Decommissioning
in Switzerland

ARRAD - ENSI
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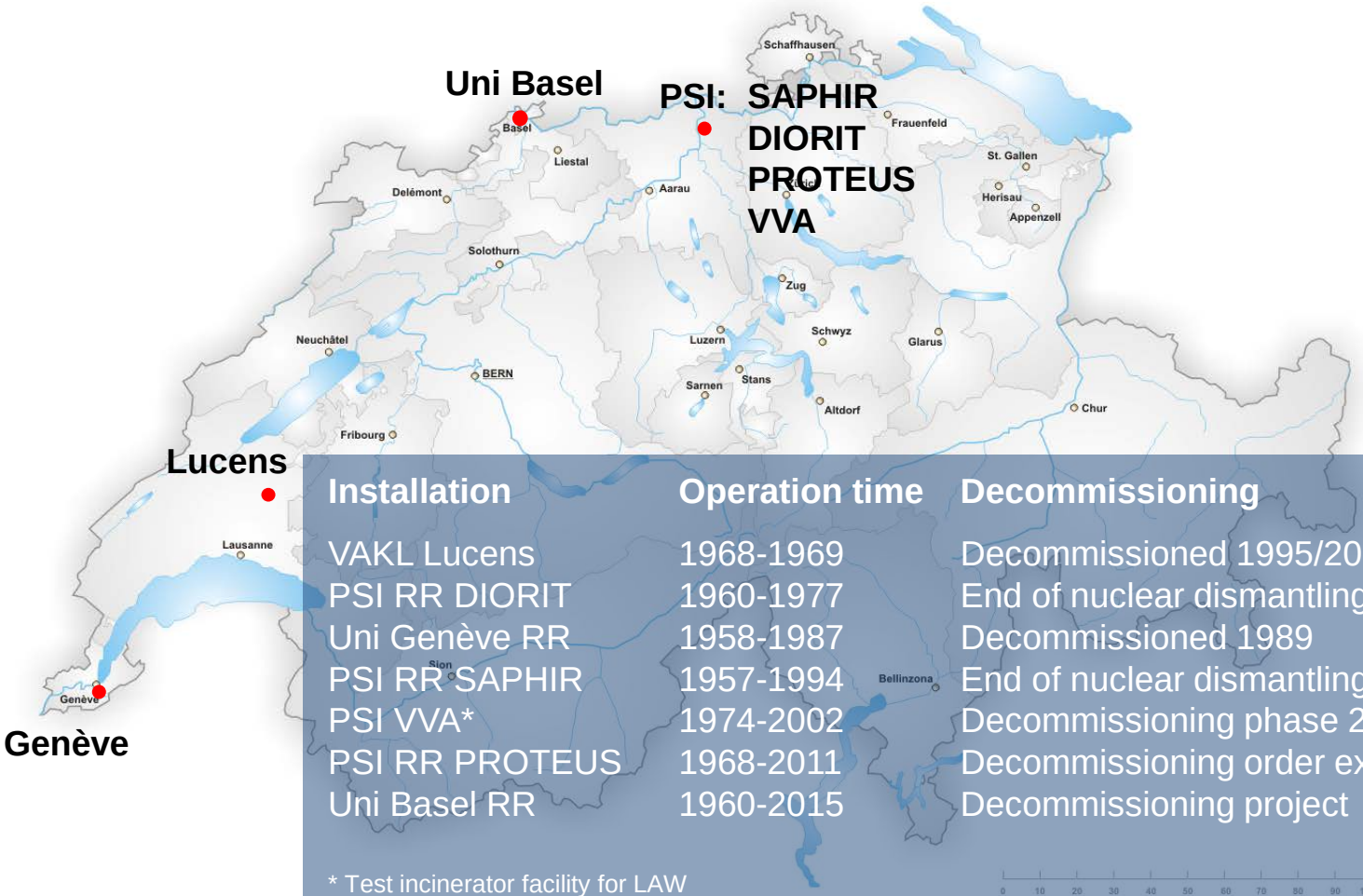
Decommissioning Experience



Installation	Operation time	Decommissioning
VAKL Lucens	1968-1969	Decommissioned 1995/2004
PSI RR DIORIT	1960-1977	End of nuclear dismantling activites
Uni Genève RR	1958-1987	Decommissioned 1989
PSI RR SAPHIR	1957-1994	End of nuclear dismantling activites
PSI VVA*	1974-2002	Decommissioning phase 2**
PSI RR PROTEUS	1968-2011	Decommissioning order expected
Uni Basel RR	1960-2015	Decommissioning project

* Test incinerator facility for LAW
** Dismantling of the combustion furnace

Key players in decommissioning

Owner: axpo ALPIQ BKW & Research Institutes

Responsible for the safety during whole lifetime

DETEC: Department of the Environment, Transport, Energy and Communications (Energy policy & licencing authority, decommissioning licence)

SFOE: Swiss Federal Office of Energy (Process leading authority)

ENSI: Swiss Federal Nuclear Safety Inspectorate

(Safety / Security supervising authority, Safety reports and approvals)

NSC: Federal Nuclear Safety Commission (Second opinion experts)

FOEN: Federal Office for the Environment (Environmental audit)

and Cantonal Environmental Protection Agencies

SUVA: Conventional occupational health and safety

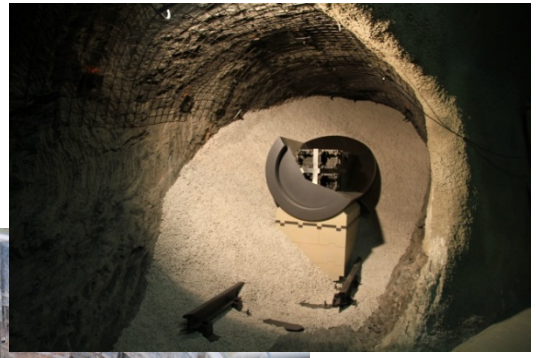
Nagra: National Cooperative for the Disposal of Radioactive Waste

