Metadata and its use in the development of robust safety cases for geological disposal

Massimo CIAMBRELLA

RepMet Secretary

Alexander CARTER

RepMet Chair

IGSC Safety Symposium 2018
10-11 October 2018

Information, Data and Knowledge Management (IDKM)

The development of robust safety cases requires large amounts of data, information and knowledge.

o **What is data?**
Facts and ideas in the form originally collected.

o **What is information?**
Organised and structured data.

o **What is knowledge?**
Information that the human brain has understood and interpreted.

IDKM in safety case development

National programmes for RWM tend to run for decades; over such timescale safety cases have to remain robust and not lose their scientific integrity.

o **Data** – They increase in number, type and quality as national programmes proceed through the successive stages of repository commissioning.

o **Information** – Safety analysts have to be confident with data and able to access and understand the associated information.

o **Knowledge** – Its acquisition is a very expensive process in terms of human time and financial resources. The explicit and implicit knowledge that radioactive waste management organisations (RWMOs) acquire has to be transmitted from generation to generation of workers to reduce the risk of loss and to avoid the need to «reinvent the wheel» each time.
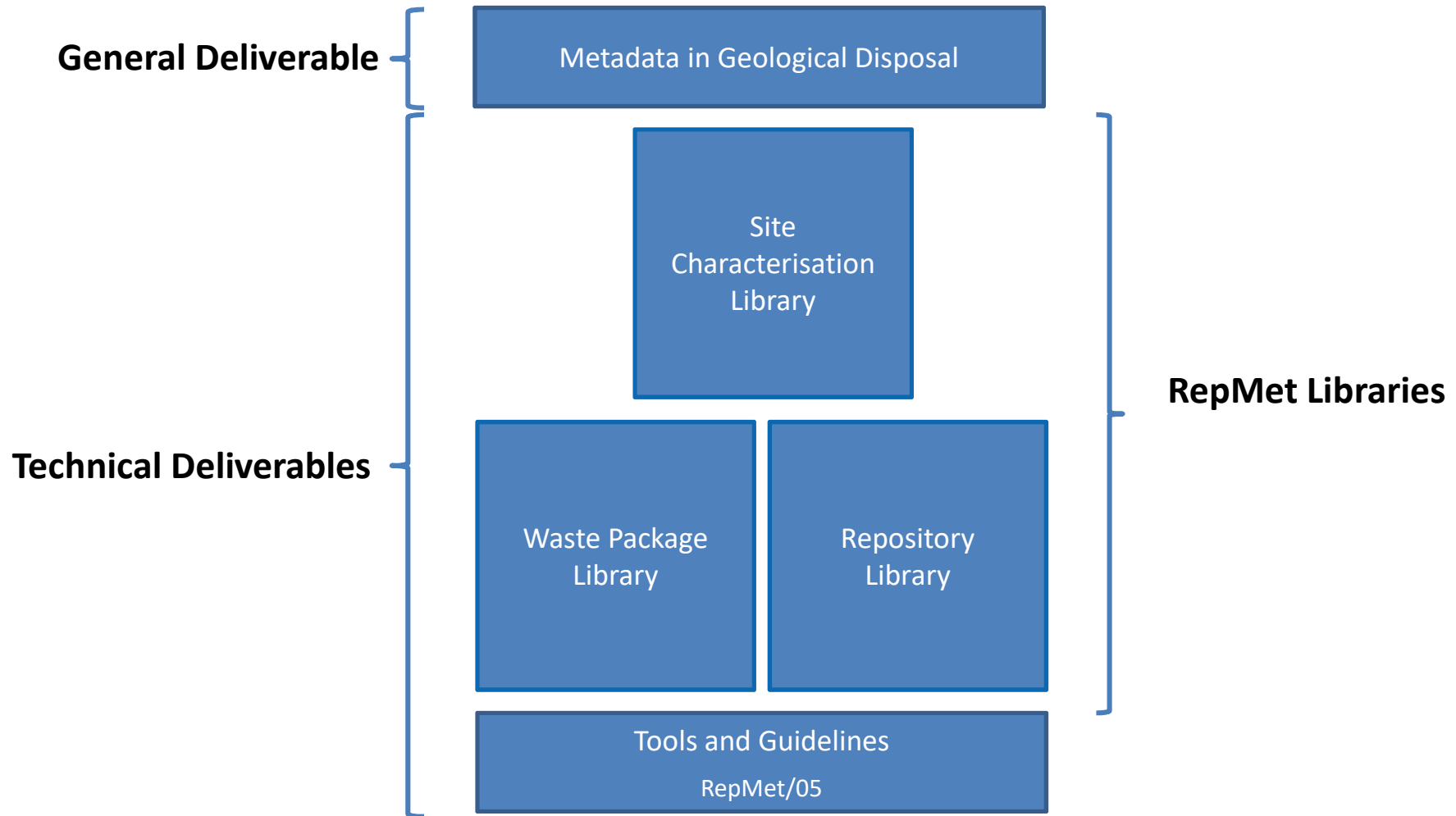
What are metadata?

