

SNF Characterization Database (GECYRE)

Jose M. Gomez

HLW Engineering Dpt

TM on Management and Preservation of Spent Fuel Data

6th to 8th December 2022



Outline

- Introduction
- Data Selection
- Technical characteristics
- Future activities
- Conclusions



Outline

- Introduction
- Data Selection
- Technical characteristics
- Future activities
- Conclusions

Introduction

- Empresa Nacional de Residuos Radiactivos S.A. (Enresa) responsible, technically and financially, for
 - Waste Management Policy (6th GRWP, 7th GRWP on comments phase)
 - Radioactive Waste National Inventory
- Near future challenges
 - Prevent NPP anticipated shutdown by providing interim storage capacity
 - Provide long term disposal solution

1.- Reracking
90's

2.- ISFSI
2000's-2070's

4.- DGR
2070's-



- 10 reactors: 7 in operation at 5 sites
- 1 NPP shutdown. Preparing pool emptying
- 2 NPPs in D&D
- El Cabril : Disposal for VLLW/ILLW

Introduction

➤ Some figures to land on the problem

	Type	Storage	Current Inventory ^(1,2) FA	Total Estimates ⁽³⁾ FA (tU)
SNF (UO ₂)	PWR	Wet	7417	12795 (5870)
		Dry	2176	
	BWR	Wet	7209	8961 (1609)
		Dry	260	
	TOTAL		17062	21756 (7479)

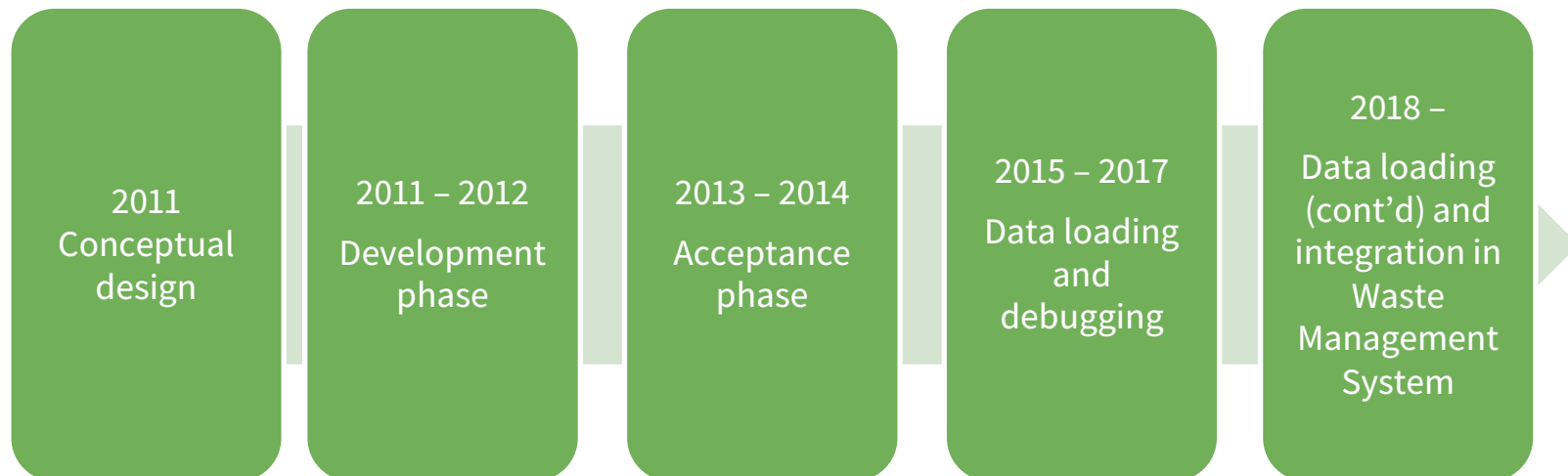
- 1) As of December 31st, 2021.
- 2) Burnup up to 60 GWd/tU
- 3) For an average operational life of 46 y (cease of operation of all NPP 2035)

➤ Regulatory framework

- CSN's technical instruction on radioactive waste management plan adaptation to safety guide 9.3 → Local databases with general spent nuclear fuel characteristics: physical, initial enrichment, operating cycles, burnup and inventory evolution.
- CSN's technical instruction on control and inventory of high-level waste and spent nuclear fuel. Additional information: irradiation history, characterization and location

