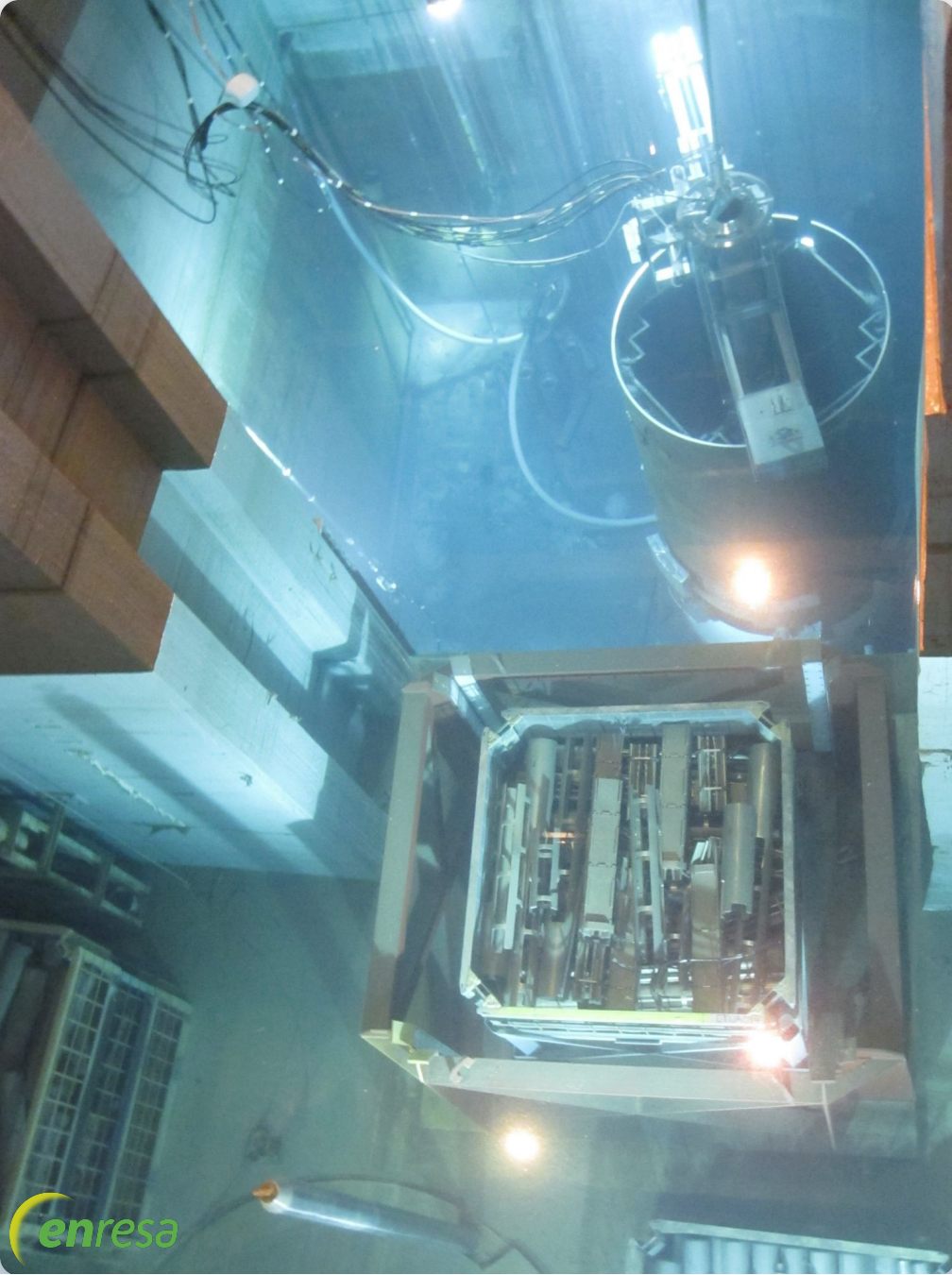




TURBINE BUILDING REPURPOSING TO AUXILIARY DECOMMISSIONING BUILDING

Case Study Zorita NPP

This is Knowledge Product prepared by ENRESA for
the JRC Nuclear Decommissioning Knowledge
Management initiative NDKM

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Foreword

In 2021, the European Commission (EC) adopted a new proposal for a Council Regulation establishing a dedicated financial programme for decommissioning nuclear facilities and managing radioactive waste. This instrument covers the co-funding of the decommissioning programmes of Bulgaria, Slovakia, and the decommissioning of the Joint Research Centre (JRC). A separate Council Regulation was adopted for the decommissioning programme of Lithuania.

The EC JRC is mandated to foster the spread of decommissioning knowledge across all the European Union Member States and facilitate knowledge sharing arising from implementing the abovementioned decommissioning programmes, funded by the Nuclear Decommissioning Assistance Programme (NDAP).

The decommissioning operators from the NDAP (NDAP Operators) implemented and tested a knowledge management methodology in 2021 through Project ENER/D2/2020-273. Using this methodology, the NDAP Operators can develop Knowledge Products that are currently available to share with other European stakeholders. In addition, this methodology is under implementation in the JRC Nuclear Decommissioning and Waste Management Directorate (NDWMD), which becomes a knowledge generator extracting the knowledge from the ongoing decommissioning activities at the different sites (Geel, Ispra, Karlsruhe, and Petten).

The JRC NDWMD aims to become a Centre of Excellence in nuclear decommissioning knowledge management and develop a decommissioning knowledge platform which allows exchanging information and building on the best practices in the EU inside the multi-annual financial framework (2021 – 2027) strategy. The operational phase of the project is expected to start in 2024 to develop ties and exchanges among EU stakeholders and document explicit knowledge and make it available through multi-lateral knowledge transfers on decommissioning and waste management governance issues, managerial best practices, technological challenges, and decommissioning processes at both operational and organisational level, to develop potential EU synergies.





Knowledge Product Information

Turbine Building repurposing to Auxiliary Decommissioning Building. Case Study at Zorita NPP

Document code	KP-EN-01
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Approved by	Andrea Piagentini, NDKM team at the JRC



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EXECUTIVE SUMMARY

What, how, for whom

Overview

Zorita NPP building repurposing

A Case Study of turbine building turned into RAW management building

+ INFO

Objective

Share Project experience

Describe the project, the processes that were involved and the lessons learned

+ INFO

Target Users

EU Operators

Waste Management Organizations in Europe can benefit from this product

Approach

Navigate the facility

Dive into the interactive panels to learn how existing buildings can be reutilized for RAW processing

+ INFO

Findings

Use what is already there

Decommissioning projects can benefit from existing assets in some waste management processes

+ INFO

Value

Applicable lessons learned

Other operators can extract tips, recommendations and insights based on Zorita NPP experience

+ INFO



Value

Operators from all EU Member States can benefit from the experience of Zorita in

- Designing solutions for waste management based on the repurposing of existing buildings
- Planning the sampling of SSC components
- Making smart decisions regarding calibration and scope of decontamination systems
- Evaluating resin storage capacity to inform the design of the decontamination process
- Taking advantage of available equipment and workforce for new processes
- Locating and estimating DFs of plugged tubes

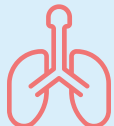


Reburshising turbine buildings that are close to the containment can streamline waste management, saving time, cost and dose to workers

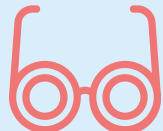


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Dose
Reduction



Reduced
Contamination
Risk



Better visibility and
less particle
migration



2.72

Person Sv
Reduction



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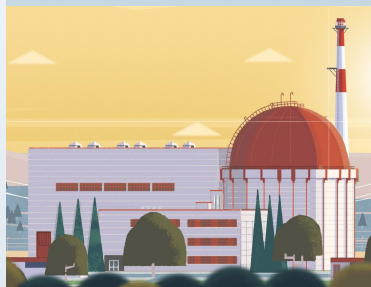
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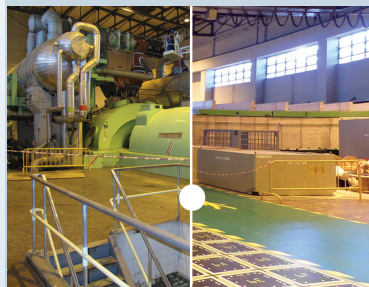


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Zorita NPP
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The Project

Repurposing of
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The Experience