- Metadata are "*data about data*"…

- Metadata enables users <u>be confident with data</u> by:

  - ❑ *Providing provenance to data (who, what, when, where, why and how);*

  - ❑ *Providing context, facilitating the accurate interpretation and (re)use of data;*

  - ❑ *Describing and maintain the original quality of data (e.g. uncertainty);*

  - ❑ *Helping users to quickly find the data they are looking for and support searching for information.*

  - ❑ *Etc...*

- Metadata structure/organise data keeping **accessible and understandable the associated information** over time.
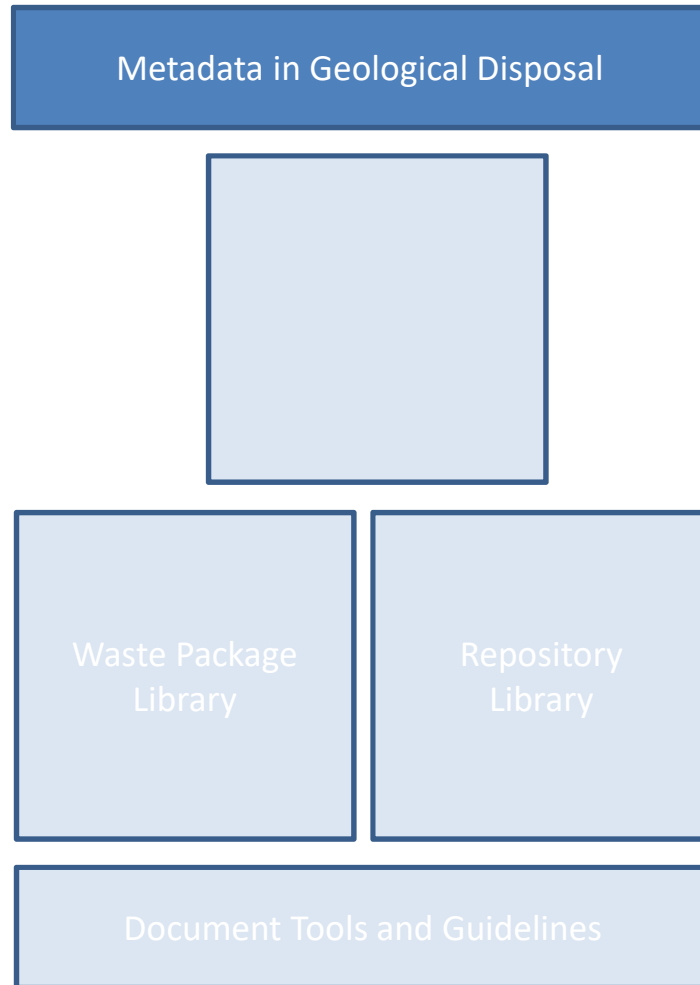
The RepMet initiative

- **Time** – from 2014 (1st meeting in January 2014) to the end of 2017.

- **Acronym** – RepMet (Radioactive Waste Repository Metadata Management).

- **Objective:**
Investigation of the role of metadata in data, information and knowledge management within national programmes for radioactive waste repositories.

- **Participation** – 12 organizations from 12 countries:

ANDRA (France), ENRESA (Spain), JAEA (Japan), NAGRA (Switzerland), NDA/RWM (United Kingdom), NWMO (Canada), ONDRAF/NIRAS (Belgium), POSIVA (Finland), PURAM (Hungary), DoE Sandia National Laboratory (USA), SKB (Sweden), SURAO (Czech Republic).

