

# INSTALLATIONS AND OPERATIONAL PROCESSES



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# THE PLANT

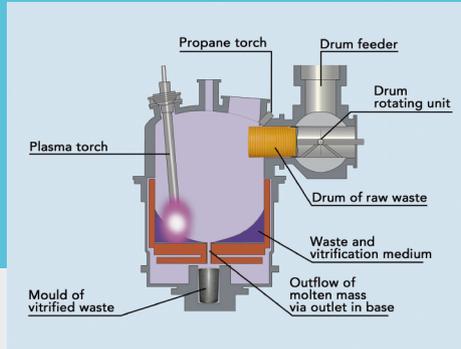
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# 1 PLASMA PLANT



FURNACE HALL



FUNCTIONAL PRINCIPLE



COMMAND BOOTH

Where the incineration of radioactive waste is concerned, Zwiilag has chosen an entirely new and state-of-the-art method. The radioactive waste is not incinerated as usual, but is thermally decomposed or melted in a plasma plant at temperatures of up to  $20,000^{\circ}\text{C}$ . First seen in metallurgy, the plasma process permits both the processing of combustible materials and the melting of metallic parts, concrete and other solid matter. The same process can be used to vitrify organic and anorganic matter in the residue ready for final storage. All organic matter is totally decomposed with an extremely hot electric arc and after-burner with a downstream rapid cooler, so that no dioxins or furans can be formed. This, the first plant of its kind to be used for nuclear waste, evolved from a conventional plasma plant for highly toxic matter.

The plasma plant is operated for several weeks without interruption every year. During these operating periods, all plasma plant processes can be steered and monitored by shift workers from a command booth equipped with state-of-the-art technology.

Although incineration cannot reduce the radioactivity of the waste, it can reduce its volume and make it more suitable for final storage by adding the medium required for vitrification.

## 2 CONDITIONING PLANT



CLEANING OF COMPONENTS



CONTAINER TRANSPORT SYSTEM



DECOMPOSITION

The conditioning plant offers a big variety of technical equipment for treating the waste delivered to the facility – mainly packaged goods and large components from the nuclear power plants. The main objective is to completely decontaminate the waste until it is free of radioactive materials so that the decontaminated waste can be recycled as conventional waste. As the waste delivered to the facility can be very different with regard to composition, consistency, packaging and weight, mechanical separation methods and abrasive treatment methods are supplemented by other processes, such as electrolytic and chemical cleaning processes. The residue is either packed in cement or in standard raw waste drums and sent to the plasma plant for further treatment. The radioactive waste water and aggregate generated during the cleaning process are processed further in the internal waste water treatment plant.

The different treatment facilities are linked to one another by a roller guide system which also includes the waste reception facility and neighbouring stations where the waste is analysed. Large volumes of raw waste drums can be stored in a high-rack warehouse until they can be treated in the plasma plant. The facility where the waste conditioned for final storage and waste free of radioactive materials are checked is also located in the conditioning plant.

### 3 TRANSFER STATION



HEAVY GOODS VEHICLES

A transfer station with a gantry crane is available for unloading the casks and containers from railway vehicles and transferring them to road transport vehicles. The required railway siding with road access was built around one kilometre from the Zwiilag facility.



