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TECHNICAL DOCUMENT

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Site Specific Decommissioning Cost Calculation for the Borssele NPP, October 2016



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Executive Summary

The present report describes the preliminary decommissioning plan (PDP) and the corresponding cost estimates for the Borssele NPP (Kerncentrale Borssele, KCB). It follows the decommissioning strategy "Immediate Dismantling" after final shutdown on 31th December 2033.

The Plant

KCB is operated by NV Elektriciteits-Produktiemaatschappij Zuid-Nederland (EPZ) in Vlissingen, the Netherlands. It is a pressurised water reactor (PWR) with a net electric capacity of 480 MWe. The plant was put into operation in 1973 (first criticality in June 1973, commercial start in October 1973).

History of PDP and Cost Estimates

Starting in 1994, EPZ has charged Siempelkamp NIS Ingenieurgesellschaft mbH (NIS) several times to elaborate a preliminary dismantling plan including the calculation of the related costs, see /1/ (1994), /2/ (2003), /3/ (2006) and /4/ (2010).

The 1994 and 2003 studies were made under the following main boundary conditions:

- final shutdown of the reactor on 31th December 2013
- deferred dismantling after 40 years of safe enclosure

In 2006 the boundary conditions were changed to:

- final shutdown of the reactor on 31th December 2033.
- immediate dismantling after final shutdown

In 2010 the day of final shut down and the immediate dismantling remained. Additionally a so called COVRA variant considering only COVRA and not KONRAD containers was performed.

In March 2015 EPZ charged NIS to carry out a new study on the decommissioning costs of the KCB based on the actual experiences gained during several real D&D projects worldwide. The present report considers several changes in the decommissioning strategy. The most important changes are:

- Dismantling RPV internals starts immediately after approving the decommissioning license. In the 2010's study at first the primary loop components are removed. So the status "free from water" can be realized earlier, which impacts advantages especially a reduction of operational measures.
- The scheduling of the dismantling steps considers the capacity of the waste management facility concerning treatment and interim storage.
- The removal of polychlorinated biphenyl (PCB) surface coatings including research program and waste disposal is considered.
- The period for releasing from controlled area constrains is adapted.
- Beside the turbine hall the removal of all other remaining buildings in the monitored area are included.





To reach the "green field" status the demolition of the piles in the ground is now included.

The present report contains following results:

- the type and quantity of the radioactive waste as well as the required waste packages
- the needed personnel per qualification and number (man-years)
- the cost in total and the cost incurred over the duration of the project, calculated in costs of 2015, and the net present value on 1st January 2015 and 1st January 2034
- the radiation exposure of the personnel
- the influence of variations in the packaging strategy

Masses to be handled

Table 0-1 below shows the total masses considered in the 2015 study in comparison to 2010. The data were reviewed and updated. The components of the controlled area now contain the equipment to be installed for decommissioning. Further component, equipment and building structure masses of all buildings of the monitored area are included. The 2010's study only considers the turbine hall and some other building of the monitored area. Additionally a number of estimated 5.000 piles are added to the building structure masses of the controlled area. Their removal is now considered.

Component Type	Mass [Mg]	Mass [Mg]
	2010	2015
Components Controlled Area	6.721	7.322
Operational media	2.032	2.032
Components Monitored Area	2.500	9.038
Building Structures Controlled Area	105.948	149.448
Building Structures Monitored Area	40.000	163.992
Total	157.201	331.832

Table 0-1: Masses 2010 and 2015 in comparison

An overview of the mass distribution is given in Figure 0-1.

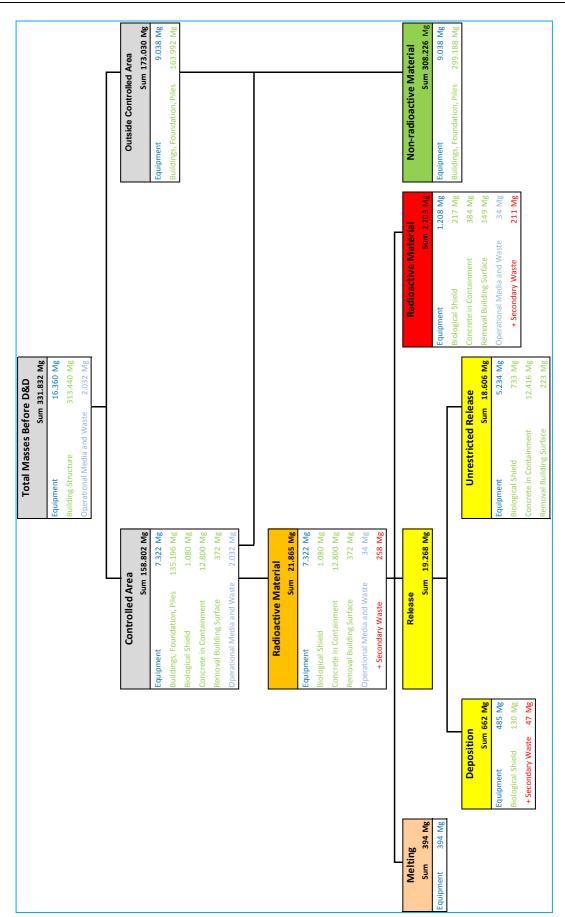


Figure 0-1: Mass Flow Overview

Waste Management

The review of the radiological evaluation of the decommissioning masses confirms that the 2010 chosen assumption concerning the selection and distribution to disposal routes as well as the selection of containers and packaging factors only needs little adjustments.

Based on actual experiences the planning of the dismantling sequences now considers capacities of waste management facilities to be installed onsite. Figure 0-2 shows the flow of the dismantled masses per annum.

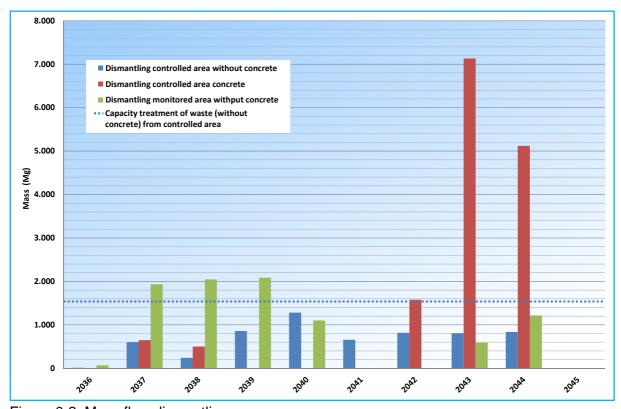


Figure 0-2: Mass flow dismantling

The number of required repository packages and the resulting repository volume shows Table 0-2 for the KONRAD as well as for the COVRA variant.

	KONRAI) Variant	COVRA Variant	
Kind of Waste Package	Number of Waste Packages	Repository Volume [m³]	Number of Waste Packages	Repository Volume [m³]
COVRA 090 l drum	6.763		8.984	
COVRA 200 I drum (solid waste)	2.210	537	9.862	2.397
COVRA 1000 I			864	848
COVRA 1000 I / 30mm Fe			288	283
COVRA 1000 I / 60mm Fe			152	149
Konrad II (NC)	325	1.502		
Konrad II (HC) 100mm Fe	20	91		
Konrad II (HC) 030mm Fe	30	136		
MOSAIK Type II (Type A)	114	151	94	124
MOSAIK Type II / 060mm Fe	42	55	42	56
Totals		2.473		3.857

Table 0-2: Number of required repository packages and volumes

 $\frac{Cost\ Estimate}{Table\ 0-3:\ shows\ the\ results\ of\ Borssele\ \ NPP\ decommissioning\ study\ 2015.}$

Wine	Costs [M	i o€ 2015]
WBS	KONRAD	COVRA
01 PRE-DECOMMISSIONING ACTIONS		
02 PREPARATORY WORK		
03 OPERATIONAL WASTE		
04 DISMANTLING OUTSIDE CONTROLLED AREA		
05 DISMANTLING CONTAMINATED MATERIAL		
06 DISMANTLING PRIMARY LOOP COMPONENTS		
07 DISMANTLING RPV INTERNALS		
08 DISMANTLING RPV		
09 DISMANTLING BIOLOGICAL SHIELD		
10 DISMANTLING REMAINING SYSTEMS		
11 CLEARANCE OF BUILDING STRUCTURES		
12 CONVENTIONEL DEMOLITION AND SITE RESTORATION		
13 PROJECT MANAGEMENT, ENGINEERING AND SITE SUPPORT		
14 SITE SECURITY, SURVEILLANCE AND MAINTENANCE		
15 WASTE PROCESSING, STORAGE AND DISPOSAL		
Total		

Table 0-3: Results of Cost Calculations 2015

Regarding the KONRAD variant the total costs increase about representing a rate about . This increase comprises on the one hand of the following price updates:

- caused by increase of container prices
- caused by increase of COVRA prices

On the other hand the consideration of additional tasks, new evaluations of decommissioning efforts and the improvement of the decommissioning strategy cause changes comprising following items:

- consideration dismantling and removal of components and equipment in every building of the monitored area
- adaption decontamination and clearance efforts
- adaption conventional demolition efforts
- consideration all buildings of the monitored area for demolition
- consideration removal of the piles including the needed trench support
- consideration conventional removal and disposal especially of toxic materials (PCB)
- adaption of efforts for multiple tasks

Primary caused by an earlier finalisation of the dismantling of the RPV the operational costs including site security, maintenance, project management, engineering and site support are nearly lower than in the 2010's study.

The costs of the COVRA variant are lower than the costs of the KONRAD variant. The COVRA variant considers more dismantling efforts. This extends the project duration for 6 months. On the one hand the more extensive dismantling and cutting efforts additionally causing a project prolongation and an increase the costs at about On the other hand the selection of containers respecting the boundary conditions of the COVRA variant brings an

Beside the containers and COVRA costs the above mentioned reasons apply to the changes regarding the COVRA variant. In sum the COVRA variant increases with an amount of nearly comparing to 2010.

Personnel requirements

Figure 0-3 shows the required personnel per year for the KONRAD variant and Figure 0-4 for the COVRA variant.

Regarding the KONRAD variant the personnel requirements decrease at 110,8 Man-years. The considering of additional tasks as the dismantling und demolition of the complete monitored area or the more extensive clearance efforts increase the requirement for personnel. Due to the earlier finalisation of the RPV also the operational personnel requirements decrease because of the shorter duration of this period. But mostly the improvement of the waste management strategy respecting dismantling mass flows, capacity and waste amounts effects the decreasing of personnel efforts in general.

Also the personnel requirements of the actual COVRA variant are reduced. Because of the more extensive efforts especially for cutting the improvement of the waste management strategy leads to higher savings. In sum the reduction is about 226,8 Man-years.



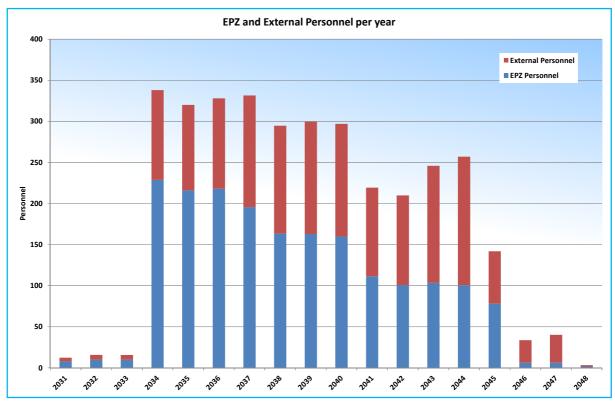


Figure 0-3: Required personnel – KONRAD variant

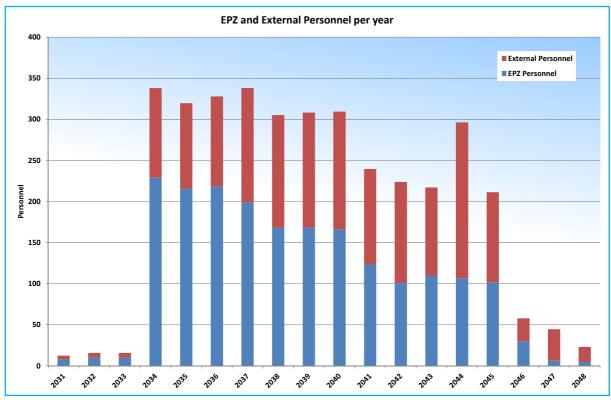


Figure 0-4: Required personnel – COVRA variant



Final Statement

In 2015 the total decommissioning costs were estimated to (KONRAD Variant) and (COVRA Variant). In comparison to 2010 this represents an increase of , respectively in the past 5 years.

The risks and probabilities that were considered indicate that there is a remaining risk of with a 30% probability.

The present study represents the state of the art and it is a good basis for the calculation of the provisions for the dismantling of the Borssele NPP. NIS recommends revising the study periodically to consider new boundary conditions and new experiences from real D&D projects.

Table 0-4 gives an overview of the main results for both variants.

Mariana	T-t-LCt-		Net present value		No HOLLIN	Total Work	Col.Dose	
Variant	Total Costs	ir [% p.a.]	Ref. Date	Costs	Ref. Date	Costs	[Man-Years]	[mSv]
KONRAD		,	01.01.2015		01.01.2034		10 1 b	MANUE .
COVRA			01.01.2015		01.01.2034		10,1.0	

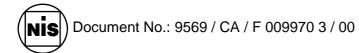
Table 0-4: Overview of the main results



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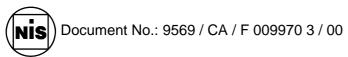
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Abbreviations

ALARA As low as reasonably achievable

Bkse Besluit kerninstallaties, splijtstoffen en ertsen BsK Besluit stralenbescherming Kernenergiewet

CORA Component registration and analysis
COVRA Centrale organisatie voor radioactief afval

D&D Decommissioning and dismantling

DP Dismantling phase

EPZ NV Elektriciteits-Produktiemaatschappij Zuid-Nederland

ICC Isolate, check, control KCB Kerncentrale Borssele Kew Kernenergiewet

MCA Maximum credible accident NAP Normaal Amsterdams Peil

NIS Siempelkamp NIS Ingenieurgesellschaft mbH

NPP Nuclear power plant PCB Polychlorinated biphenyl

PDP Preliminary decommissioning plan

POP Post operation phase
PWR Pressurised water reactor

Rboni Regeling buitengebruikstelling en ontmanteling nucleaire inrichtingen

QA Quality assurance

RPV Reactor pressure vessel WAS Water abrasive suspension



1 Introduction

The Borssele NPP, a pressurised water reactor (PWR) with a net electric capacity of 480 MWe, is operated by NV Elektriciteits-Produktiemaatschappij Zuid-Nederland (EPZ) in Vlissingen, the Netherlands. The plant was put into commercial operation in October 1973 and modernised in the 1990th. The Borssele NPP will be in operation up to at least 2033 based on a decision of the Dutch government.

1.1 Legal background

The Dutch atomic energy law (in Dutch: Kernenergiewet (Kew)) is the most important law concerning radiation protection and nuclear safety in the Netherlands. The Kew is drawn up as a result of the Euratom Treaty of 1957. The amended Kew with respect to the liability for the licensee to have financial security for dismantling based on a dismantling plan (article 15) will come into force from 1st April 2011. Several statutory regulations and 'AmvBs' (in Dutch: Algemene maatregelen van Bestuur), which are denoted as resolutions outline which regulations apply in practice.

For dismantling the 'Besluit kerninstallaties, splijtstoffen en ertsen' (Bkse) is most important. Article 10 Bkse describes which information needs to be supplied during application for a closedown/dismantling license. Article 25 Bkse obliges the licensee to have a dismantling plan during the three 'life stages' of the nuclear installation (foundation, operation & dismantling). The Bkse stipulates immediate dismantling after closedown and 'green field' as end state as two important conditions (article 30 and 30a). Furthermore the dismantling plan has to include (article 26 Bkse):

- The period in which closedown and dismantling take place;
- The planning for closedown and dismantling, distinguishing different phases for closedown and dismantling;
- The amount and activity of nuclear fuel and radioactive waste present at the institute during the different stages of closedown and dismantling;
- The number of people involved in dismantling, their expertise and the assignment of tasks;
- The techniques applied during closedown and dismantling;
- The relevant environmental aspects especially concerning waste management.

Every five years the dismantling plan needs to be updated (article 29 Bkse).

The dismantling plan serves as basis to provide for financial security for dismantling (article 44a Bkse). The financial security should cover the costs for closedown and dismantling as described in the dismantling plan. The dismantling costs should give insight into the several cost items and have to be calculated using a generally accepted cost calculation method based on the price level of the year of application for approval.

Also the law of conservation of the environment (in Dutch: Wet mileubeheer, Wm) and the administrative law (in Dutch: Algemene wet bestuursrecht, Awb) are of importance. The Kew and the accompanying resolutions state which articles of the Wm and Awb apply. In most cases it concerns public procedures that have to be followed during application for a license or alteration of a license.



Law	Article	aspect	Reference in report	
Bkse	§26, 1a	Decommissioning period	Chapter 9.5.1, Annex B	
	§26, 1b	POP and DP	Chapter 4.1	
	§26, 1c	Amount of radioactive waste	Figures 7-1, 7-2, Table 7-6	
	§26, 1d	Required personnel	Chapters 3, 9.5.3	
	§26, 1e	Decommissioning techniques	Chapter 6	
	§26, 1f	Radioactive waste	Chapter 7.4	
	§29, 1	Actualisation	Chapter 4, 6, 8	
Rboni	§3, 1a	Decription of activity and radionuclides	Chapter 2.3.2	
	§3, 1b	Inventory and categorization	Chapter 2.3.1	
	§3, 1c	Waste removal	Chapters 7.2.3, 7.4	
	§3, 1d	Clearance measurement techniques	Chapter 6.3	
	§3, 1e	Conservation of knowledge	Chapter 8.3.1	
	§3, 1f	Safety and Security	Chapter 5	
Bkse	§30, 1	Immediate dismantling	Chapter 4	
	§30, 3	Completion as fast as possible	Chapter 4, Fig. 4-2	
	§30a, 1	Unrestricted use after decommissioning	Chapters 4.9, 4.10	

Table 1-1: Relation between articles of the law and the report

1.2 Overview of the report

Since 1994 NIS performed several studies for the decommissioning of the Borssele NPP, last in 2010. The objective of the present study is to provide an updated cost calculation for the complete D&D project. All decommissioning actions between the final shut down and the green field status immediately after the final shut down and after the post operational phase are covered including preparatory work during operations. Beside costing aspects the update covers time scheduling, staff capacity, radiation exposure and dismantling as well as waste masses.

In a first step NIS verified all boundary conditions and assumptions needed for the new cost calculation. Assumptions already used for the 2010's study were also been taken into account. This verification implies an analysis of actual boundary conditions, a comparison with gained experiences of actual real D&D projects in progress and an evaluation especially concerning cost impacts.

After implementing the verified and defined boundary conditions the decommissioning strategy was adapted regarding preparation and planning tasks of actual D&D projects.

Finally the calculations were performed to deliver updated results. These results include a new time schedule and updates of costs, required staff and radiation exposure.

As in the 2010's study two variants, the KONRAD and the COVRA variant are considered. They differ in the approaches for the packaging concept, which is part of the waste management strategy. The decommissioning strategy and the used techniques are equally taken into account for both variants.

The present report describes the local conditions, the organisation, the strategy and techniques of the D&D project as well as the planning and execution. Finally the results of the present study are described including comparisons to the 2010's estimations.



2 The Borssele NPP

2.1 General description

The Borssele NPP, a pressurised water reactor (PWR) with a net electric capacity of 480 MWe, is operated by NV Elektriciteits-Produktiemaatschappij Zuid-Nederland (EPZ) in Vlissingen, the Netherlands. The plant was put into commercial operation in October 1973 and modernised in the 1990th. The Borssele NPP will be in operation up to at least 2033 based on a decision of the Dutch government.

The plant is located at 1.4 km north-west of the community of Borssele and 10 km east of the town of Vlissingen, directly behind the new Westerschelde sea dike, near Sloe-haven (the harbour area east of Vlissingen).

The nuclear site houses the buildings shown in Figure 2-1, whereby the reactor building with annulus and the reactor auxiliary building are considered as buildings of the nuclear controlled area.