What RepMet has produced – Deliverables

General Deliverable

Metadata in Geological Disposal

Technical Deliverables

Site Characterisation Library

RepMet Libraries

Waste Package Library

Repository Library

Tools and Guidelines

RepMet/05

Metadata in Geological Disposal

Metadata in Geological Disposal

Waste Package Library	Repository Library

Document Tools and Guidelines

Goals:

- Introduce metadata and RepMet to a decision maker in a RWMO

Contents:

- What is metadata?

- How can metadata help geological disposal?

- What is RepMet and what has it done?

- Who are our designated communities?

- Guidance on metadata policy in RWMOs

- **What recommendations does RepMet make to RWMOs?**

# Metadata in Geological Disposal (cont.)

RepMet's ten recommendations to RWMOs:

- R1 – Establish a comprehensive metadata policy within the RWMO

- R2 – Analyse the needs for, and benefits of, metadata in the RWMO's processes, both now and in the future

- R3 – Try to identify and define your designated communities

- R4 – Provide sufficient resource, to implement metadata schemes, train staff on their use and to populate values

- R5 – Ensure staff understand the importance of quality metadata and instil a culture of responsibility with defined accountability

Metadata in Geological Disposal (cont.)

- R6 – Try to capture metadata at the earliest opportunity and if possible generate automatically; where manual validate

- R7 – Consider existing standards before adopting a custom approach

- R8 – Make use of maintained controlled dictionaries throughout the RWMO and supply chain, with a well defined process to update, replace and cascade these dictionaries

- R9 – Where possible, make use of RepMet's metadata libraries to ensure coherence and harmonisation

- R10 – Where possible, make use of RepMet's tools and guidelines

Tools and Guidelines

Metadata in Geological Disposal

Site Characterisation Library

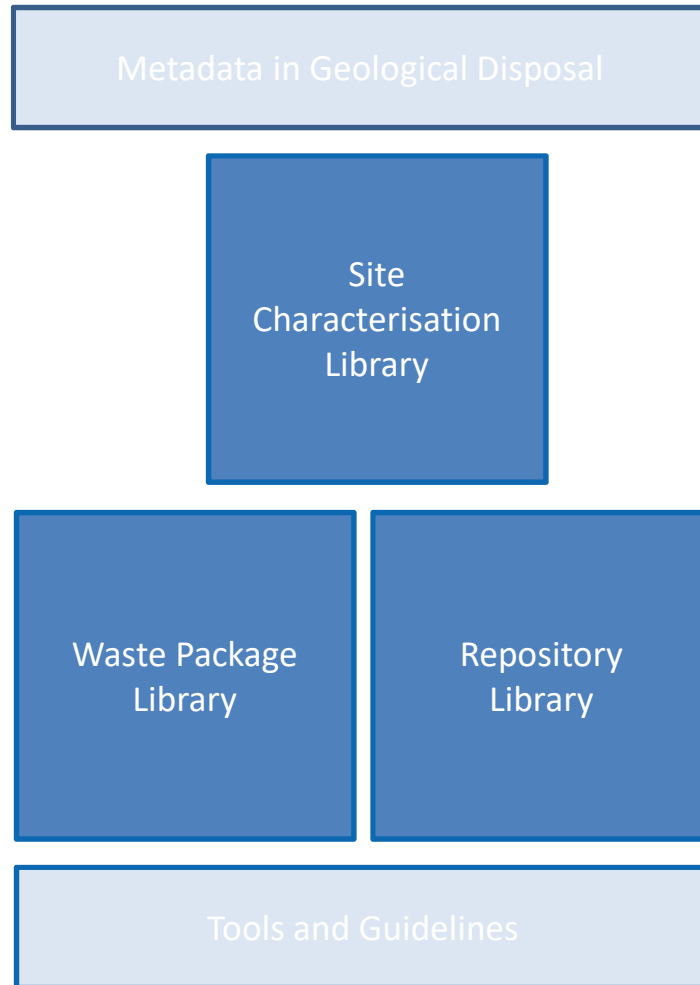| Waste Package Library	Repository Library