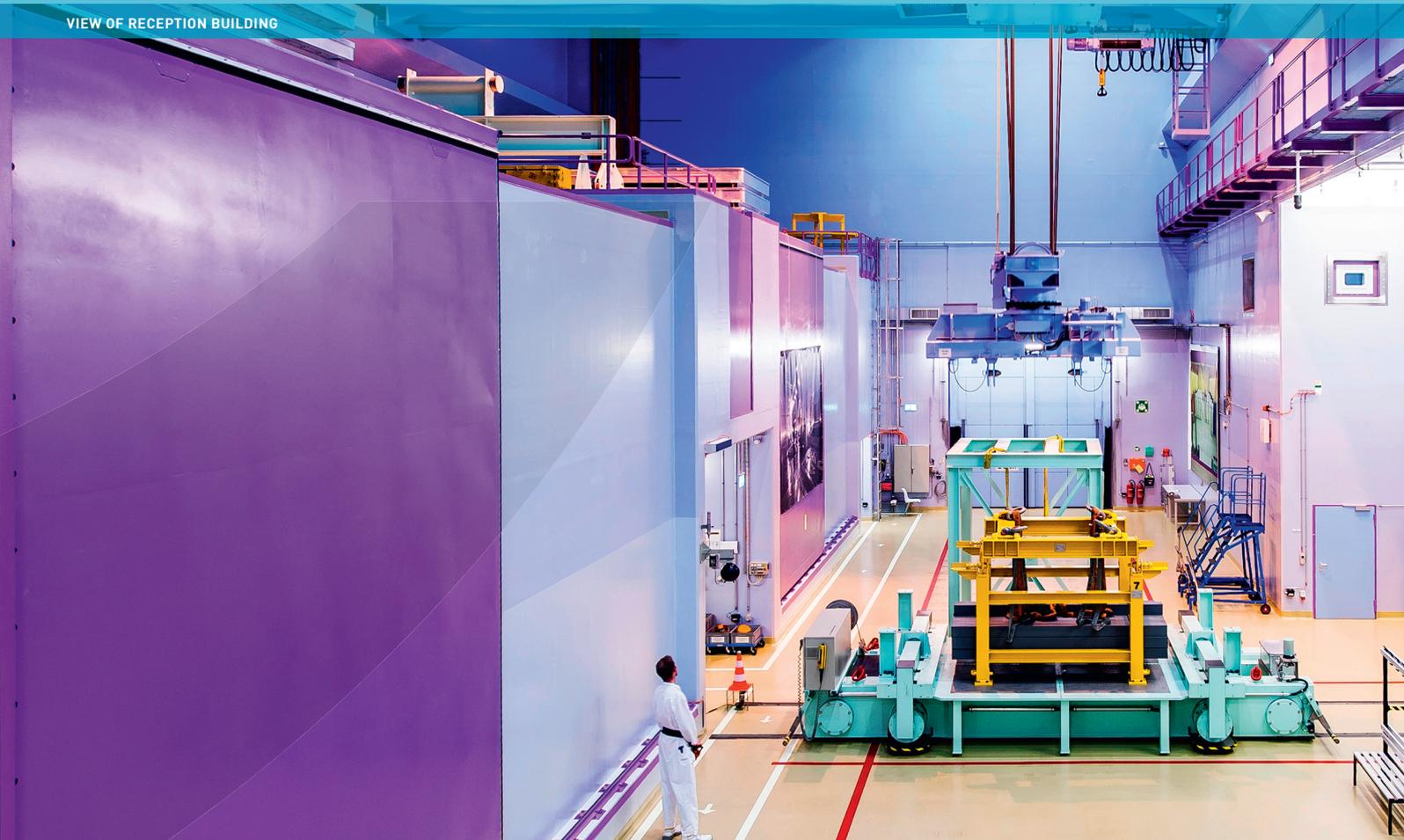
TRANSFER OF CASKS AT RAILWAY SIDING/ROAD

Mainly waste from reprocessing plants in France or Great Britain is delivered by train. A heavy goods vehicle belonging to the company is used to transport the casks and containers to the reception building.

## 4 RECEPTION BUILDING

The 26m-long reception area where casks, containers and other drums are unloaded and prepared for storage is located between the cask storage hall and the storage building for medium-level waste. The reception building can accommodate heavy goods vehicles.

VIEW OF RECEPTION BUILDING



## 5 CASK STORAGE HALL



VIEW OF THE CASK STORAGE HALL



TRANSPORT AND STORAGE CASKS

### Storage of spent fuel elements and high-level radioactive waste

The cask storage hall, 68m long, 41m wide and almost 20m high, lies at the heart of the interim storage facility. This hall is used to store vitrified highly active waste from the reprocessing plants and spent fuel elements from the Swiss nuclear power plants. The highly radioactive vitrified waste and spent fuel elements are stored in tightly sealed transport and storage casks (TLB). At full capacity, this hall has room for around 200 standing casks.