Public: Residents, associations

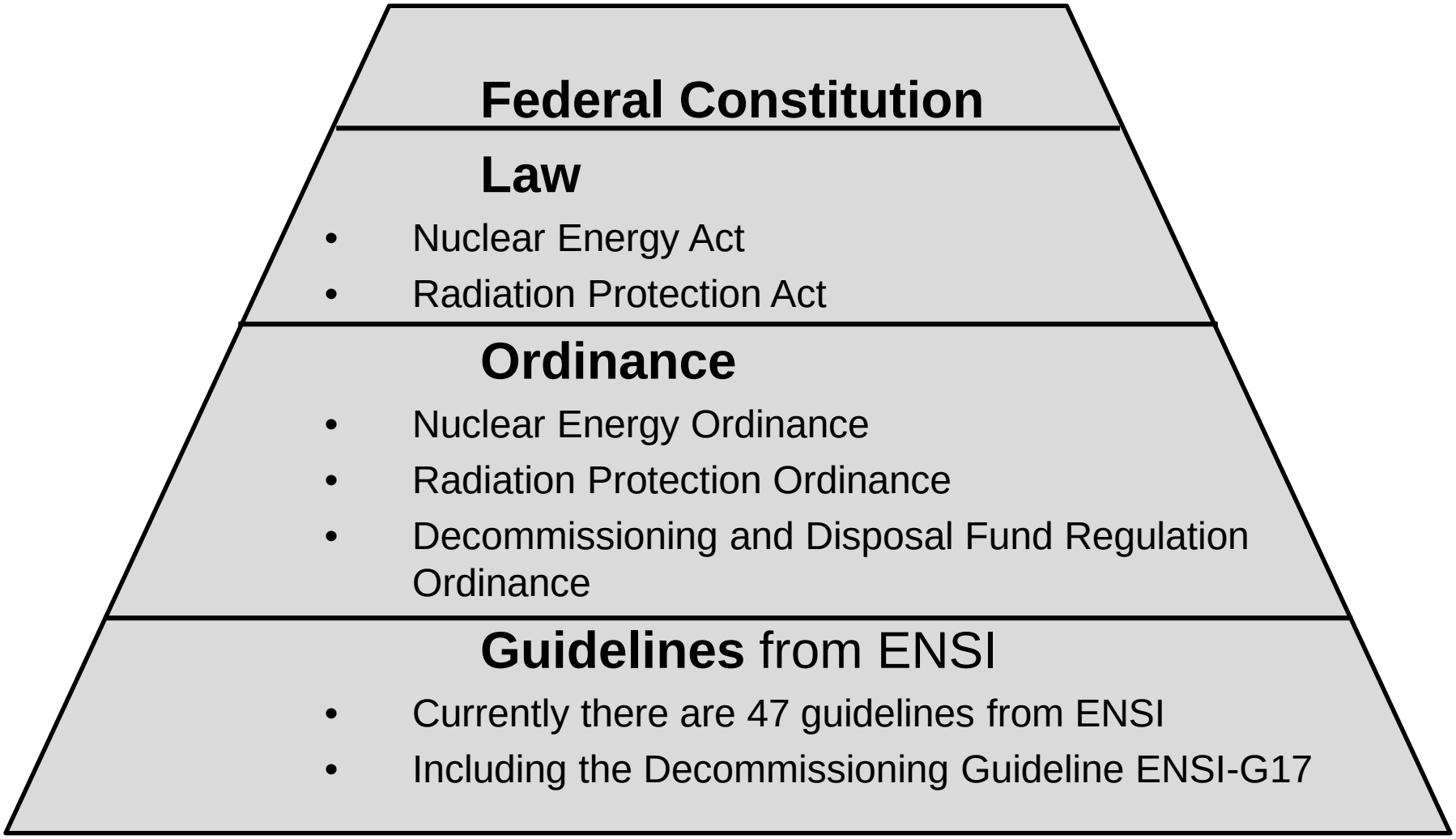
Lifetime supervision

Design | Construction | Operation | Post-operation | Dismantling | Waste disposal

Supervision



Legal basis


Federal Constitution
Law
• Nuclear Energy Act
• Radiation Protection Act
Ordinance
• Nuclear Energy Ordinance
• Radiation Protection Ordinance
• Decommissioning and Disposal Fund Regulation Ordinance
Guidelines from ENSI
• Currently there are 47 guidelines from ENSI
• Including the Decommissioning Guideline ENSI-G17

Definitions

Decommissioning (Message to the Nuclear Energy Act)

The decommissioning of a nuclear installation includes:

- all activities that are required in order to reuse the site for other purposes.

The site will no longer be:

- a radiological hazard
- a subject to nuclear energy legislation.

Dismantling (Nuclear Energy Order & Guideline ENSI-G17)

- Includes: disassembling, decontamination and demolition
- Dismantling starts when the decommissioning order becomes legally effective and ends when the nuclear installation is no longer subject to nuclear energy legislation.

Decommissioning process (NEA)

Owner: Decommissioning obligation (after final shutdown)

Owner: Decommissioning project

- Includes a phase concept specified by the owner
- Describes the dismantling strategy by concept

ENSI: Expert report (with requirements)

DETEC: Decommissioning license (order)

- Replaces the operating license
- May be legally binding at the time after final shutdown
- Regulates ENSI's requirements (Expert report)
- Regulates ENSI's approvals (phases and working steps)

DETEC: Release from NEA

Content of the decommissioning project (NEO)

- Phase concept
- Dismantling and demolition concept
- Safety concept
- Security concept
- Radiation protection concept
- Waste separation and disposal concept
- Emergency concept
- Personnel and organisation concept
- Quality management concept
- Environmental impact concept

Content of the Decommissioning License (NEO)**:**

- Scope of decommissioning activities
- The various decommissioning phases
- Limits for the discharge of radioactive substances into the environment
- Monitoring of immissions of radioactive substances and of direct radiation
- Organisation

Definition of approvals (NEO)

The **Decommissioning Licence** has to define an approval especially for the following activities:

- Procedure for the clearance measurement of resulting materials
- Conditioning of resulting radioactive waste
- Demolition of buildings after their decontamination and clearance measurement
- Non-nuclear use of installations after completion of the decommissioning process
- Repeal of security measures
- Disassembly of the reactor vessel and its surrounding building elements

Guideline ENSI-G17

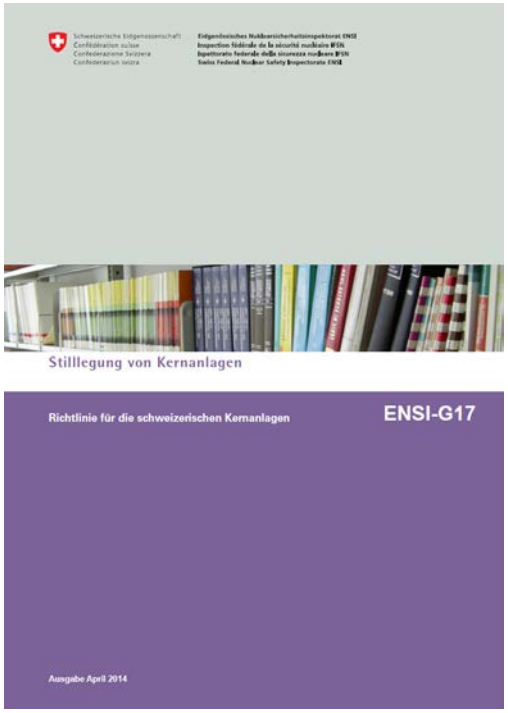
"*Decommissioning of nuclear installations*"

Requirements for decommissioning:

- Specifies the requirements from NEO

Requirements for the application documents:

- Decommissioning project
- Post-shutdown period
- Decommissioning phases
- Final report



Guideline ENSI-G17

"*Decommissioning of nuclear installations*"

Important aspects:

- Subdivision into phases by owners
- Approval for phases and working steps by ENSI
- Removal of nuclear fuel as soon as possible to another nuclear installation (no binding to post-shutdown operation)
- Decommissioning is possible with nuclear fuel on site
- Safe storage is considered as a phase of the decommissioning project

Decommissioning of Mühleberg NPP

Timetable of the preparation process

12/2015	▪ Submission of BKW application letter and decommissioning project
01/2016 – 09/2017	▪ Completeness check by authorities SFOE/ENSI/FOEN ▪ Revision by BKW ▪ Public hearing (Possibility of objection) ▪ **Safety assessment and expert report by ENSI** (Statement of NSC) ▪ Statements from cantons and federal authorities (FOEN)
10/2017	▪ Exchange of involved authorities
06/2018	▪ Decommissioning order (licence) from DETEC
2018 …	▪ Complaint/litigation (Federal Administrative Court, Federal Court)