Lessson Learned
and Takeaways





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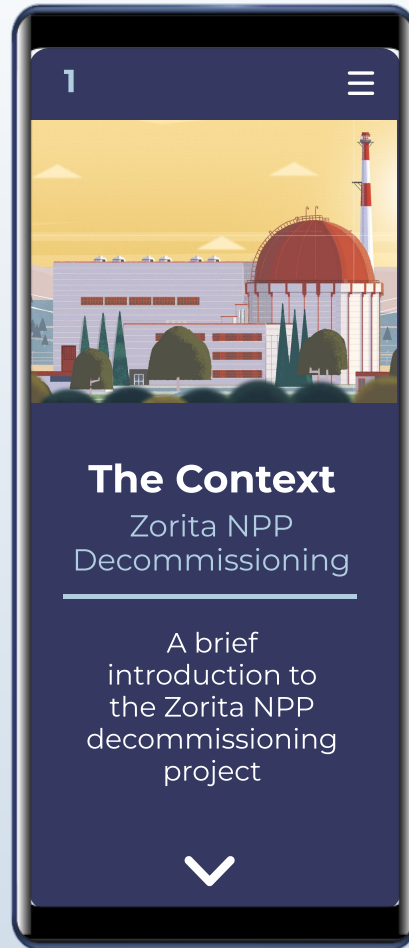
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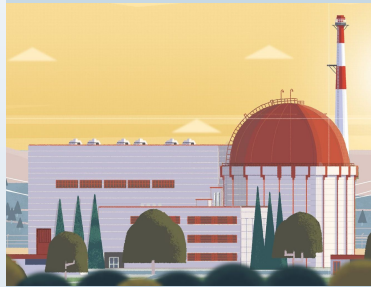
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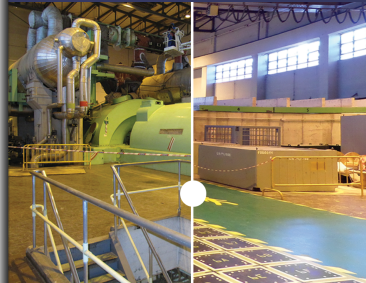


The Context

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Decommissioning



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The Project

Repurposing of
Turbine Building

How the turbine
building was
refurbished to
accommodate
radioactive waste
treatment



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The Experience

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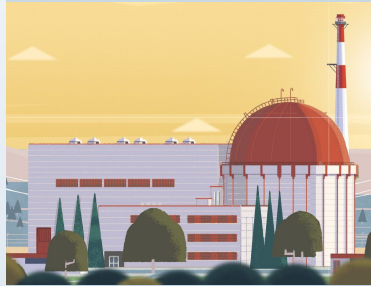
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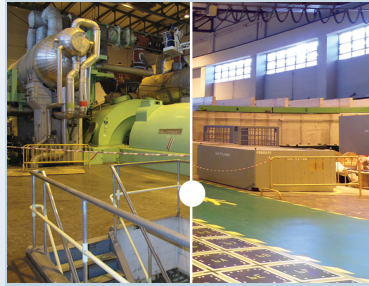


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The Experience

Lessson Learned
and Takeaways

What was learned
by the project team
and how to transfer
this experience to
other operators in
Europe





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Nuclear Energy in Spain

Zorita Decommissioning

THE CONTEXT

Nuclear Energy in Spain



LEARN MORE
ABOUT ZORITA



COFRENTES

CHARACTERISTICS	
LOCATION	VALENCIA
REACTOR TYPE	BWR
POWER (MWE)	1 X 1087
START OF OPERATION	1984



ALMARAZ

CHARACTERISTICS

LOCATION	CÁCERES
REACTOR TYPE	PWR
POWER (MWE)	2 X 1037
START OF OPERATION	1983, 1984



VANDELLÓS II

CHARACTERISTICS	
LOCATION	TARRAGONA
REACTOR TYPE	PWR
POWER (MWE)	1 X 1045
START OF OPERATION	1987



JOSÉ CABRERA

CHARACTERISTICS

LOCATION	GUADALAJARA
REACTOR TYPE	PWR
POWER (MWE)	1 X 160
START OF OPERATION	1969



El Cabil

El Cabil is the only low and medium level radioactive waste warehouse in Spain. It is located on a farm in the Sierra Albarrana, in the municipality of Hornachuelos (Córdoba). The waste is classified and stored in earthquake-proof concrete containers, which are kept in cells built in huge warehouses on the surface.





TRILLO

CHARACTERISTICS

LOCATION	GUADALAJARA
REACTOR TYPE	PWR
POWER (MWE)	1 X 1066
START OF OPERATION	1988



VANDELLÓS I

CHARACTERISTICS

LOCATION	TARRAGONA
REACTOR TYPE	UNGG
POWER (MWE)	1 X 480
START OF OPERATION	1972



ASCÓ

CHARACTERISTICS

LOCATION	TARRAGONA
REACTOR TYPE	PWR
POWER (MWE)	2 X 1045
START OF OPERATION	1984, 1985



SANTA MARÍA DE GAROÑA

CHARACTERISTICS

LOCATION	BURGOS
REACTOR TYPE	PWR
POWER (MWE)	1 X 466
START OF OPERATION	1971



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Nuclear Energy in Spain

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THE CONTEXT

Some facts about José Cabrera NPP (Zorita)

Construction

The first NPP in Spain

Construction started in 1964. It was commissioned in 1968

+ INFO

Technology

160MW PWR 1-loop

One single-loop PWR of 160 MWe, built by Zachry Construction Corporation for Westinghouse

+ INFO

Operation

38 years

Zorita operated 38 years, from 1968 to 2006.

+ INFO

Decommissioning

2006

The first decommissioning project of a Spanish NPP



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José Cabrera NPP

The José Cabrera nuclear power plant, also known as Zorita, was a technological milestone for the nuclear industry in Spain, being the first nuclear power plant that was built in the country.

Construction began in July 1965 and lasted 36 months, as the hot functional test was performed on March 31st 1968. In June of that year, the core was loaded and initial criticality was reached. The first kilowatt-hours of electricity produced by nuclear means were launched to the Spanish national grid on July 14th 1968, and since then a power ramp up was performed that eventually led to the commercial operation of the plant.



Clean

Zorita NPP produced electricity for over 38 years, avoiding the emission of 32.37 million tons of CO₂ to the atmosphere



Reliable

Zorita produced 36,515 MkW/h, the equivalent to the annual electric consumption of 25 provinces like Guadalajara.



Social

During almost four decades of operation the plant provided direct employment to 300 workers, and indirect employment to 6,000 more.



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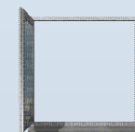
THE CONTEXT

The José Cabrera NPP (Zorita)
decommissioning project

Zorita Decommissioning

Since its shutdown in 2006, Enresa began to draft the regulatory documentation for the Dismantling and Decommissioning Plan.

The tasks include: the removal of conventional elements; the disassembly of radiological components; decontamination and demolition of buildings; and environmental restoration of the site.

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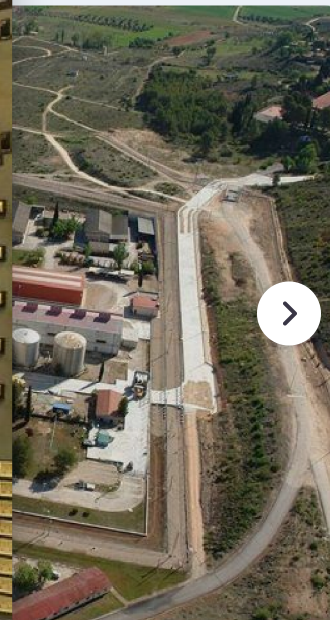
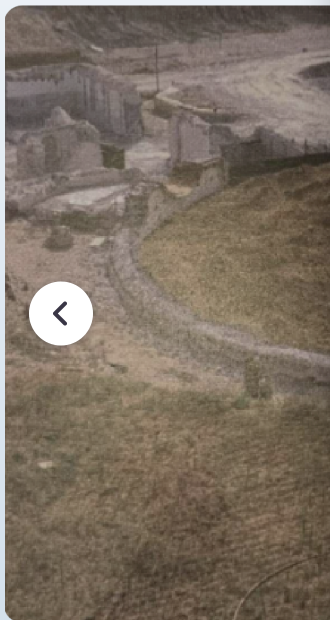
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Zorita decommissioning project milestones



2006 Phase out by ministerial order



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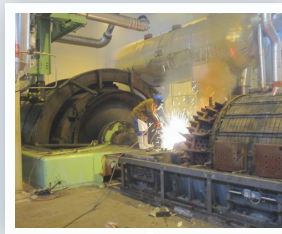
Zorita Decommissioning

THE CONTEXT

Timeline of the repurposing of the turbine building project

2003

Basic study of dismantling strategies



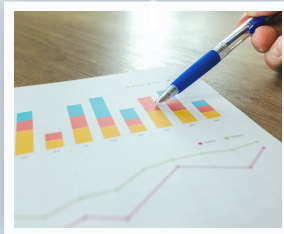
2012

Conditioning of the first cask with reactor waste



2010

Civil conditioning of the turbine building



2018

Final radiological disassemblies

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THE PROJECT

Repurposing of Turbine Building

Challenges

During the planning of the Zorita decommissioning project, ENRESA identified significant challenges.