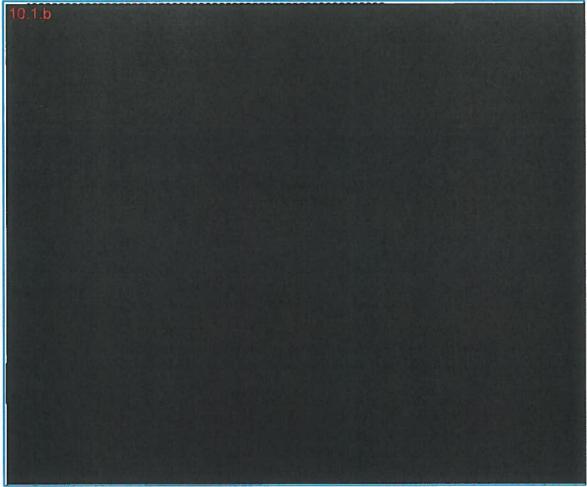


Figure 2-1: Buildings of the Borssele NPP

2.2 Buildings within the controlled area

2.2.1 Reactor building

The reactor building shown in Figure 2-2 consists of a cylindrical body of 50 m diameter with a hemispherical roof. Apart from the 60 m high exhaust air chimney, the reactor building is the highest of all nuclear plant buildings.

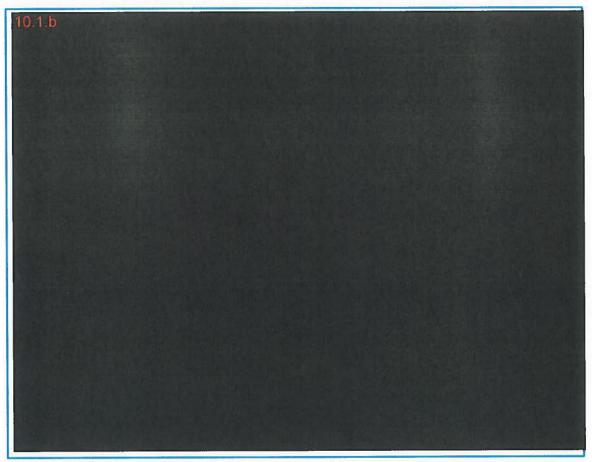


Figure 2-2: Reactor building

The internals of the reactor building are enclosed by two containment shells, one inner gastight, spherical steel shell and one outer reinforced concrete shell. Both containment shells are placed on a reinforced concrete foundation slab.

The reactor building and its protection facilities are designed such that the population in the surroundings of the nuclear power plant will not be affected by any unacceptable radiation exposure, even in case of a most unlikely break of the reactor coolant pipe (this is the so-called MCA – maximum credible accident).

The space between the lower part of the steel shell and the concrete shell – the so-called annulus – is accessible. The steel shell and the outer concrete shell are accessible on both sides for the most part during operation. If the pressure in the reactor building rises above the atmospheric pressure, the annulus will be charged with a low pressure vs. the environment to prevent leakages into the environment beyond control.

The most important components in the reactor building are the reactor pressure vessel (RPV), the steam generators, the reactor coolant pumps, the pressuriser and the pressuriser

relief tank. They are placed in the reactor cavity or around the biological shield. The reactor coolant pumps and the steam generators are connected with the RPV through short thick-walled pipes. To compensate for thermal expansion they are suspended flexibly from the intermediate ceiling.

The fuel pool is directly adjacent to the reactor compartment and separated from this by a gate. During refuelling, the fuel assemblies can be carried from the RPV into the fuel pool and vice-versa via one single transport procedure of the fuel handling crane.

The reactor building is supported by massive reinforced concrete foundation slabs on piles and it is built up by a massive reinforced concrete construction. The thickness of the walls, ceilings and other construction parts has partially been determined for shielding reasons.

The lower part of the reactor building is carefully insulated against ground water and flood. The insulation prevents from uncontrolled escape of radioactivity in the underground and/or the penetration of groundwater and flood into the buildings.

2.2.2 Reactor auxiliary building

The auxiliary building, shown in Figure 2-3, contains several auxiliary systems for the reactor operation, i.e. supply air, exhaust air and air conditioning in the entire hot areas, the evaporating system, decontamination rooms and the hot workshop. Besides, there are the boricacid mixing system, the chemical proportioning, the filter installation and the volume control tank. Liquid waste hold-up and sedimentation tanks as well as the intermediate cooling pumps and heat exchangers, the boric-acid pumps and tanks, the chemical store, the barrel press, the radioactive solid waste treatment equipment, the waste vault and the material lock are also situated there. From 5,50 m +NAP to the roof there are four big refuelling water storage tanks with borated water.

The reactor auxiliary building is the access to the controlled area and contains also the hygienic area for all staff entering or leaving the controlled area. The hygienic area includes changing rooms, shower and washing facilities, the laundry, and monitors for the radiation monitoring. Furthermore there are the first aid service, laboratories, radiation measuring rooms and offices for the staff in the controlled area. The personnel airlock leads from the auxiliary building to the reactor building.

Two main steam pipes go across the roof of the reactor auxiliary building to the turbine hall. These pipes as well as the safety valves and the relief valves are under a steel frame super-structure with a light casing that covers everything but the silencers.

The reactor auxiliary building is supported by massive reinforced concrete foundation slabs on piles and it is built up by a massive reinforced concrete construction. The thickness of the walls, ceilings and other construction parts has partially been determined for shielding reasons. The building was finished with two cross expansion joints and it has got a special press water proof insulation.

Most rooms of the controlled area can be separated airtight from the environment. They can be ventilated through a supply air and exhaust air system. The ventilation stack is on top of the reactor auxiliary building directly adjacent to the secondary shielding of the reactor building. It is made of reinforced concrete. The exhaust air is led from the reactor auxiliary building into the stack through steel sheet ducts.



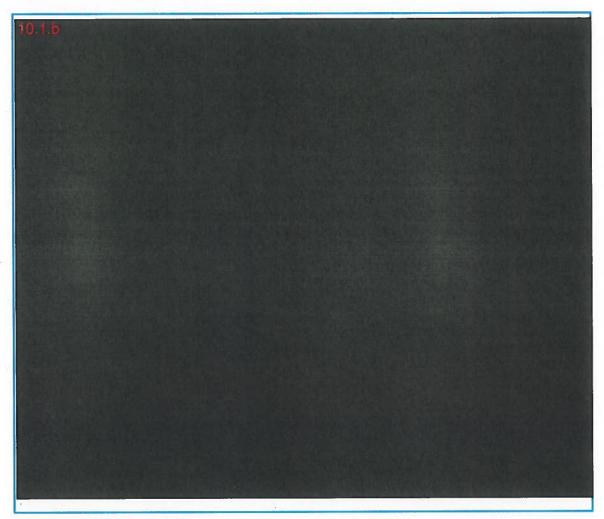


Figure 2-3: Auxiliary building

2.3 Inventory specification

2.3.1 Technical inventory

For the determination of the decommissioning costs it is important to know the quantities and masses of the inventory to be dismantled. For that purpose the dismantling masses are classified as:

Primary masses

Primary masses are the complete inventory of the plant at the time of the final shut down, i.e. buildings, structures, constructions, systems and components but also remaining operational waste, tools and equipment from the operation. The nuclear fuel elements are not considered to the primary masses. Moreover the so called additional masses are included in the primary masses in this study. These masses are a group of material generated during the D&D project by the use of special machines, tools, and other equipment. Opposite to the secondary masses the additional masses are not completely radioactive waste and most of it can be reused after the finalisation of the D&D project.





Secondary masses

Additional radioactive waste will be generated during the dismantling process, i.e. protective clothes, gloves, residuals from decontamination, clothes, cleaning agents, foils, water from hygienic area, and other consumable materials. These materials are the so called secondary masses.

The primary mass data of the Borssele NPP were determined and collected during the earlier cost calculation studies 1994 to 2010 and stored in the NIS database program CORA within a list of about 10.000 data records. For the 2015 study components, equipment and building masses of all building of the monitored area were added as the 2010's study only considered the turbine hall and some other buildings in the monitored area. Furthermore a number of estimated 5.000 piles in the ground which have to be removed to realize the "green field" status are now included.

The data stored in CORA carry information about the location (building, room), material, geometry, type of component, as well as additional information about the specification of the components.

Figure 2-4 shows the primary masses per site area. The total mass of components and equipment in the controlled area has increased as it now contains 600 Mg equipment representing machines, tools etc., which will be placed for decommissioning measures. Also the amount of building structures in the controlled area has increased as the removal of the piles in the ground is now taken into account. The total masses in the monitored area strongly raised, as the study in 2010 only took the turbine hall into account.

Table 2-1 gives an overview which buildings including their masses are now considered. Table 2-2 shows the primary masses per component type and Table 2-3 per material group.



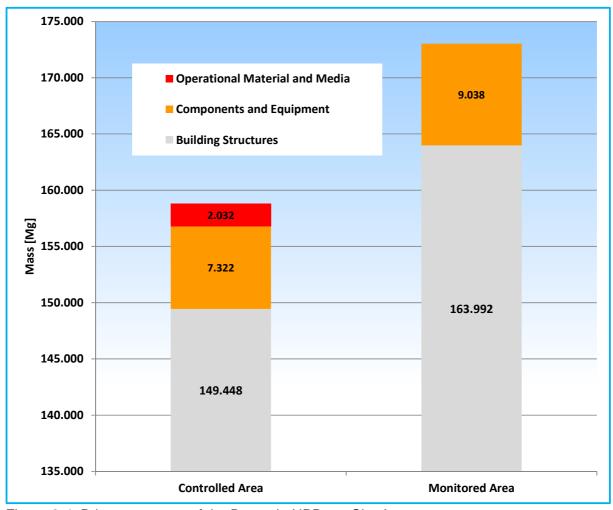


Figure 2-4: Primary masses of the Borssele NPP per Site Area

		Components	Building
Buildi	ng	[Mg]	structure [Mg]
	Controlled area	7.322	149.448
1/2	Reactor building, containment / annulus	4.238	113.829
3/13	Reactor auxiliary building / Ventilation duct	3.084	35.619
,	Operational media	2.032	0
	Monitored area	9.038	163.992
4	Turbine hall	2.500	40.000
5	Switchboard plant	990	21.090
6	·	100	1.500
7/71	Operation building	590	
	Workshop / Training building Office	320	10.150 4.380
9	Demineralised water supply building	225	4.380
10	Emergency Diesel building	550	5.450
	Machine transformer foundation	0	1.040
14	Guards building	10	1.040
15	Office building	12	2.700
16/48	Fire brigade garage and workshop BO	6	1.000
26	Gas bottles store	22	800
30	Dogs kennel	7	900
31	Lift building	13	450
32	Canteen / Office building	10	3.190
33	Spare supply building	270	3.870
34	Waste store	12	9.050
35	Spare control room building	30	500
40	10kV-building	44	1.400
42	Hydrazine store	4	250
47	Maintenance store	12	2.065
67	Washing and changing room	4	1.490
70	Oil store	2	122
72	Emergency Diesel building II	270	5.450
-	Cooling water canals	3.035	41.735
	incl. Intake and outtake buildings		
	Total	18.392	313.440

Table 2-1: Primary masses per building

Component Type	Mass [Mg]			
Components and Equipment Controlled Area	7.322			
Valve	546			
Vessel	726			
Heat Exchanger	706			
Pump	388			
Pipe	447			
Lifting device	190			
Ventilation stack	152			
Sluices, airlock	75			
Cable	320			
Cable tray	140			
Motor	225			
Electrical component	58			
Insulation	355			
Storage rack	43			
Steel structures, Stairways, grill	877			
Shielding block	1.150			
Reactor and Internal	313			
Core Component	11			
Equipment*	600			
Operational media and waste Controlled Area	2.032			
Components and Equipment Monitored Area	9.038			
Building Structures Controlled Area	149.448			
Biological Shield	1.080			
Removed by Decontamination	372			
Concrete in Containment	12.800			
Building	64.273			
Foundation	27.423			
Piles	43.500			
Building Structures Monitored Area	163.992			
Total	331.832			
*machines, tools, etc., which will be placed for decommissioning measures				

Table 2-2: Primary masses per component type

Material Group	Mass [Mg]
Steel	13.724
Operational media	2.000
Concrete	304.522
Cables	320
Metal	140
Electric	57
Insultation	334
Insultation RPV	21
Machines	3.798
Motor	225
Ventilation	152
Mixed	6.538
Total	331.832

Table 2-3: Primary masses per material group

2.3.2 Radioactive inventory

The radioactive inventory of a NPP can be classified in three groups:

- activated components: RPV internals, RPV and biological shield
- components with inner contamination caused by contact with radioactive media
- components with outer contamination and building structures with contaminated inner surfaces caused by spreading of contamination, or by airborne radioactive particles and dust

Details on the radioactive inventory of the Borssele NPP are not available actually but the magnitude and the ranges can be defined by a rough estimation based on a radioactive analysis of other NPPs given in the literature /5/.

More than 99% of the radioactivity is concentrated within the spent fuel elements. This radioactivity will be removed and therefore won't be important for the D&D project.

The remaining radioactivity at the beginning of decommissioning and dismantling work is distributed in the categories mentioned above, whereby almost 100% is contained in the activated material of the RPV internals and the RPV.

The rest of the expected radioactivity is contained in the remaining contaminated components and building structures. It is distributed more or less on all systems, components, equipment and building structures.

Table 2-4 shows some expected main nuclides for the reactor building and some components determined in other Dutch projects.



Building /		Used for		Main nuclides	
Component		2)	3)	iviani nuciides	
Light concrete of biological shield		х		Co-60, Cs-137, Eu-152	
Heavy concrete of biological shield		х		Mn-54, Co-60, Zn-65, Ba-133, Cs-134, Eu-152	
Steel	х	х		Mn-54, Fe-55, Co-60, Ni-63	
Reactor Building	х		Х	Mn-54, Co-60	
Stainless Steel	х	х		Mn-54, Fe-55, Co-60, Ni-63	
Core Parts		х		Co-60, Sb-125	
1) contamination of components					
2) activation of components					
contamination of room surfaces					

Table 2-4: Expected main nuclides for some building / components

2.3.2.1 Radioactivity of the activated components

The estimate of the radiological inventory of the activated components was based on data from literature /5/.

Figure 2-5 shows as an example the averaged, maximum specific Co-60 and Eu-152 activities for several activated components, as a function of the radius (distance from the centre), 5 years after shutdown.

Figure 2-6 shows as an example the averaged, maximum specific Co-60 activity for reactor components, as a function of the axial height, 5 years after shutdown.

Such information was used to calculate the magnitudes of the activity of the RPV internals and the biological shield.

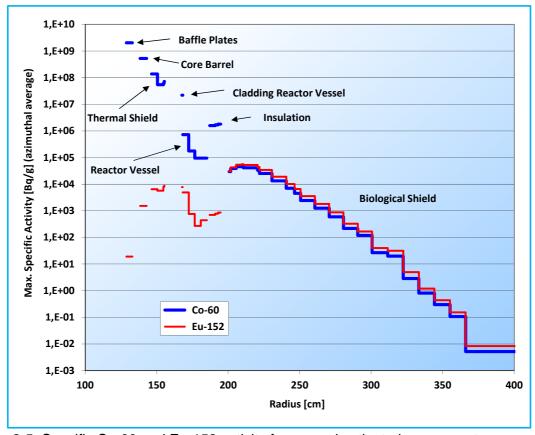


Figure 2-5: Specific Co-60 and Eu-152 activity for several activated components

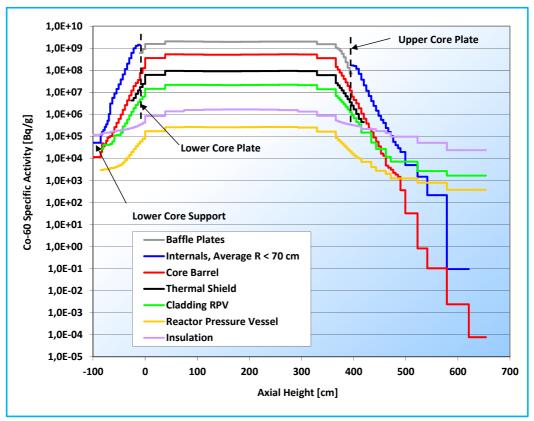


Figure 2-6: Specific Co-60 activity for reactor components

2.3.2.2 Radioactivity of the inner contamination

The radiological inventory in the systems and components at the date of plant shut down, which arose during the operational time by contact with radioactive media, cannot be calculated exactly but at least we can use some information from literature.

A possible nuclide composition was evaluated and provided by /5/ based on some operational experiences. For the decommissioning cost calculation of Borssele NPP were used:

- 60% Co-60
- 1% Sb-125
- 9% Cs-134
- 30% Cs-137

To verify this nuclide vector, effortful measurements would be necessary which is not possible in the frame of this report.

Finally, average values for the inner contamination can be defined based on some values for different NPPs. Figure 2-7 shows typical developments of the inner contamination of different systems.

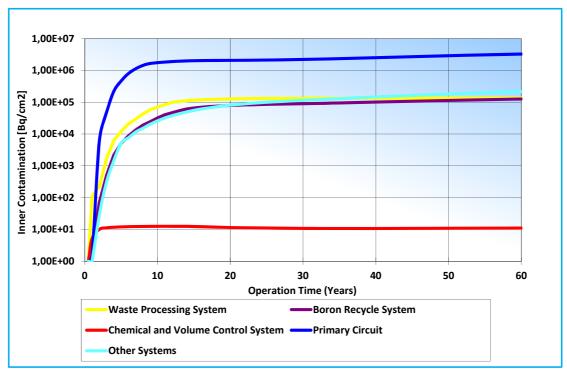


Figure 2-7: Development of inner contamination

2.3.2.3 Radioactivity of the outer contamination

Outer, mainly airborne contamination, is found

- on systems and components in the controlled area which were not in contact with radioactive media
- on steel girder construction
- on building surfaces (inside)

The level of this kind of contamination is usually rather low. Experiences were made in Germany in the NPP Gundremmingen A and in the "Versuchsatomkraftwerk Kahl". Most of the values obtained are in an area of some 10 Bq/cm² but below 100 Bq/cm². Only in special places, e.g. in building draining sumps, the contamination could be higher.

Based on these contamination values an average of 30 Bq/cm² will be used for the further calculation work (see also Figure 2-8).



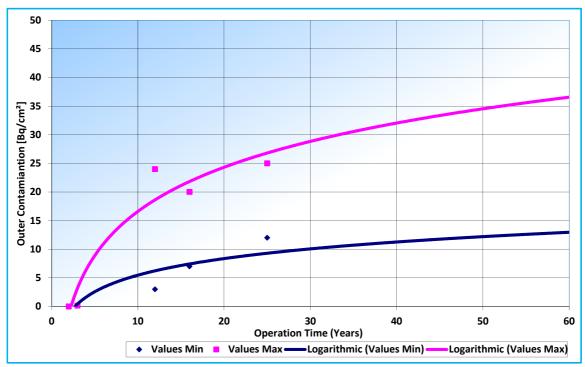


Figure 2-8: Development of outer contamination

2.3.2.4 Results for the radioactive inventory

The preceding paragraphs have given a general overview of the level of the radioactivity of activated and contaminated material in an NPP.

As no specific activation values for the inventory of the Borssele NPP are known, the masses of the D&D project are allocated to so called "Categories of Radioactivity" (see Table 2-5). With the help of these categories it is possible to decide, how every single component is treated in the course of dismantling and conditioning.

Category of Radioactivity	Mass [Mg]
Activated	669
High Contaminated	296
Medium Contaminated	2.560
Low Contaminated	6.065
Suspect for Contamination	13.793
incl. Operational media and waste	2.032
Not contaminated	4.070
Outside Nuclear	304.378
Total	331.832

Table 2-5: Primary masses per category of radioactivity

In comparison to the study in 2010 the value of activated and high contaminated masses are unchanged. The differences concerning medium and low contaminated as well as suspect for contaminated are caused by the raising masses for new equipment to be installed for decommissioning purposes. The category not contaminated now contains all equipment and components of the turbine hall. The increase of the masses assigned to the category outside nuclear is explains Table 2-1.



2.3.3 Toxic Non-radioactive Materials

The main toxic non-radioactive material is asbestos. When the Borssele NPP was built, asbestos was commonly used e. g. for gaskets, building construction elements, and fire protection applications. In the past an asbestos remediation campaign was performed and most of the original asbestos is already removed from the plant.

For the present study it was assumed that during the planning phase the asbestos inventory will be checked as a preparation for a new remediation campaign. This new campaign will start immediately after final reactor shutdown so as to provide asbestos-free conditions for the decommissioning work. There will be only a few spots left which will be marked as asbestos containing and which will be removed later in parallel to the decommissioning work.

In addition to the past study in 2010 the removal of PCB probably used as surface coatings is considered respecting the year of the plant's construction. PCB contaminated areas have to be identified in a registration program (cadastre) preferably before the start of dismantling. Then the removal and disposal of PCB is taken into account during the dismantling phase.