Decommissioning project

Application letter

Decommissioning Project (Main report)

Accident analysis & emergency preparedness measures (Part 1)

Environmental impact report (Part 2)

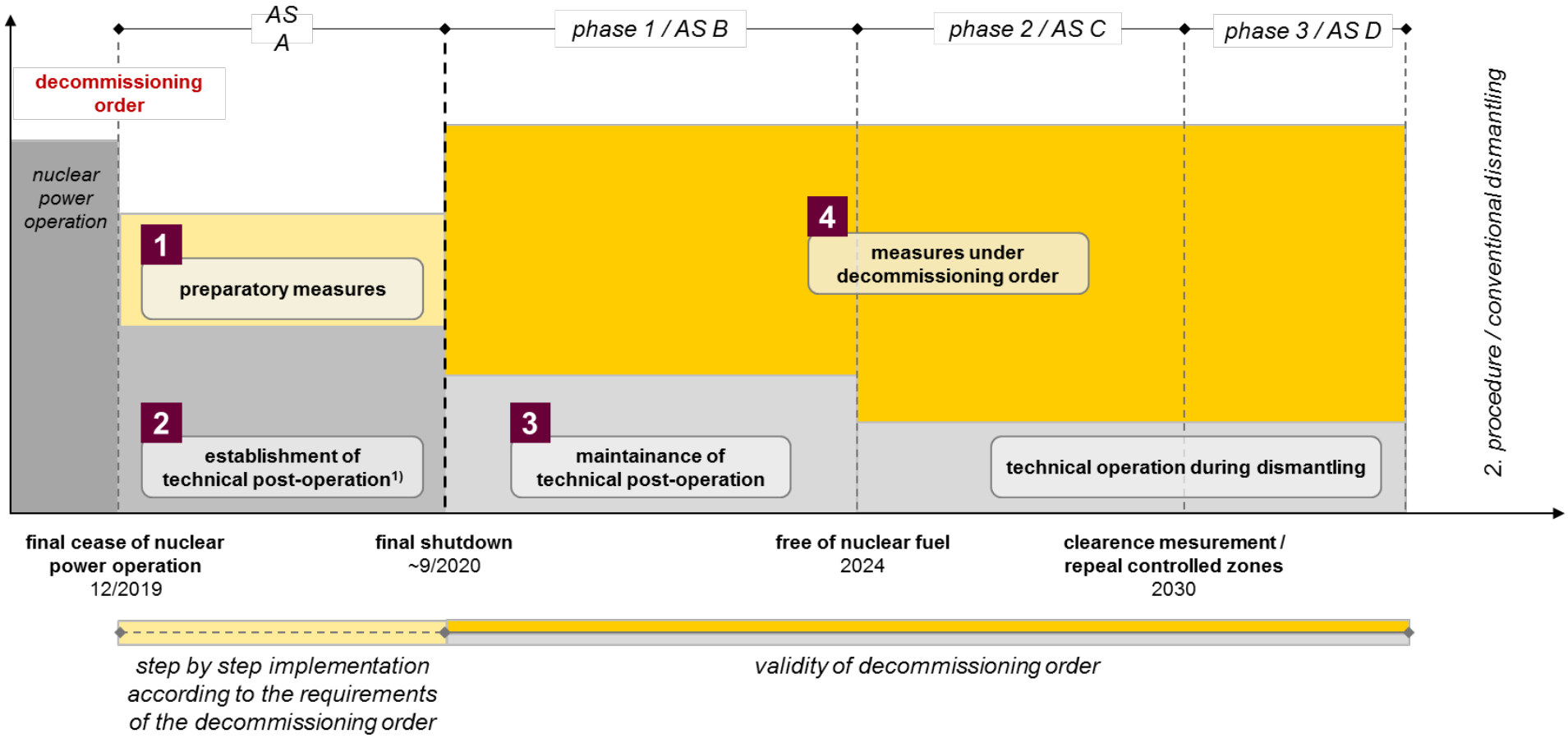
Security measures (Part 3)

Nine requests in the application letter

Application letter

1. Decommissioning order for **direct dismantling** according to the submitted decommissioning project
2. Limitation of the **scope** of the decommissioning activities according to the submitted decommissioning project
3. Dividing of the decommissioning activities into **three decommissioning phases**
4. **Release of BKW from the liability to guarantee nuclear safety and security** and termination of supervision by the competent authorities after completion of the radiological clearance measurements
5. Implementation of **“Preparatory Measures" after final cease of operation**
6. Definition of **limits for radioactive discharges**
7. Definition of the **organisational structure** according to the submitted decommissioning project
8. Issuance of the required **approvals** by ENSI for the decommissioning phases as well as the activities defined in Art. 47, Nuclear Energy Ordinance
9. Definition of provisions for the **withdrawal and return of cooling water** from and to the Aare

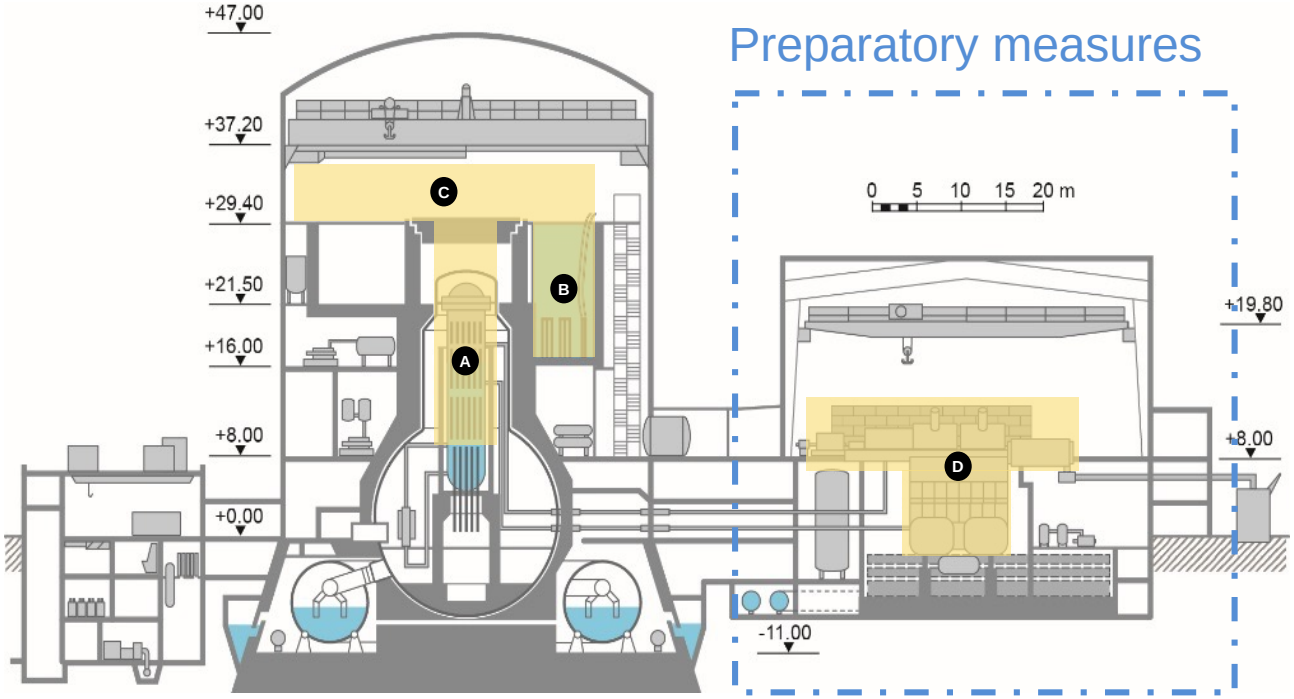
Decommissioning phases



AS: status
1) based on supervisory process with ENSI
2) final assessment report ENSI