A significant quantity of low and intermediate level waste was expected. The waste acceptance criteria at the El Cabril centralized radioactive waste site requires this type of waste to be cemented inside of concrete or metal containers.

Other challenges were the need to segment big components and manage elevated dose rates in tight spaces..

Check details clicking on the interactive buttons on the picture to the right

[THE SOLUTION](#)



Dose

Segmentation of Reactor Vessel (RV) and internals was expected to result in high personnel exposure and therefore require stringent radiological controls during the segmentation.



Workspace

Workspace around highly radioactive systems and components in the Containment Building was very tight, forcing workers into proximity to this equipment.



Need for Segmentation of big components

One of the most significant challenges was that the reactor coolant system primary components, such as the reactor vessel and steam generator, could not be shipped as single, intact components to the radwaste disposal site at the El Cabril Centralized Low and Intermediate Level Waste Disposal Facility due to restrictions on the waste package dimensions and radiation levels that could be accepted at the site.



Availability of systems during dismantling



During the initial stage, between 2010 and 2011, it was necessary to adapt some of the plant's systems and auxiliary facilities to make them available and functional for the dismantling activities



Dose

Segmentation of Reactor Vessel (RV) and internals was expected to result in high personnel exposure and therefore require stringent radiological controls during the segmentation.



Workspace

Workspace around highly radioactive systems and components in the Containment Building was very tight, forcing workers into proximity to this equipment.



To build or not to build...



One of the most important actions was the disassembly of the original equipment and decide how to build or transform existing facilities for the treatment and temporary storage of waste from the containment building



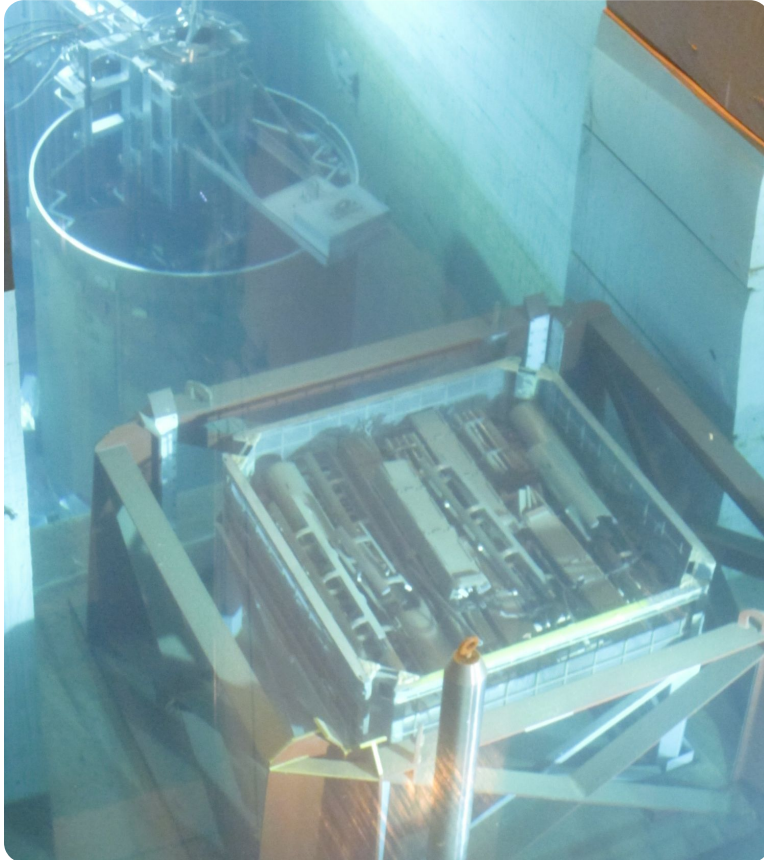
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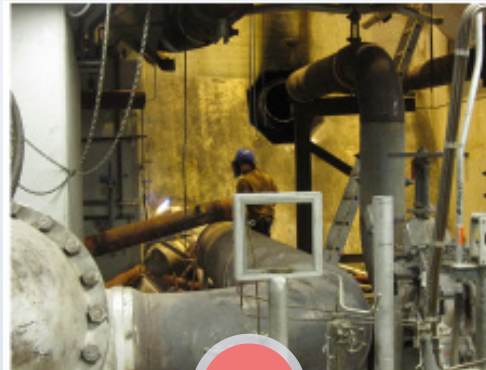
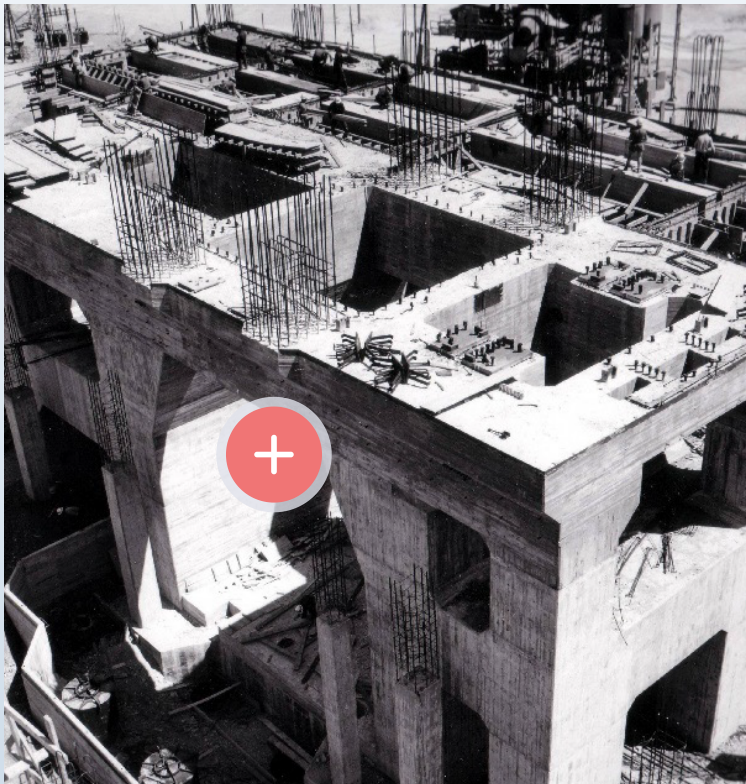
Need for Segmentation of big components

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Repurposing of Turbine Building

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Solution (1/2)



ENRESA modified the turbine building to allow its use as a waste processing facility. Also, to facilitate the shipment schedule for the solidified waste to El Cabril, shielded temporary waste storage areas were included in the turbine building modification

After consideration of the various factors involved, ENRESA decided to design and build two systems to minimize the radiological risk as well as the final volume of waste

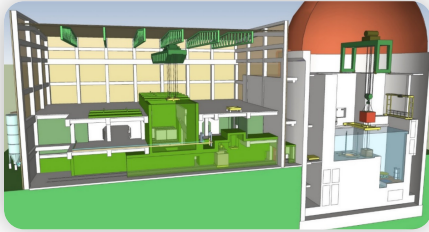
This repurposed building (Auxiliary Building for Dismantling) was thereafter used for the treatment and temporary storage of waste from the containment building..

[+ INFO](#)



Modification of turbine pedestal

The turbine pedestal was located within the turbine building and was modified to provide and shielding and support for the new systems and personal access for their use.



Radioactive Waste Transfer System

The Radioactive Waste Transfer System was conceived with the objective of remotely moving, manipulating and conditioning the radioactive waste produced during the dismantling of the plant's primary circuit.

This system uses a mobile radiological shielding hood that was capable of carrying the waste to the storage casks, in which these wastes were immobilized, stored and finally sent to the Cabril.



Material Decontamination Systems

Composed of chemical decontamination equipment and physical grit blasting, the Material Decontamination Systems had several objectives:

- Reduce unnecessary radiological exposures
- Reduce the final volume of radioactive waste or reduce its activity
- Reduce the mobility of radioactive materials



Advancing work in non-contaminated areas

During plant operation, the turbine building housed a large quantity of systems and concrete structures. As the systems in the turbine building were not contaminated, they could be removed by conventional methods and the building modified during the transition period.