The principle of the dry storage of vitrified highly active waste and spent fuel elements is a safe and much tested concept. The highly active waste emits heat. This heat must at all times be able to escape. The heat can always dissipate thanks to the natural circulation of air through openings in the side walls of the hall and in the roof. Initially, the heat output of a steel cask filled with high-level radioactive waste can amount to between 40 and 50 kilowatts. The heat output drops continuously and equals only around 25 to 30 kilowatts after ten years in interim storage. Given the current state of the technology, it is not yet possible to use this heat potential economically. The hot air released through the openings in the roof is not radioactive and does not have any negative impact on the environment.

## 6 STORAGE BUILDING FOR MEDIUM-LEVEL WASTE



SOLID CONCRETE LIDS COVERING STORAGE SHAFTS



STORAGE CONTAINERS WITH LOW- AND MEDIUM-LEVEL WASTE

### Storage building for medium-level waste

The storage building for medium-level waste has storage capacity for 384 twenty-foot storage containers. The storage containers are filled with conditioned waste ready for final storage and are stacked one on top of the other in the storage shafts by remote control. The solid construction of the building not only shields the waste, but also protects it from external effects. As the stacks may have a maximum height of 16 metres per storage bay, eight normal-sized containers can be stacked on top of one another. The individual storage shafts in the storage building are covered by solid concrete lids.

The storage building is managed in accordance with the latest principles of radiation protection. The reception, unloading and storage areas are separate. The stored goods are controlled remotely with the help of cameras as well as in direct eye contact through lead glass windows. The contents of the containers destined for storage can be checked at special measuring stations.

There is a centralised inventory and careful inventories are also kept for each location and of the contents of each individual container. The condition of the stored casks and containers is also checked regularly.

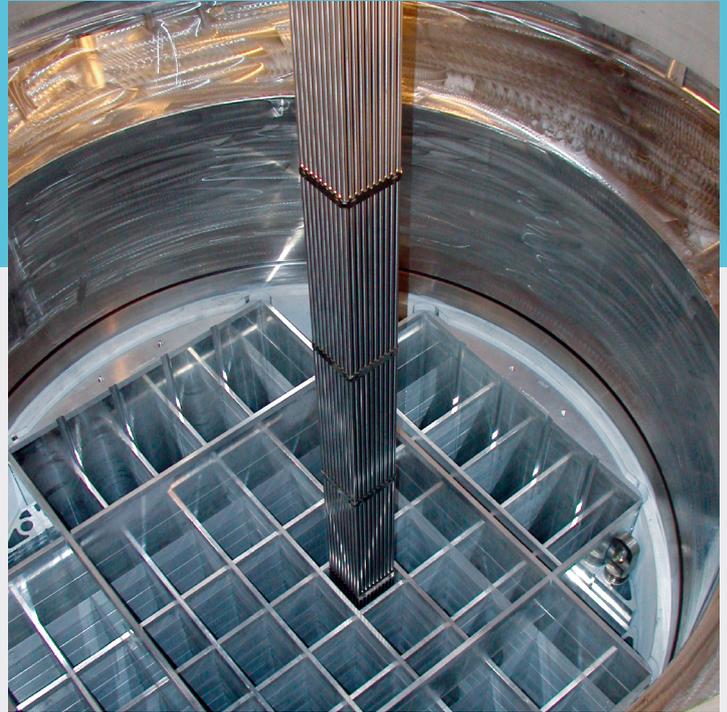
The gas warning device installed in the exhaust air vents continuously monitors the concentration of gases such as hydrogen and methane as well as the temperature in the storage building.

## 7 HOT CELL



VIEW OF THE HOT CELL

Storage casks can be checked and repaired in the hot cell, which has been built to withstand even a falling airplane. This area is also used for the inspection and unloading of spent fuel elements.



TRANSFER OF FUEL ELEMENTS

All handling operations in the hot cell are remote-controlled. The operators can steer everything by camera while still keeping direct eye contact through the lead glass windows.

## 8 STORAGE HALL

### Storage hall for low- and medium-level radioactive waste

The storage hall for low- and medium-level waste was built during a second construction phase. This building is 98m long, 33m wide and almost 20m high and has storage capacity for 1,144 containers. It consists of a reception and a storage area. Until further notice this storage hall is only used for conventional storage, such as empty drums and containers and replacement materials.