source: BKW

Establishment of technical post-operation and preparatory measures



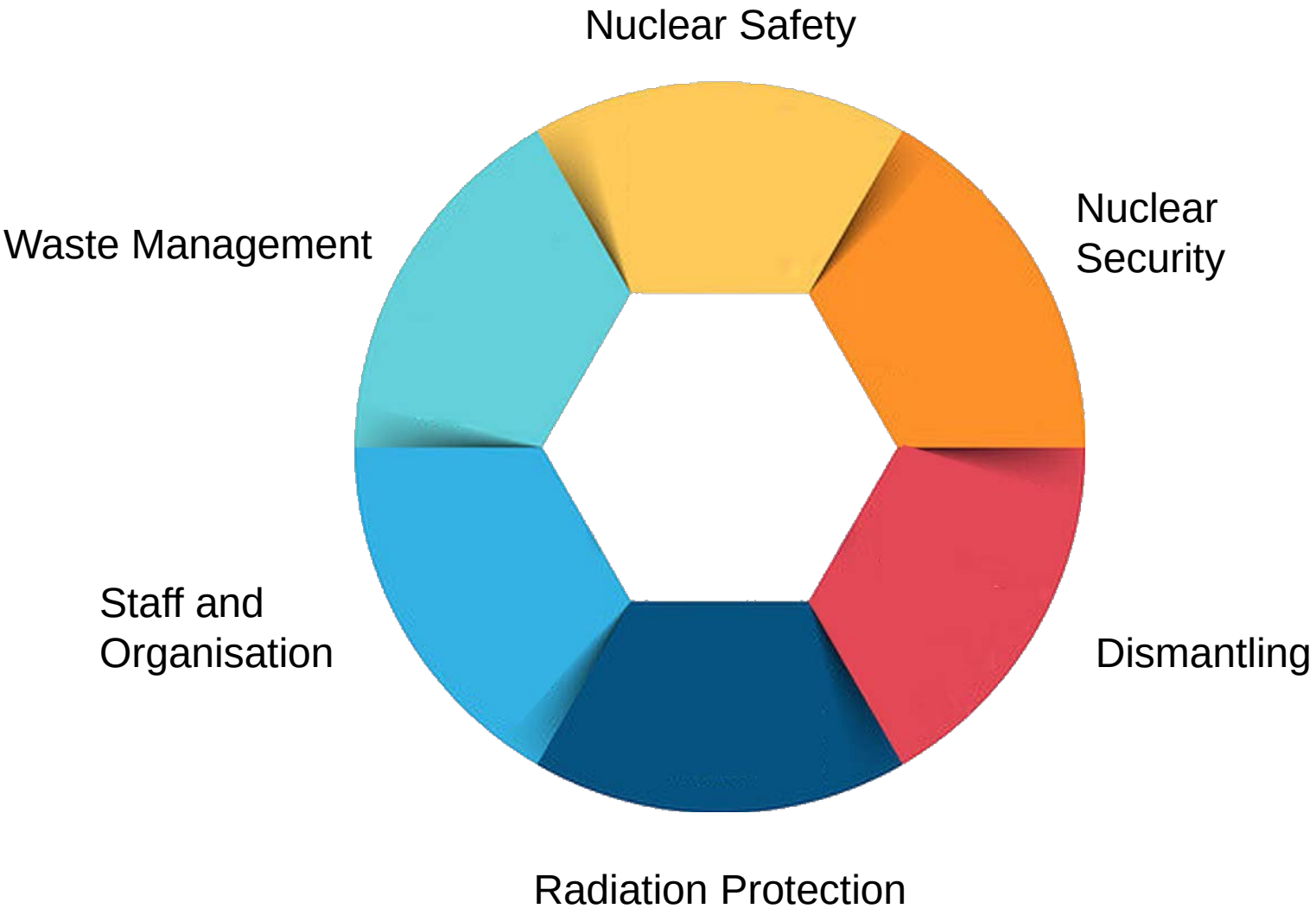
A: Unload the reactor pressure vessel (transfer of spent fuel to the spent fuel pool)
B: Installation of the **safety grade spent fuel pool cooling system**
C: Removal of mobile equipment in the reactor building at +29m
D: Removal of components in the turbine hall and Installation of the material treatment facilities

Requirements for phases

- **Preparatory Measures** need an approval. They can be carried out from the date of the final cease of operation under the existing operating license.

- **Decommissioning phases 1 to 3** need an approval. The documents to be submitted for the approval (phases 1 and 2) are based on chapter 5.5 of the guidance ENSI-G17.

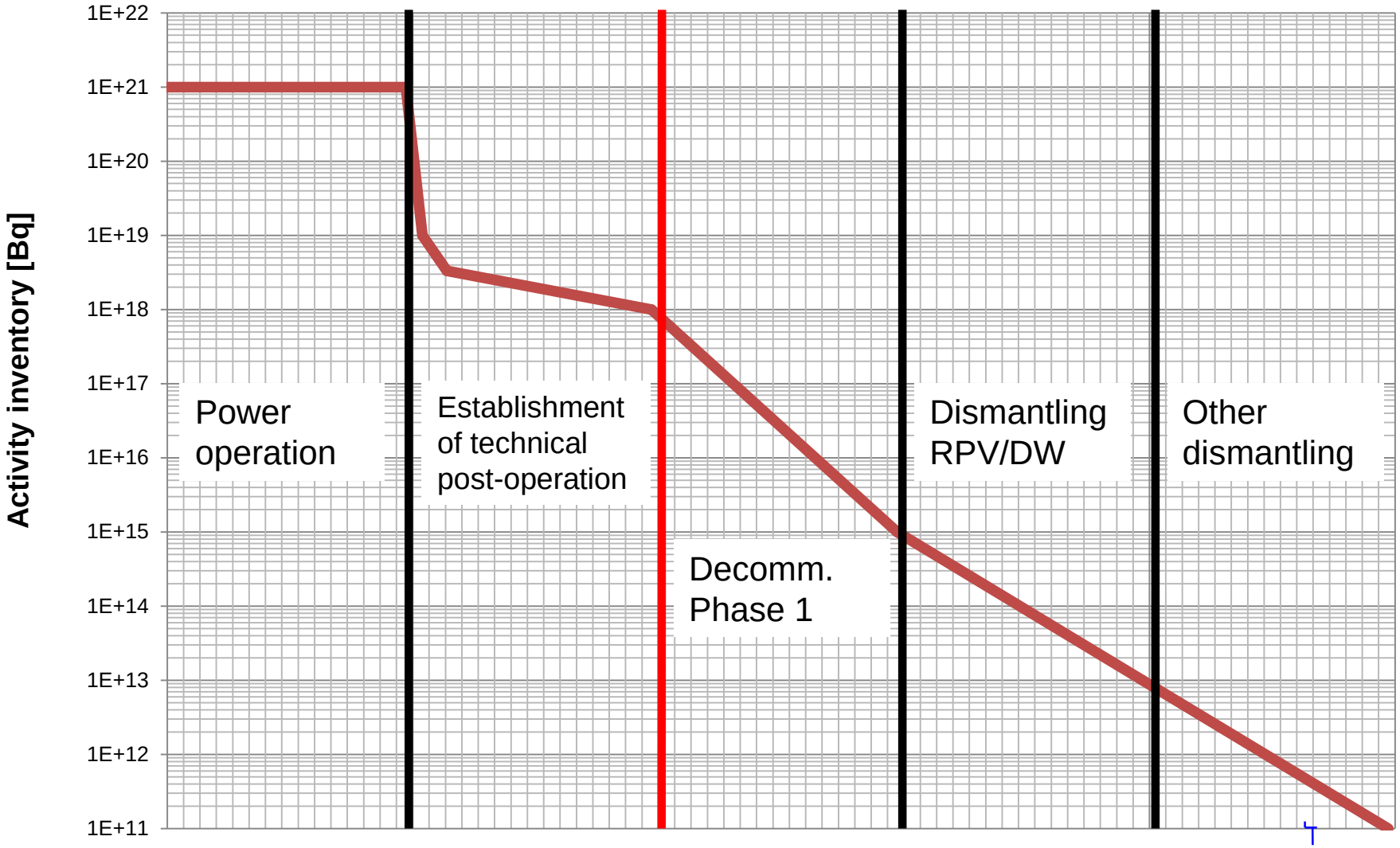
Inspection fields for the decommissioning