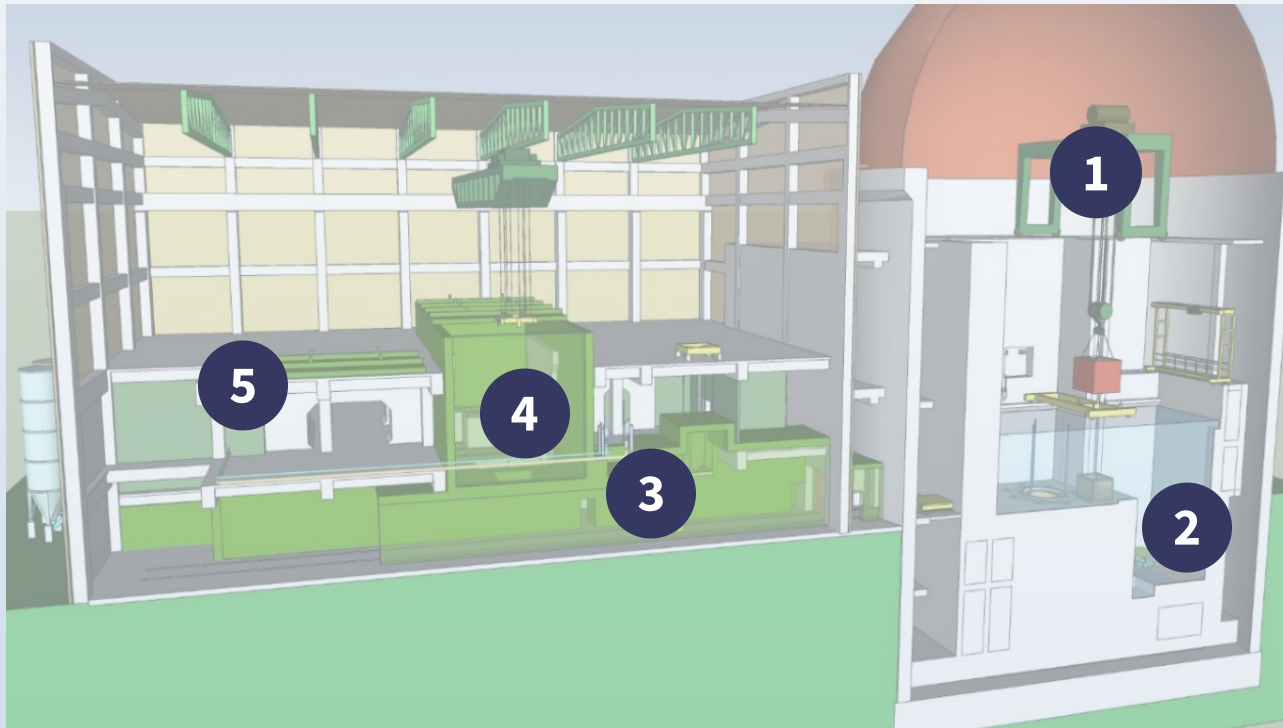
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Solution (2/2)

One of the main functions of the repurposed Turbine Building was to receive and prepare the Low and Intermediate Waste for shipment to the El Cabril disposal site.

After the modifications were complete, the repurposed turbine building included:

- 1 Remote controlled crane and trolley system for the movement of high dose rate waste
- 2 Cutting area for large components
- 3 Remotely operated cement solidification system for waste packaging
- 4 Shield storage for high dose rate waste
- 5 Cutting and decontamination workshop



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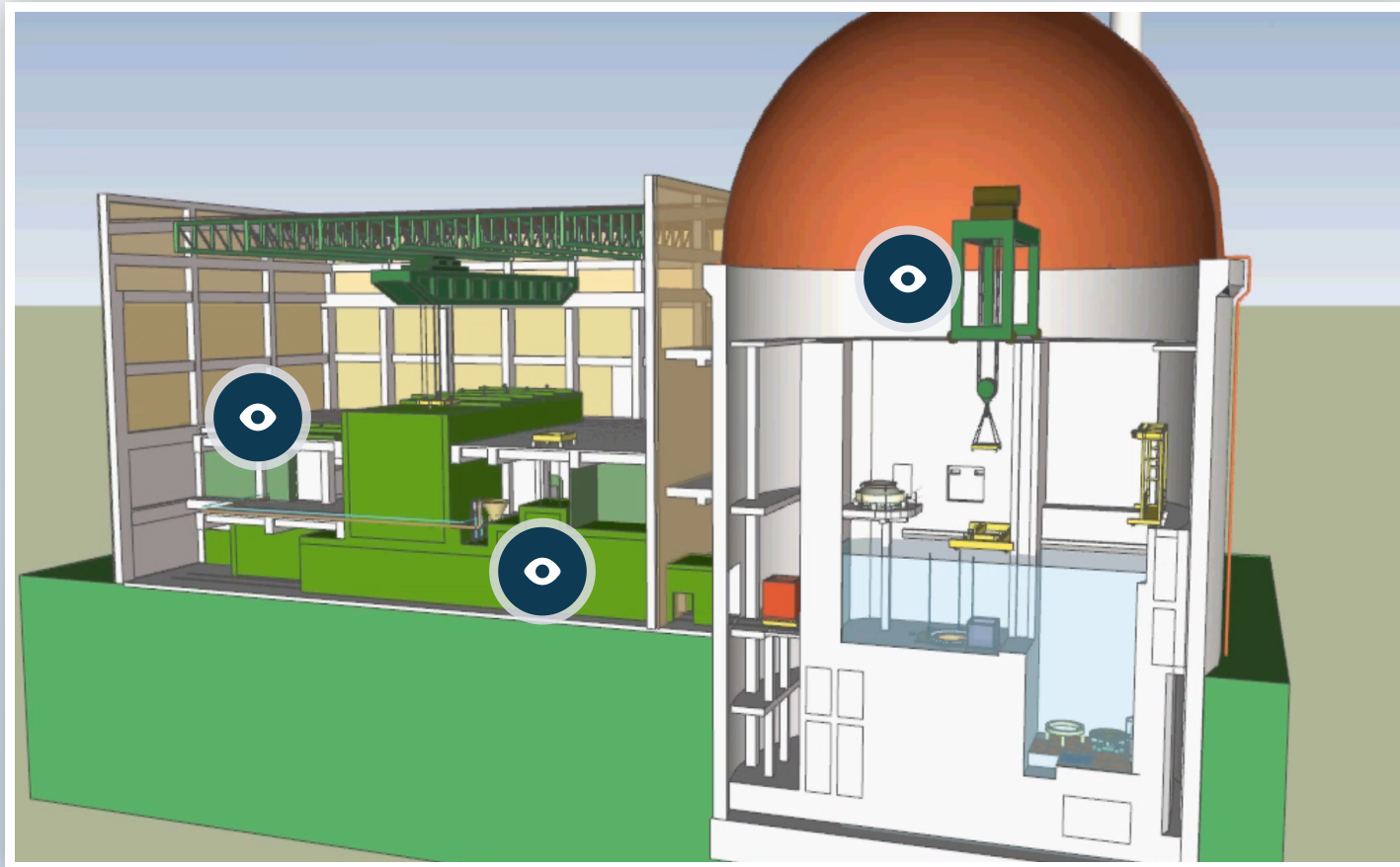
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Repurposing of Turbine Building



Take a Tour

Dive into the activities to gather, transfer and treat waste from the containment building to the repurposed Auxiliary Decommissioning Building