Generally, the hazardous materials are separated from the normal non-hazardous materials. If the material is contaminated, it is treated as radioactive material anyway, as the nuclear requirements are superior and therefore all the necessary standards are fulfilled. If the material is considered as non-radioactive, it is assumed that it is treated according to the Dutch legal requirements and disposed separately e.g. on an available landfill.

2.3.4 Remaining operational media and waste

Based on the information given by the operator, 2.032 m³ of operational media and waste is expected to be present when the decommissioning of the Borssele NPP starts.

The NIS software CORA which is used for the waste management calculations requires the input of the mass rather than the volume. Experiences from other NPPs show that the packaging density of such type of material is about 1 Mg/m³. Therefore the quantity of operational media and waste is input as 2.032 Mg.



3 Project organisation

3.1 Staff organisation

The staff organisation for the D&D project will be different from the operation staff. It is assumed in this report that the EPZ staff on site will lead the D&D project and that it will be supported by several contractors, depending on the individual tasks to be fulfilled. EPZ will take care of overall plant management, finance and administration, license issues, health physics, guarding (management), and the operation and maintenance of remaining systems. The new EPZ staff organization will be as shown in Figure 3-1.

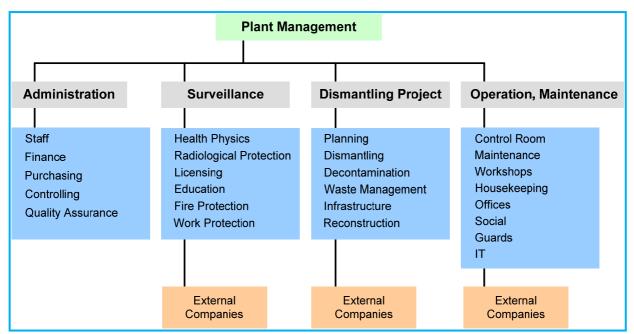


Figure 3-1: Personnel organisation for the decommissioning

Contractors are employed to support the EPZ staff whenever specific experiences are needed for the nuclear dismantling work and for the on-site waste management activities. Contractors will also stock up the EPZ staff for the operation of the remaining systems if the qualifications and number of EPZ staff needed for the Borssele decommissioning is not available.

3.2 Staff qualifications

In the Borssele NPP decommissioning cost calculation 7 different staff qualification are considered. Below the tasks and the work of the staff is described. Additionally it contains some examples explaining which qualification is required for special tasks during the decommissioning work.

Engineer 1 (Project manager)

He is an engineer with many years of work experience in project leading and management.

The plant manager and his assistant have to co-ordinate all de-commissioning activities and they are responsible for safety and cost-efficiency of the whole D&D project.

On-site managers are responsible for all technical and economic aspects of individual fields during the decommissioning of a NPP. The following on-site managers are assumed:





Operations/maintenance manager:

Tasks: Co-ordinating and supervising the decommissioning and providing the engineering services with procedures to carry out the decommissioning safely and cost-effectively

Health physics manager

Tasks: Co-ordinating and supervising the activities in the field of radiation protection, recommending and enforcing radiological safety policy, advising the other on-site managers on all safety matters concerning radiation protection, implementing the environmental survey and the emergency preparedness programmes

Security manager

Tasks: Co-ordinating and supervising of all measures of the occupational safety, recommending and enforcing industrial safety policy, surveying of the decommissioning with regard of safety aspects, furthermore responsible for site security during decommissioning and supervising the security personnel (guards) and providing liaison with offsite civil authorities

Quality assurance (QA) manager

Tasks: Responsible for preparing the quality assurance plan for decommissioning and implementing it in collaboration with the management personnel, supervising of a quality assurance unit, which maintains audit and job performance records

Engineer 2

Such engineers will execute the planning works and the licensing procedures; they will prepare routine and special reports, performing the radiation protection activities, and supervise the decommissioning. They will work as shift engineers.

For example, the following positions are occupied by engineers:

- industrial safety specialist
- planning/scheduling engineer
- radioactive shipping specialist
- chemistry supervisor
- quality assurance engineer
- health physics supervisor
- operations supervisor
- maintenance supervisor
- plant engineer
- licensing specialist

Accountant

Staff within this qualification works in the commercial department and is responsible for economic aspects (e.g. purchasing, contracts).



Technician, foreman

Staff within this qualification supports the on-site managers and the engineers to plan the assignment of labour on site, is responsible for ensuring compliance with radiation work procedures. This includes the directing of the measures concerning the monitoring all decommissioning activities. Technicians/foremen have to measure and record the on-the-job radiation dose information and operate the plant laboratory facilities including sampling and analysis. Furthermore these personnel direct the work crews in the performance of the different decommissioning tasks (crew leader). For example, the following positions are occupied:

- chemistry technician
- health physics technician
- health physics/ALARA planner
- nuclear records specialist
- crew leader of working groups

Craftsman

Craftsmen are personnel with an appropriate vocational training, e.g.: welders, electricians, locksmiths, shop men, craftsmen in the area of radiation protection.

Worker

Workers are staff without a special vocational training, supporting the craftsmen during dismantling work and the health physics during the radiation protection works, e.g.:

- supporting decontamination works
- execution of internal transports
- auxiliary services
- drafting specialist
- secretaries
- typists
- auxiliary services in the offices

Guard

Guards represent the site security staff.



4 Strategy for the D&D project Borssele

4.1 General

The main strategy for the D&D project Borssele is as in the past study the immediate dismantling after operation and the following decay period of the fuel elements. Opposite to the safe enclosure strategy operational staff is still available for decommissioning purposes offering detailed knowledge about the plant.

As in the 2010's study two variants, the KONRAD and the COVRA variant are considered. They differ in the approaches for the packaging concept, which is part of the waste management strategy. The decommissioning strategy is equally taken into account for both variants.

The most important adaption in the strategy is starting with the dismantling of the RPV internals direct after the license approval. This relies on gained experiences in the planning work of current projects. The aim is to realize the status "free from water" faster leading to an earlier start of the dismantling of these systems. Of course this decreases operational efforts.

The decommissioning project Borssele consists of the following phases:

- Operation Phase (OP)
- Post operation phase (POP)
- Dismantling phase (DP)

For each phase a separate license is required. They are applied in time.

4.1.1 Operation Phase (OP)

The decommissioning project starts with a general planning of the project activities and with the collection of data. Then the licensing documents will be prepared and the licensing procedure will start. These pre-decommissioning actions will be performed before the final shutdown of the Borssele NPP, i.e. during operation phase.

4.1.2 Post Operation Phase (POP)

The main task of the POP, which follows immediately after the final shut down of the Borssele NPP, is to secure the nuclear safety, the radiation protection, and the maintenance of the plant as well as to initiate the first measures for the preparation of the dismantling phase, e.g.:

- removal of the spent fuel elements (packages for the fuel and reprocessing are not included in this study)
- dismantling, cutting and packaging of mobile RPV internals
- treatment and packaging of existing operational media and waste
- shut down of operational systems not needed anymore

4.1.3 Dismantling Phase (DP)

The main task of the DP is the dismantling, treatment, and packaging of the components, systems, and buildings.



The concept on hand is based on one approval for the POP and one approval for the DP. However the decommissioning of the Borssele NPP will start during the operation with planning and application of the licenses. Preparation measures will be already performed before the DP license is issued. Therefore all preparation measures on site which are initiated before the DP license is granted must be compatible with the POP license.

The spent fuel stored in the fuel pool will be packed and transported away from the site. This will be done during operation. The spent fuel from the last core will have to remain in the pool to decay and cool down for several years before it can be removed and transported.

Immediately after the final shut down of the plant the following tasks will be performed under the POP license:

- shut down of systems not needed anymore
- reconstruction and improvement of infrastructure
- installation of service areas, e.g. for decontamination and clearance measurements
- installation of storage areas
- in-situ decontamination of the primary loop
- removal of the mobile RPV internals
- removal of the insulations of components

After these initial activities the shutdown of systems which are not needed furthermore will continue and some dismantling work in the areas outside the controlled area will start. Figure 4-1 indicates which buildings will be needed or used for the dismantling work.

To minimize the efforts for plant operation in a possibly short time is a task with high priority. New experiences show that the operational cost during the DP depends strongly on the number of systems in operation. Therefore the RPV internals will be dismantled as soon as possible. After that there is no more need for aquiferous systems in the plant. Another effective measure to reduce the operational effort is the reduction of the fire load in the plant.

So, the dismantling work will start with the dismantling of the RPV internals and the RPV.

Figure 4-2 shows the summarized strategy. It assumes that the spent fuel elements will be removed from the site in due time. The critical path beginning after fuel removal is as follows:

- dismantling of the RPV internals including the preparation work
- dismantling of the RPV
- dismantling of the primary loop components
- dismantling fuel pool structures and biological shield
- decontamination and clearance of building structures (reactor building)
- demolition turbine, reactor und auxiliary buildings
- filling building pits and landscaping

Contaminated auxiliary components will be dismantled in parallel, or whenever necessary to improve the infrastructure or the working conditions. Most of the contaminated components will be dismantled after dismantling RPV internals.



These main steps of the critical path are described in section 4.2.

4.1.4 Distinction between POP and DP

The decommissioning cost calculation makes a distinction between the costs for the POP (which are related to the final shutdown of the reactor and to the removal of nuclear fuel and operational waste) and the costs for the DP (which are related to the dismantling work). From the technical point of view there is a clear separation given between the two phases, even if the technical measures are scheduled in parallel. As long as there is nuclear fuel on site, in principle all activities are assigned to the POP. Exceptions are measures which are definitely and clearly assigned to DP, e.g. the installation of dismantling tools, or the acquisition of equipment for a release measurement facility.

For administration and operational tasks it is not possible to make a clear distinction between what is POP and what is DP. The allocation of the costs to POP or to DP will be made by defining a particular milestone (a moment in time) when the POP ends and the DP starts. This milestone will be the date when all nuclear fuel has left the site. From this moment on all measures belong to the DP.



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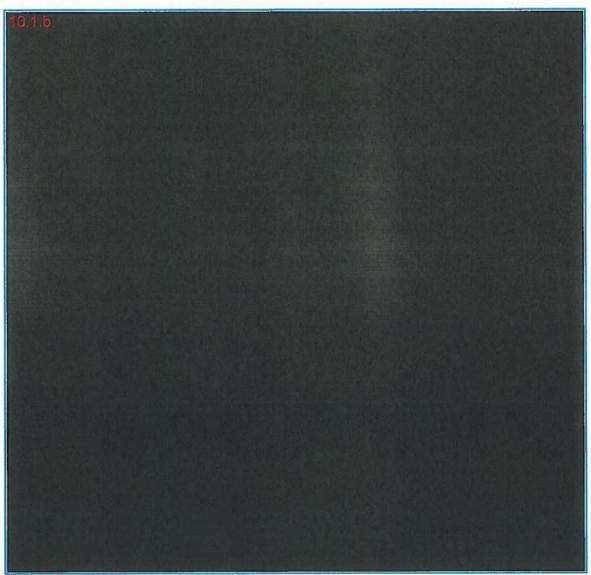


Figure 4-1: Site areas regarding the sequence of decommissioning

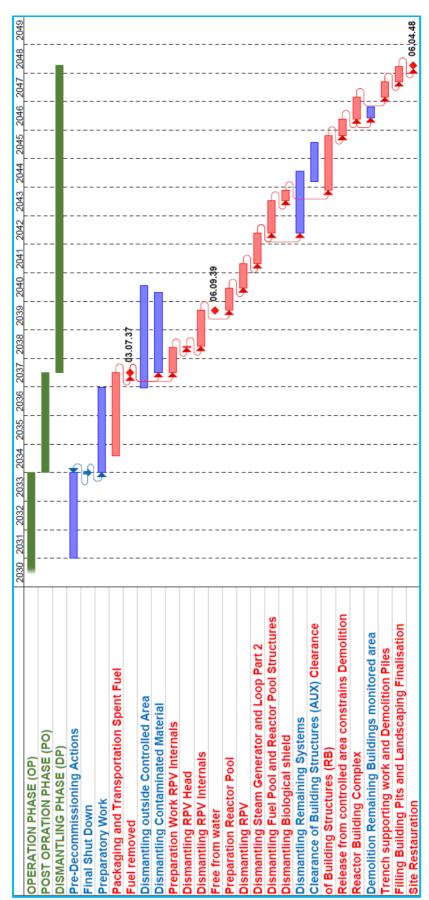


Figure 4-2: Strategy sequence of decommissioning

4.2 Main steps of the critical path

4.2.1 Dismantling of RPV internals including the preparation work

After fuel removal the DP starts with the preparation work for dismantling RPV internals. This includes:

- the preparation of reactor pool
- the installation and test of equipment (remote controlled equipment, cutting tools, control panels, cameras, mobile water filters)
- installation of shielding elements as needed
- the training of staff

The RPV internals such as grid plates and the core structure, which cannot be removed with normal operation procedures, will be dismantled and packaged directly in repository containers without any treatment.

For the disassembling and the cutting of the RPV internals appropriate remote controlled underwater cutting techniques have to be taken into account:

- water abrasive suspension (WAS)
- acetylene burning
- plasma burning
- mechanical cutting such as sawing, milling, grinding, nibbling

Each technique has its pros and cons. It is part of the planning work to assess and decide which technique applies best in the future project. However the realisation should proceed as described below:

First the RPV head will be put into the fuel pool where the further separation and packaging of the parts will take place.

The control rod drive mechanism will be removed before the dismantling of the RPV can start. It will be disassembled and transferred to the fuel pool for further dismantling.

The RPV internals are disassembled as far as possible by cutting the fixing screws. The components will be cut in suitable pieces and packaged under water in special drums. A drum will be put in a MOSAIK cask using a shielded transport unit. The drum and its content, still wet at this time, will be dried in a special drying unit by heating the MOSAIK cask.

The MOSAIK cask including the internal drum and the waste will have a total weight of 5 to 7 Mg, so it is possible to use the already existing handling equipment.

After the dismantling of the RPV internals there is no more need for aquiferous systems.

4.2.2 Dismantling of RPV

The dismantling of the RPV will be carried out in following steps under dry conditions:

- cutting the loop pipes from inside with mechanical inside pipe cutters
- installation of a fixing equipment in the reactor cavity above the RPV
- installation of a cutting device equipment in the reactor cavity
- disassembling of the RPV fixation





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- lifting the RPV for 1m into the reactor cavity by the reactor building crane
- fixing the RPV with the fixing equipment
- cutting the RPV upper part
- lifting the cut piece to the cutting device in the reactor cavity
- cut the upper part in suitable sizes for packaging
- in parallel lifting the RPV again for 1m
- cut the next ring
- and so on up to the RPV bottom

The cut pieces will be packed in appropriate packages. This requires shielded transport equipment. It is assumed that the RPV insulation is a part of the RPV and will be removed during the cutting of the RPV in a common working step.

4.2.3 Dismantling of primary loop components

The primary loop includes the following components:

- steam generators
- pressurizer
- pressurizer relief tank
- primary pumps and motors
- primary loop pipes

The components of the primary circuit are high contaminated and the dose rates on the components lead to a complex dismantling task. Therefore it is planned to decontaminate the primary circuit in an in-situ decontamination technique. According to the experiences made in the decontamination actions in Germany (Obrigheim, Mülheim-Kärlich and Stade) it can be assumed that the dose rate will be reduced in average by a factor of 10 - 20; on dedicated places by a factor up to 1.000. The primary circuit decontamination process is planned to carry out during the preparatory work in the POP.

The dismantling of the steam generators and further primary loop components starts after segmentation and packaging the RPV. Thereby the larger components have to be segmented in-situ. Further disassembling and dismantling of the segments as well as packing into waste containers will carry out at separate working places. Within the planning work during operation and post operational phase appropriate areas have to be identified to install there special constructed dismantling equipment. In current projects different rooms in the reactor auxiliary building are taken into account, for example the hot workshop or decontamination rooms. The techniques used there are:

- rope saw cutting
- hydraulic shear
- grinder
- self-rotating buzz saw



Some information can be taken from the following pictures: The secondary part of the steam generator was cut from the primary part by a rope saw. Pieces were cut by mechanical techniques.







Figure 4-3: Dismantling of primary loop components

4.2.4 Dismantling fuel pool structures and biological shield

The activated part of the biological shield will be dismantled by means of the rope sawing and blade sawing method. Therefore a rope is pulled through holes drilled and kerfs sawed in the concrete. The rope is led through deflection pulleys to a drive unit. With this method it is possible to detach square meter large pieces. These pieces will be directly packed into containers. The parts of the biological shield and the fuel pool structures where the activation of the concrete is below the clearance levels and where only the activation of the reinforcement is too high, will be demolished (at another place) and the activated reinforcement will be separated and packed into containers.

4.2.5 Decontamination and clearance of building structures

After the dismantling of the components the building structures will be decontaminated and cleared. Meanwhile the remaining equipment, e.g. lighting, stairs, grid plates and steel girders will be removed. The purpose is the final release of concrete structures from nuclear constraints.

The decontamination of the concrete structures in the controlled area shall bring the entire remaining concrete below the release level /6/, so that it can be released and reused, for example for road constructions.

The building surfaces within the controlled area will be cleaned either by using special cleaners or by the application of mechanical surface removal techniques. Which procedure is applied depends on the kind of contamination (e.g. loose, only superficial, or diffused into the concrete).

All concrete building structures inside the containment will be removed so as to show that the inner surface of the containment is below the clearance level. The demolition of this concrete is performed under the requirements of the controlled area with standard demolition tools. That means that all the removed material has to be measured in order to show that the radioactivity is below the clearance levels.

4.2.6 Release of building structures and site

Prior to the demolition of the building structures it is necessary to prove that the remaining radioactivity is below the permissible limit values. Corresponding control activities are necessary.



After the decontamination of the buildings final release measurements have to be performed to demonstrate that the site itself is free from radioactivity.

Before starting conventional demolition the release from controlled area constrains is needed (150 days estimated).

4.2.7 Demolition buildings

General in case of building demolition it is to consider two building complexes:

- reactor building complex (reactor building, auxiliary building, turbine hall and adjacent buildings)
- remaining buildings outside controlled area

The demolition of the reactor building complex runs on the critical path. The remaining steel elements (supports, scaffolds, stairs, gratings, lifting devices) will be removed, mainly by oxyacetylene cutting devices. Then the building structures will be demolished over ground with percussive rammers at cable dredgers and rock chisels at hydraulic excavators. In some cases loosening explosions are used. Afterward trench support has to be placed along the reactor building complex and the basement as well as the foundation piles up to about 15m in the ground will be removed.

The demolition of the remaining buildings the outside controlled area takes place in parallel. In particular case some buildings can be demolished before.

The arising concrete rubble will be crushed in appropriate crushers on-site. The concrete will be separated from the reinforcement. The crushed concrete will be sent to a conventional landfill.

4.2.8 Filling building pits and landscaping

The project will be terminated with conventional works to reach the so called "green field condition". The pits will be filled with suitable material and finally compacted.



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5 Safety

5.1 Introduction to radiation safety

Main principle of the radiation safety while normal operation as well as while fault conditions and accidents is, that hazardous or dangerous situations for employees and co-workers in the plant, for the surrounding population and for employees of surrounding businesses deemed unacceptable damages will be avoided.

As part of the government's environmental policy the development of risk-approximation were required. Protection against the risks of ionizing radiation is laid down in the "Besluit stralenbescherming Kernenergiewet" (BsK). In accordance with the BsK-decision the assumed dose for members of the population in the vicinity of the device must not exceed 0.1 mSv per year under normal operating conditions.

In accordance with the relevant government applies also the aim to keep any individual risk below 1E-8 per year - the so-called secondary level, equivalent to 4 E-4 mSv per year.

In accident situations around the dismantling the aim is to reduce the level of the individual security risk below the secondary level of 1 E-8 per year.

Additionally a criterion for the group risk is considered, which is designed to prevent social disruption. But since no realistic scenario is conceivable causing actual victims in the area due to this criterion its relevance for final decommissioning is denied.

Potential malfunctions and accidents in installations during Final Decommissioning will be considered in the final Safety Analysis Report with emphasis on the various dismantling aspects. The up-mentioned limitation of any individual risk for the environment due to accidents with the possibility of severe consequences is the main premise.

In the elaboration of the BsK-decision some major recognized safety principles (principles) - the most important are the ALARA, the "defense-in-depth" - and the ICC principle - are considered likewise.

5.2 Basic Assumptions for Radiation Safety

5.2.1 The ALARA principle

The premise for the policy of the radiation protection for the staff and the environment is to prevent each avoidable exposure to radiation and each unavoidable exposure limit to the highest degree possible.

This policy has to ensure that exposure is "As low as reasonably achievable" (ALARA). Further preconditions remain, that the established dose limits are not to be exceeded.