Introduction

- Suitability of centralized data repository for management of interim and consolidated storage projects and regulatory compliance
- Activities carried out
 - Data selection
 - Database and user interface development and implementation
 - Data transfer scheme definition with data providers (NPP operators)





Outline

- Introduction
- **Data Selection**
- Technical characteristics
- Future activities
- Conclusions

Data Selection

- What is most important is to comply with the safety functions: fuel and system-related
- Data can be classified in different categories according to where they come from/lifecycle phase:
 - NF data (before irradiation)
 - Reactor data (during irradiation)
 - Characterization data (after irradiation)
- Data has been hierachized for the efficiency of storage: individual objects and type entities. Types group attributes common to individual objects. Any individual object must belong to a type.

SNF CHARACTERIZATION MATRIX			WHAT?			
			PLANT DATA	SNF DATA		PHYSICAL INSPECTIONS AND OTHER DATA
MECHANICAL DESIGN	NUCLEAR DESIGN					
WHY?	SAFETY FUNCTION (SF)	HEAT REMOVAL	- Burnup and cycle duration - Cooling time - RCCA/BA operation - Fuel temperature - Reactor operating parameters (temperature, pressure, boron, power and axial distribution) - RCh records	- Overall dimensions (length, mass, section) - Fuel rod information (number, location, geometry, mass, material) - Structural components information (number, location, geometry, mass, material)	- Fuel (mass, material, fissile isotopes initial enrichment, density) - Active column geometry - Presence of IBA / IFBA and absorbers enrichment - Lattice design (geometry and enrichment distribution) - Axial design (geometry and enrichment distribution) - Component materials, densities and isotopic compositions	- FA integrity inspection: foreign materials and crud deposits, geometry deformation - Nuclear data
		CONFINEMENT				- Fuel rod integrity inspection: - Leak tightness - Corrosion measurements
		CRITICALITY CONTROL				- System geometry and materials - Burnup measurements - FA integrity inspection: geometry deformation, missing pins - Nuclear data
		RADIATION SHIELDING				- System geometry and materials - Nuclear data
		RETRIEVABILITY				N/A
	SAFEGUARDS		Burnup	N/A	Fuel composition	Burnup measurements
	WHO?	DATA SOURCE		NPP	NPP (FUEL VENDOR)	

Data Selection

- “General” module: reactor, cycle and wet and dry storage data.
- “Defectology” module: defects, inspection, and spent fuel characterization data.
- “Designs and types” module: fuel assembly mechanical and nuclear design, fuel assembly components data, NFH data, dry storage systems data and other radioactive waste stored at site.
- “Spent fuel” module: spent fuel inventory with irradiation history data
- “Special waste” module: for PWR reactors mainly NFH with irradiation history data
- “Inventory” module
- “Queries” module: user-defined reports
- “Data” module: load data to the data base

The screenshot shows a web application interface for the Almaraz I reactor. At the top, there is a header 'Reactor' with a dropdown menu currently showing 'Almaraz 1'. Below this, a large box displays 'Almaraz I' in a bold, blue font. Underneath, there is a section titled 'Menú' (Menu) containing a list of modules, each with a dropdown arrow: 'Generales', 'Defectología', 'Diseños y tipos', 'Residuos Nucleares', 'Residuos Especiales', 'Inventarios', 'Consultas', and 'Datos'.

Defectology Module

- Identified a defect catalog (18 defects) with the most common “pathologies” found in SF (Spanish NPP)
- Established 5 categories to capture the extension of damage in a SNF due to a particular defect (O, S, X, D/DD, RO, RX, RD)
- Characterization process = Inspection (Reparation) for a defect → detect (correct) extension of damage to SF → assign a category → Characterization array
- SNF characterization is translated into defect-category allocation. Each pair defect - category can store relevant information: damage features, engineering justification report, handling procedure, etc...
- SNF preliminary classification is derived from the set of defect - category pairs assigned during the characterization process. Final classification results from preliminary classification (experienced based) + pending inspections
- Example of defectology module record:

# in the sequence of inspections	Inspection	Category
1	I1 (I7/I8)	2S (2D if I7 o I8)
2	R2	2RO 11D(4)
3	R1	2RO 11RO(4)



Outline

- Introduction
- Data Selection
- **Technical characteristics**
- Future activities
- Conclusions