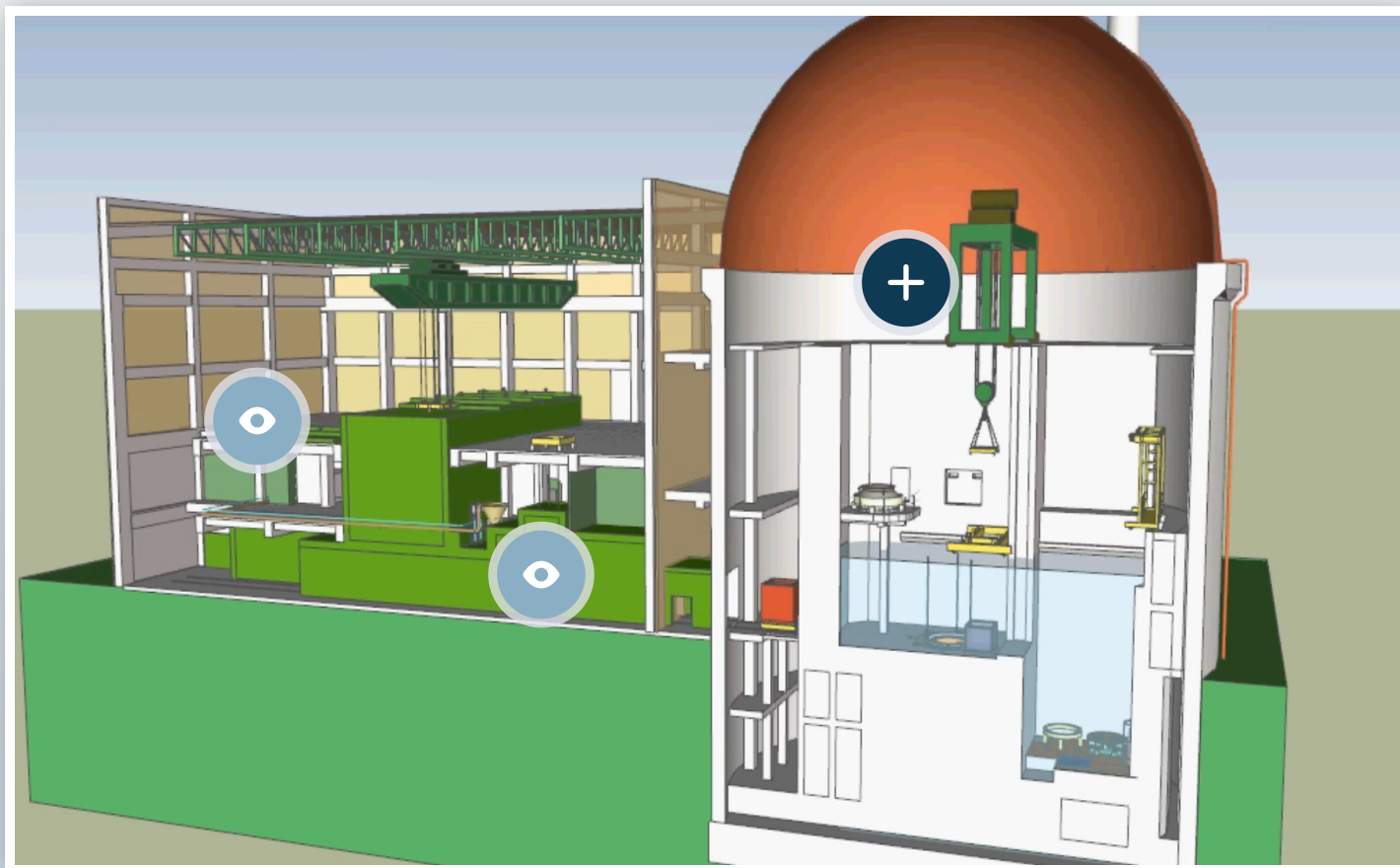
Click on each of the interactive buttons to have details on how the facilities were repurposed and what were the steps taken from start to end

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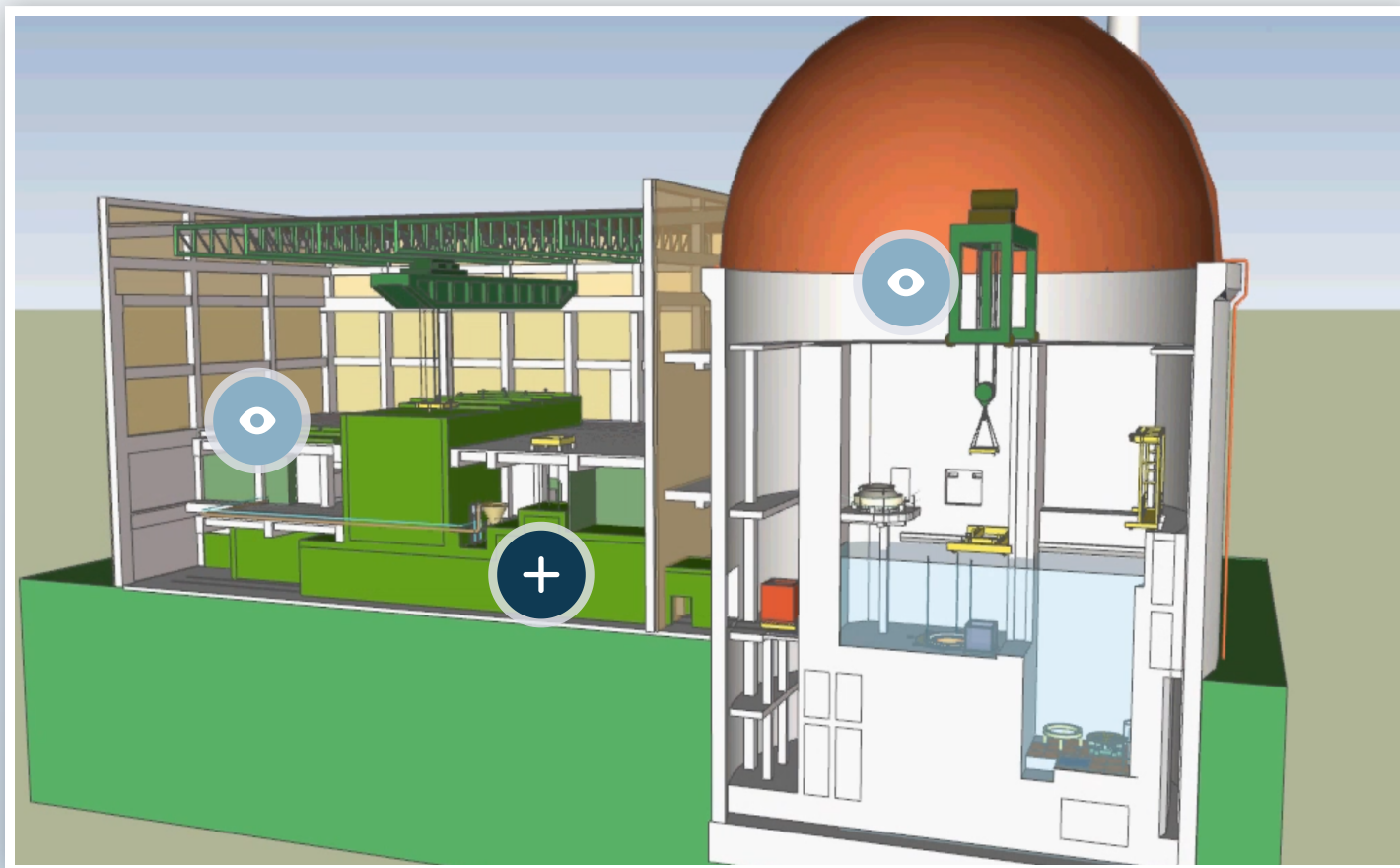
Containment Building

The containment building was modified to house a sophisticated system of shielding hoods and cranes capable of extracting and transporting the radioactive material to the ADB.

[VIEW THE PROCESS](#)

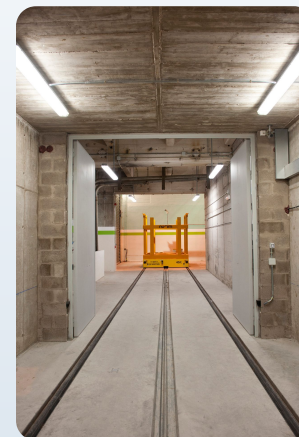
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Waste transfer & conditioning system

A Transference Channel was built to connect the Auxiliary Dismantling Building to the Reactor Building. This corridor facilitated the operations to transfer radioactive waste from the containment building and its conditioning.