The practical implementation of the ALARA principle in the design and operation of the Safe Containment forces to consider techniques and procedures with the ability to reduce radiation doses for employees, third parties and human populations. It has to find a balance between achieving the reduction of the radiation dose and the required cost for the measures to enable this reduction.

5.2.2 The "Defence in depth"- principle

The "defence-in-depth" principle shall compensate possible human error leading to failure of the whole (or parts of the) plant by the presence of appropriate multiple safety-levels, in order to prevent the release of radioactive substances into the environment.

These safety levels are:





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Safety-Level 1:

Failures are prevented by the quality of the design, of the construction and the operation of the plant using quality assurance and maintenance as tools of an adequate safety culture.

Safety-Level 2:

Preventing failures leading to accidents are achieved by means of detecting abnormal situations and adequate responses to them

Safety-Level 3:

Limiting the consequences of accidents by means of the application of active and / or passive safety features

Safety-Level 4:

By means of further measures the consequences of accidents for the personnel, the public and employees of surrounding businesses and the environment are reduced.

5.2.3 The ICC principle

The ICC principle is closely related to the "Defence-in depth"-Principle. It means that the containment around the radioactive material is required to:

- Isolate
- Control
- Check

Isolate:

Radioactive material is enclosed by means of one or more barriers existing in the material itself, in the packaging, in the location of plants equipment and / or in the filters of the ventilation system within the Containment. It is elaborated in the next explanations:

- In potential contaminated areas the degree of vacuum is kept proportional to the degree of expected contamination.
- A directed air flow is always directed from an area without radioactive contamination to the areas with increasing radioactive contamination.
- Mechanical Installations are set up for further separation of several zones such as providing ventilation systems discharging to the environment with filters.

Control:

This part of the principle takes measures to secure the containment around radioactive material as long as possible. The barriers, preventing any release of radioactive materials, are held in position for the whole duration of final decommissioning.

The structural system and the technical facilities of the containment are to be kept together with their maintenance and inspection programs as well as their quality assurance system during the whole duration of Final Decommissioning.

Check:

This principle means that no radioactive materials are allowed to leave the installation unnoticed. This will be achieved by:





- The only discharge of aerosols and gaseous effluents flows through filters. The amount
 of radioactivity downstream a filter is always measured and recorded.
- The essential process parameters are measured and recorded.
- No radioactive effluent discharge bypasses the drainage into the contaminated water collection tank by design.
- Unconditioned radioactive material in transports is detected by the material monitor at the exit of the site.

5.3 Internal and external influences on safety

The Borssele NPP is designed to provide an environmentally safe operation with preferably no failures and accidents. So systems are installed to control abnormal operating conditions. Furthermore adequate safety installations are designed to control accidents. The principle of the safe operation continues during the POP and DP. So it concerns the erection or adaption of required equipment as well as the dismantling of systems in the advanced D&D project.

The safety criteria for these aspects are related to so-called design events. They take the seriousness of their consequences and the probability of their occurrence into account. For internal influences on safety distinctions can be made between normal operation, failures, accidents and extreme accidents. External influences on safety like flood, earthquake, storm or plane crash belong to the extreme accidents concerning the probability of their occurrence.

The analysis of the potential impacts of internal and external events will be developed in the safety analysis report of the final decommissioning plan.

5.4 Security

Security is necessary in order to prevent the trespassing of the area from unauthorized persons and expose their selves to radiation or contamination with radioactive substances. In addition, the inclusion of security is necessary to ensure that unauthorized persons cannot create dangerous situation for the environment. The following security measures will be taken.

Organisational measures:

These measures concern the organization, the staff and any resources used to shape protection. The resources are means like the necessary policy documents, procedures, guidelines, regulations, instructions.

Structural measures:

These measures with all material provisions shall increase the resistance of protected objects against intrusion of the protected object to a reasonable degree.

Electronic measures:

These measures include all electronic equipment, electrical and optical facilities with observation, signalling or alarming functions.

The protection of the radioactive material is presently characterized by active security measures and the addition of a high degree of passive safety measures (primarily chemically bound and activated material) which is independent of the continuous operation of mechanical and electrical systems, and therefore insensitive to be made inoperative by deliberate damage. The nature and the form of radioactive products reduce the risk of the release of radioactivity resulting from sabotage or from actions by unauthorized personal.





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5.5 Industrial safety

In accordance with the provisions of the health and safety act the care for industrial safety is integrated into the care for working conditions (safety, health and welfare) and the safety of the own employees and of third parties.

6 Decommissioning techniques

6.1 New developments

Each technique has a specific suitability and individual process parameters so that it can be applied in a certain spectrum. In the period since the last study the individual techniques have been advanced and optimised in a wide variety of research projects, and studies have been performed on how different procedures compare.

Concerning separation techniques in general, thermal separation techniques are marked by their fast cutting speeds and universal application, but partly produce large volumes of aerosols and possibly problematic secondary waste and may therefor require complex filtration. Mechanical procedures are also suitable for a multitude of separation tasks, but may fail when it should apply to complex geometries. They produce more easily handled cutting waste and do not normally require filtering.

The choice of the right separation technique is therefore a question of optimisation, for which factors such as required time, costs, space requirements, volumes of waste, and the interaction with other techniques need to be considered. This evaluation will be carried out during the planning work before the DP. So comparing to the past study it follows the description of actual available techniques.

6.2 Dismantling techniques

6.2.1 General

When the first nuclear installations were decommissioned and dismantled, available techniques and tools had to be adapted to the special needs of the nuclear boundary conditions. In some cases completely new techniques and tools had to be developed. Today however experience is available with a wide variety of dismantling and decontamination techniques as well as clearance techniques. All the needed techniques are available and known.

Not all techniques that were developed in the past could achieve acceptance in practice. In the course of the last years there has been a process of consolidation. Most of the useable techniques and tools are marketable and commonly used.

Different dismantling techniques will be used according to the requirements of the different material and radiological categories during a D&D project as following described.

The dismantling provides that the components are in suitable dimensions for:

- internal transfer
- decontamination
- measuring for clearance
- conditioning and packaging as radioactive waste as effectively as possible

Activated objects will be dismantled in situ, either under water, at a distance, or from behind a local shielding. As a consequence, remote controlled techniques will be used.

Some components will be removed in one piece, e.g. the steam generators.

Additional cutting actions in separate cutting stations are needed either to facilitate decontamination, to achieve a better utilisation of the packages, or to facilitate release measurements.



6.2.2 Mechanical cutting

Mechanical cutting is the name for techniques such as sawing, cutting, milling, planning, abrasive cutting etc. These separation processes are possible "in the air" as well as "under water".

Many mechanical cutting tools exist that meet the needs of nuclear decommissioning. A typical application is the cutting of small diameter pipes or thin sheet metal. This technique generates negligible aerosols and no slag. Most of the mechanical cutting techniques can be remotely operated if the remote equipment can withstand the forces incurred in the cutting process.

The criteria used to compare different tools for in-air or underwater cutting are speed, handling, kerf, and the production of secondary waste. The joint material resulting from the separation processes (chips, etc.) will be treated as secondary waste.

In principle, it is possible to dismantle all components through mechanical separation processes. The thicker the wall, the bigger the stress which requires a massive construction of the tool supports.

Band saw cutting

Band saw cutting is especially suitable for cutting large components with thick walls. The equipment needs place: for bringing in the large components, for the removal of the cut parts, also for the traverse path of the saw and for interventions and maintenance (for example: replacement of the saw band).



Picture by courtesy of EWN Figure 6-1: Band saw

The component to be cut is put on a deposit table, fixed by clamps, and then taken to the saw blade, or the saw has a movable sawing frame. Some components may require a sub-



structure to fix the cut piece and the remaining component so as to guarantee a trouble free cutting (without pieces falling down, or vibrations, etc.).

The large components are usually handled by means of a crane. The cut pieces can also be removed by the crane, or by other means.

When selecting replacement cutting bands, of course the cutting performance is an important issue, but more emphasis will be put on the lifetime.

Swarf from cutting contaminated or activated components will be removed at the place of origin (by suction) or it will be guided (guiding plates) and collected to be removed without problems.

The factors that influence the total cutting time are the actual time for cutting, but also the non-productive time (handling time). The ratio of actual cutting time to non-productive time depends on the geometry and the thickness of the component.

Angle grinder

Angle grinders are used to remove obstacles or bulky parts such as brackets, sieve inserts, sticky screws and nuts etc. from the components with relatively moderate machine and manpower effort. But they are not always the optimum tool. If all nuts of a flange are sticky, simple thermal cutting may be significantly faster and more effective.

Circular diamond saws

The maximum thickness which can be cut by a circular saw depends on the diameter of the saw and is, in general, about one third of its diameter.

The largest saw was developed for cutting concrete biological shields in power reactors, has a diameter of 2,5m and can cut a 1m thickness of reinforced concrete. The blade advance of this saw is 180 mm per minute, giving a cutting yield of 10 square metres per hour. The blade has to be changed about once every 200 square metres, that is about once every 20 hours of operation. This tool weighs 2,5 Mg which involves the use of manipulation and guidance equipment which are adapted as necessary to the prevailing conditions in the work zone. Saws of all diameters can be purchased readily and may be portable or operated by remote control. Circular saw drive motors are usually hydraulic or pneumatic.

Diamond saws produce little pollution and are well suited to cutting concrete. They are good for breaching concrete walls, floors and ceilings at competitive costs and with a minimum of harmful effects. Setting them up becomes more difficult when cutting thicknesses of more than 30cm, the weight and bulk of the machines then require special adaptations to the manipulation and guidance equipment.

Diamond cables

Diamond cables offer all the advantages of circular saws and enable greater thicknesses to be cut through. In theory, the thickness is limited by the fact that the cable must pass right around the piece being cut. The drive motor must be powerful enough to overcome the resulting friction, which is proportional to the length of the kerf.

Wire saw cutting is suitable for reinforced concrete but also for simple thick steel structures. Diamond cable cutting can be done either dry or wet. Dry cutting is slower than wet cutting (50% performance), but it avoids wet waste with high costs for removal. On the other hand it requires a well-directed suction of the cutting gap and the wire guide with a separate ventilation unit.





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The technique of cable cutting is very widespread in conventional industry and is capable of cutting cleanly and precisely with minimal effects on the surroundings e.g. shocks, vibrations, noise, sparks and dust and with reduced production of secondary wastes. The loop is made up of lengths of cable assembled for particular operation. The lengths must be about equally worn otherwise the least worn lengths will do all the work and will have a much shorter life. It is thus important to keep up to date records on cable use.

Hydraulic shear

A hydraulic shear is suitable for cutting pipe shaped parts or smaller steel equipment (angle, flat bars, small T-profiles). Commercial shears are available operating with 400 bar pressure and providing a cutting force up to 400 kN.



Picture by courtesy of EWN Figure 6-2: Hydraulic shear

6.2.3 Thermal Cutting

Thermal cutting processes include, for example, acetylene cutting, plasma torching, arc oxygen wire cutting. High thermal energies are applied for separating the components. In general, thermal cutting is very efficient. It can cut thick steel, it is easy to use, and it can be used under water. Thermal cutting is also possible in case of complicated geometry. The thicker the wall, the more difficult is the application of thermal processes.

On the other hand, thermal cutting generates gas, smoke and aerosols that require the installation of filtration and ventilation systems which in turn increase the cost of cutting. Thermal separation "in the air" produces dust and aerosols, which may contaminate the surrounding surfaces. Additional ventilation systems and/or caissons can avoid or restrain this. "Under water" particles and aerosols are held back at a high rate by the water, but this water has to be treated as radioactive waste.

Acetylene cutting

Flame cutting is a thermal cutting technique which is performed with an oxy-fuel gas flame and cutting oxygen. The material to be cut has to fulfil the following requirements:

- The material must react with oxygen in an exothermal process.
- The ignition temperature of the material must be lower than its melting temperature. For temperatures above the ignition temperature, the combustion heat exceeds the



dissipated heat. For mild steel, which is well-suited to flame cutting, the ignition temperature is about 1.150°C.

- The melting temperature of the generated oxides must be lower than the melting temperature of the material.
- The viscosity of the slag should be as low as possible.
- The thermal conductivity of the material should be as low as possible.
- The combustion energy should be as high as possible.

Due to these restrictions, the use of flame cutting is limited to mild steel, titanium and molybdenum. Stainless steel and the remaining non-ferrous metals are not suitable for flame cutting without additional powder injection. The maximum cut thicknesses of more than 2000 mm can be achieved for mild steel.

In the past acetylene cutting technique was used for cutting the RPV head in the NPP Gundremmingen A.

Plasma arc cutting

Thermal plasma is a highly heated gas or gaseous mixture which is conductive and consists of ions, electrons and neutral atoms or molecules. Monatomic gases such as argon and helium, polyatomic gases such as nitrogen and hydrogen, and also mixtures of these or air can be used as plasma gases.

The plasma arc is constricted by means of a copper nozzle. The thermal and electrical pinch effects are used to attain temperatures which are considerably higher than the temperatures obtained with the open arcs described in the section above. The maximum temperature in the inner plasma arc is approximately 20.000 K or more.

For practical applications, the transferred arc is used almost exclusively for cutting and eroding any conductive material. The non-transferred arc can cut any material, i.e. also non-conductive materials, but significantly less energy is transmitted to the work piece.

For decommissioning purposes, modular cutting torches were developed for the remote-controlled replacement of worn parts by means of manipulators. Thus, those parts with the highest wear rate, i.e. the nozzle and electrode, can be easily replaced and the torch can be adapted for individual cutting tasks. This also gives the possibility of switching between straight and cranked cutting units. Such a unit must be as small as possible, since it is used for cutting confined, complex structures.

The maximum cut thickness obtainable in atmosphere is 172 mm for stainless steel, 150 mm for mild steel and 80 mm for aluminium.

For decommissioning purposes, plasma arc cutting is the most commonly used thermal cutting technique for activated components. The technique was used in several projects, e.g.:

- 1963 Oak Ridge National Laboratory, USA;
- 1968 Elk River Reactor, USA;
- 1969, 1986/87 JPDR, Japan;
- 1975 Niederaichbach, Germany;
- 1977 Douglas Point NPP, Canada;
- 1980 NPP Gundremmingen A, Germany;
- 1981 RI reactor, Sweden;
- 1986 NPP Rheinsberg, Germany;
- 1986 BR-3 Pressurized Water Reactor, Belgium;



1991 Advanced Gas Cooled Reactor at Windscale, UK.



Picture by courtesy of EWN Figure 6-3: Thermal Cutting

6.2.4 Hydraulic Cutting

Hydraulic cutting techniques can be used for metallic structures and for concrete. There are many different techniques. The most interesting for the present project is the high pressure water technique in which abrasive additives are added to a high pressure water jet.

The used abrasives are not regenerated because the grain size has changed and the additives are not useable any more. The used additives are removed together with the material from the gap and treated as radioactive waste.

The technique can be used in the air or under water, for wall thicknesses up to 300 mm. Among its advantages are the low dust and aerosol emissions.

WAS technique

Using the water abrasive suspension (WAS) cutting process with the aid of a water jet and sharp-edged abrasive material – preferably very fine garnet sand – even high-strength steels up to 30 cm thick and reinforced concrete up to a metre in thickness, as well as a wide variety of other materials, can be effectively and precisely parted.

The special features of this process are: the cuts are executed in a contact-free manner, with no significant heat generation or deformation, regardless of the material in question, and can also be performed using remote manipulation at distances of more than 1.000 metres. Only very thin parting seams are produced, with low secondary waste.

The important parts of the equipment include a high pressure pump, a mixing unit for the abrasive material, high pressure hoses and a cutting nozzle of 0,5 to 1,3 mm diameter. The water jet and the abrasive material are pushed through the cutting nozzle. Depending on the



intended application and requirement the cutting equipment with a range of pressure levels from 450 to 2.500 bar is available. The composition of the jet stream will be (2-phase system) water 92% and abrasive 8% or (3-phase system) air 90%, water 6%, abrasive 4%. Advantages of the WAS cutting are:

- cold cutting without thermal influence
- rapid precision machining of materials including non-conductive materials
- narrow cutting kerfs
- easy operation of the cutting tools
- easy replacement of tools
- easy accessibility for interventions

6.2.5 Shielding measures

Shielding measures are to be understood as an aid for the dismantling work, to minimise the radiation exposure for the dismantling personnel. Shielding can be temporary or permanent. Temporary shields are installed for individual, maybe even short activities. Usually they consist of shielding walls, made of individual elements that can be installed and removed quickly. Permanent shields and equipment such as caissons serve as a shielding for the direct radiation, but they also create a defined environment with a separate ventilation system to prevent spreading of aerosols. Permanently installed caissons with remote controlled tools are used for example for the dismantling of the RPV and its internals.

6.2.6 Remote controlled techniques

Work on activated or highly contaminated components may require remote control. Several techniques exist such as a telescopic beam, self-locking ring supports, electrical master-slave-manipulators, and special tools for picking up, lifting and holding. These remote control tools are carriers for mechanical, hydraulic or thermal cutting tools.

Marketable tools will be used, but they may have to be adapted to the local conditions. The following properties are relevant:

- easy operation of the cutting tools
- easy replacement of tools
- easy accessibility for interventions
- easy handling of cut parts for sluicing out and packaging
- simple further processing (cutting on site or at separate cutting place)

6.3 Decontamination techniques

6.3.1 General

Decontamination is an important issue in the D&D project. Decontamination before and during the dismantling work can reduce the radiation level for the dismantling crew. Decontamination after dismantling is used to reduce the amounts of radioactive waste. So the fields of application are:

- system decontamination
- attendant decontamination during dismantling
- decontamination of dismantled components and structures



decontamination of building structures

- decontamination of tools and equipment
- decontamination of transport equipment and packages

The selection of the decontamination techniques depends on the expected result, the duration of the decontamination process, the secondary waste and also on the expected radiation exposure for the personnel. The geometry, the surface properties of the material and the physical properties of the material must also be considered.

The decontamination techniques hereafter focus on the cleaning of the surfaces of the dismantled components and equipment. The purpose is to get the contamination below the release level.

6.3.2 Wet decontamination

This technique is well known from non-nuclear applications. It is used for superficial contaminations. Water at high pressure is used to spray on the surface. Also complicated surfaces can be cleaned. The consumption of additives is low.



Picture by courtesy of EWN

Figure 6-4: Decontamination by high pressure water

The applicability of the wet decontamination technique becomes limited when the contamination is chemically bound to the surface or has penetrated into the surface. In such a case a surface removal technique is advised.



For the sake of completeness, the simple washing with detergents, which is also a type of wet decontamination, is mentioned here.

6.3.3 Mechanical decontamination

Mechanical decontamination methods can be classified either as surface cleaning (e.g. sweeping, wiping, scrubbing) or surface removal (e.g. grit blasting, scarifying, drill and spall).

The procedures range from simple washing and brushing, mostly in combination with decontamination cleansers, to abrasion and mechanical removal of the surfaces for example by sandblasting. The procedures are applied on outer, well accessible surfaces of all materials, from loose dust to firmly clinging contamination. The amount of secondary waste is relatively small, as the abrasive media, for instance, may be applied several times. A partial decontamination of surfaces is possible to remove so-called hot spots. Mechanical decontamination can be used as a stand-alone technique or in sequence with chemical decontamination.

Mechanical decontamination can only be applied to accessible surfaces. It requires significant protection measures against the spreading of the dust and the personnel needs are high.

The grit blasting technique is commonly called sand blasting or abrasive jetting. This technique uses abrasive materials suspended in a medium that is projected onto the surface being treated. It results in a uniform removal of surface contamination. Compressed air or water or some combination of both can be used to carry the abrasive. Removed surface material and abrasive are collected and placed in appropriate containers for treatment and/or disposal.

Grit blasting is applicable to most surface materials except those that might be shattered by the abrasive such as glass or Plexiglas. It is most effective on flat surfaces and as the abrasive is sprayed it is also applicable on hard-to-reach areas such as ceilings or areas behind equipment. Nonetheless, obstructions close or bolted to the wall must be removed before application and precautions should be taken to stabilize, neutralize, or remove combustible contaminants, because some abrasives can cause some materials to detonate. Static electricity may be generated during the blasting process. Therefore the component being cleaned should be grounded. Remotely operated units are available.