Tools and Guidelines
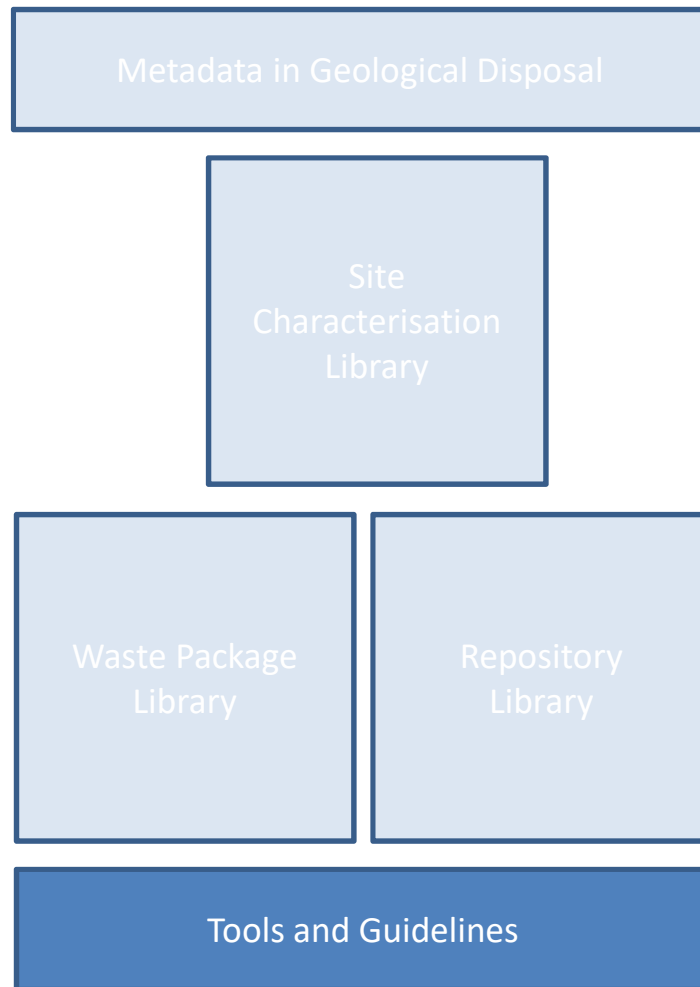
Goals:

- Introduce and describe in a separated document the metadata-based tools and the techniques used for the development of the RepMet Libraries.

Contents:

- What is the data modelling?

- Conceptual data models (ERD diagrams, difference with UML diagrams)

- Dictionaries and controlled vocabularies (SKOS, RDF)

- Common metadata standards used in multiple libraries:

  - ➢ OGC Observation & Measurement;

  - ➢ Minnesota Record Keeping.

Data and Metadata Libraries

Metadata in Geological Disposal

Site Characterisation Library

Waste Package Library

Repository Library

Tools and Guidelines

Goals:

- Conceptual design of databases built with the metadata-based tools and techniques introduced in the Tools and Guidelines

- Define, at a suitable level, databases about disciplines relevant to geological disposal (i.e. geoscience, waste management, engineering)

Contents:

- Review of existing standards (as applicable)

- Conceptual data model development and methodology

- Data and metadata attributes and high-level justifications (including mindmaps)

- Domain specific dictionaries

- Web-product output format

Conclusions

- A safety case requires large amounts of data, information and knowledge that common working life and succession of worker generations (considering the timescales of typical national programmes too) may erode both qualitatively and quantitatively

- Metadata structure data → **they mantain information!**

- RepMet, an IGSC initiative, has investigated **why** and **how** metadata should be used by RWMOs in geological disposal programmes

  ❖ **Why** – Is explained in the Metadata in Geological Disposal report

  ❖ **How** – Detailed examples are provided in the «RepMet Libraries» (i.e. Site Characterisation, Waste Package and Repository Library) and in the «Tools and Guidelines» report