At a later stage the storage hall should also be used for the interim storage of decommissioning waste from the Swiss nuclear power plants.

STORAGE HALL FOR EMPTY DRUMS AND REPLACEMENT MATERIALS



# DRUMS AND CONTAINERS FOR LOW- AND MEDIUM-LEVEL WASTE



RAW WASTE DRUM

## Raw waste drum

This 200 litre steel plate drum is used to collect, pack and transport low-level raw waste. This includes operational waste that is only slightly contaminated from the nuclear power plants as well as radioactive medical, industrial and research waste. The delivery drum, is sealed with a clamping ring. This raw waste is treated in the conditioning plant or the plasma plant.



DRUM FOR FINAL STORAGE

## Drums for final storage

This drum is a 200 litre steel drum suitable for the final storage of low- and medium-level waste. It is used to deliver finally conditioned waste from the nuclear power plants to the central interim storage facility and is stored in the storage building for medium-level waste. Residue also results from the treatment of raw waste in the plasma plant which is then vitrified and packed into drums for final storage, ready for storage in deep geological repositories.



SMALL CEMENT CONTAINER

### Small cement containers

Waste that is not flammable and cannot be treated in the plasma plant because of its bulk or where the melting process cannot reduce the volume are encased in KC-T12 small cement containers. These containers have been built to be ready for storage in deep geological repositories and measure  $1.5 \times 1.5 \times 2$  metres. They are also put into the storage building for medium-level waste.



STEEL CANISTER FOR VITRIFIED HIGH- AND MEDIUM-LEVEL WASTE

### Steel canisters for vitrified high- and medium-level waste

The reprocessing of spent fuel elements in foreign plants produces highly active and medium-active waste. This waste is vitrified and placed into 180 litre steel canisters. The steel canisters are delivered by rail in transport casks. While the steel canisters containing medium-level waste can be transferred from the casks to storage containers and taken to the storage building for medium-level waste, the steel canisters containing highly active waste remain in the transport casks and are stored in the cask storage hall.

# CASKS FOR HIGHLY ACTIVE WASTE AND SPENT FUEL ELEMENTS



TRANSPORT AND STORAGE CASKS WITH VITRIFIED HIGHLY ACTIVE WASTE

The vitrified highly active waste and spent fuel elements are kept in intermediate storage in the cask storage hall in massive steel casks that weigh up to 140 tonnes.