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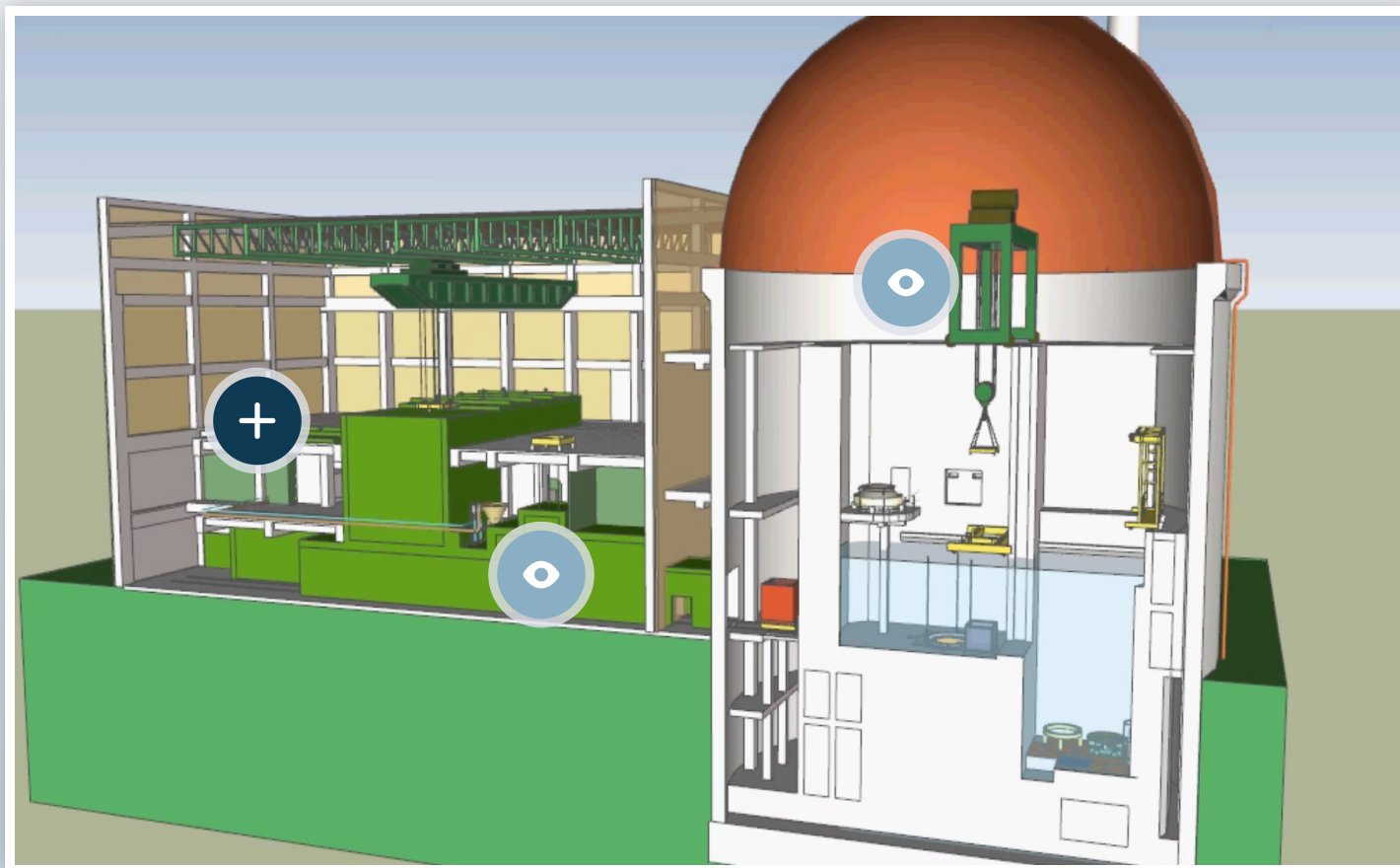
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Decontamination Workshop

Two metal decontamination systems were installed in the Auxiliary Decommissioning Building (former Turbine Building) to reduce the cost of waste management and disposal

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To manage the radioactive components and parts generated during the dismantling of the primary system, a radiological protection campaign was developed using mobile shielding.

A sophisticated crane system transported the waste underwater, limiting radiation exposure



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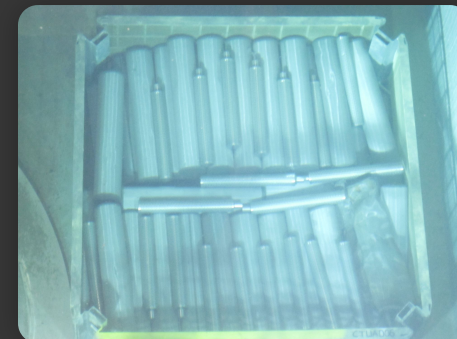
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Step 1. Cutting and loading in the basket

Reactor components are cut using underwater cutting techniques.

The fragments are deposited in a transfer basket specially designed for this system.



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Step 2 Basket transfer

Once full, the transfer basket is transported to the transfer area.

In this area there is a series of equipment that will help align the radiological shielding bell during the transfer process.



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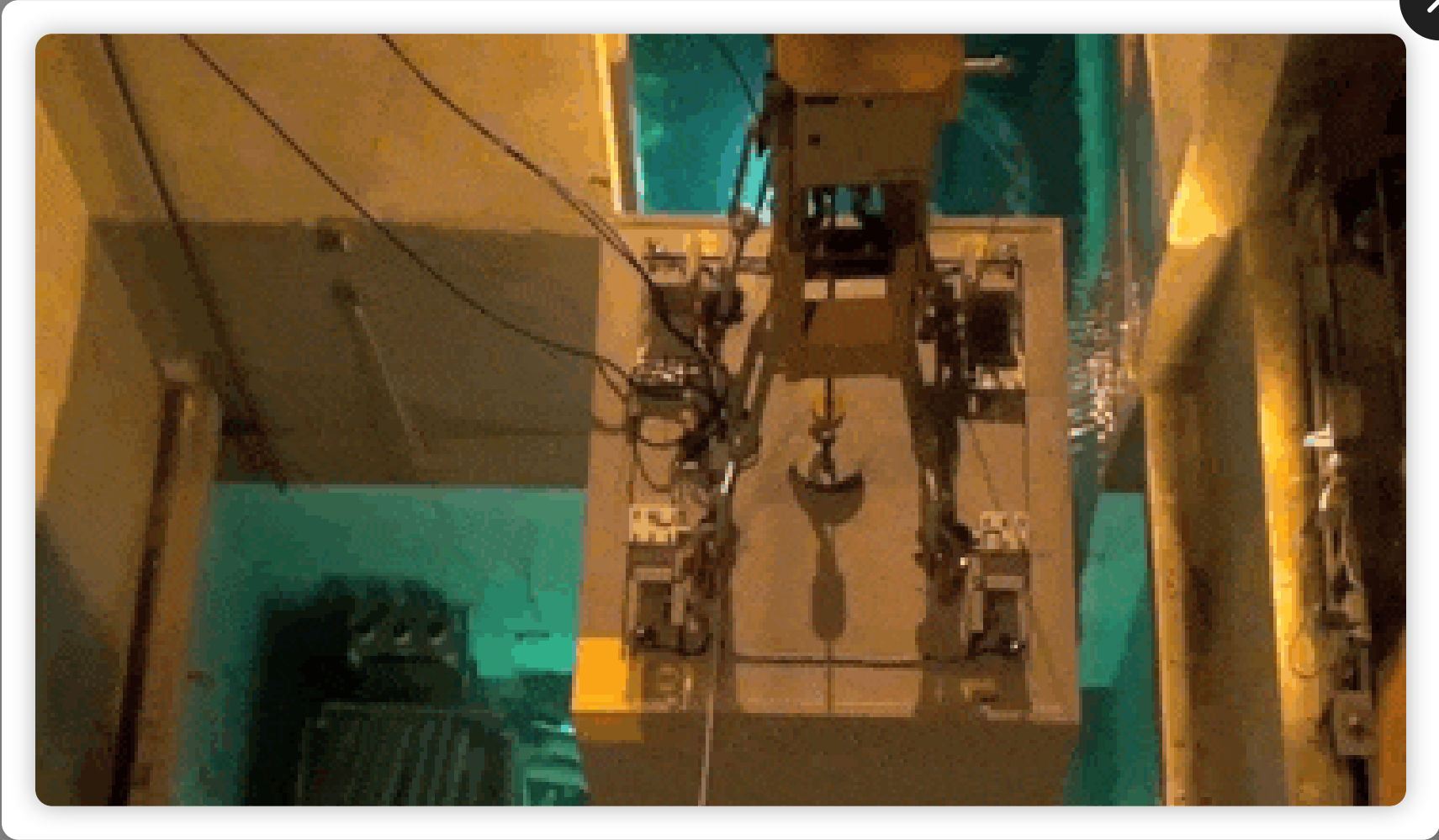
Step 3. Hood alignment and basket transfer to channel