Future plans

- Beyond RepMet, there is a proposal to continue the work in metadata for safety case in the next RWMC activities in IDKM
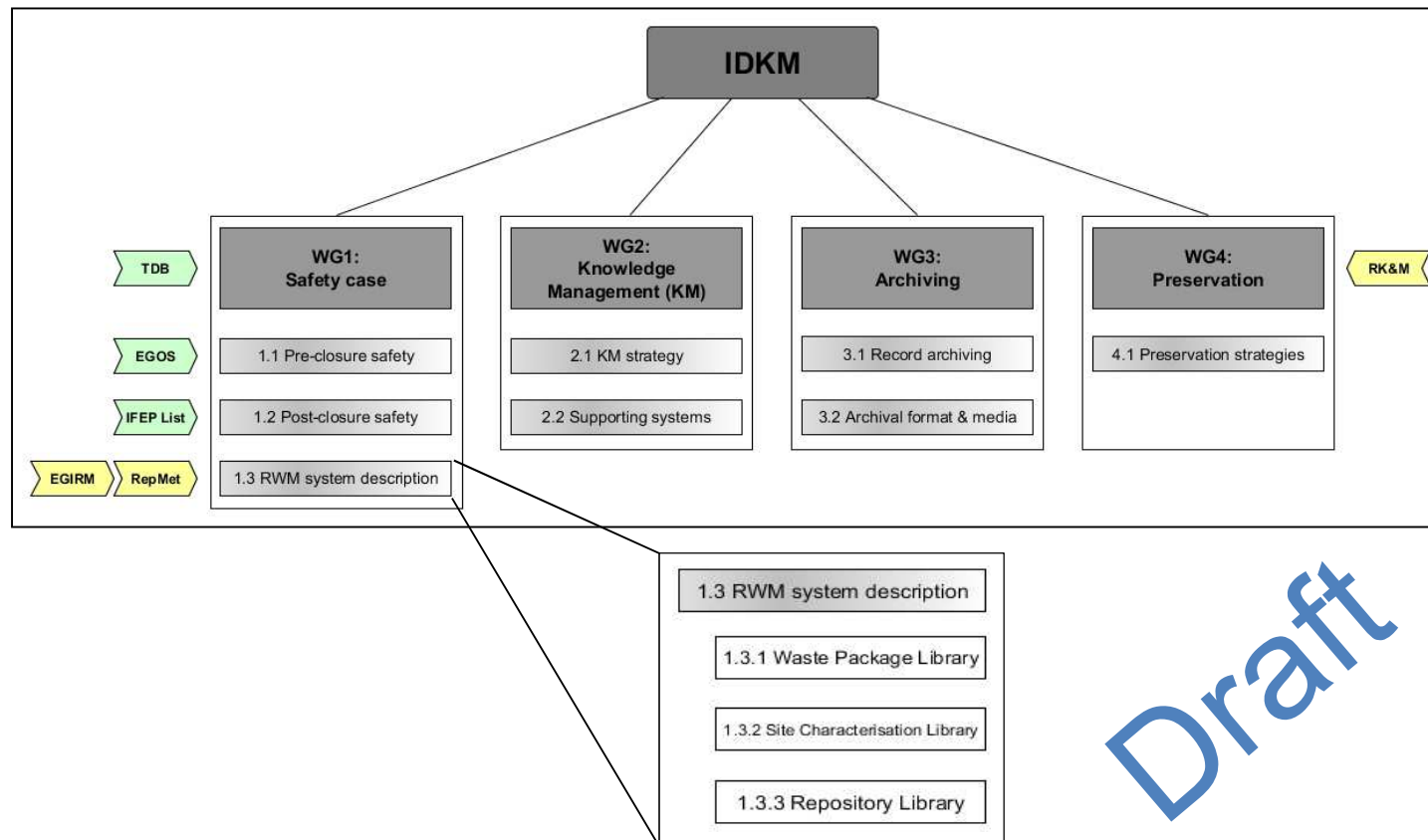
Merci, Grazie, Grazia, Takk, Danke, Tack, Gracias, Arigatô, Спасибо, Nǐ hǎo and Thank You

Contacts:

Massimo CIAMBRELLA
Jr. Radioactive Waste Management Specialist
Division of Radioactive Waste Management
OECD Nuclear Energy Agency
+33 (0) 1 45 24 11 47
massimo.ciambrella@oecd-nea.org
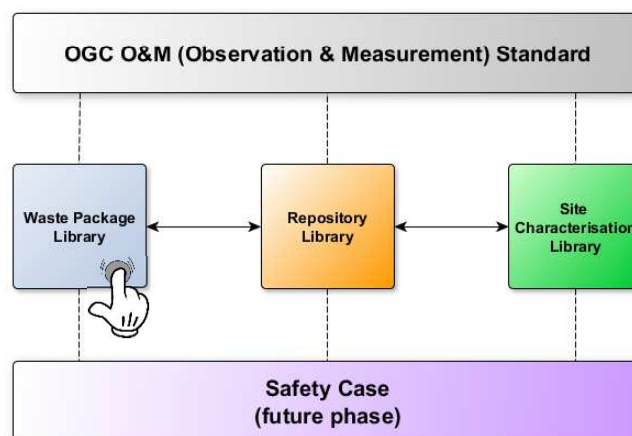
Data and Metadata Libraries

Introduction

In the initiative framework, the term "*library*" means the conceptual design of a database about a remarkable scientific and technical topic. The RepMet group designed three libraries on selected topics across three main disciplines involved in the radioactive waste repository programmes, i.e. radioactive waste management, engineering, geoscience. Each library is composed of:

- *Abstract data models* according to the Entity-Relationship Diagram (ERD) notation; and
- List of *properties* (alt. attributes) describing the library entities, in the form of controlled dictionaries according to the RDF/SKOS ontologies.

The information related to each property in the libraries plays a role in the development of the safety case for a radioactive waste repository. This information has to be maintained and preserved overall the repository lifecyle. To achieve this important result, it would not be enough just to maintain the data related to a property: e.g. the numeric value (i.e. data) of the activity of a transuranic radionuclide in a spent nuclear fuel assembly (i.e. property) might be poor in meaning if the data-user does not know how it was obtained. It would be fundamental to have additional data, alias metadata, in order to describe and keep the information behind the single data.

RepMet selected the "OGC Observation & Measurement (O&M) metadata standard" (ISO19156) to describe the property information. This standard provides some abstract (meta)data models that identify and arrange metadata to describe a single property in a way that future users will be confident in it.

Moreover, RepMet designed the list of properties in the libraries as ontologies, alias as tools to represent the human knowledge associated to the properties. The synergy between the O&M standard and the ontologies represents a potential and fundamental *modus operandi* to maintain and preserve the information and the knowledge related to a radioactive waste repository.