The casks protect the waste and fuel elements from all conceivable hazards

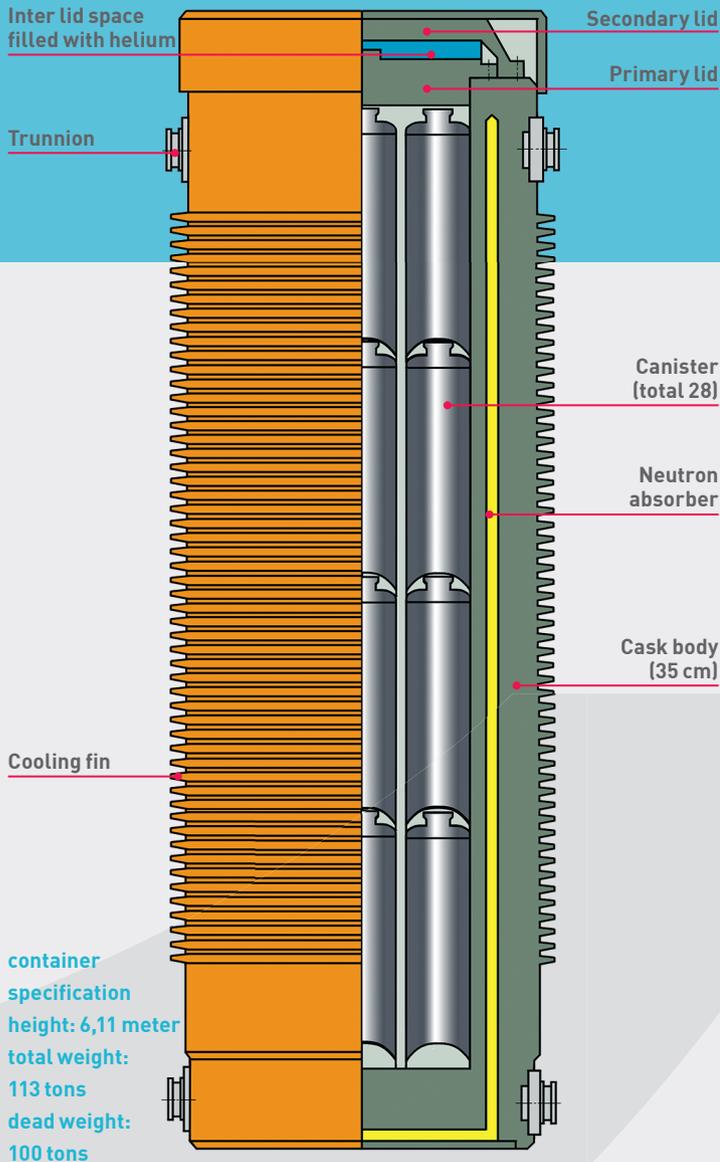


TRANSPORT AND STORAGE CASKS WITH SPENT FUEL ELEMENTS

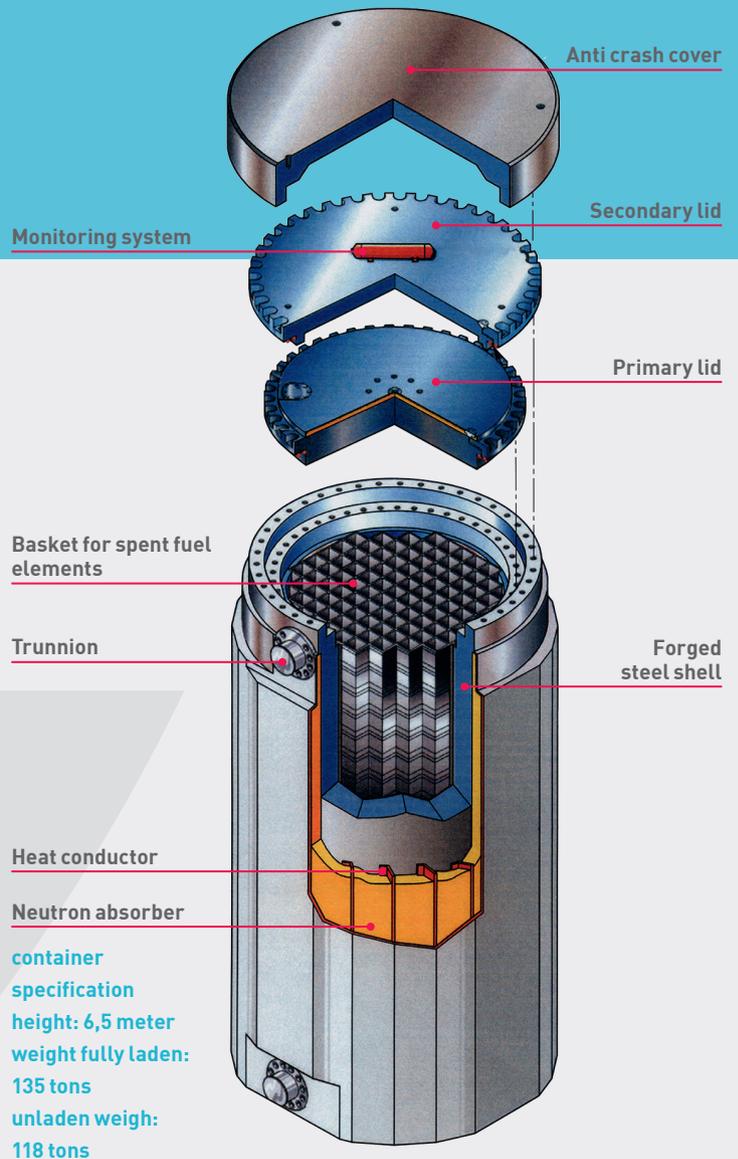
such as airplane crashes, earthquakes, fire and other incidents.

The casks are constantly monitored during the entire interim storage period to make sure that they remain tightly sealed. Only cask types licensed and approved by the authorities are used.