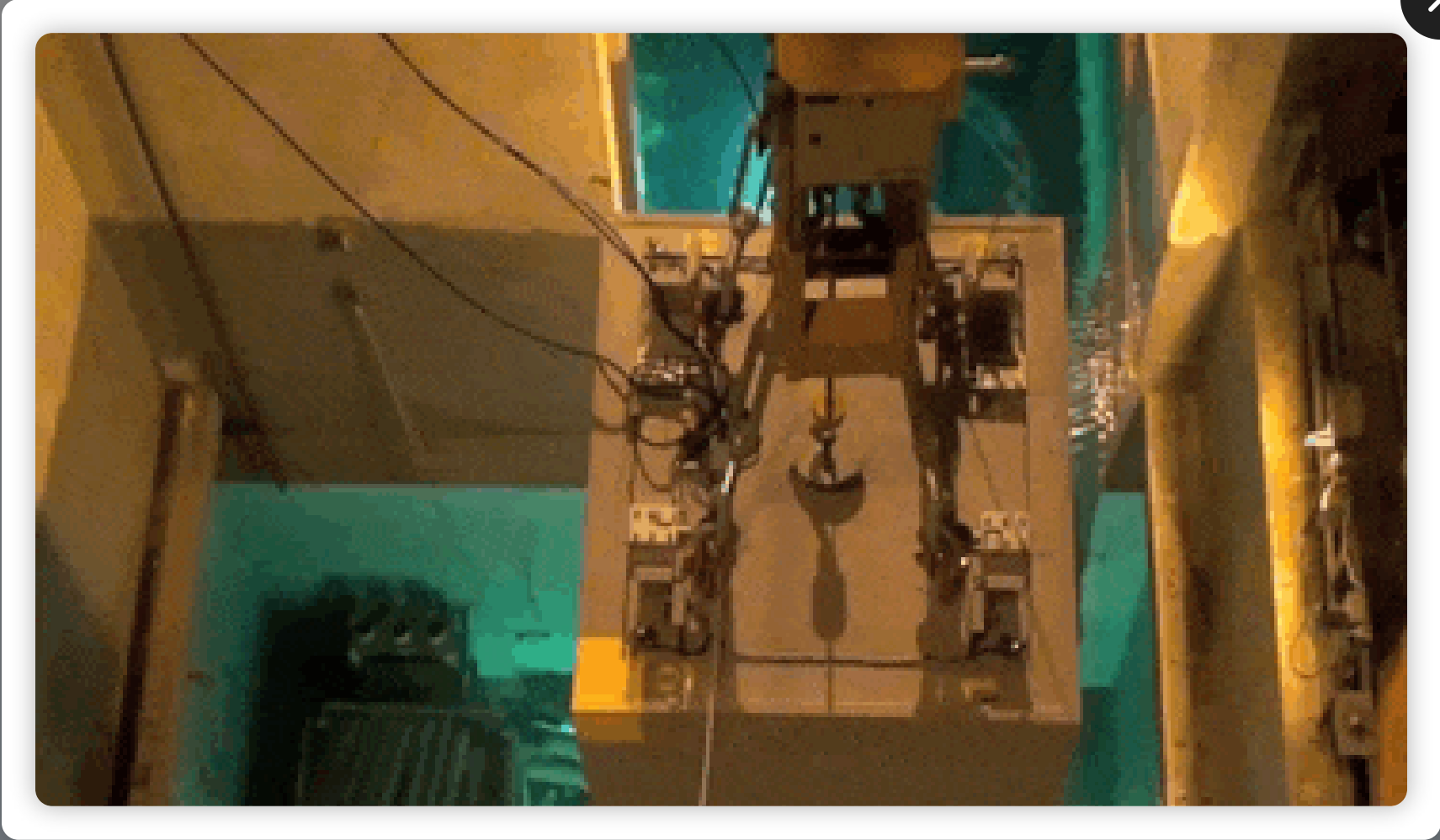
The shielding bell is transported from the Transference Channel to a pedestal at the upper area of the containment building

Once there, the bottom cover of the hood is removed. The shielding bell moves to the transfer zone, where the loaded transfer basket is introduced into the shielding bell.

Once this operation is carried out, the hood will be redirected to the starting point

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Waste transfer

Radioactive waste from the containment building is transferred and conditioned in CE-2 containers

Containers will later be stored and transferred to the low and medium activity radioactive waste repository in Spain (El Cabril).

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Step 1 Lid Removal

The radioactive waste storage cask (CE-2) enters the transfer aisle. Once inside, the lid of said container is removed.

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Step 2 Hood Lowering and residue transfer

The full radiation shielding bell is moved to the transfer zone.

There it is lifted and fitted with the storage cask

Once aligned and stabilized, the transfer basket full of radioactive waste is transferred vertically from the shielding bell to the CE-2 container.



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Step 3 Cementation (1/2)

The container, once loaded, is directed towards the cementing system, where cement is introduced until the container is full and the lid is placed.

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PHOTO

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Step 4 Cementation (2/2)

To ensure complete filling of CE-2, a second cement injection system is used.

This is designed to fit into the holes in the upper lid of the CE-2 and inject cement until ensuring complete immobilization of the internal elements of the container.

Once emptied, the radiation shielding bell is placed in the transport system and redirected to the containment building.



1

2

3

4

5







HOME

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THE
EXPERIENCE

Challenges
Solution
Take a Tour



PLAY
VIDEO

5

4

3

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Step 5 Storage

The last step of the process is to move the filled and sealed cask to the storage area of the building.

To do this, a heavy duty crane is used to lift and move the CE-2 container to the designated storage space



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Decontamination Workshop



Chemical Decontamination

Parts with contaminated surfaces that were difficult to access were subjected to chemical decontamination by immersion in tanks with 6% diluted sulphuric acid and subsequent washing with water.



Grit Blasting

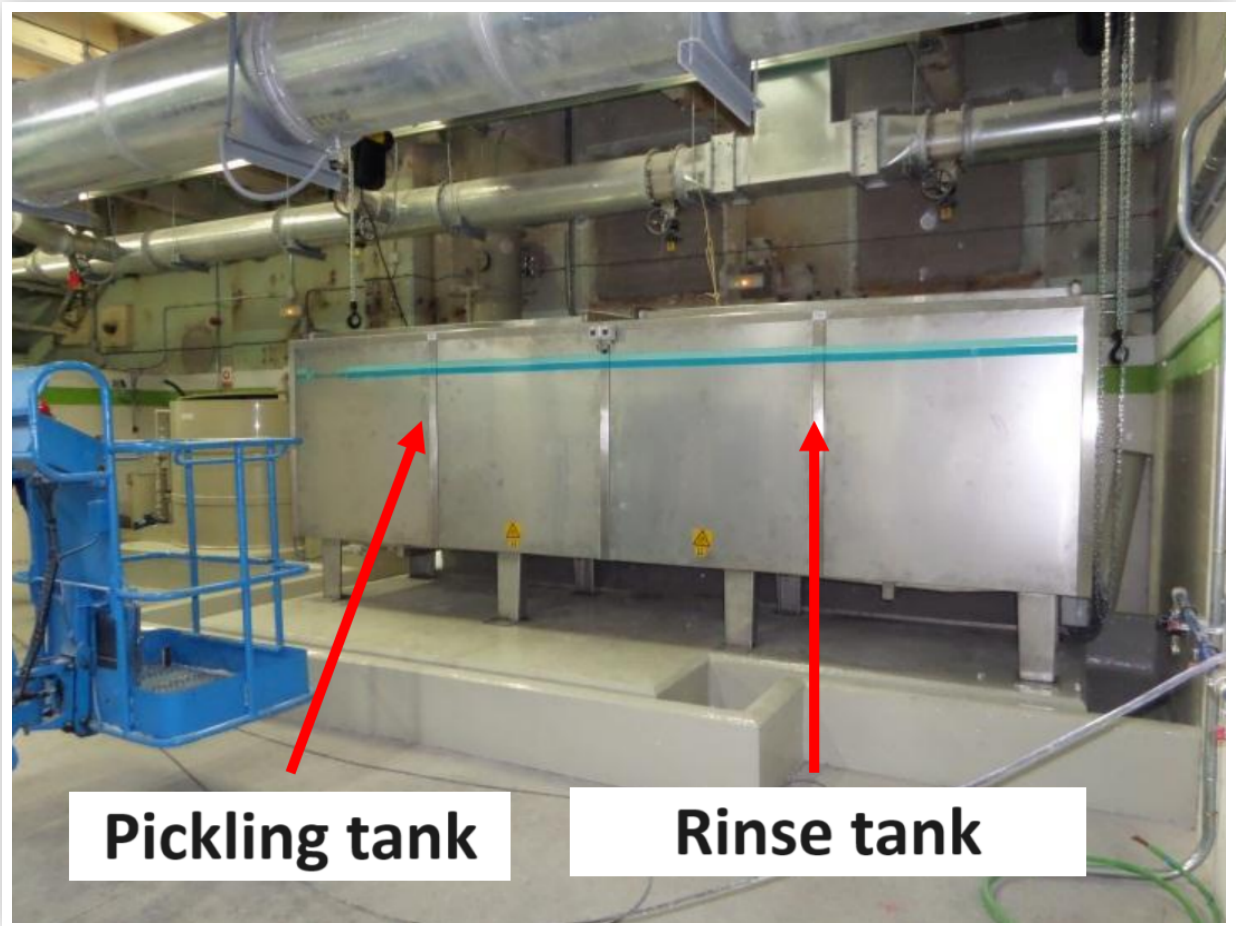
The parts whose contaminated surface was accessible were treated by abrasive blasting with spherical metal shot in a booth



Chemical Decontamination System

A neutralisation tank was provided for the treatment of the spent solutions from the pickling and washing tanks, and their subsequent delivery to the facility's liquid radioactive waste treatment system.