Under dry conditions, dust-control measures may be needed to control dusts and/or airborne contamination. This problem can be reduced by using filtered vacuum systems in the work area. Depending on the application, the following variety of materials can be used as the abrasive media:

- minerals (e.g. magnetite or sand)
- steel pellets
- glass beads/glass frit
- plastic pellets
- natural products (e.g., rice hulls or ground nut shells)





Picture by courtesy of EWN

Figure 6-5: Dry blasting decontamination



Figure 6-6: Blasting caisson at NPP Kahl

Scarification physically abrades both coated and un-coated concrete and steel surfaces. The scarification process removes the top layers of contaminated surfaces down to the depth of sound uncontaminated surfaces. Today's refined scarifiers are not only very reliable tools, they also provide the desired profile for new coating systems in the event the facility is to be released for unrestricted use. For steel surfaces, scarifiers can completely remove contaminated coating systems, including mill scale, leaving a surface profile to bare metal. To achieve the desired profile and results for contaminated concrete removal, a scraping scarification process is implemented; for steel decontamination, a needle scaling scarification process is used.

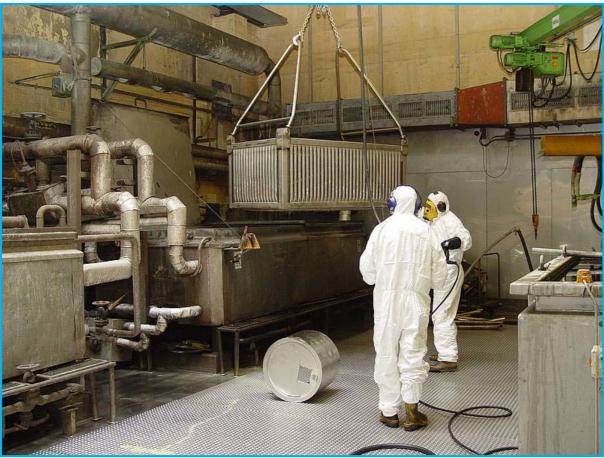
6.3.4 Chemical decontamination

Chemical decontamination uses concentrated or diluted solvents in contact with the contaminated item to dissolve either the base metal or the contamination film covering the base metal. Dissolution of the film is intended to be non-destructive to the base metal and is generally used for operating facilities. Dissolution of the base metal should only be considered in a decommissioning program where reuse of the item will never occur. Chemical flushing is recommended for remote decontamination of intact piping systems. Chemical decontamination has also proven to be effective in reducing the radioactivity of large surface areas such as floors and walls as an alternative to partial or complete removal.

The success of chemical decontamination methods depends on how aggressive the solvent is, on time and on temperature.

The advantages of chemical decontamination are that it can be used for inaccessible surfaces, it requires fewer work-hours, it can decontaminate process equipment and piping in place, and it can usually be performed remotely. Chemical decontamination also produces few airborne hazards, uses chemical agents that are readily available, produces wastes that can be treated remotely, and generally allows the recycling of the wash liquors after further processing. For these procedures solvents, acids and caustics are used as decontamination agents. The decontamination result strongly depends on aggressiveness, reaction time, reaction temperature and material. While combined, mostly two-step procedures are the most successful.

The disadvantages of chemical decontamination are that it is not effective on porous surfaces, it can produce large volumes of waste (although volume may be reduced by a radioactive waste treatment system), it may generate mixed waste and it can result in corrosion and safety problems when misapplied. In addition, it requires different reagents for different surfaces; it requires drainage control; for large jobs, it generally requires the construction of chemical storage and collecting equipment; and it requires addressing criticality concerns, where applicable. More disadvantages are the long reaction times, the decreasing effect of the decontamination agent with increasing chemical saturation as well as the large quantity of secondary waste.



Picture by courtesy of EWN

Figure 6-7: Chemical decontamination

6.3.5 Decontamination by melting

Melting can be regarded as a method of decontamination. Whereas the melt (representing the main mass flow) is partially decontaminated, the activity will be accumulated in the slag, the dust and the cladding of the furnace. This distribution of activity can be controlled to a certain extent by adding slag forming materials. Imbedding activity into a liquid slag may be considered as a type of vitrification.

A particularly advantageous consequence of melting is its "decontamination" effect on Caesium-137, a volatile element that has a half-life of 30 years. During melting Cs-137 accumulates in the dust collected by ventilation filters and is removed. The dominant remaining nuclide in the ingots (for most reactor scrap) is Cobalt-60. This element has a half-life of only 5.3 years. Other remaining nuclides have even shorter half-lives. Consequently, ingots with reasonably low-activity concentrations may be stored for release in a foreseeable future.

The dust is radioactive waste. Volume reduction by super compaction is not always possible but because of the low masses of dust that are normally produced, it may be disposed of without any treatment into a suitable waste container.

During the last years the melting of contaminated steel in special-purpose plants for recycling has developed as a new industry. Established techniques are used to minimise the quantity of active metallic waste. A number of plants have used and still use the melting process for contaminated metals on an industrial scale, including:



- CARLA Plant, Siempelkamp, Germany
- STUDSVIK Melting Facility, Sweden
- INFANTE Plant, Marcoule, France
- Science Ecology Group (SEG) Plant, Oak Ridge, USA
- Capenhurst Melting Facility, United Kingdom
- Manufacturing Science Corporation (MSC), Oak Ridge, USA.

Not all of these facilities or plants offer melting service to external companies.

All melting equipment is operated in controlled areas using safety precautions, including filtered ventilation and health physics supervision. The slag and dust collected in the filters are treated as radioactive waste.

6.4 Clearance measurement techniques

6.4.1 Measuring of superficial contamination by direct measurement

For a direct measurement the measuring device needs access to the surface of the material. A technical instruction manual will describe items such as the distance between measuring device and the measured material, the damping factor to be used, and the duration of the measurement. The calibration instructions will consider the type of material, the surface condition and the assumed penetration depth of the contamination.

If the distribution of the contamination is known to be rather homogeneously distributed, then samples can be taken from representative surfaces.

6.4.2 Measuring of superficial contamination by indirect measurement

Such measurements are normally used for preliminary inspections. Material samples (pieces of material, drill samples) and / or superficial samples (from scratching or wiping) will be investigated. The analysis can be nuclide specific. Usual techniques are the gamma nuclide analysis and the liquid scintillation measurement technique. In some cases special analyses must be made for non-gamma emitters (alpha, or pure beta emitters).

6.4.3 Total gamma measurement

Total gamma measuring devices will measure complete materials. The measuring result data will be processed by specialized software to make sure that the clearance levels are complied with and all measurements and decisions will be documented in a traceable way. All operations will be described in a technical instruction manual.

6.4.4 Measurement of representative samples

Sometimes – especially in case of decision measurements for bulk material or for liquids – it is more favourable to measure the specific activity using samples of the material. In that case representative samples will be taken and measured. For material with large volume a combination of sampling and direct measurement can be the optimum solution.

6.4.5 In-situ gamma measurement

Infrastructure (such as parts of building structures, or external areas: earth, roads) can be measured using in-situ gamma spectrometry. In this case for example complete rooms or room areas are measured at once. This assumes that a pre-examination has shown that the distribution of the contamination is sufficiently homogenous, and that the penetration depth of the contamination is known.



6.4.6 Nuclide specific gamma measurement (gamma spectrometry)

Nuclide specific gamma spectrometers can measure complete batches at once for gamma nuclides. The result is a spectrum of the total batch with additional information about the partition of the activity in the batch. This procedure is more complex than the total gamma measurement, but it delivers more information.

6.4.7 Handheld monitors

The handheld beta-gamma contamination monitor for the measurement of radioactive surface contamination is based on high performance Xenon filled proportional counter technology or another proven technique.

The detection technique provides extremely high sensitivity for both beta and gamma radiation. The instrument is therefore ideally suited for the measurement of photon emitting radionuclides, widely found in nuclear facilities.

The software of these monitors offers many useful modes of operation, complex functions, utilities, and access to all parameters for experienced users. For unskilled users the instrument's configuration can be defined in supervisor mode as a simple or even extremely simple system. The supervisor can grant access authorization for user profiles only for selected menus, functions or parameters according to the special needs of the site. The instrument has a memory to store measured values and bi-directional serial RS232 communication. This provides program download, parameter download, remote control and data transfer to a host computer or printer.

6.4.8 Measurement in release stations

The clearance decisions will be made on the basis of total gamma activity measurements. The measurement equipment and the software used will be flexible so they can be adapted to special cases, and they will be capable to detect any local concentrations of activity.

As the nuclide vectors will be complex, the key nuclides will be determined first, and the clearance levels for these key nuclides will be fixed. The selected measuring technique will allow demonstrating that the relevant nuclides are below the clearance level.

Depending from the type and properties of the material, the throughput is up to 30 Mg per day. Experience shows that, as a typical value, more than 90% of the material presented for clearance can be cleared without restrictions, or as conventional waste.



7 Waste management strategy for the D&D project

7.1 Basics

As in the 2010's study two variants, the KONRAD and the COVRA variant are considered. They differ in the approaches for the packaging concept, which is part of the waste management strategy.

7.1.1 Considerations and definitions

During decommissioning and dismantling of a NPP a lot of components, structures, other residuals etc. with very different physical, chemical and radiological properties have to be treated, conditioned and packaged. The aims of all of the treatments are:

- release of non-radioactive material for industrial recycling, if necessary a decontamination treatment can be processed before
- conditioning and packaging of radioactive waste for final repository
- preparation of non-radioactive waste for conventional repository

During treatment and / or conditioning the so-called decommissioning masses will be generated, i.e.:

- Non-radioactive material: Material that has been released from nuclear obligations or that has never been suspected of being radioactive.
- Conventional waste: Material that is free from nuclear constraints, but there are other (non-nuclear) reasons why this material must be treated as waste.
- Radioactive waste: Material that cannot be released from nuclear constraints and must be stored in a final repository.

The packaging concept for radioactive waste is concerned by national and international requirements, rules and laws, e.g.:

- regulations for the Safe Transport of Radioactive Material
- COVRA Radioactive Waste Acceptance Criteria for Disposal /7/, /8/, /9/

7.2 Qualitative and quantitative estimate of the decommissioning masses

7.2.1 Primary masses

The primary masses are already given in chapter 2.3.1 and summarized in Table 7-1. By the way these masses contain 600 Mg additional equipment which has to be installed for decommissioning measurements e.g. special machines, tools, and 372 Mg of building scarification material.



Component Type	Mass [Mg]
Components Controlled Area	7.322
Operational media	2.032
Components Monitored Area	9.038
Building Structures Controlled Area	149.448
Building Structures Monitored Area	163.992
Total	331.832

Table 7-1: Primary masses summarized

7.2.2 Calculation of secondary masses

Masses such as clothes, tools, and other consumables used during the decommissioning work are so called "Secondary Masses". The amount of this kind of waste will be calculated in the Cora data base and taken into account for the treatment of radioactive waste and also in the cost estimation.

The amount of secondary masses will be calculated based on specific factors which are defined as a relationship to the primary masses, e.g. the secondary masses which are expected during the dismantling of a component in the controlled area is related to the component mass:

- 1,5% clothes, shoes, gloves
- 3,2% sanitary water
- 4,8% tools, other consumables

Similar factors are defined for several works and applications. The results of the calculation are given in Table 7-2:

Туре	Secondary Mass [Mg]
Combustible waste (compressible)*	133,8
Concentrates hygienic water	6,1
Interstice material	1,1
Noncombustible waste	82,6
Residues from melting	13,8
Solids from blasting	20,6
Total	257,9
*super compaction considered	

Table 7-2: Calculated secondary masses

7.2.3 Mass distribution

During treatment and/or conditioning the so-called dismantling masses will be generated, i.e.:

- Non-radioactive masses for recycling or reuse:
 Material that has never been suspected of being radioactive, or that has been released from nuclear constraints.
- Radioactive waste:
 Material that cannot be released from nuclear constraints.



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Conventional waste:

Material that is free from nuclear constraints, but there are other (non-nuclear) reasons why this material must be treated as waste.

Thousands of different components have to be considered for the decommissioning planning. For the calculation of the decommissioning costs the treatment of these components has to be decided: decontamination, compaction, incineration, packaging, etc. Each component has its own specific properties, history, contamination data etc. It would be difficult, even impossible, to consider each component individually. But these thousands of components are susceptible to statistic considerations. The calculation of the total amounts of the masses per procedure is done via the so called mass distribution factor. A distribution factor indicates how the component will be treated concerning waste management aspects. As an example the distribution factor for mixed materials in the controlled area is given:

- 50% releasing procedure without further treatment
- 15% releasing procedure after high-pressure water decontamination
- 10% releasing procedure after blasting
- 15% packaging as radioactive waste
- 10% deposition without further treatment

For an evaluation each component listed in the database has been allocated with a distribution factor. All used factors are given in Appendix /A/.

The waste amounts result from the product of primary and secondary masses with its distribution factors. Figure 7-1 and Figure 7-2.



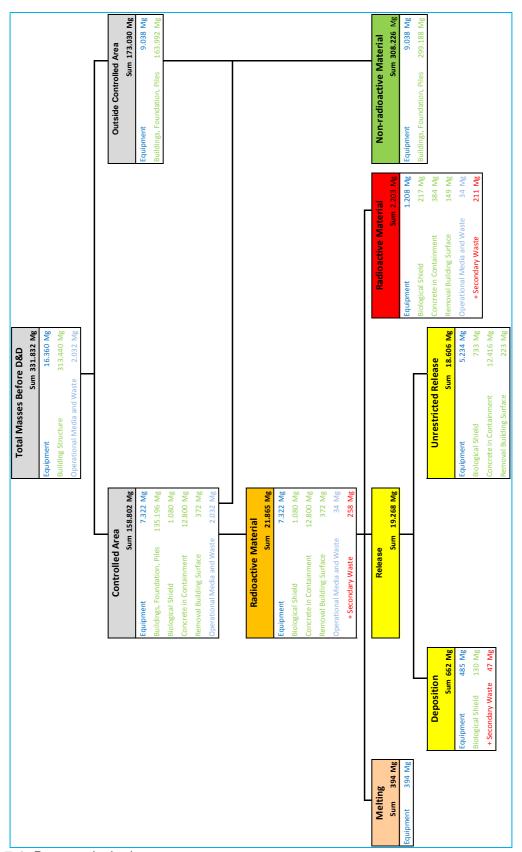


Figure 7-1: Decommissioning masses

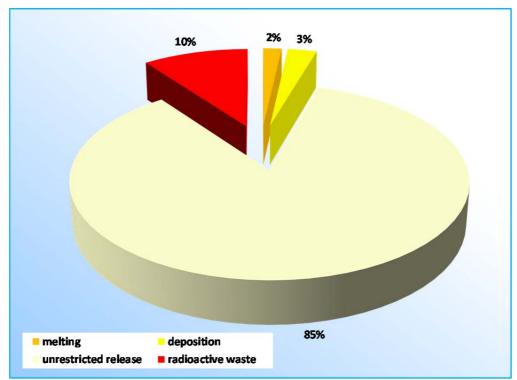


Figure 7-2: Disposal of radioactive material

7.3 Waste management strategy for the D&D project

Beside the total waste amounts the waste management strategy has to take into account the approved general procedure shown in Figure 7-3, space requirements and a possible efficiency. According to the amount of the different masses to be treated, it is decided to use existing buildings and rooms for treatment, conditioning, and packaging, as the existing plant offers enough space and possibilities to perform the treatment actions. Based on actual experiences the planning of the dismantling sequences now considers capacities of waste management facilities to be installed onsite. Figure 7-4 shows the flow of the dismantled masses per annum fulfilling efficiency constraints of the waste treatment areas. Three different mass flows are shown. They are dismantled masses from the controlled area without concrete (blue), dismantled concrete masses from the controlled area (red) and dismantled masses of the monitored area without concrete. The dismantled material without concrete from the controlled area is assumed to be handled in the waste treatment areas. Actual studies assume a capacity of 1.500 Mg to be treated in these areas shown as a dotted blue line in the figure. The greatest part of the concrete assumed as radioactive waste will packed directly and need not be considered in this capacity constraint.

The dismantled components are cut to transportable sizes (i.e. size of a lattice box) at the location where they are installed. Except the activated parts (i.e. RPV-internals, RPV, and Biological Shield) all other dismantled parts are pre-sorted (e.g. materials) and transported to the treatment areas. The preparation of the transport routes, i.e. dismantling of installed components and installation of corresponding transport equipment (e.g. cranes) is one of the first activities in the dismantling project.

Before the installation of the treatment equipment and facilities the present equipment is dismantled and the area is prepared for the new installations. Treatment methods and techniques are combined to the actual needs. It includes:





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Further cutting / disassembling:

Not all dismantled components and equipment that arrive in the treatment area have the optimum dimensions for treatment and conditioning. Maybe the dimensions of the dismantled parts exceed the permissible dimensions for packaging and transportation, or maybe the internal surfaces are not accessible to the measurement tools or to the decontamination equipment.

Decontamination of components and equipment:

Decontamination of components and equipment is done to reduce the quantity (in kg) of radioactive waste. Fractions with contamination that is hard to remove will normally not be decontaminated at all. Fractions with loose contamination will be decontaminated and most of it is expected to be ready for clearance after decontamination. Most contamination is restricted to the internal surface of the components that have been in contact with radioactive fluids. Another portion is at the external surface of equipment in the controlled area. Such contaminated surfaces are decontaminated by mechanical decontamination techniques (e.g. dry blasting, grinding). In some cases the contamination cannot be removed. Then one will try to separate the contaminated portion from the rest, to minimise the amount of radioactive waste. For the Borssele D&D project the decontamination of the following types of component is considered respecting on the size and the decomposability as well as efficiency aspects:

- 25% of mixed material
- 10% of steel structures
- 100% of shielding blocks
- 10% of valves > 100kg
- 20% of large pipes
- 20% of vessels, filter and heat exchanger

These percentages represent average values for the component types gained in current decommissioning projects and are not applicable to the single component.

Compaction / Super-Compaction:

Super-compaction is done to reduce the size (in m³) of radioactive waste, to get a better filling grade of the waste packages and thus to reduce the number of needed packages. In the present study, it is assumed that the super-compaction is performed onsite. Therefore a mobile super-compactor is installed. An alternative treatment at COVRA is not foreseen in this study because of cost savings respecting the defined assumptions and boundary conditions.

Packaging:

Radioactive waste will be packed in suitable waste packages. The packages must fulfil the waste acceptance criteria of the destination facility (i.e. COVRA) but also the requirements for transportation over public roads and for shielding of the personnel. Depending on the kind of waste and package an internal basket may be used, or spacers to keep e. g. pellets from super-compaction in place. More details contains the following chapter.

Cementation:

All types of waste and packages (except the MOSAIK-containers) require an immobilization of the waste inside the package. This is done by filling the package with a liquid concrete so that the waste with the concrete becomes a monolithic block. After filling





the concrete one will wait for the concrete to be hardened before the package will be closed with its cover.

- Incineration:
 - In this study combustible waste will not be sent to an incineration facility. Combustible waste will be super-compacted onsite because of cost advantages.
- Liquid waste treatment:
 The liquid waste is collected in a storage tanks will be evaporated on site.

At the end, before the material can leave the site, it has been measured to show that the remaining radioactivity is below the clearance levels. Otherwise it has been packed into the containers and stored for 5 years in the storage building on site according to the operational license (Art. E 44 and 45). Then the containers will be transported to the interim storage at COVRA for the later disposal.

For the description of the techniques please refer to chapter 6.

The implementation in the cost calculation concerning personnel aspects takes into account the necessary numbers and qualifications of the waste treating staff with respect to the demand during the dismantling periods.