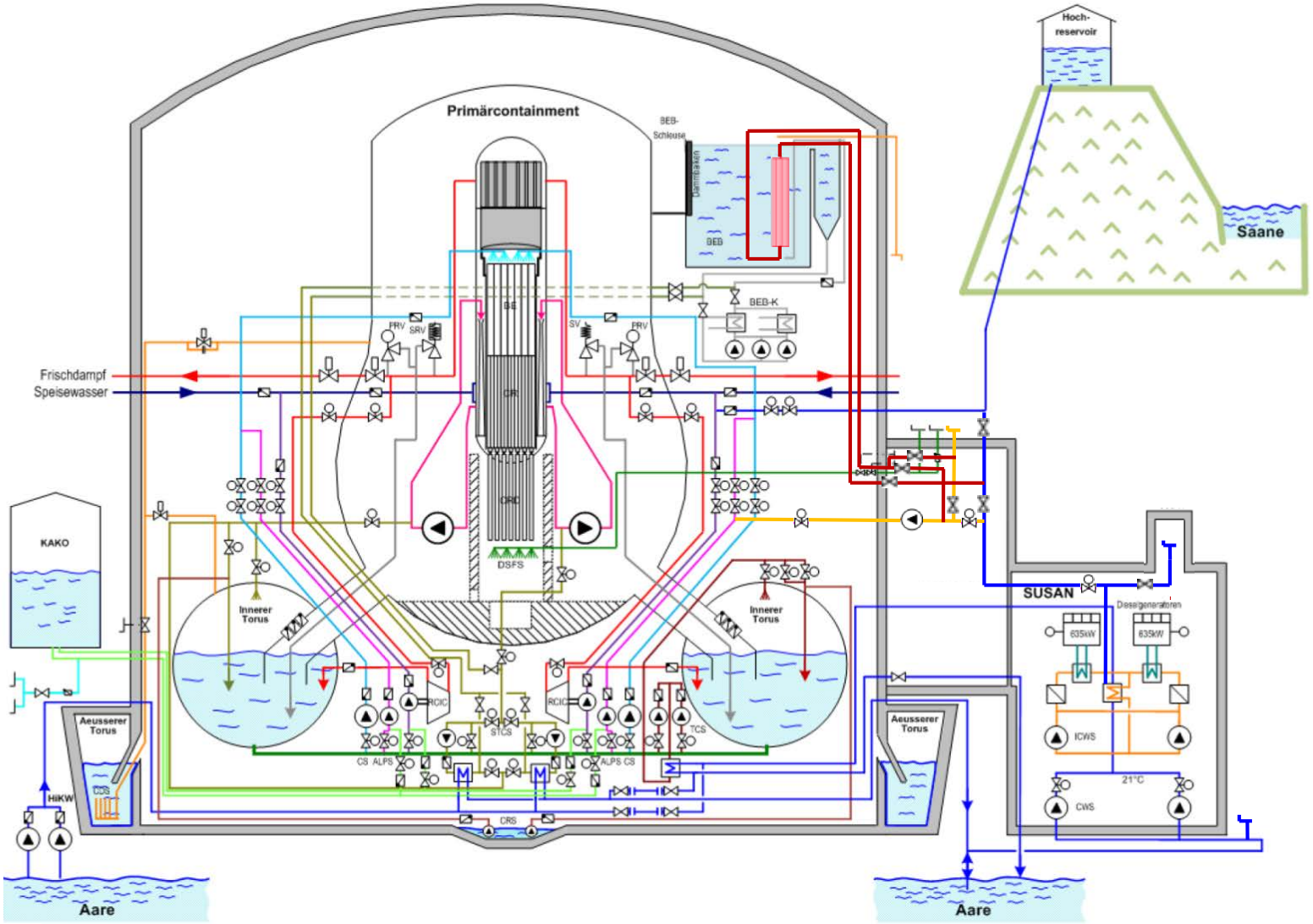
Nuclear Safety

- Compliance of protection goals
- Safety related systems & equipment
- Classification, Tech. Spez., maintenance
- Fire protection- & emergency exit concept
- Safety analysis
- Emergency management