### Cross-section of transport and storage cask for vitrified highly active waste



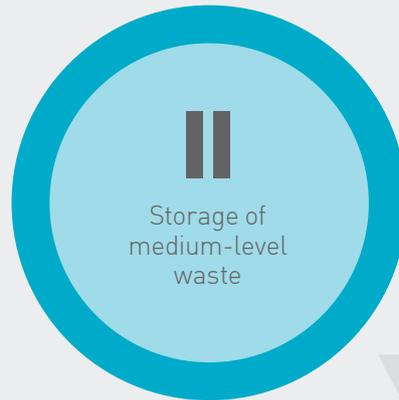
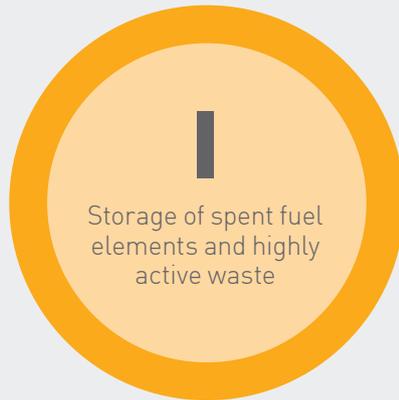
### Cross-section of transport storage cask for spent fuel elements



# OPERATIONAL PROCESSES

Use this simplified model to get to know four typical operational processes

- I Storage of spent fuel elements and highly active waste
- II Storage of medium-level waste
- III Treatment of operational waste in the plasma plant
- IV Decontamination and component conditioning





The individual plants use a large number of methods and processes to treat and store the different categories of radioactive waste. A very simplified model is used to describe the most important components and typical operational processes.



The typical operational processes I and II show the storage of casks and containers containing high- and medium-level waste.

The typical operational processes III and IV show the treatment of low-level waste originating from nuclear power plants and waste for which the Confederation is responsible, i.e. radioactive medical, industrial and research waste.



# STORAGE OF SPENT FUEL ELEMENTS AND HIGHLY-ACTIVE WASTE

18





1



2



3

**1 Delivery by rail or road**

Casks holding spent fuel elements from nuclear plants or highly active waste from reprocessing facilities are delivered through the transfer station or directly by road in heavy goods vehicles to the reception building.

**2 Unloading and leak tests**

The casks are unloaded in the reception building and checked for leaks by specialist staff at a specially fitted workstation.

**3 Storage in the cask storage hall**

A transfer vehicle is used to transport the cask to the cask storage hall, where a crane is used to move them to their permanent location. The casks are then connected to a monitoring system and are monitored constantly for leaks.



# STORAGE OF MEDIUM LEVEL-WASTE

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### **1 Delivery by rail**

Medium-level waste from foreign reprocessing facilities is delivered to the transfer station in large transport casks. A cask usually holds up to 28 heat-sealed steel canisters of vitrified medium-level waste.

### **2 Transfer to storage containers**

The steel canisters holding vitrified, medium-level residue from reprocessing facilities are unloaded from the transport casks in the reception building and transferred to storage containers. Everything is done by remote control using state of the art equipment.

### **3 Transfer to storage building for medium-level waste**

The full storage containers are taken to the storage building for medium-level waste and stacked in the storage bays. The storage building was constructed to be earthquake-proof and is constantly monitored with the help of various measuring instruments.



# TREATMENT OF OPERATIONAL WASTE IN THE PLASMA PLANT

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**1 Delivery of operational waste**

Low-level operational waste from the Swiss nuclear plants and radioactive medical, industrial and research waste are delivered in raw waste drums. A special 40-foot container is used for these transports.

**2 Melting down and incineration in the plasma plant**

The raw waste drums are melted down together with their content. The organic matter is incinerated and the residue is mixed with liquid glass and poured into steel moulds.