Data and Metadata Libraries – Data Model
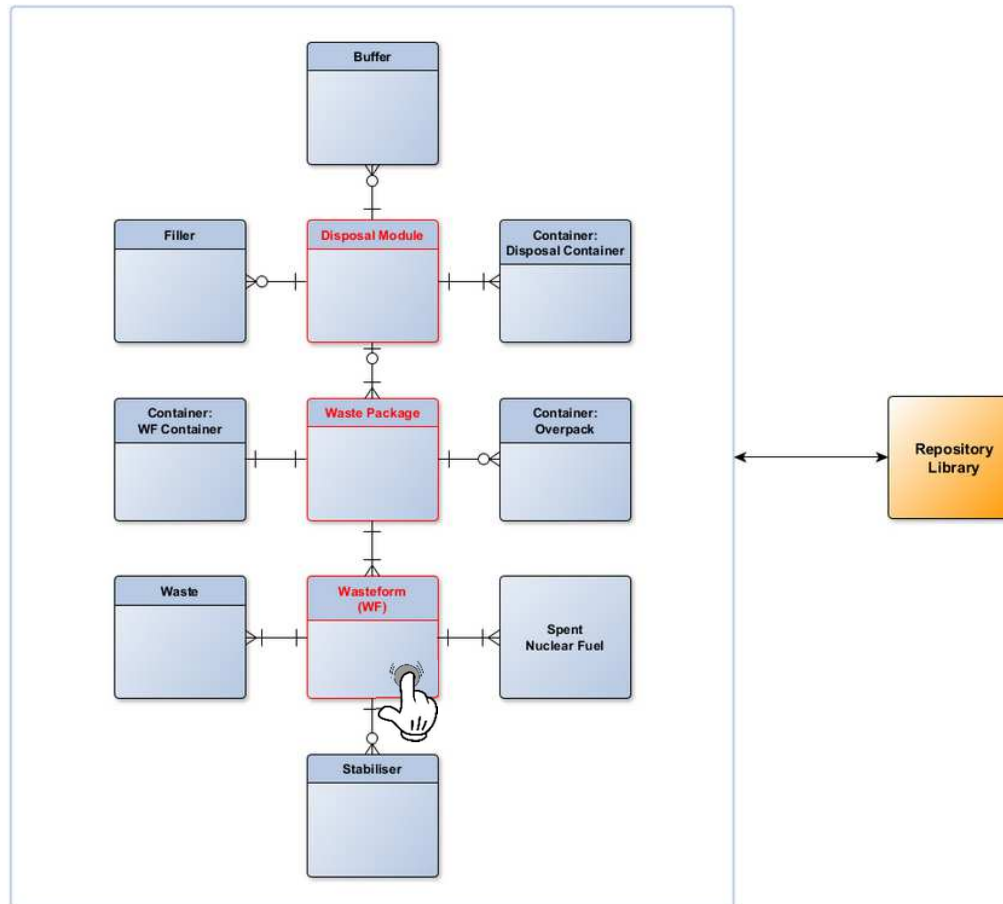
Data and Metadata Libraries – Properties
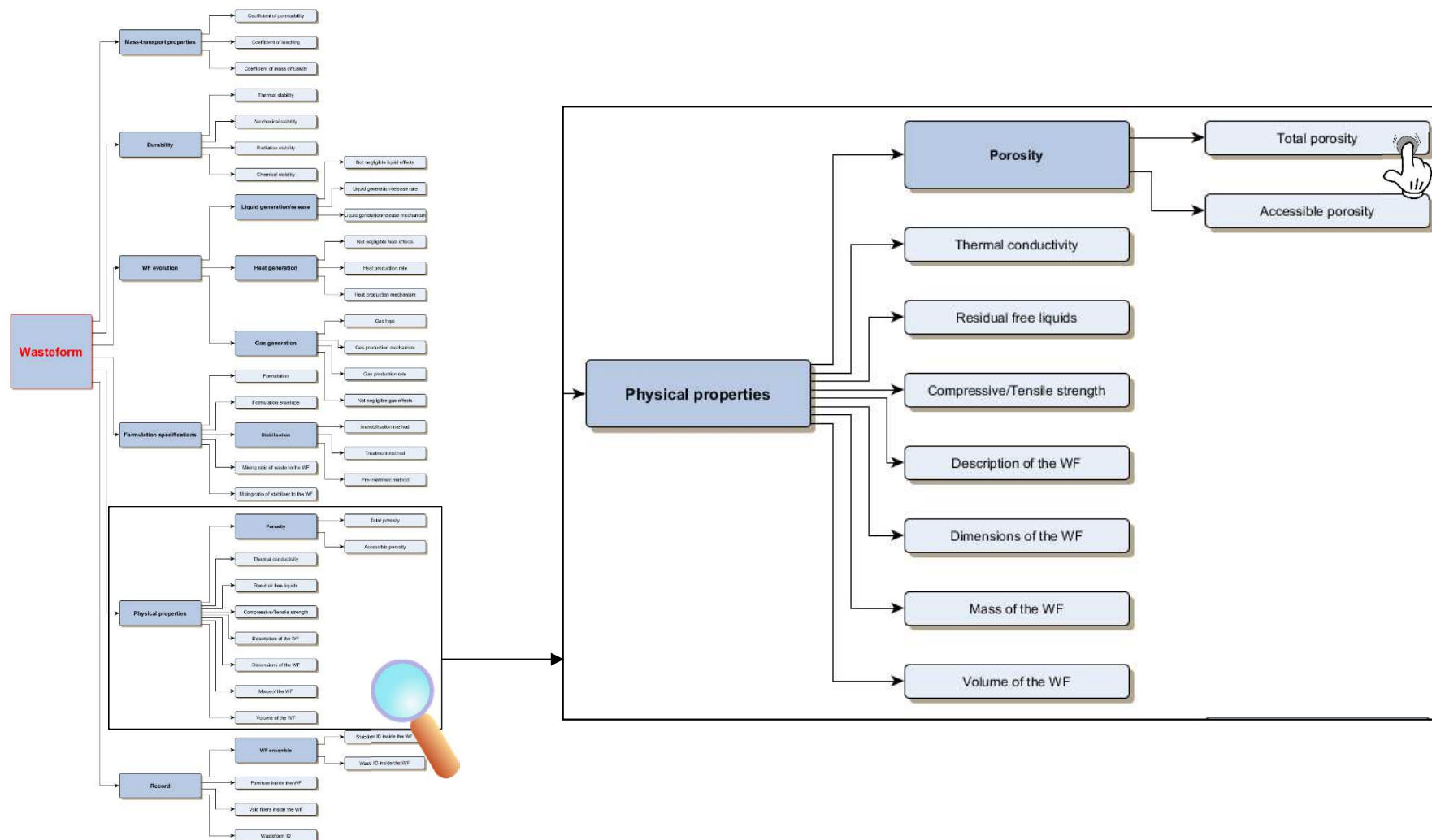
Data and Metadata Libraries – Vocabularies