Technical Characteristics

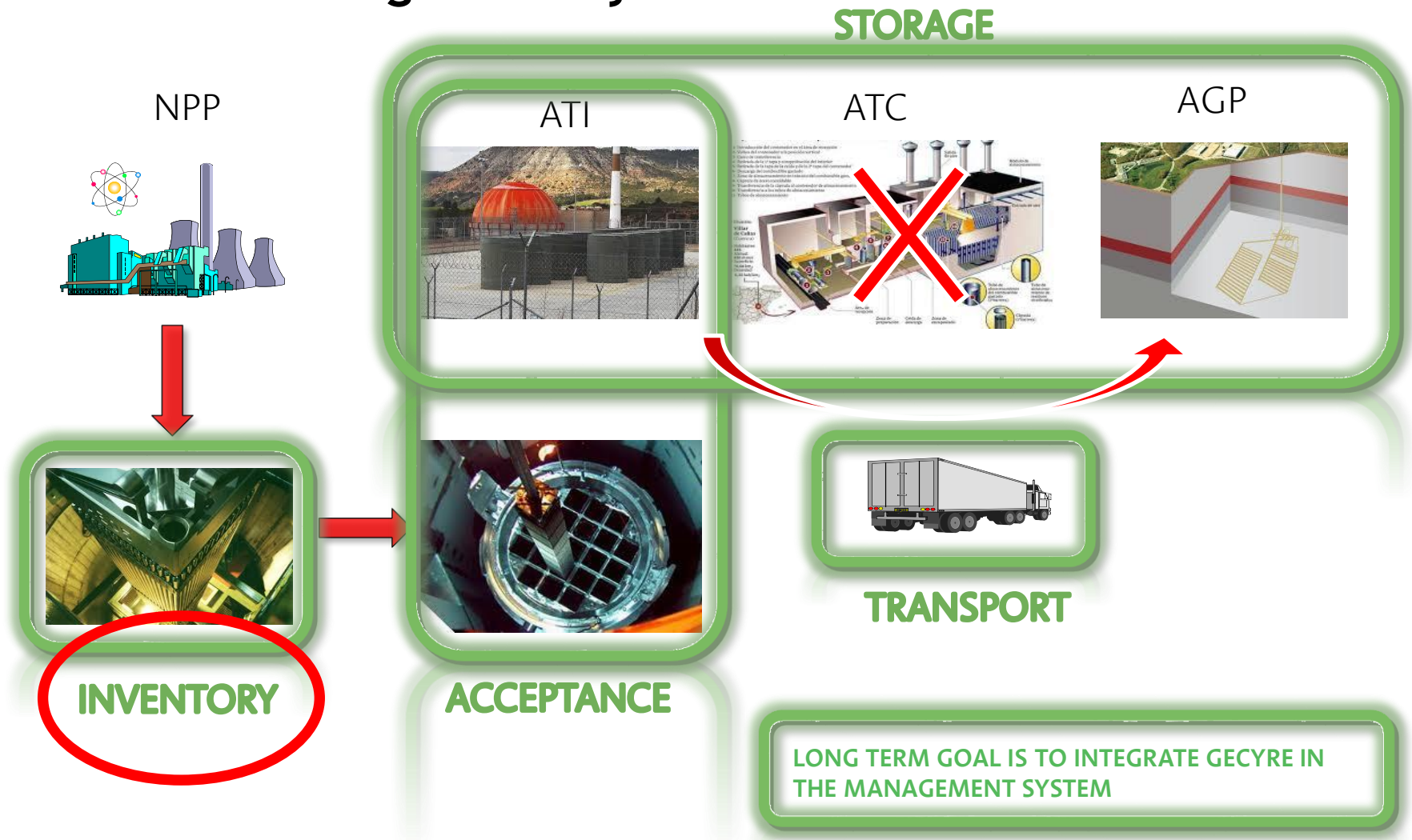
- Database has been developed in SQL Server
- User interface has been coded in C++ under .NET framework running on Windows OS
 - Independent of the database
 - Main functions: data queries, export data (Excel), user-defined report
- Data transfer from NPP to Enresa by XML files
 - XML generated according XSD tree structure of entities and attributes
- Database and user interface are hosted in a server out of Enresa:
 - Currently working on the migration to Enresa