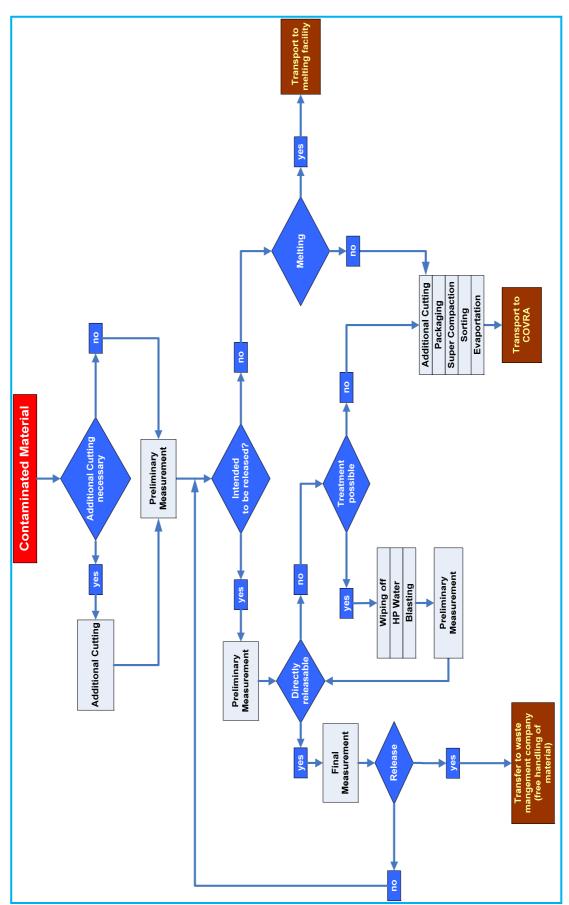


Figure 7-3: General procedure for waste treatment at the Borssele NPP

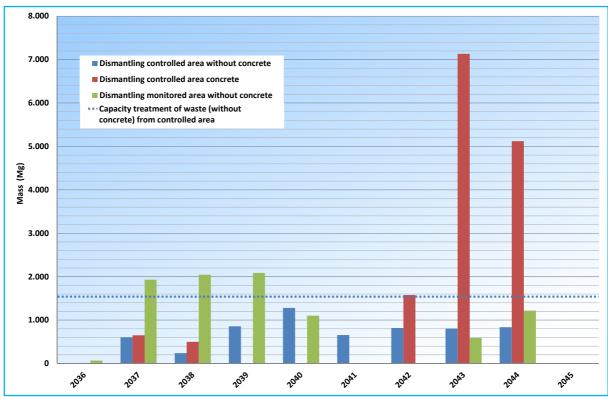


Figure 7-4: Mass flow dismantling

7.4 Packaging of Radioactive Waste

As in the 2010's study two variants, the KONRAD and the COVRA variant are considered. They differ in the approaches for the packaging concept. As shown in Figure 7-1 an amount 2.203 Mg has to be stored in a repository finally. In the decision which containers have to be considered for this the KONRAD and the COVRA variant differ.

As far as no additional shielding is needed, the cost calculation described so far is based on the packaging of the radioactive waste in rectangular steel plate containers, the so called KONRAD Type II Containers, named after the technical acceptance criteria for the KONRAD repository in Germany. Thus the unmodified KONRAD variant approves the choice of the containers presented in Table 7-3.

Packages	Height [m]	Width [m]	Length [m]	Diameter [m]	Volume (outside) [m³]
COVRA 090 l drum	0,63			0,45	0,10
COVRA 200 I drum (solid waste)	0,92			0,58	0,24
Konrad II (NC)	1,70	1,70	1,60		4,62
Konrad II (HC) 100mm Fe	1,70	1,70	1,60		4,62
Konrad II (HC) 030mm Fe	1,70	1,70	1,60		4,62
MOSAIK Type II (Type A)	1,50			1,06	1,32
MOSAIK Type II / 060mm Fe	1,50			1,06	1,32

Table 7-3: Container data KONRAD variant



The legal situation in the Netherlands requires that all the waste has to be sent to the COVRA as the central national facility for treatment and interim storage of radioactive waste. COVRA approves of the chosen container concept, however asks a high price in comparison to COVRA containers (see Table 9-5) although the KONRAD containers require less volume. However an alternative packaging concept is used for the calculation of the COVRA variant. It approves the choice of the containers presented in Table 7-4. The consideration of only COVRA containers means following changes in the packaging concept:

- Radioactive waste from contaminated auxiliary systems is packaged in 200 litre drums rather than KONRAD Type II container as far as possible considering the dose rate.
- Radioactive waste from contaminated auxiliary systems and from primary loop components with higher dose rate values is packaged in cylindrical 1000 litre containers rather than KONRAD Type II containers.
- Radioactive waste from the activated components is packaged in MOSAIK cast iron casks as well as in cylindrical 1.000 litre containers.

Packages	Height [m]	Diameter [m]	Volume (outside) [m³]
COVRA 090 l drum	0,63	0,45	0,10
COVRA 200 l drum (solid waste)	0,92	0,58	0,24
COVRA 1000 I	1,25	1,00	0,98
COVRA 1000 I / 30mm Fe	1,25	1,00	0,98
COVRA 1000 I / 60mm Fe	1,25	1,00	0,98
MOSAIK Type II (Type A)	1,50	1,06	1,32
MOSAIK Type II / 060mm Fe	1,50	1,06	1,32

Table 7-4: Container data COVRA variant

The packaging factors given in Table 7-5 define the quantities of different waste types that fit into each package type, which were collected and evaluated by NIS during several D&D projects. They are used to calculate the needed number of the different packages. The necessary disposal volume is calculated by the number of containers multiplied with the outer volume of the containers (given in Table 7-3 and Table 7-4). The results of these calculations show Table 7-6. Drawings are shown in Appendix /D/. The number of packages per year is given in Appendix /E/.

Package Type	Waste Type	Capacity [kg]
COVRA 090 l drum	EPZ experience factor	42,6
COVRA 0901 druiii	Standard component	62,5
	Concentrates	180
	Concrete rubble	360
COVRA 200 l drum	Packaging 4 EPZ standard pellets	350
	Standard 4 pellets	350
	Standard component	210
	200-I drum filled with steel parts	320
COVRA 1.000 I	Standard Component	450
	Concrete blocks, shielding blocks	500
COVRA 1000 I / 30mm Fe	Standard component	340
COVRA 1000 I / 60mm Fe	Standard component	260
	Components light (without supercompaction)	1.750
Konrad II (NC)	Concrete blocks, shielding blocks	4.300
Romad ii (NC)	Concrete rubble	3.500
	Standard component	5.700
Konrad II (HC) 100mm Fe	RPV internals	2.000
	Components light (without supercompaction)	1.600
Konrad II (HC) 030mm Fe	Concrete rubble	2.700
Komad ii (iic) osoiiiii Fe	RPV	4.600
	Standard component	4.800
MOSAIK Type II (Type-A)	RPV	800
WOSAIK Type II (Type-A)	RPV internals	500
MOSAIK Type II / 060mm Fe	RPV internals	380

Table 7-5: Packaging Factors

	KONRAD Variant		COVRA Variant	
Kind of Waste Package	Number of Waste Packages	Repository Volume [m³]	Number of Waste Packages	Repository Volume [m³]
COVRA 090 l drum	6.763		8.984	
COVRA 200 I drum (solid waste)	2.210	537	9.862	2.397
COVRA 1000 I			864	848
COVRA 1000 I / 30mm Fe			288	283
COVRA 1000 I / 60mm Fe			152	149
Konrad II (NC)	325	1.502		
Konrad II (HC) 100mm Fe	20	91		
Konrad II (HC) 030mm Fe	30	136		
MOSAIK Type II (Type A)	114	151	94	124
MOSAIK Type II / 060mm Fe	42	55	42	56
Totals		2.473		3.857

Table 7-6: Number of required repository packages and volumes

8 Planning

8.1 Work Breakdown Structure

The Work Breakdown Structure (WBS) includes all activities to be necessary for the decommissioning. The WBS has a hierarchical organisation divided into several levels which are defined as follows:

- Project (Working package)
- Sub-Project

The actual defined WBS bases on the 2010 chosen to ensure continuity and consistency. Table 8-1: compares it with the 2012 released OECD/NEA list /11/.

01 Pre-decommissioning actions	01 PRE-DECOMMISSIONING ACTIONS
02 Facility shutdown activities	02 PREPARATORY WORK
03 Additional activities for safe enclosure or entombment	/ /
04 Dismantling activities within the controlled area	05 DISMANTLING CONTAMINATED MATERIAL
	06 DISMANTLING PRIMARY LOOP COMPONENTS
	07 DISMANTLING RPV INTERNALS
	08 DISMANTLING RPV
	09 DISMANTLING BIOLOGICAL SHIELD
	10 DISMANTLING REMAINING SYSTEMS
	11 CLEARANCE OF BUILDING STRUCTURES
05 Waste processing, storage and disposal	15 WASTE PROCESSING, STORAGE AND DISPOSAL
06 Site infrastructure and operation	14 SITE SECURITY, SURVEILLANCE AND MAINTENANCE
07 Conventional dismantling, demolition and site restoration	12 CONVENTIONAL DEMOLITION AND SITE RESTORATION
	04 DISMANTLING OUTSIDE CONTROLLED AREA
08 Project management, engineering and support	13 PROJECT MANAGEMENT, ENGINEERING AND SITE SUPPORT
09 Research and development	/ /
10 Fuel and nuclear material	03 OPERATIONAL WASTE
11 Miscellaneous expenditures	04 DISMANTLING OUTSIDE CONTROLLED AREA

Table 8-1: Cross link table OECD/NEA and KCB 2015 WBS

8.1.1 Level 1: Project (Working package)

The level 1 "Project" divides the Borssele decommissioning in several separate projects according to the "IAEA List of Standardised Cost Items" but completed by some additional items and re-arranged in the sequence for reasons of better cost organisation. The defined projects are listed in Table 8-2.

8.1.2 Level 2: Sub-Projects

A Sub-Project indicates the specific details of a project, e.g. localisation of dismantling work, details of tasks, kind of material. The list of sub-projects is given in Table 8-2.

24 225 2500 W W2810 W W A 47 0 W S	[20 510 441 2 110 510 10 10 10 10 10 10 10 10 10 10 10 10 1	
01 PRE-DECOMMISSIONING ACTIONS	09 DISMANTLING BIOLOGICAL SHIELD	
Collection Technical Data	Planning and Engineering	
Project Planning and Engineering	Attendant Measures	
Licensing Procedure	Preparation Work	
02 PREPARATORY WORK	Execution Project	
Shut Down of Systems	10 DISMANTLING REMAINING SYSTEMS	
Modification of Equipment	Planning and Engineering	
Decontamination Primary Circuit	Attendant Measures	
Removal of mobile Core Internals	Execution Project	
Erection Container Storage Area	11 CLEARANCE OF BUILDING STRUCTURES	
Preparation of Material Treatment Facility (Geb. 07)	Planning and Engineering	
Clearance Measurement Facility	Attendant Measures	
Material Sluice	Execution Project	
Asbestos Material	12 CONVENTIONAL DEMOLITION AND SITE RESTORATION	
Improvement Infrastructure	Planning and Engineering	
03 OPERATIONAL WASTE	Attendant Measures	
Removal Operational Waste and Material	Execution Project	
04 DISMANTLING OUTSIDE CONTROLLED AREA	13 PROJECT MANAGEMENT, ENGINEERING AND SITE SUPPORT	
Turbine Building	Administration	
Other Buildings in Monitored Area	Finance and accountancy	
05 DISMANTLING CONTAMINATED MATERIAL	Personnel management	
Auxiliary Building	Technical Project Management	
Reactor Building	Project Controlling	
06 DISMANTLING PRIMARY LOOP COMPONENTS	Documentation	
Planning and Engineering	IT	
Attendant Measures	14 SITE SECURITY, SURVEILLANCE AND MAINTENANCE	
Preparation Work	Operation, Maintenance	
Execution Project	Radiological Protection/Health Physics	
07 DISMANTLING RPV INTERNALS	Guarding	
Planning and Engineering	Surveillance	
Attendant Measures	Other Operational Expenditures	
Preparation Work	15 WASTE PROCESSING, STORAGE AND DISPOSAL	
Execution Project	Treatment of Dismantled Material at KCB	
08 DISMANTLING RPV	Treatment of Secondary Waste at KCB	
Planning and Engineering	Container Cost Primary Waste	
Attendant Measures	Container Cost Secondary Waste	
Preparation Work	External Treatment of radioactive waste	
Execution Project	Repository cost radioactive waste	
	Conventional Waste	
	Revenues material sales	
	Attendant Measures	

Table 8-2: List of Projects and Sub-Projects

8.1.3 Other levels

The entities at the other levels are not listed here in the text. The total WBS for the D&D project, including all activities at all levels, is given in Appendix /C/.

8.2 Generic sequence for the D&D project

The generic sequence for the D&D project respecting the elements of the defined work breakdown structure is presented in Appendix /B/. This detailed schedule considers the rough sequence described in chapter 4.



8.3 Content of the Elements in the WBS Level 1 "Projects"

8.3.1 Pre-Decommissioning Actions

Project 1 "Pre-Decommissioning Actions" contains the following activities before the final shutdown of the plant assigned to the operation phase:

- data collection and analysis of the technical and radiological status of the plan.
 All information conserved during operation applying to the operational license will be regarded. Also the valuable know-how in the operating staff of the installation will be taken into account as the immediate dismantling prevents its loss.
- PCB registration program
- project planning and engineering, decommissioning plan, capacity calculation for installations and dismantling equipment, personnel requirements and time schedule
- generation of the licensing documents, in particular the safety analysis and the environmental impact analysis
- licensing procedure, which covers the approval of a general license for the D&D project

The planning and the licensing include:

- conceptual planning
- planning of the licensing proceedings and issue of the necessary documents
- expertise proceedings
- license proceedings
- detailed planning

8.3.2 Preparatory Work

Project 2 contains preparatory activities for the D&D project assigned to the post operation phase. The project 2 contains the following sub-projects:

- shutdown of systems
- modification of systems and equipment
- decontamination primary circuit
- removal of mobile core internals
- erection container storage area
- preparation of material treatment facilities
- preparation of clearance measurement facility
- preparation of material sluice
- asbestos clean up
- improvement infrastructure

These activities are related exclusively to the D&D project and are not comparable to operational activities.

8.3.2.1 Shutdown of Systems

The shutdown of a system for dismantling includes the physical separation from systems which must remain in operation for operational or safety reasons. This separation is a prerequisite for the dismantling work. The shutdown for dismantling is different from the shut-



down for maintenance and it requires a careful planning. Therefore the final shutdown of systems belongs to the D&D project, not to the operation.

The shutdown of systems includes costs and expenditures for:

- preparation of technical concepts
- discussions with experts and authorities
- performance of the shutdown

The performance of shutdown includes mainly the draining of systems and components, the separation from electrical power supply, and locking valves (removal of actuators or hand wheels).

8.3.2.2 Modifications of systems and equipment

Modifications of systems and equipment necessary for the remaining safety operation of the plant will be performed to reduce the expenses for maintenance and recurring safety checks. The preparatory activities will be coordinated with the planning so that no situations occur which can disturb the later dismantling.

The systems to be modified are e.g. the heating, the evaporation of liquid waste and the pressurized air system. The new systems substitute the former ones and they will be installed at other places.

8.3.2.3 Decontamination of Primary Circuit

The primary circuit will be decontaminated to reduce the dose rate for further dismantling activities. These measures are performed by an external company. According to the experiences made in the decontamination actions in Germany (Obrigheim, Mülheim-Kärlich, Stade and Grafenrheinfeld) it can be assumed that the dose rate will be reduced in average by a factor of 10 - 20; on dedicated places by a factor up to 1.000.

8.3.2.4 Removal of Mobile Core Internals

The removal of mobile core internals, i.e. control rods, core instrumentation lances and fuel assembly channels will be performed closely after plant shutdown. The components will be cut into pieces and packaged in the reactor cavity. This action will be performed by an external company.

8.3.2.5 Preparation of a container storage areas

During the decommissioning period a higher amount and other types of waste is treated and stored onsite than during operation. So container storage areas to provide internal transports to the waste storage building will be prepared. Furthermore the waste storage building has to be adapted and improved respecting the higher amount of containers and packages which will be sent to COVRA.

8.3.2.6 Preparation of material treatment facility

The treatment, additional segmentation and packaging of dismantled components is planned to be performed at several locations. The locations will be identified within the planning work during the end of the OP and during the POP. In the material treatment facility following tasks will be performed:





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- segmentation and packaging of contaminated material
- segmentation and packaging of concrete material
- decontamination of dismantled components
- clearance of dismantled components
- handling of liquid and solid secondary waste

The equipment for cutting and packaging of the activated components is developed especially for the remote controlled work. It is assigned directly to the dismantling activities. The following equipment is included:

- air exhaust and filter systems
- cementation station for containers
- centrifuge
- connection installations
- deco-box abrasive
- lifting devices
- manual saws
- measuring station for containers
- press
- scissors
- shielding
- silo station for cement and gravel
- stationary saw
- stationary thermic cutting device
- storage tanks
- weighting station for containers
- decontamination box water jet

The existing waste treatment equipment will be largely used or improved.

8.3.2.7 Preparation of clearance measurement facility

Additionally to the equipment listed above clearance measurement equipment will be installed.

8.3.2.8 Improvement infrastructure incl. preparation of the material sluice

The complete infrastructure will be improved. This covers for example lifting devices, conveyers and trolleys to provide the mass flow during the decommissioning period. Also the existing material sluice is included. It has to be prepared to the decommissioning requirements especially to the higher frequency of transports during the dismantling phase of the decommissioning project.

8.3.2.9 Asbestos clean-up

During the preparatory work the asbestos clean-up is planned. Planning, removal and disposal are included.



8.3.2.10 Operational waste

Project 3 "operational waste" covers the management of the remaining operational effluents, media, and other waste from operation. For the cost calculation described in this study it is assumed that the costs for

- packaging the fuel elements
- transport and storage container
- external transport
- reprocessing or final repository

are not considered. As the removal of fuel elements is an important action in the time schedule the packaging will be taken into account but without costs.

The remaining operational waste will be treated to a conditioned form and packaged in appropriate containers as used during the operation of the plant. The waste will be transported to the COVRA facility.

Oils and lubricants from turbine and transformers which are not contaminated will be sent to a conventional recycling or disposal facility.

8.3.3 Dismantling Outside Controlled Area

The D&D project covers all buildings and installations of the Borssele NPP in the controlled area as well as in the monitored area. This project contains the dismantling and removal of components and equipment being located in the buildings of monitored area listed in Table 2-1 and not needed anymore. This project is mainly assigned to the DP. But it is planned to execute some tasks already during the POP.

8.3.4 Dismantling Contaminated Material

The dismantling of contaminated material covers the dismantling of systems and components within the controlled area which are not needed anymore for the remaining dismantling and operation. This project is divided in two particular projects, one for the reactor building and one for the auxiliary building. For each part planning, preparation and execution work is considered. The dismantling of equipment such as steel girders, stairs, doors, lighting, cable trays, and so on is not contained in this project. This project is mainly assigned to the DP. But it is planned to execute some tasks especially planning and preparation work already during the POP.

8.3.5 Dismantling Primary Loop Components

Project 6 covers the dismantling of the main components of the primary loop:

- steam generators
- pressurizer
- pressurizer relief tank
- primary pumps and motors
- primary loop pipes

It includes planning and preparation work as well as the execution. This project is assigned to the DP.



8.3.6 Dismantling Reactor Pressure Vessel Internals

This project covers the removal of the RPV internals such as grid plates and the core structure, which cannot be removed with normal operation procedures. It includes planning and preparation work as well as the execution. In detail for preparation the following steps are evaluated:

- preparation reactor pool
- installation and test of the dismantling equipment (remote control equipment, cutting tools, cameras)
- installation of shielding elements as needed
- training of staff

The execution of the project includes the dismantling and cutting activities as well as the clearing of the site. This project is assigned to the DP.

8.3.7 Dismantling Reactor Pressure Vessel

This project covers the complete dismantling of the RPV. It includes planning and preparation work as well as the execution. In detail for preparation the following steps are evaluated:

- preparation reactor pool
- installation and test of the dismantling equipment
- training of staff

The execution of the project includes the dismantling and cutting activities as well as the clearing of the site. This project is assigned to the DP.

8.3.8 Dismantling Biological Shield

Beside the activated and non-activated part of the biological shield this project covers the dismantling of the fuel and the reactor pool structures.. It includes planning and preparation work as well as the execution. In detail for preparation the following steps are evaluated:

- preparation reactor pool
- installation and test of the dismantling equipment
- training of staff

The execution of the project includes the dismantling, cutting, segmentation and packaging activities as well as the clearing of the site. This project is assigned to the DP.

8.3.9 Dismantling Remaining Systems

This project includes the dismantling of the remaining systems. The execution of it is subdivided into the dismantling of the remaining systems in the

- auxiliary building
- the containment of the reactor building
- the annulus of the reactor building
- the turbine hall
- and the remaining building of the monitored area.



All remaining contaminated material, systems and components which were needed before will be removed here. This project is assigned to the DP.

8.3.10 Clearance of Building Structures

In this project the efforts for decontamination in the controlled area, thus reactor and auxiliary building, is evaluated to realize a radioactivity below the permissible values. The necessary measures to verify the results are included. Additionally the removal of PCB surface coating is considered. This project is assigned to the DP.

8.3.11 Conventional demolition and site restoration

This project includes the complete demolition and removal of the cleared buildings located in the controlled area as well as in the monitored area. Additionally the removal of the piles rising in the ground with required trench support is evaluated. Further measurements as filling the building pits and landscaping to reach the "green field" status are implied. This project is assigned to the DP.