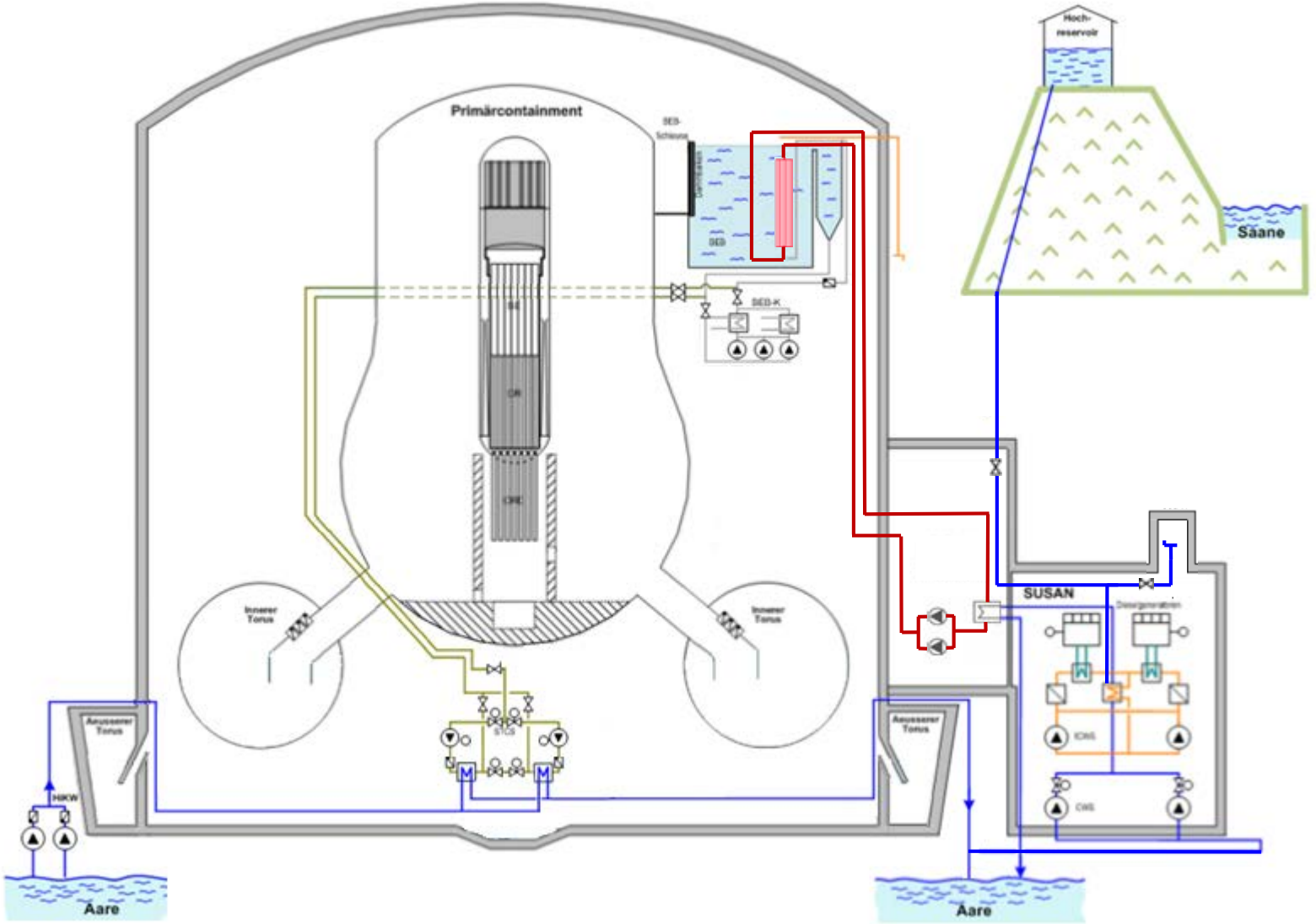
Hazard potential



Coolant systems in operation



Coolant systems in technical post-operation



Nuclear safety requirements

- Safety related Structurs, Systems and Components (SSC) necessary for post operation need a *Safety Classification*.
- *Safety Classified SSC* modifications need an approval.
- *Technical Specifications* need an approval.
- The *Maintenance Program* for safty classified SSC has to be submitted.
- Detailed *Safety Analyses* for phase 1 have to be submitted.
- *Emergency Regulations* need an approval for every phase.

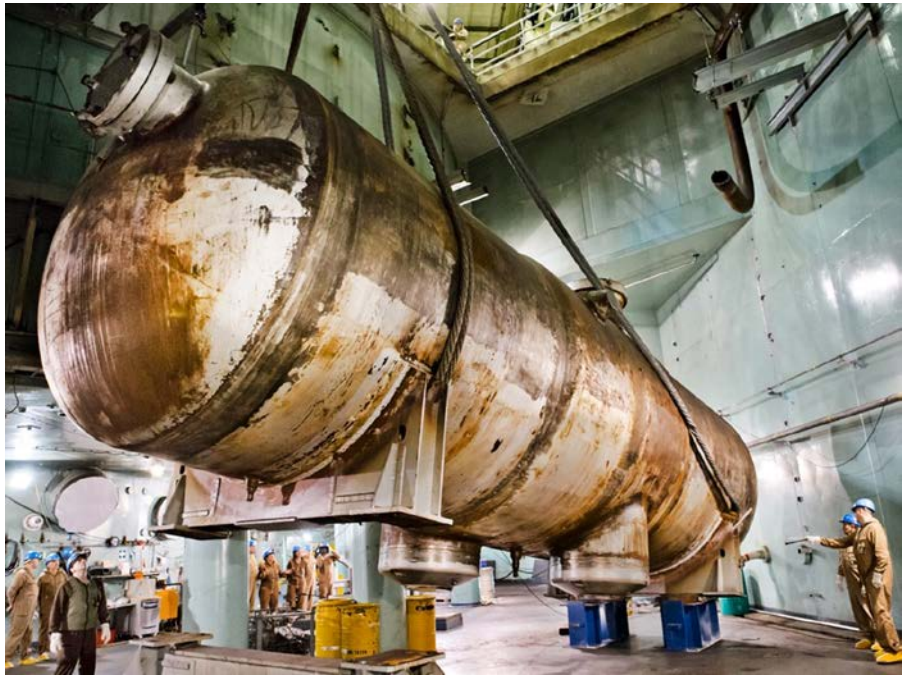
Nuclear Security

- Nuclear security concept
- Classification of security relevant informations
- Personnel requirement und organisation of the security guard
- Personell security check

Nuclear security requirements

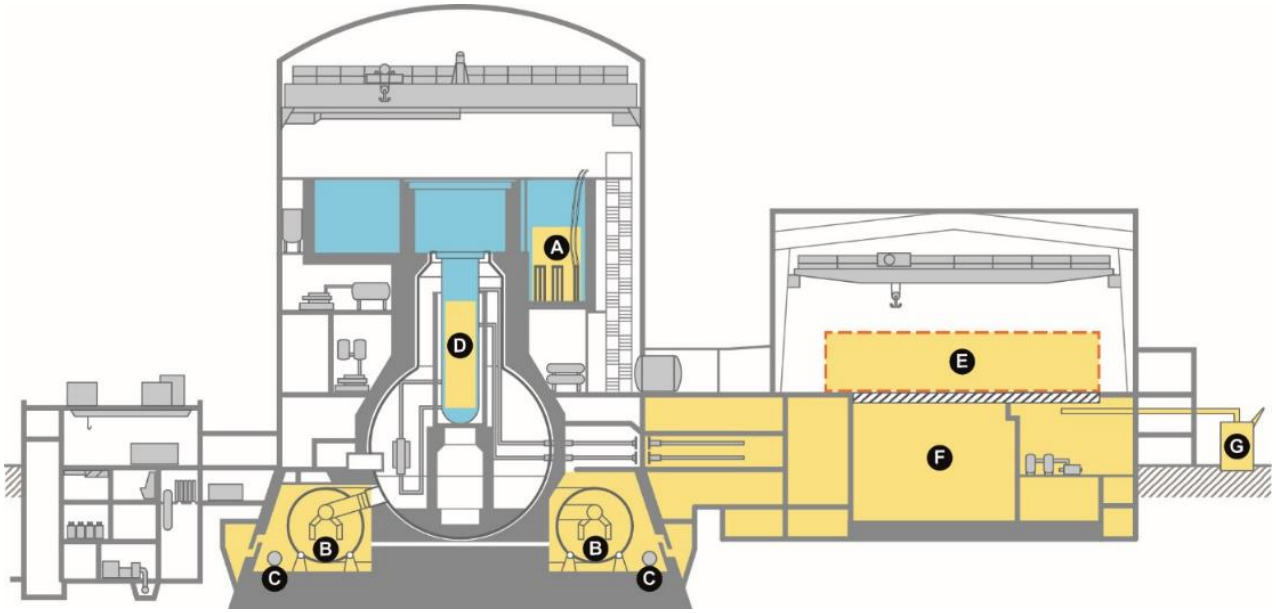
- Specifications for nuclear security need an approval.