**3 Transfer to 200-litre drums for final storage**

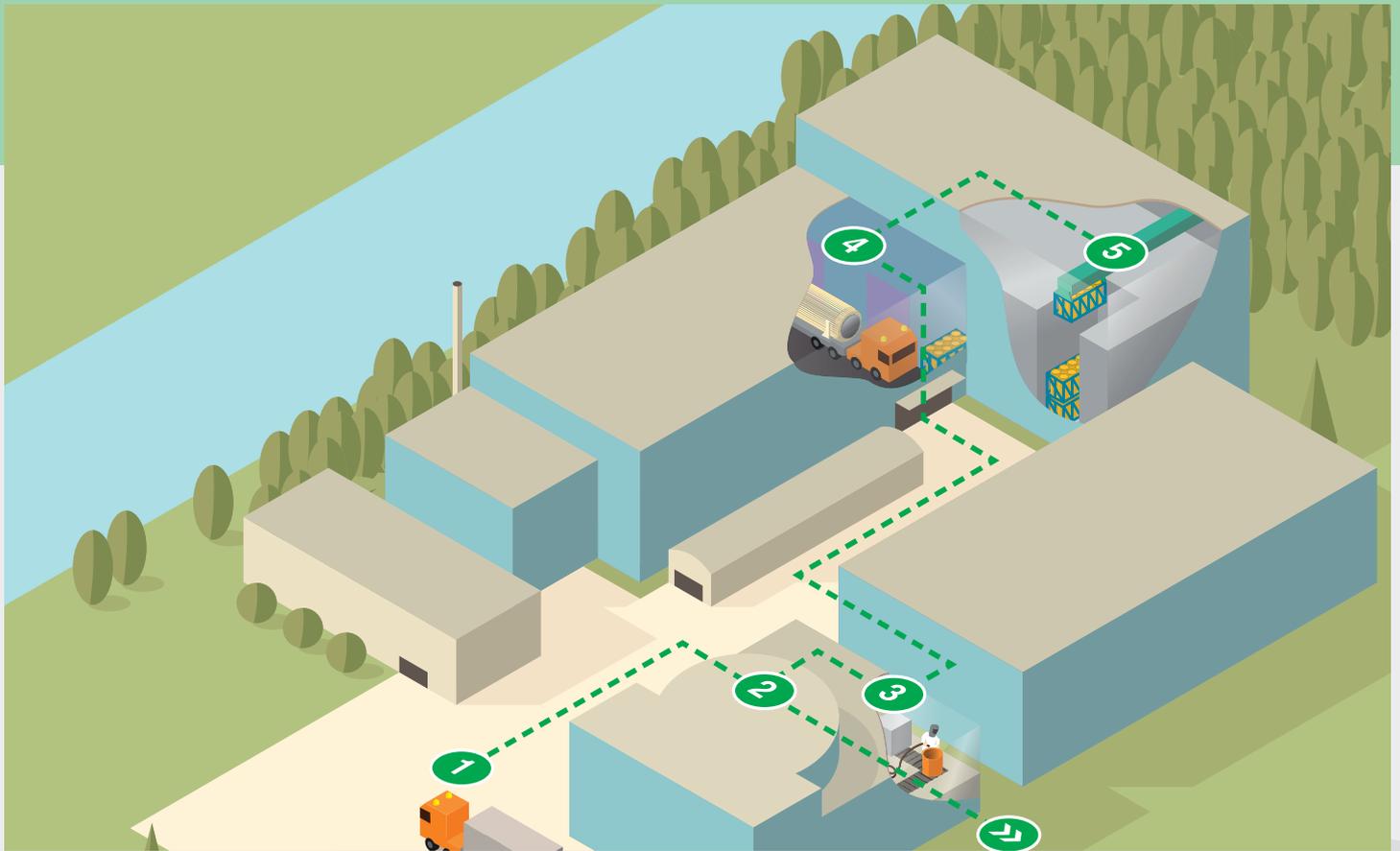
The processed 200-litre drums for final storage prepared in the plasma plant are transferred to containers in the reception building. Each storage container holds 68 drums for final storage.

**4 Transfer to storage building for medium-level waste**

The full storage containers are taken to the storage building for medium-level waste and stacked in the storage bays. The storage building was constructed to be earthquake-proof and is constantly monitored with the help of various measuring instruments.

IV

# DECONTAMINATION AND COMPONENT CONDITIONING





### 1 Delivery of components from nuclear power plants

Spent components and other goods are collected as waste during maintenance projects in the nuclear power plants. This waste is delivered to the conditioning plant by road.

