deposited data, under the latest available version of the Creative Commons Attribution International Public License (CC BY) or Creative Commons Public Domain Dedication (CC 0) or a licence with equivalent rights, following the principle 'as open as possible as closed as necessary', unless providing open access would in particular:
 - o be against the beneficiary's legitimate interests, including regarding commercial exploitation, or
 - o be contrary to any other constraints, in particular the EU competitive interests or the beneficiary's obligations under this Agreement; if open access is not provided (to some or all data), this must be justified in the DMP.
- provide information via the repository about any research output or any other tools and instruments needed to re-use or validate the data.

Metadata of deposited data must be open under a Creative Common Public Domain Dedication (CC 0) or equivalent (to the extent legitimate interests or constraints are safeguarded), in line with the FAIR principles (in particular machine-actionable) and provide information at least about the following: datasets (description, date of deposit, author(s), venue and embargo); Horizon Europe or Euratom funding; grant project name, acronym and number; licensing terms; persistent identifiers for the dataset, the authors involved in the action, and, if possible, for their organisations and the grant. Where applicable, the metadata must include persistent identifiers for related publications and other research outputs.

Additional practices

Where the call conditions impose additional obligations regarding open science practices, the beneficiaries must also comply with those. Where the call conditions impose additional obligations regarding the validation of scientific publications, the beneficiaries must provide (digital or physical) access to data or other results needed for validation of the conclusions of scientific publications, to the extent that their legitimate interests or constraints are safeguarded (and unless they already provided the (open) access at publication). Where the call conditions impose additional open science obligations in case of a public emergency, the beneficiaries must (if requested by the granting authority) immediately deposit any research output in a repository and provide open access to it under a CC BY licence, a Public Domain Dedication (CC 0) or equivalent. As an exception, if the access would be against the beneficiaries' legitimate interests, the beneficiaries must grant nonexclusive licenses — under fair and reasonable conditions — to legal entities that

need the research output to address the public emergency and commit to rapidly and broadly exploit the resulting products and services at fair and reasonable conditions. This provision applies up to four years after the end of the action (see Data Sheet, Point 1)

3.2 General framework for data collection within FREDMANS

In this section, the data types to be collected in each WP of the FREDMANS project are presented.

Work package WP1 – Manufacturing Methods

The dataset will contain the individual dataserieS of the experimental work.

Work package WP2 – Recyclability

The dataset will contain the individual dataserieS of the experimental work.

Work package WP3 – Waste Management Methods

The dataset will contain the individual dataserieS of the experimental work.

Work package WP4 – Industrial application

The dataset will contain the individual dataserieS of the experimental work.

Work package WP5 – Education and training

The WP5 outcomes that are the subject of the DMP are:

- Teaching materials elaborated in support to the training courses organized by FREDMANS
- Training materials elaborated for the Summer School on Actinide Science and Innovative Nuclear Fuel Cycles organized by FREDMANS.

Each lecture included in the agenda of the above scientific events will be generated, collected and deposited as pdf file, not exceeding 500MB.

- Data received from beneficiaries of the Travel Fund (personal data, bank account data, etc.) on which ENEN GDPR policy applies <https://enen.eu/index.php/gdpr-privacy-statement/>.

Work package WP6 – Project Management

The dataset will contain the project management documentation.

Work package WP7 – Ethics requirements

The dataset will contain the documentation related to ethics requirements.

Project documentation will be generated and collected in MS Word, MS Excel, PDF and CSV formats. The size of the data should be within several hundreds of megabytes.

4. FAIR Data Management in FREDMANS

In compliance with applicable rules, every Horizon Europe project is required to draft a DMP in order to make the data Findable (1), Accessible (2), Interoperable (3) and available for Re-use (4) (FAIR principles).

In 2016, the ‘FAIR Guiding Principles for scientific data management and stewardship’ were published in Scientific Data <https://www.nature.com/articles/sdata201618>. The authors intended to provide guidelines to improve the Findability, Accessibility, Interoperability, and Reusability of digital assets. The principles emphasise machine-actionability (i.e., the capacity of computational systems to find, access, interoperate, and reuse data with none or minimal human intervention) because humans increasingly rely on computational support to deal with data as a result of the increase in volume, complexity, and creation speed of data.

Findable

The first step in (re)using data is to find them. Metadata and data should be easy to find for both humans and computers. Machine-readable metadata are essential for automatic discovery of datasets and services, so this is an essential component of the FAIRification process.

F1. (Meta)data are assigned a globally unique and persistent identifier. F2. Data are described with rich metadata (defined by R1 below).

F3. Metadata clearly and explicitly include the identifier of the data they describe.

F4. (Meta)data are registered or indexed in a searchable resource.

Accessible

Once the user finds the required data, she/he/they need to know how they can be accessed, possibly including authentication and authorisation.

A1. (Meta)data are retrievable by their identifier using a standardised communications protocol.

A1.1 The protocol is open, free, and universally implementable.

A1.2 The protocol allows for an authentication and authorisation procedure, where necessary.