Dismantling



- New Process «taking out of service» and «dismantling»
- Complex actions (dismantling Reactor Presure Vessel etc.)
- Retroactive effects of changes, taking out of service and dismantling
- Material treatment equipment (dismantling & decontamination)
- Conversion of buildings

Dismantling strategy phase 1



A **Removal of spent fuel from the site**

B Disassembly of the torus incl. linked systems

C Disassembly of emergency core cooling system / systems for decay heat removal

D **Disassembly of reactor internals**

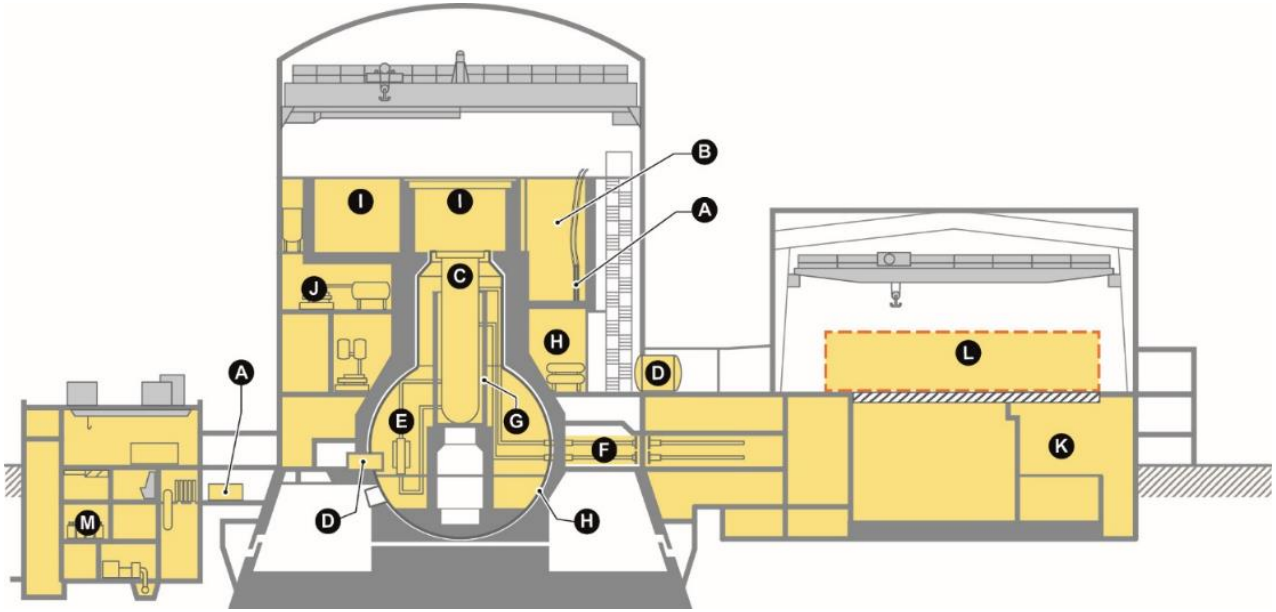
E **Installation of material treatment equipment**

F Disassembly of remaining systems and initiation of decontamination of facilities and buildings

G Disassembly of block transformer A1

Source: BKW

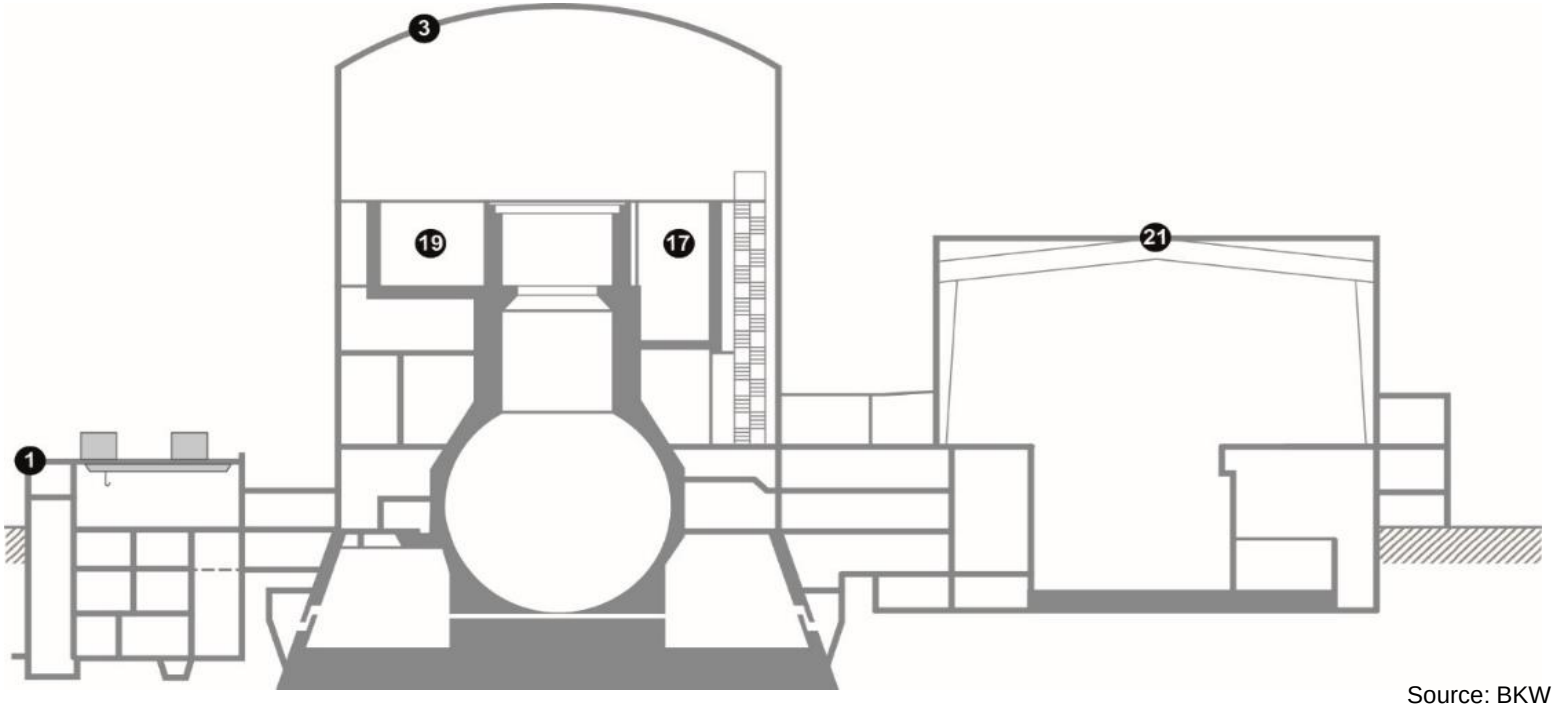
Dismantling strategy phase 2



Source: BKW

A Disassembly of **spent fuel pool cooling systems**
B Disassembly of pool internals
C **Disassembly of reactor pressure vessel (RPV)**
D Removal of personnel and material airlocks
E Disassembly of **drywell components**
F Disassembly of steam pipes and feed water pipes
G Disassembly of upper part of the biological shield
H Disassembly of **drywell steel liner**
I Disassembly of steam dryer and moisture separator storage pool liner and RPV cavity
J Disassembly of all remaining systems, e.g. reactor water clean up system
K **Decontamination of facilities and buildings**
L Operation of material treatment equipment
M Disassembly of systems in the SUSAN-building