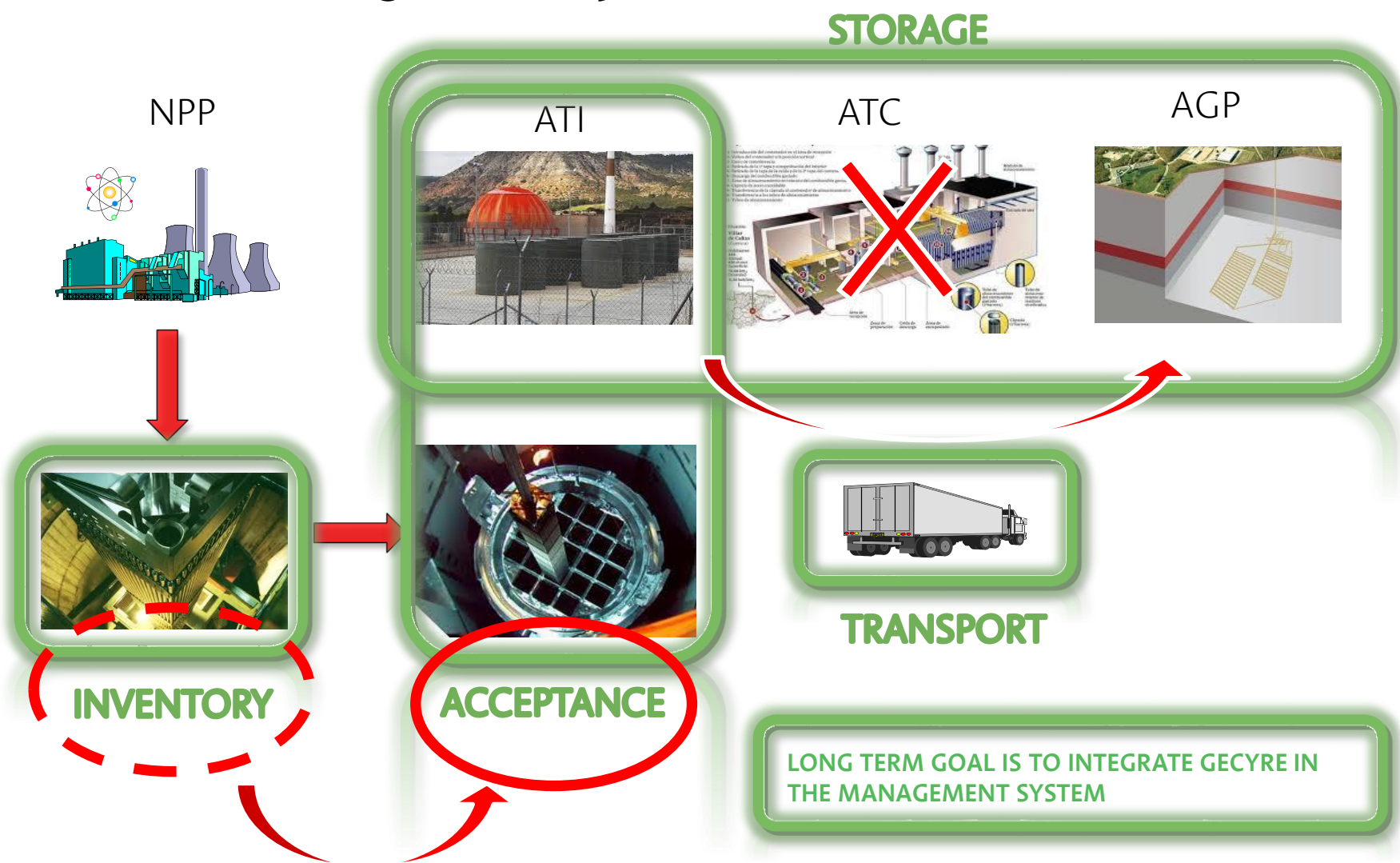
Outline

- Introduction
- Data Selection
- Technical characteristics
- **Future activities**
- Conclusions