Total porosity -

ID	http://www.oecd-nea.org/repmet/Wasteform/n
RDF Type	http://www.w3.org/2004/02/skos/core#Concep
Broader Term	Porosity
Name	Total porosity
Definition	Ratio of the void volume in a porous wasteform to the total wasteform volume.
Comment	-
Definition Source	Mory M., Fluid Mechanics for Chemical Engineering, John Wiley & Sons, 2013.
Purpose	Relevant parameter in hydrodynamics study for safety case.

Accessible porosity -

ID	http://www.oecd-nea.org/repmet/Wasteform/n30
RDF Type	http://www.w3.org/2004/02/skos/core#Concept
Broader Term	Porosity
Name	Accessible porosity
Definition	Ratio of the volume of accessible pores in a porous wasteform to the total wasteform volume.
Comment	Some pores inside the porous wasteform maybe enclaves unconnected to the outside, and the fluid cannot flow through them.
Definition Source	Mory M., Fluid Mechanics for Chemical Engineering, John Wiley & Sons, 2013.
Purpose	Relevant parameter in hydrodynamics study for safety case.

Data and Metadata Libraries – RDF Output

```xml
- <rdf:Description rdf:about="http://www.oecd-nea.org/repmet/Wasteform/n29">
    <rdf:type rdf:resource="http://www.w3.org/2004/02/skos/core#Concept"/>
    <skos:inScheme rdf:resource="http://www.oecd-nea.org/repmet/Wasteform/n0"/>
    <skos:broader rdf:resource="http://www.oecd-nea.org/repmet/Wasteform/n28"/>
    <skos:prefLabel xml:lang="en">Total porosity</skos:prefLabel>
  - <skos:definition xml:lang="en">
      Ratio of the void volume in a porous wasteform to the total wasteform volume.
    </skos:definition>
    <rdfs:comment xml:lang="en">-</rdfs:comment>
  - <dc:source>
      Mory M., Fluid Mechanics for Chemical Engineering, John Wiley & Sons, 2013.
    </dc:source>
  - <skos:scopeNote>
      Relevant parameter in hydrodynamics study for safety case.
    </skos:scopeNote>
  </rdf:Description>
- <rdf:Description rdf:about="http://www.oecd-nea.org/repmet/Wasteform/n30">
    <rdf:type rdf:resource="http://www.w3.org/2004/02/skos/core#Concept"/>
    <skos:inScheme rdf:resource="http://www.oecd-nea.org/repmet/Wasteform/n0"/>
    <skos:broader rdf:resource="http://www.oecd-nea.org/repmet/Wasteform/n28"/>
    <skos:prefLabel xml:lang="en">Accessible porosity</skos:prefLabel>
  - <skos:definition xml:lang="en">
      Ratio of the volume of accessible pores in a porous wasteform to the total wasteform volume.
    </skos:definition>
  - <rdfs:comment xml:lang="en">
      Some pores inside the porous wasteform maybe enclaves unconnected to the outside, and the fluid cannot flow through them.
    </rdfs:comment>
  - <dc:source>
      Mory M., Fluid Mechanics for Chemical Engineering, John Wiley & Sons, 2013.
    </dc:source>
  - <skos:scopeNote>
      Relevant parameter in hydrodynamics study for safety case.
    </skos:scopeNote>
  </rdf:Description>
```

- O&M standard then used to record observed/measured value