8.3.12 Project Management, Engineering and Site Support

This project covers the functions and services concerning project management, engineering and site support needed during the D&D project. This means the consideration of the following positions:

- plant administration
- quality assurance
- environmental protection
- plant and working safety
- public relations
- external experts
- finance and accountancy
- personnel management
- technical project management
- project controlling
- documentation
- IT including staff, hard- and software
- finance and accountancy
- personnel management
- technical project management
- project controlling
- documentation
- support services, IT, procurement

The evaluation of these efforts considers the progress of the D&D project. This project is assigned to all three phases.

8.3.13 Site Security, surveillance and maintenance

This project contains the necessary measures for the retention of a safe operation of the plant and the inclusion of the remaining radioactivity during the decommissioning work. It





contains operation and maintenance efforts, radiological protection and health physics, guarding and other operational expenditures.

Operation and maintenance considers the following positions:

- control room staff
- staff for mechanical, electrical and civil workshops
- efforts for the operation of the controlled area entrance
- efforts for the operation of the nuclear laundry
- efforts for the operation of the nuclear sanitary
- provision of energy, water, steam, oil and gas
- efforts for mechanical and electrical maintenance including staff and consumables
- efforts for the erection of shielding and scaffoldings
- staff for the generation of operational and working orders
- civil engineering staff
- accompanying decontamination efforts

The radiological protection and health physics contains following positions including staff and consumables:

- general plant health physics
- chemical laboratory
- working safety
- fire protection

Lastly following other operational expenditures are evaluated:

- guarding staff
- housekeeping staff
- canteen staff
- staff for conventional cleaning and the plant outdoor area
- costs for assurance
- costs for mail, communication and office material
- education costs
- costs for medical service

Comparable to project management, engineering and site support project the evaluation respects the respects the progress of the D&D project. This project is assigned to the POP and to the DP.

8.3.14 Waste Processing, Storage and Disposal

This project comprises activities for the treatment and packaging of the dismantled components either for treatment and packaging of the secondary waste. In particular it contains:

- staff for waste treatment (decontamination, cutting, release measurements etc.)
- consumables for waste treatment
- container costs
- COVRA costs including transport and storage





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- external costs for melting
- repository costs for conventional waste and PCB material
- revenues of material sales

This project is assigned to the POP and to the DP.



9 Decommissioning costs

9.1 Introduction

For almost 35 years NIS has been involved in nuclear D&D projects and has analysed them from a technical and an economical point of view. These experiences have steadily been included in the NIS calculation programme CORA & CALCOM to assure an up-to-date cost calculation with regard to modern techniques.

Today, CORA & CALCOM is used by NIS for the annual update of the decommissioning cost calculations for the German NPPs, and the operators in the actual D&D projects at Stade, Würgassen, Obrigheim and Karlsruhe use it for the ongoing projects.

Since the 1990s the NIS experience in this field led to several contracts in foreign countries, e.g. Belgium, The Netherlands, Slovenia, Switzerland and Lithuania.

Important for NIS are the D&D projects:

- KKN (Niederaichbach) prototype NPP (100 MWe, CO2 cooled and D2O moderated) with NIS as a member of the consortium for the decommissioning work
- VAK (Kahl) the first NPP in Germany decommissioned by Nukem/NIS
- KWW (Würgassen), KKS (Stade), KWO (Obrigheim), and KMK (Mülheim-Kärlich), whereby NIS is responsible for the decommissioning cost estimation, strategic planning and controlling purposes. The owners of KWW, KKS, and KWO have purchased the NIS software (CORA & CALCOM) which was adapted by NIS to the special needs of the D&D projects at the sites.
- WAK (Karlsruhe) fuel reprocessing plant works with CORA & CALCOM with technical and personnel support of NIS. Costs for the decommissioning of the reprocessing plant and the research facilities in Karlsruhe were calculated since 1995 and updated regularly last in 2015. Moreover WAK has bought the licence for the use of CORA/CALCOM.
- Other plants in the decommissioning stage in Germany are at Greifswald and at Rheinsberg. Here NIS has provided the know-how on decommissioning cost calculations and a series of computer tools to the owner EWN so that he is able to follow up his own D&D projects.

For the German NPPs still in operation, NIS prepares every year expert reports for liability purposes, relevant for the company balances.

As shown by the list before NIS does not only calculate the cost for future D&D projects, it is also directly involved in the project management work for real projects. NIS people are integrated in the cost planning teams at the site and get a profound insight in the projects.

9.2 Audits

9.2.1 Quality assurance

The NIS QA system is described in a QA manual. The NIS QA system is certified according EN ISO 9001.

The application of the QA rules is verified by regular internal and external audits.



9.2.2 Audits by External Organisations

The cost calculation methods applied by NIS were checked by several external organisations and companies:

- November 1997: Audit by Bundesamt für Finanzen (German federal tax authority)
- December 1997: Audit by University of Delft, The Netherlands (in the course of decommissioning cost estimates for the Dodewaard NPP)
- November 1998: Peer review by IAEA (in the course of the decommissioning cost estimates for the KRŠKO NPP)
- February 2002: Audit by HSK (Swiss authority) for cost estimates for Swiss NPPs
- August 2010: IAEA group of experts concerning decommissioning cost calculation of the KRŠKO NPP
- August 2011: Audit by GRS (Gesellschaft für Anlage- und Reaktorsicherheit) concerning cost calculation for two WAK facilities (Multipurpose and compact sodium-cooled nuclear reactor)
- December 2013 and 2014: Extensive audits by an external German auditing and accounting firm concerning cost calculation of the RWE, E.ON and VENE NPPs

9.3 Software tools and calculation models

The purpose of the following brief overview is to give a basic understanding of the software principles of CORA & CALCOM.

CORA & CALCOM are database applications which were especially developed by NIS for the decommissioning cost calculation of nuclear D&D projects. They are working on the base of either MS-ACCESS or ORACLE applications:

- CORA is used for the processing of the plant data: physical inventory, room data, radiological inventory, waste processing data, waste packaging data;
- CALCOM is used for planning and estimation of the D&D project/costs.

9.3.1 CORA: Inventory Tool

The NIS database CORA (Component Registration and Analysis) is used for the processing of the plant data for decommissioning purposes, especially for the determination of physical inventory, room data, radiological inventory, waste processing data, waste packaging data. CORA is developed on the platform of the Microsoft product MS-ACCESS.

For the Borssele NPP almost ten thousand entities corresponding as components are listed. The following information is assigned to the registered components:

- location (building and room for components corresponding to the controlled area)
- type of component
- type of material
- radiological evaluation (radiological category, expected waste treatment including proposed interim and final storage containers, amount of secondary waste caused by dismantling and treating the component)

Based on these technical and radiological data CORA calculates results important for the evaluation of the waste management. Results used for the actual Borssele NPP study are:



- mass distribution to different waste treatment procedures
- calculation of the expected secondary waste
- packaging data numbers of needed waste containers
- calculation of the repository volume

These results are available in total or classified respecting the assignments listed above.

9.3.2 CALCOM: Project cost estimation and planning tool

CALCOM basically provides following tasks:

- project planning
- project management structure setup and maintenance
- management of project schedule
- resource management
- cost estimates:
- data exchange with MS-PROJECT

All results of this study concerning time scheduling, costs, required personnel and dose rates are calculated by CALCOM.

9.3.2.1 Project Management Structure Setup

The structure of a project management plan is hierarchical and is defined considering the needs of individual facilities and the actual boundary conditions for the D&D project. Here the work breakdown structure presented in chapter 8.1 is implemented. Additionally the sequence of tasks and their dependencies respecting the decommissioning strategy described in chapter 4 are transferred to the tool.

Due to the bottom up principle CALCOM can deliver results at any level of work breakdown structure, but the calculation by means of evaluation and assignments takes place in the lowest. The superior level will then summarise the results for the subsidiary tasks.

9.3.2.2 Project Cost Calculation and Resource Management

The base of the cost calculation is the technical and radiological inventory of the plant registered in CORA (see chapter 9.3.1). This includes the calculation of the decommissioning masses, of the radioactive waste and the reusable material, as well as the number and types of packages. The decommissioning cost calculation presupposes an existing project structure plan that identifies all necessary decommissioning activities from the beginning to the end. The cost calculation for a decommissioning task comprises the following types of costs:

- personnel costs for internal and external personnel (including personnel dose estimates, if wanted)
- investment costs
- consumable costs
- other costs (e.g. melting, interim storage, repository)

Different calculation models are available for each of the cost types:



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- manual calculation (all necessary data are given by the user, the module will calculate
 the cost; e.g. personnel cost are resulting from the duration of the task multiplied with
 the hourly wage rate of the involved staff with its qualifications)
- mass dependent calculation: a plant specific value, e. g. the mass (kg) of a component, or the mass (kg) of a set of components, or the surface (m²) of a building area, will be used in combination with a specific working factor (Man-hour/kg or Man-hour/m²) to calculate the decommissioning data (costs, duration, etc.)
- time dependent calculation: the duration of a decommissioning task will be defined by other decommissioning tasks, e.g. radiological protection in parallel to the dismantling work
- expenditure of labour dependent calculation: the labour for one task is related to the labour of other tasks, e. g. the expenditure of labour for site management is a percentage of the expenditure of labour for dismantling activities; the relation is represented by a specific factor (Man-hour/Man-hour)

Since mass, time and labour dependent calculation use specific factors, the module provides for the possibility to store and maintain these factors. Due to growing practical experience in a D&D project these factors may need to be updated. During task calculation correction parameters are available for specific factor; taking different working conditions into account (e.g. work under radiation protection measures, work on scaffoldings).

Along with the calculation of the personnel cost this module will provide for the possibility of a resource management (separated by own and external personnel). For this purpose several management and analysis functionalities are implemented.

Since this module uses data from the registration module it will be possible to assign cask cost and storage cost, which can be estimated in the Registration Module, to a decommissioning task.

All rates or prices for personnel, equipment, consumable and other costs are stored in the CALCOM database. For realistic results in case long-term calculations these prices can be escalated with inflation rates (average rate or rates for every year separately).

For cost comparison purposes the module will provide for the possibility to store actual task cost.

9.3.2.3 Definition and Use of Specific Factors

Specific factors allow the transmission of experiences on decommissioning work from one project to another project using some plant specific reference indicators which is in the most relevant cases mass, radioactivity or surface of an item.

CALCOM use such specific factors in different ways:

- Working factors e.g. kg-dismantling / Man-hour factors can be used for the calculation
 of the dismantling effort; factors for Man-hour (radiation protection) / Man-hour (dismantling) defines the relation between different kinds of work and allows an easy way
 to calculate the cost
- Cost factors for consumables and investment cost, e.g. €/kg provides also an appropriate way for the cost estimation.

The CALCOM database contains the needed specific factors which are collected by NIS during more than 35 years experiences. Besides the use of different specific factors, CALCOM allows also adapting the specific factors to the local circumstances directly in the calculation



file. So it is possible to use the same specific factor for similar activities, but to make a finetuning for each individual activity depending on the different circumstances.

9.4 Basic Assumptions for the Decommissioning Calculation

The cost estimation for the decommissioning of the Borssele NPP refers to future activities and costs. This future is still far away and so many factors and boundary conditions are not known yet. The calculations must use reasonable assumptions.

The following gives these definitions separated in assumptions with and without costs.

9.4.1 Non-cost assumptions

The following assumptions not directly referring to costs are made in the actual study:

- The decommissioning project covers the POP, the DP and the pre-decommissioning actions.
- The goal of the decontamination and dismantling activities is to reach the "green field" status. This means the removal of all buildings listed in Table 2-1 including various underground structures especially the foundation piles.
- The dismantling plan bases on component, equipment and building masses listed in Table 2-1, Table 2-2, Table 2-3 and Table 2-5.
- The dismantling of the NPP starts immediately after the final shutdown. A deferred dismantling after an enclosure period is not taken into account.
- The final shut down is planned on 31st December 2033.
- The plant will be decommissioned after a normal operation life without accidents; the
 decommissioning is planned and well prepared. In the period between the last and the
 actual study no incidents occurred having an impact on the actual study.
- The D&D project considers all necessary measures after the final shutdown and the measures before shutdown if such measures serve the preparation of the D&D project.
- After final shutdown of the reactor there is a post operational phase with a duration of 3,5 years.
- The spent fuel and the operational waste from the operation time will be removed from the plant before the end of the post operational phase.
- At the beginning of the decommissioning activities all systems and installations at the site are in function. The equipment and facilities to be used for decommissioning work comply with the state of the art.
- At the Borssele site there is an interim storage building for cemented waste. This building will also be used for the dismantling project and adapted if necessary.
- For external treatment of radioactive waste (e.g. melting) it is assumed that suitable plants are available and acceptance criteria are in place.
- All material in the controlled area is supposed as being radioactive, unless measurements indicate that the contamination is below the clearance levels.
- The mass specific clearance levels are those specified in the Dutch Radiation Protection Regulations /6/, e.g. 1 Bq/g for Co-60, 10 Bq/g for Eu-152 and for Eu-154
- Surface specific clearance levels are taken from the German "Strahlenschutzverordnung" (Radiation Protection Ordinance), e.g. 1 Bq/cm² for Co-60, Eu-152 and for Eu-154, as in the 2010 study.
- COVRA Radioactive Waste Acceptance Criteria for Disposal /7/, /8/, /9/ apply.





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- On all buildings and site areas outside of the controlled area a measuring program is carried out; it is considered that no contamination will be found outside the controlled area.
- Along with the dismantling of the site all buildings are demolished. The non-radioactive concrete rubble which is produced during the demolition will be transported to a conventional repository.
- The work will be carried out by the staff on site and external companies. External companies are charged if it is required for specific decommissioning activities or if the capacity of the staff on site is not sufficient.
- The radiation exposure is kept ALARA. In any case the radiation exposure per person is limited to 20 mSv per year. This is the current Dutch dose limit for workers occupationally exposed to radiation.
- An asbestos restoration is considered during the post operational phase.
- The containers listed in Table 7-3 and Table 7-4 with its packaging factors defined in Table 7-5 are used.
- To estimate the working effort the working factors in Table 9-1 are used. To respect the local circumstance concerning size of component, accessibility, need for protective measures, hoisting or lifting devices as well as scaffoldings adaptions corresponding to Table 9-2 are done. For the COVRA variant calculation there is a further adaption of some working factors presented in Table 9-3 respecting higher cutting efforts because of using smaller COVRA containers instead of KONRAD containers. The working factors were reviewed and adapted if necessary relying on gained experiences since the last study.

Working factor	Value
Cut and Pack Core Internals	8,7 kg / Man-Hour
Dismantling biological shield (activated)	20,0 kg / Man-Hour
Dismantling biological shield (non activated)	100,0 kg / Man-Hour
Dismantling building masses in containment	200,0 kg / Man-Hour
Dismantling controlled area	33,3 kg / Man-Hour
Dismantling outside controlled area	50,0 kg / Man-Hour
Dismantling Primary system components	12,5 kg/Man-Hour
Dismantling remaining systems	117,6 kg / Man-Hour
Dismantling RPV internals	1,4 kg / Man-Hour
Surface abrasion	4,0 kg / Man-Hour
Clearance measurement	1,3 m² / Man-Hour
Removal PCB	0,8 m² / Man-Hour
Accompanying decontamination	10% % of dismantling
Experts / Authorities	10% % of dismantling
Internal Transport	5% % of dismantling
Onsite radiological protection	10% % of dismantling
Projectmanagement	15% % of dismantling
Projectmanagement Monitored Area	10% % of dismantling
Supervision	10% % of dismantling
Supervision Monitored Area	5% % of dismantling

Table 9-1: Working Factors



Working factor	Value of Variation		Value of Variation	
Size of Component	Small	0,2-1	Big	1-3
Accessibility	Bad	0,4-1	Good	1,0
Protective measures	Necessary	0,1-1	No	1-1,2
Hoisting or Lifting devices	No	0,2-1	Available	0,8-1
Scaffolding	Necessary	0,2-1	No	1,0

Table 9-2: Adaption of Working Factors to Local Situations

	Value "KONRAD"	Value "COVRA"
Working Factors Dismantling		
Dismantling controlled area	33,3 kg / Man-Hour	27,0 kg / Man-Hour
Dismantling Primary system components	12,5 kg / Man-Hour	9,0 kg / Man-Hour
Dismantling remaining systems	117,6 kg / Man-Hour	108,0 kg / Man-Hour
Attendant Measurements Dismantling		
Internal Transport	5% % of dismantling	10% % of dismantling
Onsite radiological protection	10% % of dismantling	15% % of dismantling

Table 9-3: Adaption of working factors for COVRA variant

9.4.2 Cost assumptions

The following assumptions referring to costs are made in the actual study:

- Price basis of the cost calculation is 2015; all costs given are without VAT.
- Both actual and net present value costs are estimated; the discount rate is
- The personnel costs are calculated considering the hourly wages listed in Table 9-4.

 The wages for shift personnel contain surcharges for late, night or weekend work. This represents an escalation of for EPZ and for external personnel of the 2010's study.
- The costs for containers and the corresponding COVRA costs including transport and storage presents Table 9-5. The COVRA costs are based on actual costs respecting the actual amount of waste packages handled there.
- The specific cost factors needed for the calculation of consumables and other nonpersonnel costs given in Table 9-6 are used. For the COVRA variant the adapted values shown in Table 9-7 apply.
- For the POP as well as for the DP a separate license is required. In sum are considered.
- The calculation is performed as a best estimate strategy. Risks and contingencies are not included.



Qualification	Cost per Man-hour [€/h]	
	EPZ personnel	External personnel
Engineer 1		
Engineer 2		
Engineer 1 (shift)		
Technician, Foreman, Accountant		
Technician, Foreman (shift)		
Craftsman		
Craftsman (shift)		
Worker		
Guard		

Table 9-4: Qualifications and Wages of the Personnel

Packages	Empty Pack. Costs [€]	COVRA Costs [€]
COVRA 090 l drum	COSTS [C]	[c]
COVRA 200 I drum (solid waste)		
COVRA 1000 I		
COVRA 1000 I / 30mm Fe		
COVRA 1000 I / 60mm Fe		
Konrad II (NC)		
Konrad II (HC) 100mm Fe		
Konrad II (HC) 030mm Fe		
MOSAIK Type II (Type A)		
MOSAIK Type II / 060mm Fe		

Table 9-5: Empty package and COVRA costs per container

Cost factor	Value
Assurance	
Chem Laboratory	
Consumable Workshop Civil	
Consumable Workshop Elec	
Consumable Workshop Mechan	
Education	
Fire Protection Brigade	
IT Hardware	
IT-Software	
Mail, Communication	
Medical Service	
Officematerial	
Provision Energy	
Provision Energy in PO	
Provision Steam, Oil, Heating	
Provision Water	
Recurring Safety Checks	
Cond./Pack. Secondary Liquid (Complete Cost)	
Consumable costs complex dismantling	
Consumable costs demolition	
Consumable costs regular dismantling	
Consumable costs release measurement	
Consumable costs remote controlled dismantling	
Consumable costs surface abrasion	
Consumables Blasting Decontamination	
Consumables Wet Decontamination	
Costs Melting	
Decont Dry Blasting (Complete Cost)	
Demolition buildings	
Invest costs dismantling	
Repository cost PCB material	
Revenue Reinforcement	
Trench supporting work	

Table 9-6: Specific Cost Factors

Cost factor	Value "KONRAD"	Value "COVRA"
Consumable costs complex dismantling		
Consumable costs regular dismantling		

Table 9-7: Adaption of cost factors for COVRA variant

9.5 Results

The present chapter gives the results. It contains the important milestones, costs, required personnel and the dose rate for the KONRAD as well as for the COVRA variant.



9.5.1 Milestones

The main milestones for the Borssele NPP D&D project are shown in Table 9-8. For more information concerning the sequence please refer to Figure 4-2 where the sequence of the D&D project is presented. The complete time schedule for the D&D project is given in Appendix /B/.

Milestones	KONRAD variant	COVRA variant			
Start of decommissioning project (Pre-decommissioning actions)	01/2031	01/2031			
Final shut down	12/2033	12/2033			
Fuel removed	07/2037	07/2037			
Approval decommissioning license	07/2037	07/2037			
Finalisation dismantling RPV	04/2041	06/2041			
Building structures cleared	10/2045	04/2046			
Green field status	04/2048	09/2048			

Table 9-8: Important milestones KONRAD and COVRA variant

For the KONRAD as well as for the COVRA variant the same decommissioning strategy and sequence apply. The delay of the COVRA variant is caused by the higher efforts for dismantling and cutting activities effecting nearly a half year extra work.

9.5.2 Total Cost

9.5.2.1 KONRAD variant

The total costs for the D&D project are calculated . A calculation with a net interest rate of amounts to a net present value of

- Mio€ for the reference date 1st January 2015 and
- Mio€ for the reference date 1st January 2034.