Final state after nuclear dismantling



Source: BKW

1 SUSAN-building
3 Reactor building (Secondary containment)
17 Spent fuel pool
19 Steam dryer and moisture separator storage pool
21 Turbine hall

Dismantling requirements

Approvals are necessary for:

- Process *Taking out of Service*
- Process *Dismantling*
- Constructional measures to avoid retroactive effects on classified SSC
- Built-in material treatment and system decontamination equipment
- Demolition or conversion of buildings
- Dismantling of core internals, reactor pressure vessel, drywell and biological shield

Radiation Protection

- Radiation and incorporation protection, monitoring concept
- Monitoring of immissions of radioactive substances and of direct radiation
- Dose estimation of personnel
- Discharge of radioactive substances into the environment and **limits**
- Radiation exposure
- Radiation measuring technique

Radiation protection requirements

Modification of limits for radioactive discharges into the environment

	Power Operation		Deccommissioning phase 1		Deccommissioning phase 2	
	KAL	JAL	KAL	JAL	KAL	JAL
chimney air						
noble gas	2E14 Bq/d	2E15 Bq/a	4E11 Bq/d	4E12 Bq/a		
Iod-131	4E9 Bq/w	2E10 Bq/a				
aerosole	2E9 Bq/w	2E10 Bq/a	2E9 Bq/w	2E10 Bq/a	2E9 Bq/w	2E10 Bq/a
waste water						
Tritium	-	2E13 Bq/a	-	2E12 Bq/a	-	2E12 Bq/a
water	200 LE	4E11 Bq/a	-	4E10 Bq/a	-	4E10 Bq/a

Radiation protection requirements

- Target value for liquid radioactive discharge is 1 GBq/a (no Tritium)
- Monitoring of immissions of radioactive substances and of direct radiation are allowed according to the:

  Regulations for the discharge of radioactive substances and the monitoring of radioactivity and of direct radiation.

Staff and organisation

- Organisation and resposibilities
- Personnel resources & qualification
- Safety culture
- Quality management
- Documentation

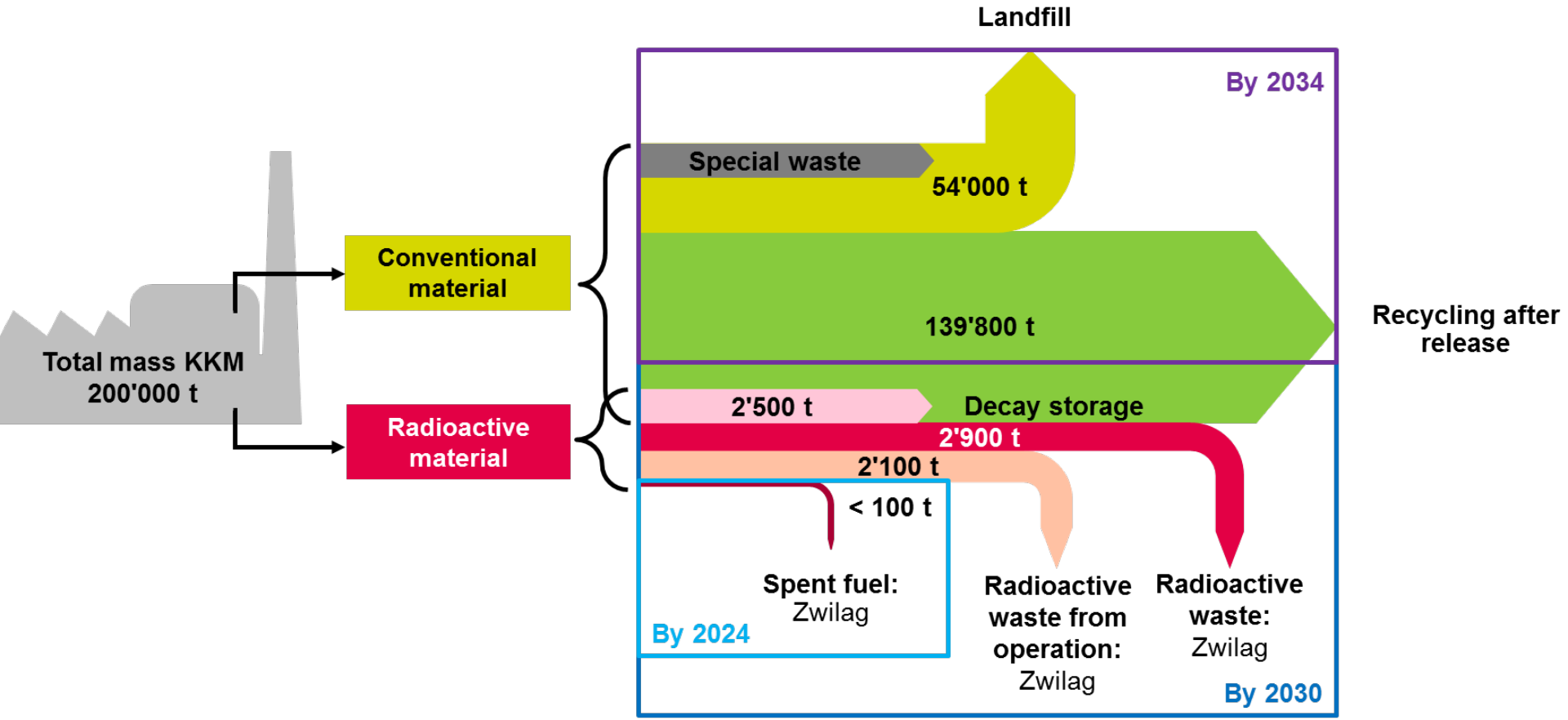
Staff and organisation requirements

- *Organisation and responsabilities* have to be arraged in a way that the safe execution and control of decommissioning is guaranteed.
- *Site Regulations* needs an approval.
- The *Concept for Personnel Training and Education* needs an approval.
- The superior *Program for Human and Organizational Factors* has to be submited.

Waste management

- Masses and flow of material
- Seperation and assignement of radioactive waste
- Intern und extern transport-logistics
- Clearence measurement of material and areas
- Decay storage

Flow dismantled materials



Source: BKW

Decay storage

The legal specifications for decay storages are under modification.

➡ **No subject of the ENSI decommissioning report**

The applications for planed decay storages have to be submitted to the responsible authority.

The measurement procedure (for the decision if materials underly decay storaging) needs an approval.

Waste management requirements

- The procedure for the «clearence measurement» of materials needs an approval.
- The assignment of the expected quantities of waste to the types of casks has to be provided.
- The conditioning treatment of radioactive waste needs an approval.

Conclusions

- Legal framework for decommissioning is up-to-date
- Experience in decommissioning from several decommissioning projects
- Decommissioning Project for NPP Mühleberg submitted in 12/2015
- The ENSI expert report with 35 requirements was finished in 08/2017
- Decommissioning order (licence) from DETEC is expected in 06/2018

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Eidgenössisches Nuklearsicherheitsinspektorat ENSI
Inspection fédérale de la sécurité nucléaire IFSN
Ispettorato federale della sicurezza nucleare IFSN
Swiss Federal Nuclear Safety Inspectorate ENSI

Thanks for your attention.