Pickling tank

Rinse tank



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THE EXPERIENCE

Lessons Learned and Key Takeaways



Use existing
infrastructure



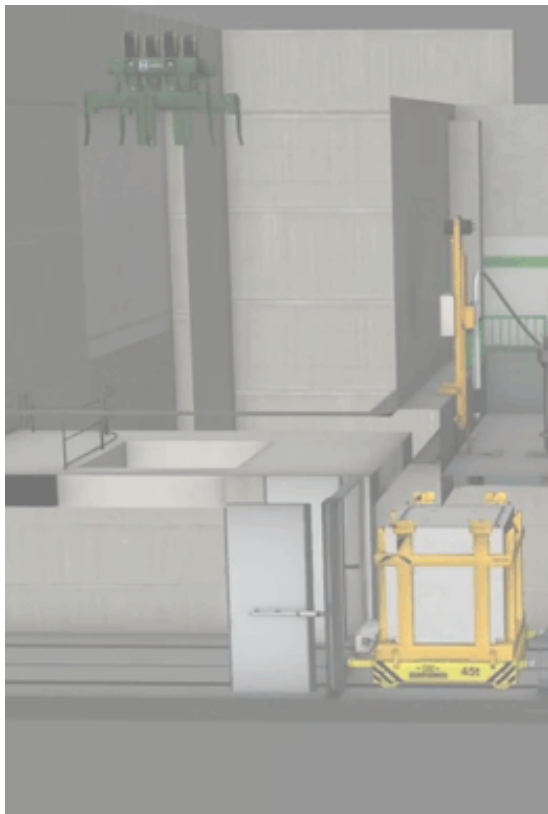
Concentrate
auxiliary systems



Consider
infrastructure life
span



Automate
D&WM
processes

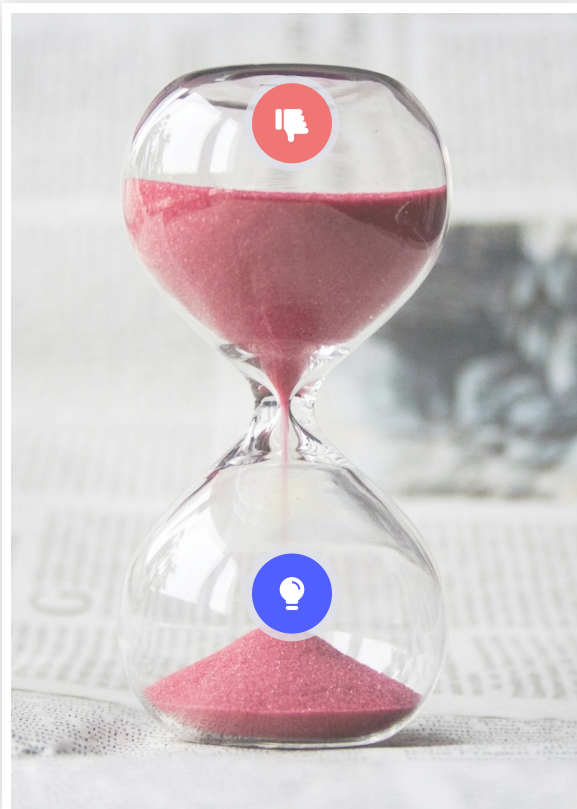


Automate D&WM processes

Even if your organization can't take advantage of existing buildings (due to distance to the containment or other reasons) you can always learn from the experience of other operators automating cutting, retrieval, transport, and conditioning processes.

- Safer operations
- More efficient operations

Zorita NPP designed an automated process to cut, move, pack, transfer, shield and process fuel and RPV internals.

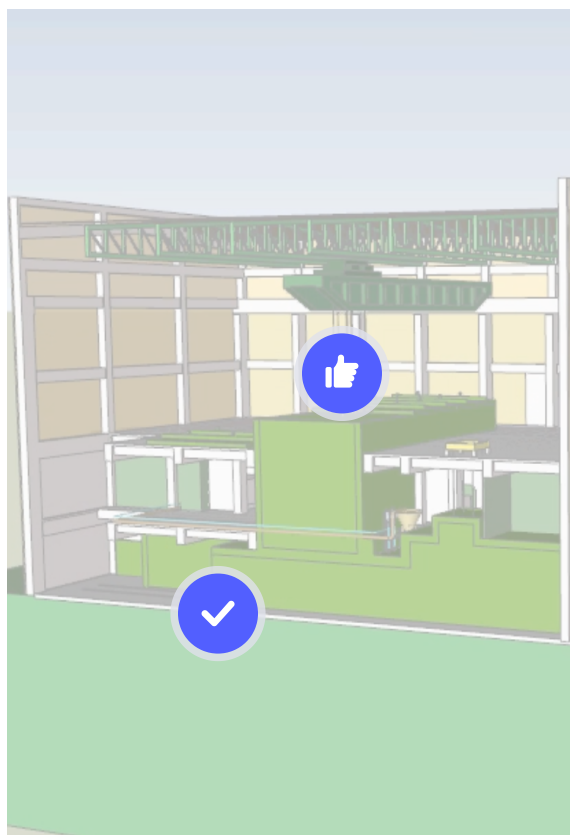


Consider the life span of infrastructure

The turbine building is one of the latest to be dismantled and therefore it is a good choice from the planning point of view.

Concentrating systems in the turbine building will save additional work along the plan decommissioning program, allowing these systems to operate to the very end.

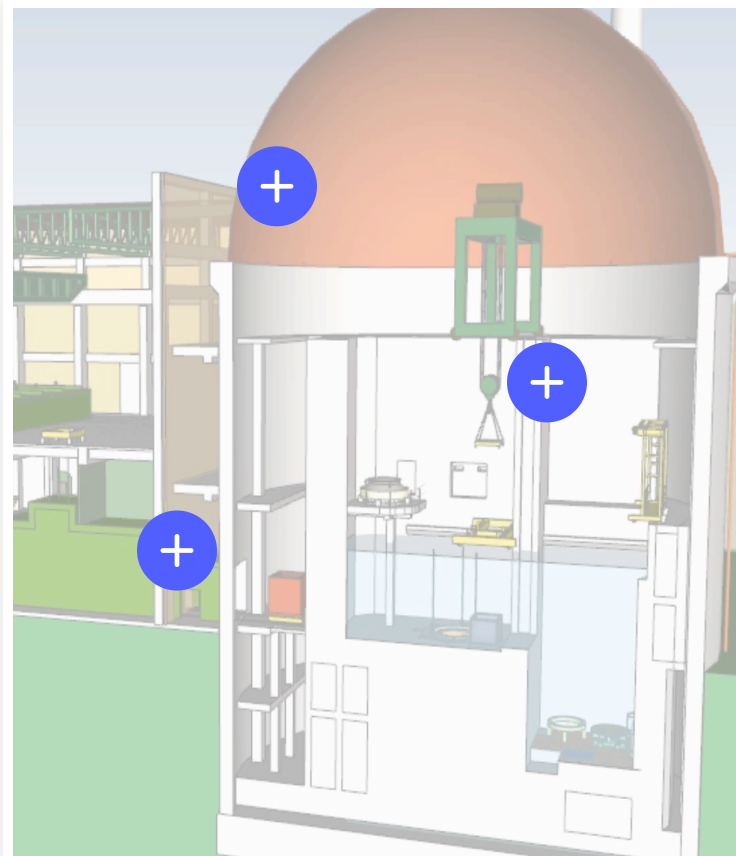
Zorita NPP repurposed turbine building proved to be useful as an auxiliary decommissioning building for X years



Concentrate auxiliary systems

Several auxiliary systems will be required to treat, pack, move, store and process rad waste. The more concentrated these systems are, the better to optimize operations and save time and dose between processes.

Zorita NPP turbine building concentrated decontamination systems, blasting and storage of radioactive waste from the containment building as an auxiliary decommissioning building for decontamination and storage operations.



Use existing infrastructure

Decommissioning and radioactive waste activities require specific equipment, systems, and space for certain processes like decontamination, processing, and transport.

It is essential to take advantage of existing equipment and infrastructure to optimize resources and operations.

ENRESA decided to use Zorita NPP turbine building as an auxiliary decommissioning building for decontamination and storage operations