A2. Metadata are accessible, even when the data are no longer available.

Interoperable

The data usually need to be integrated with other data. In addition, the data need to interoperate with applications or workflows for analysis, storage, and processing.

I1. (Meta)data use a formal, accessible, shared, and broadly applicable language for knowledge representation.

I2. (Meta)data use vocabularies that follow FAIR principles.

I3. (Meta)data include qualified references to other (meta)data.

Reusable

The ultimate goal of FAIR is to optimise the reuse of data. To achieve this, metadata and data should be well-described so that they can be replicated and/or combined in different settings.

R1. (Meta)data are richly described with a plurality of accurate and relevant attributes.

R1.1. (Meta)data are released with a clear and accessible data usage license.

R1.2. (Meta)data are associated with detailed provenance.

R1.3. (Meta)data meet domain-relevant community standards.

The principles refer to three types of entities: data (or any digital object), metadata (information about that digital object), and infrastructure. For instance, principle F4 defines that both metadata and data are registered or indexed in a searchable resource (the infrastructure component).

4.1 Making data findable, including provisions for metadata

This section will provide insight into how FREDMANS intends to make it easier to find data collected or produced by the partners. The way to proceed in order to achieve this goal is to describe properly the content of the data sets and the accessibility.

Description of the dataset

Each data set that will be collected, processed, or generated within the project will be summarized and monitored (see initial Datasets for FREDMANS project in Annex 1). The following information has been suggested for collecting to manage the project data:

- Who has generated data: Partner and WP
- A persistent identifier (PID) and a type of PID. Options: DOI, ARK, Handle, URI, None, Other
- Description of a dataset and its location (URL)
- Information if the dataset is already available in open access or how it will be made accessible if it underpins a publication
- Information if the dataset is part of a publication and if so, identification of the publication (via PID)
- Information on open accessibility of the metadata of deposited data access.

The information will be collected in the summary table as shown in the Annex 1 of this document. As stated in the project basic documents, each and every partner is responsible for delivering the information on the data and making it accessible. The table will be regularly updated as part of the internal 6 month monitoring procedure and revised at the project meetings.

4.2 Making data accessible

Open accessibility of the data is the second key aspect for making data FAIR.

This section will describe the type of data to be made available, its location and the procedure to obtain it. Several degrees of accessibility are identified, including both open access and restricted access.

As per the data set produced in the projects, the aim will be to make them “as open as

possible and as close as necessary” in line with the guidelines of Horizon Europe projects.

Data licensing

Data licensing standards are used to lay out the openness of data sets in concrete terms. There are many types of licenses to choose from, and this document will not cover them in depth. Data licenses that will be considered for use in the project (based on definitions from <https://opendefinition.org/>) are as follows:

License (SPDX IDs)	Domain*	By*	SA*	Comments
Creative Commons CCZero (CC0-1.0)	Content, Data	N	N	Dedicate to the Public Domain (all rights waived)
Open Data Commons Public Domain Dedication and Licence (PDDL-1.0)	Data	N	N	Dedicate to the Public Domain (all rights waived)
Creative Commons Attribution 4.0 (CC-BY-4.0)	Content, Data	Y	N	
Open Data Commons Attribution License (ODC-By-1.0)	Data	Y	N	Attribution for data(bases)
Creative Commons Attribution Share-Alike 4.0 (CC-BY-SA-4.0)	Content, Data	Y	Y	
Open Data Commons Open Database License (ODbL-1.0)	Data	Y	Y	Attribution-ShareAlike for data(bases)

* Domain = Domain of application, i.e., what type of material this license should/can be applied to.

BY = requires attribution

SA = require share-alike

After collection, data will be generally organised in Excel files and Word documents, for some of the data special formats like csv will be used.

For open access data FREDMANS will use special tools: project website, ENEN website, Socials, Zenodo repository to systematically publish open data, open access presentations and public deliverables in order to maximise reuse and promote the project results. Prior to any upload, the FREDMANS Governing Board has to be notified in line with the rules set by the Consortium Agreement/Project Handbook. Ideally storing data at the special tools should be free of charge with no expiry date.

Confidential data will be stored at the FREDMANS internal servers.

Before sharing the data on open access platforms, the partners shall comply with all applicable governmental laws and EU regulations governing the export and re-export of technology. Delivery of export-controlled items is subject to the obtaining of all export licenses demanded by the competent authorities. Partners shall not be obligated to publish any data, if such fulfilment is prevented by the absence of an export license or any other impediments arising out of national or international foreign trade, customs requirements, embargoes or other sanctions, as amended from time to time.

4.3 Making data interoperable

Standard vocabulary may be used on a case-by-case basis to make the data interoperable between researchers, institutions, organisations, countries, etc. Further, a list of acronyms and/or abbreviations will be provided at the beginning of every report. Data will be stored using file formats in widespread use, if possible, to maximise interoperability between software solutions, operating systems, etc.