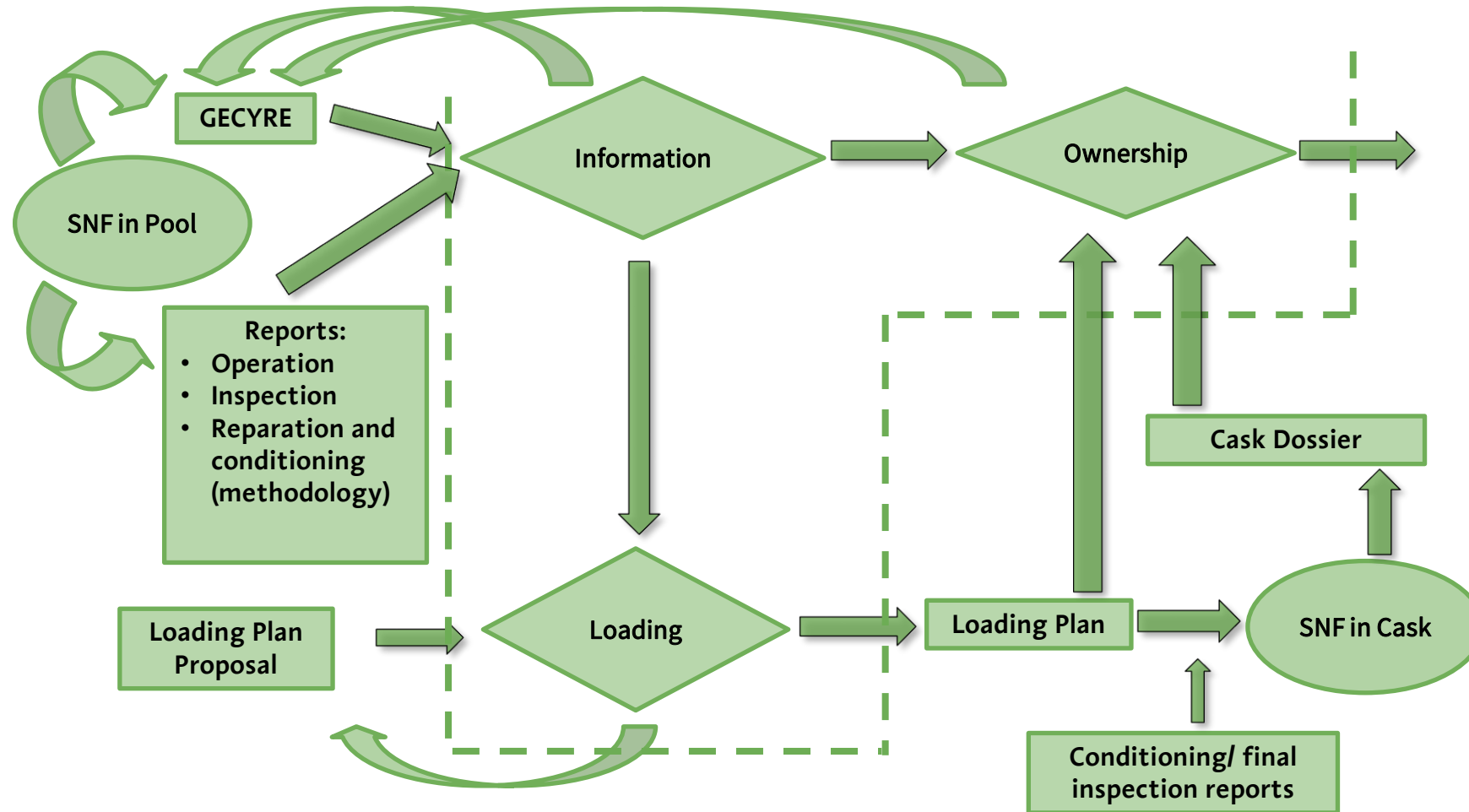
ENRESA HLW Data Management System



ENRESA HLW Data Management System



SNF Acceptance Module Flow Diagram





Outline

- Introduction
- Data Selection
- Technical characteristics
- Future activities
- **Conclusions**



Conclusions

- ENRESA is working towards a **HLW Data Management System** that allows us to keep waste key information for its safe and efficient management.
- First module “INVENTORY” is at a very advanced level of development as GECYRE.
- “ACCEPTANCE” module under development: SNF acceptance criteria and procedure are set. To be agreed with NPP.