### 2 Treatment and decontamination

The delivered components are dismantled and completely decontaminated of radioactive materials if possible so that it can be disposed conventionally as inactive waste.

### >> Release and conventional disposal

The waste is tested to make sure that it is free from radioactive materials and is transferred to the normal recycling process as conventional waste. These tests are subject to strict official requirements and are monitored by the authorities.

### 3 Compaction of residue in cement containers

The residue from the decontamination process is packed in cement in small cement containers or sent to the plasma plant for further treatment.

### 4 Transfer to storage containers

The cement containers holding the compacted, low-level conditioning waste are transferred to storage containers.

### 5 Storage in storage building for medium-level waste

The full storage containers are taken to the storage building for medium-level waste and stacked in the storage bays. The storage building was constructed to be earthquake-proof and is constantly monitored with the help of various measuring instruments.

# WE ARE ALWAYS HAPPY TO WELCOME VISITORS

## Guided tours of the facility

We are happy to receive visitor groups. During a tour of the facility you can see for yourself how radioactive waste is treated and processed for interim storage in a safe, responsible and environmentally compatible manner. Please make a reservation by calling us on +41 (0)56 250 00 31 or by sending us an e-mail.

A guided tour takes around two hours.

We are looking forward to your visit to the central interim storage facility in Würenlingen.

TRANSPORT CHANNEL BETWEEN THE PROCESSING PLANTS AND STORAGE BUILDINGS



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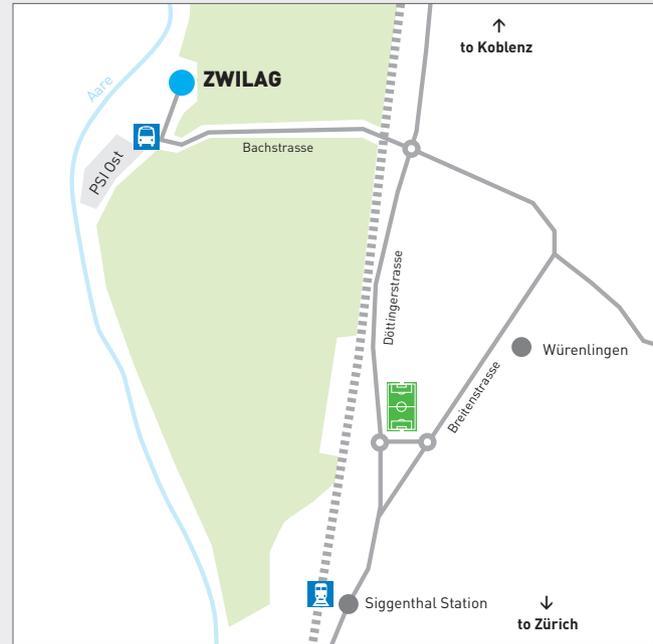
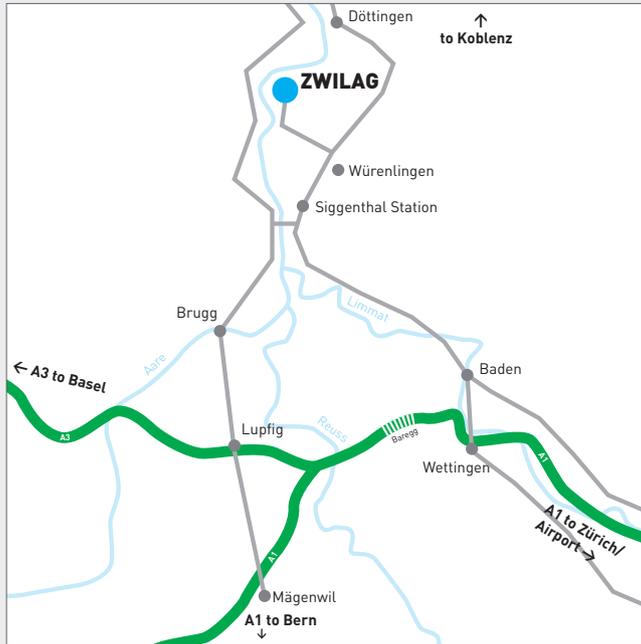
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