4.4 Increase data re-use

Restrictions for reuse

FREDMANS will be compliant with the General Data Protection Regulation (GDPR), and data generated through interviews, surveys and travel fund applications will not be re-used directly due to privacy concerns. To allow reuse, respect privacy and avoid loss of research data, two different techniques could be used to disseminate its data, while abiding by regulations on privacy.

- Anonymization of data

“Anonymization” of data means processing it with the aim of irreversibly preventing the identification of the individual to whom it relates. Data can be considered anonymised when it does not allow identification of the individuals it is related to, and no individuals can be identified from the data by any further processing of that data or by processing it together with other information which is available or likely to be available.

There are different anonymization techniques like:

Generalisation: generalising data means removing its specificity. For example, in the case of a table containing household income levels, with 4 figures mentioned: \$164,000, \$58,543, \$90,893, and \$232,234. One way of generalising this numbers would be to write that the values are “more than \$150,000, less than \$60,000, between \$90,000 and \$100,000, and more than \$225,000” respectively. Essentially it means taking exact figures, establishing a baseline category, and then obfuscating the data by assigning it to one of the categories in order to remove any sense of specificity from it.

K-anonymity; A release of data is said to have the k-anonymity property if the information for each person contained in the release cannot be distinguished from the other individuals whose information also appear in the release. For instance, in a table composed of six attributes (Name, Age, Gender, State of Domicile, Religion and Disease), removing the name and the religion column while generalising the age is a way to effectively k-anonymise the data.

Other techniques, such as “masking” or “pseudonymisation”, which are aimed solely at removing certain identifiers, may also play a role in reducing the risk of identification. In many cases, these techniques work best when used together.

- Pseudonymisation of data

"Pseudonymisation" of data means replacing any identifying characteristics of data with a pseudonym, or, in other words, a value which does not allow the data subject to be directly identified.

Although pseudonymisation has many uses, it should be distinguished from

anonymization, as it only provides limited protection for the identity of data subjects in many cases as it still allows identification using indirect means. Where a pseudonym is used, it is possible to identify the data subject by analysing the underlying or related data.

- Archiving and preservation

It is of utmost importance for FREDMANS to keep the data available after the end of the project. To ensure medium-term preservation of the datasets, anonymised data will be stored on Zenodo, which is a multi-functional open platform recognised by OpenAIRE and the European Commission.

5. Data Management Plan implementation

Every project partner in FREDMANS will be responsible for the data management within his/her own organization in accordance with the present FREDMANS DMP and the rules of the EC Grant Agreement. Data will be curated and reported within internal periodic reports (using Annex 1 to the DMP) by individual partners overseen by the WP leaders. The overall implementation of the DMP in the project will be supervised by the coordinator with assistance of the project Administrative Management Office (AMO). The Coordinator and the AMO is responsible for storing the information about the datasets generated and reported by the partners and for uploading the collected data to the EC periodic reporting system. In case of deviations, appropriate measures shall be identified and implemented by decision of the GB.

FREDMANS SharePoint

The main tool for internal document exchange and storage is FREDMANS repository SharePoint run by ENEN. The access to the FREDMANS repository is granted on request directly and exclusively by ENEN.

Information in FREDMANS repository is organized as follows:

- Basic project documents
- Contact list
- Deliverables
- Handbook
- Meetings
- Promotion materials
- Publications
- Reports
- Templates
- Video ENEN
- WPs.

6. Ethical aspects

6.1 General Data Protection Rules

This DMP was drafted and updated taking into account the GDPR for the collection, storage and re- use of the data, in line with the following general principles.

Personal data shall be:

1. processed lawfully, fairly and in a transparent manner in relation to the data subject ('lawfulness, fairness and transparency');

2. collected for specified, explicit and legitimate purposes and not further processed in a manner that is incompatible with those purposes; further processing for archiving purposes in the public interest, scientific or historical research purposes or statistical purposes shall not be considered to be incompatible with the initial purposes ('purpose limitation');
3. adequate, relevant and limited to what is necessary for relation to the purposes for which they are processed ('data minimisation');
4. accurate and, where necessary, kept up to date; every reasonable step must be taken to ensure that personal data that are inaccurate, having regard to the purposes for which they are processed, are erased or rectified without delay ('accuracy');
5. kept in a form which permits identification of data subjects for no longer than is necessary for the purposes for which the personal data are processed; personal data may be stored for longer periods insofar as the personal data will be processed solely for archiving purposes in the public interest, scientific or historical research purposes or statistical purposes subject to implementation of the appropriate technical and organisational measures required by this Regulation in order to safeguard the rights and freedoms of the data subject ('storage limitation');
6. processed in a manner that ensures appropriate security of the personal data, including protection against unauthorised or unlawful processing and against accidental loss, destruction or damage, using appropriate technical or organisational measures ('integrity and confidentiality').

Conclusion

This report collects information about the Data Management Plan to be implemented within the FREDMANS project. It provides information on the data that will be generated and collected in the different work packages, as well as on the underlying principles that will be used for the generation, collection, storage, dissemination, and curation of the FREDMANS data.

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