Detailed results of the decommissioning costs calculation are given in the tables and figures below:

- Table 9-9: Variant KONRAD Costs per cost category
- Table 9-10: Variant KONRAD Costs per year, with net present value
- Figure 9-1: Variant KONRAD total costs per year
- Figure 9-2: Variant "KONRAD Costs per year, per cost category

Figure 9-3 shows the total net present value for reference date 1st January 2015, for several net interest rates.

			Cos	ts [Mio€2	015]		
WBS	Total	I	Personne	el	Invest-	Consum-	Others
		Total	EPZ	External	ments	ables	Others
01 PRE-DECOMMISSIONING ACTIONS							
02 PREPARATORY WORK							
03 OPERATIONAL WASTE							
04 DISMANTLING OUTSIDE CONTROLLED AREA							
05 DISMANTLING CONTAMINATED MATERIAL							
06 DISMANTLING PRIMARY LOOP COMPONENTS							
07 DISMANTLING RPV INTERNALS							
08 DISMANTLING RPV							
09 DISMANTLING BIOLOGICAL SHIELD							
10 DISMANTLING REMAINING SYSTEMS							
11 CLEARANCE OF BUILDING STRUCTURES							
12 SITE RESTORATION, CLEANUP AND LANDSCAPING							
13 PROJECT MANAGEMENT, ENGINEERING AND SITE SUPPORT							
14 SITE SECURITY, SURVEILLANCE AND MAINTENANCE							
15 WASTE PROCESSING, STORAGE AND DISPOSAL							
Total							

Table 9-9: Variant KONRAD - Costs per cost category

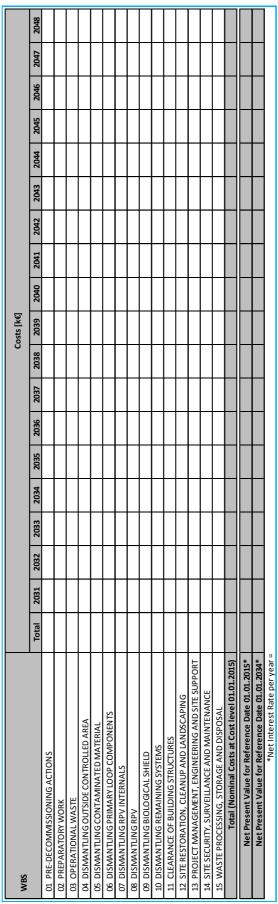


Table 9-10: Variant KONRAD - Costs per year, with net present value



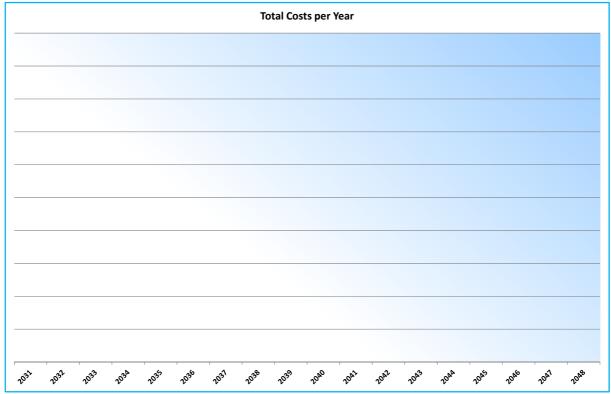


Figure 9-1: Variant KONRAD - total costs per year

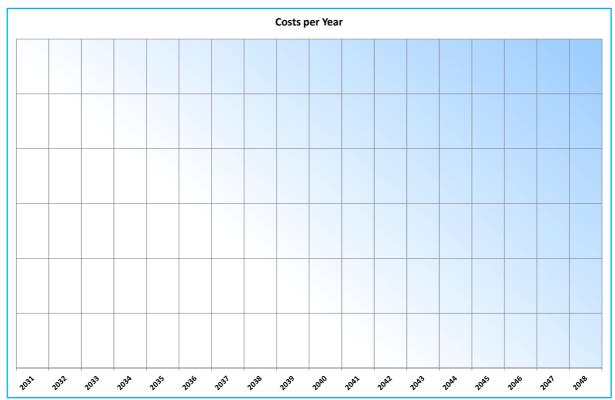


Figure 9-2: Variant "KONRAD - Costs per year, per cost category

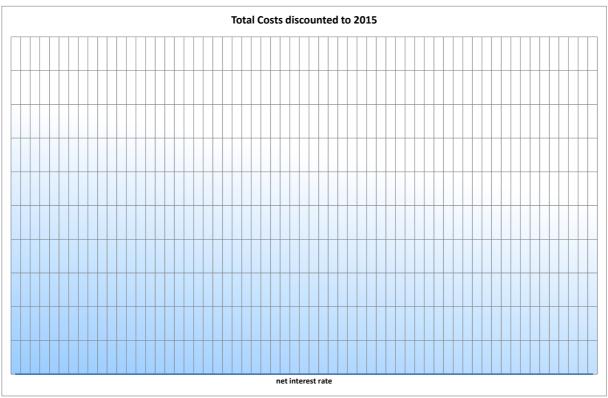


Figure 9-3: Variant KONRAD - Total costs, discounted to 2015, several interest rates

9.5.2.2 COVRA variant

The total costs for the D&D project are calculated as . A calculation with a net interest rate of amounts to a net present value of

- for the reference date 1st January 2015 and
- for the reference date 1st January 2034.

Detailed results of the decommissioning costs calculation are given in the tables and figures below:

- Table 9-11: Variant COVRA Costs per cost category
- Table 9-12: Variant COVRA Costs per year, with net present value
- Figure 9-4: Variant COVRA total costs per year
- Figure 9-5: Variant COVRA costs per year, per cost category

Figure 9-6 shows the total net present value for reference date January 1st, 2015, for several net interest rates.

The costs of the COVRA variant are than the costs of the KONRAD variant. The COVRA variant considers more dismantling efforts. This extends the project duration for 6 months. One the one hand the more extensive dismantling and cutting efforts additionally causing a project prolongation increase the costs at about € On the other hand the selection of containers respecting the boundary conditions of the COVRA variant brings an

	Costs [Mio€2015]											
WBS	Total	I	Personne	el	Invest-	Consum-	Others					
		Total	EPZ	External	ments	ables	Others					
01 PRE-DECOMMISSIONING ACTIONS												
02 PREPARATORY WORK												
03 OPERATIONAL WASTE												
04 DISMANTLING OUTSIDE CONTROLLED AREA												
05 DISMANTLING CONTAMINATED MATERIAL												
06 DISMANTLING PRIMARY LOOP COMPONENTS												
07 DISMANTLING RPV INTERNALS												
08 DISMANTLING RPV												
09 DISMANTLING BIOLOGICAL SHIELD												
10 DISMANTLING REMAINING SYSTEMS												
11 CLEARANCE OF BUILDING STRUCTURES												
12 SITE RESTORATION, CLEANUP AND LANDSCAPING												
13 PROJECT MANAGEMENT, ENGINEERING AND SITE SUPPORT												
14 SITE SECURITY, SURVEILLANCE AND MAINTENANCE												
15 WASTE PROCESSING, STORAGE AND DISPOSAL												
Total												

Table 9-11: Variant COVRA - Costs per cost category

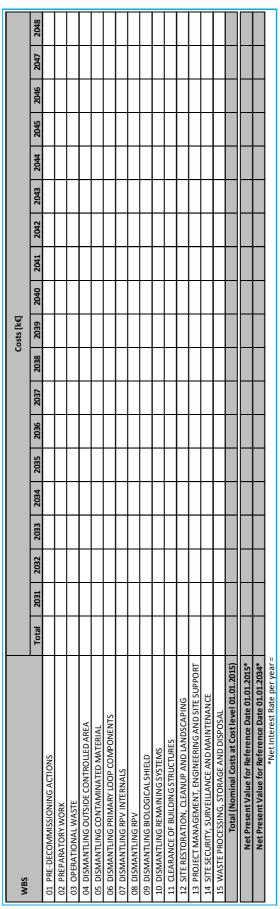


Table 9-12: Variant COVRA - Costs per year, with net present value



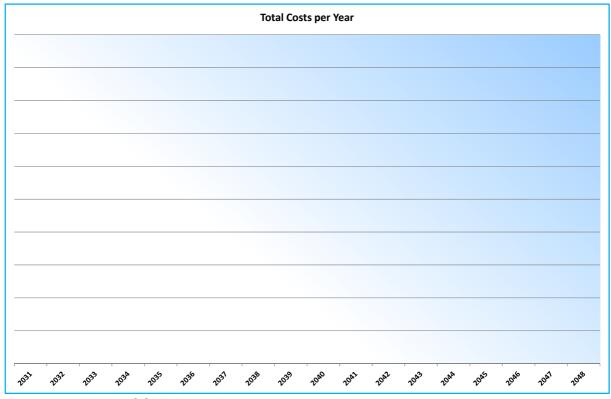


Figure 9-4: Variant COVRA - total costs per year

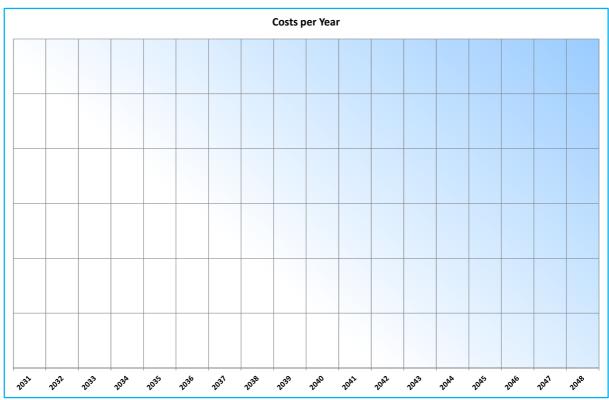


Figure 9-5: Variant COVRA - costs per year, per cost category

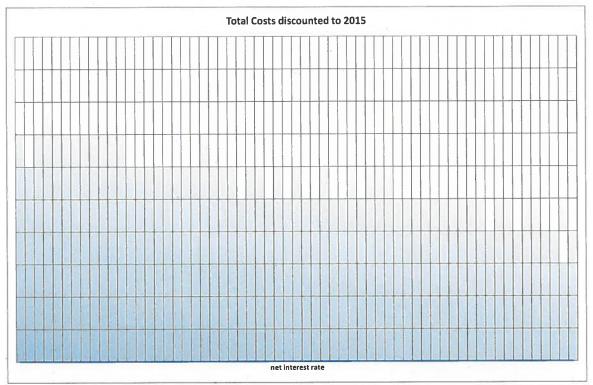


Figure 9-6: Variant COVRA - total costs, discounted to 2015, several interest rates

9.5.3 Personnel requirements: Man-Hours and Dose Rate

9.5.3.1 KONRAD variant

The calculated manpower for the D&D project is 10.1.5 man-years. The total dose rate is 10.1.5 mSv. More detailed information is given in the following figures and tables.

WBS	Dose Rate [mSv]	Man-Years
01 PRE-DECOMMISSIONING ACTIONS	-	28,3
02 PREPARATORY WORK	111	119,3
03 OPERATIONAL WASTE	370	71,4
04 DISMANTLING OUTSIDE CONTROLLED AREA	-	75,3
05 DISMANTLING CONTAMINATED MATERIAL	524	84,9
06 DISMANTLING PRIMARY LOOP COMPONENTS	427	74,0
07 DISMANTLING RPV INTERNALS	194	76,6
08 DISMANTLING RPV	138	46,2
09 DISMANTLING BIOLOGICAL SHIELD	39	80,5
10 DISMANTLING REMAINING SYSTEMS	82	80,2
11 CLEARANCE OF BUILDING STRUCTURES	144	122,4
12 SITE RESTORATION, CLEANUP AND LANDSCAPING	_	63,8
13 PROJECT MANAGEMENT, ENGINEERING AND SITE SUPPORT	_	830,7
14 SITE SECURITY, SURVEILLANCE AND MAINTENANCE	10.1.b	
15 WASTE PROCESSING, STORAGE AND DISPOSAL	642	320,4
Total	10.1.b	

Table 9-13: Variant KONRAD - man-years and dose rate per project



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WBS		Qualification	Man- Yers
01 PRE-DECOMMISSIONING ACTIONS	EPZ	Engineer 1	3,1
	EPZ	Engineer 2	6,3
	EPZ	Foreman/Technician/Accountant	6,3
	External	Engineer 1	3,1
	External	Engineer 2	9,4
02 PREPARATORY WORK	EPZ	Craftsman	8,3
	EPZ	Engineer 1	1,0
	EPZ	Engineer 2	7,1
	EPZ	Foreman/Technician/Accountant	13,7
	EPZ	Worker	5,1
	External	Exp./Auth.	4,6
	External	Craftsman	26,9
	External	Engineer 1	0,5
	External	Engineer 2	22,8
	External	Foreman/Technician/Accountant	13,9
	External	Worker	13,6
	External	Craftsman (shift)	0,9
	External	Engineer 1 (shift)	0,1
		Foreman/Technician (shift)	0,9
03 OPERATIONAL WASTE	EPZ	Craftsman	6,6
	EPZ	Foreman/Technician/Accountant	23,1
	EPZ	Worker	13,6
	External	Craftsman	17,5
	External	Worker	10,5
04 DISMANTLING OUTSIDE CONTROLLED AREA	EPZ	Craftsman	3,0
	EPZ	Engineer 2	1,6
	EPZ	Foreman/Technician/Accountant	3,0
	External	Exp./Auth.	3,5
	External	Craftsman	6,0
	External	Engineer 2	9,1
		Foreman/Technician/Accountant	1,6
	External		47,6
	External	Foreman/Technician (shift)	0,1
05 DISMANTLING CONTAMINATED MATERIAL	EPZ	Craftsman	8,5
	EPZ	Engineer 2	2,2
	EPZ	Foreman/Technician/Accountant	9,3
	EPZ	Worker	4,6
	External	Exp./Auth.	4,0
	External	Craftsman	36,1
	External	Engineer 2	8,9
		Foreman/Technician/Accountant	2,2
		Worker	9,0
06 DISMANTLING PRIMARY LOOP COMPONENTS	EPZ	Craftsman	6,6
	EPZ	Engineer 2	1,8
	EPZ	Foreman/Technician/Accountant	8,8
	External	Exp./Auth.	4,4
	External	Craftsman	16,5
	External	Engineer 2	10,5
		Foreman/Technician/Accountant	14,3
		Worker	11,0
07 DISMANTLING RPV INTERNALS	EPZ	Craftsman	6,3
	EPZ	Engineer 1	2,5
	EPZ	Foreman/Technician/Accountant	8,4
		Exp./Auth.	4,2
		Engineer 1	1,2
		Engineer 2	5,5
		Foreman/Technician/Accountant	6,7
		Worker	5,2
		Craftsman (shift)	24,4
			12,2

Table 9-14: Variant KONRAD – man-years per project (01-07) and qualification

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WBS		Qualification	Man- Yers
08 DISMANTLING RPV	EPZ	Craftsman	4,
	EPZ	Engineer 2	1,
	EPZ	Foreman/Technician/Accountant	5,
	External	Exp./Auth.	2,
		Craftsman	21,
		Engineer 1	7,
		Engineer 2	2
		Foreman/Technician/Accountant	1,
		Craftsman	
	EPZ		6
	EPZ	Engineer 2	2
	EPZ	Foreman/Technician/Accountant	9
		Exp./Auth.	4,
	External	Engineer 2	7,
	External	Foreman/Technician/Accountant	5,
	External	Foreman/Technician (shift)	45,
LO DISMANTLING REMAINING SYSTEMS	EPZ	Craftsman	7,
4	EPZ	Engineer 2	1,
	EPZ	Foreman/Technician/Accountant	9
	External	Exp./Auth.	4
		Craftsman	14
		Engineer 2	7
		Foreman/Technician/Accountant	3
			1 '
	External		10
		Foreman/Technician (shift)	20
	EPZ	Craftsman	12,
	EPZ	Engineer 2	3,
	EPZ	Foreman/Technician/Accountant	8,
	External	Exp./Auth.	8,
	External	Engineer 1	17
	External	Engineer 2	6
		Foreman/Technician/Accountant	3
	External	Craftsman (shift)	63
	EPZ	Engineer 2	0
		Exp./Auth.	5
		Engineer 2	1
			o
		Foreman/Technician/Accountant	1 '
	External		55
	EPZ	Engineer 1	66
	EPZ	Engineer 2	215
	EPZ	Foreman/Technician/Accountant	284
	EPZ	Worker	45
-		Worker Engineer 1	
	External		28
	External External	Engineer 1	28 94
	External External	Engineer 1 Engineer 2	28 94
14 SITE SECURITY, SURVEILLANCE AND MAINTENANCE	External External External	Engineer 1 Engineer 2 Foreman/Technician/Accountant	28 94 97
14 SITE SECURITY, SURVEILLANCE AND MAINTENANCE	External External External 10.1	Engineer 1 Engineer 2 Foreman/Technician/Accountant	28 94 97
	External External External 10.1 EPZ EPZ	Engineer 1 Engineer 2 Foreman/Technician/Accountant Craftsman Foreman/Technician/Accountant	28 94 97 4 89
14 SITE SECURITY, SURVEILLANCE AND MAINTENANCE	External External External 10.1	Engineer 1 Engineer 2 Foreman/Technician/Accountant	28 94 97

Table 9-15: Variant KONRAD - man-years per project (08-15) and qualification

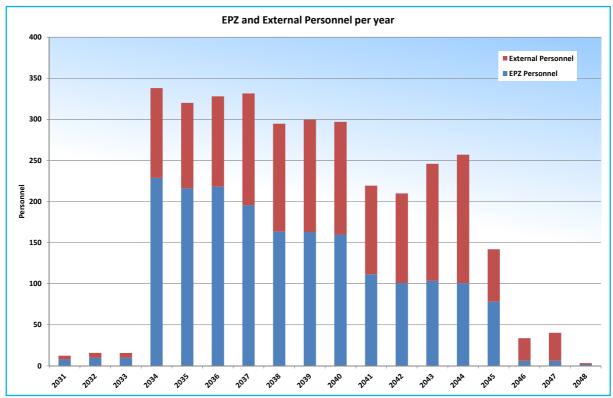


Figure 9-7: Variant KONRAD - EPZ and external personnel per year

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					T	_		_	1		T	Т	1	-	T	Т		-		
2048	6,0	0,8	0,3	0'0	0,3	0'0	1,6		0,0	0,1	0,0	0,1	0,0	0,0	0,0	6'0		0,7		
2047	1,0	3,3	1,0	0,0	1,0	0,0	6,3		0,0	0,5	0,0	0,3	0,0	0,0	0,0	30,6		2,7		
2046	1,0	3,3	1,0	0,0	1,0	0,0	6,3		0,0	0,5	0,0	0,3	0,0	0,0	0,0	24,4		2,2		
2045	1,8	16,2	35,6	11,5	13,1	0,0	78,1		8,3	5,5	0,0	10,7	0,0	0,0	0,1	31,0	0	3,3		
2044	2,0	20,7	45,8	16,1	16,0	0,0	100,6		10,6	10,4	0,0	14,6	12,3	3,9	49,0	44,2		5,4		9
2043	2,0	50,9	49,3	15,2	16,0	0,0	103,4	,	1,8	11,9	0,0	16,3	42,0	3,4	14,8	41,5	0	4,8		
2042	2,0	19,2	48,8	14,8	16,0	0,0	100,8		1,0	9,4	0,0	16,5	11,9	15,3	0,0	44,4		4,5		
2041	5;1	24,6	49,4	14,4	17,9	0,0	111,4		1,8	14,4	0,0	22,6	0,0	11,8	0,0	43,0		1,7		
2040	12,0	34,3	66,2	25,3	22,0	0,0	159,8		7,4	15,1	0,0	15,4	0,1	28,7	0,0	39,6		3,9		
2039	12,3	34,5	2'29	26,5	21,9	0,0	162,9		3,4	15,0	4,7	14,8	0,0	13,8	9,3	43,6		5,1		
2038	12,4	34,0	68,1	26,7	22,0	0,0	163,3		2,2	13,2	9'9	14,4	0,0	4,6	13,3	44,8		5,2		
2037	11,9	43,0	71,9	35,2	33,7	0,0	195,7		2,7	17,9	6'0	15,7	0'0	15,3	1,8	52,1		2,6		
2036	7'6	52,2	77,4	41,3	37,5	0,0	218,1		2,5	19,5	0,0	16,5	0,0	18,2	0,0	24,0		2,1		
2035	7,6	54,3	76,5	38,8	36,7	0,0	216,0 2	_	3,2	19,8	0,1	13,9	6'0	11,5	6'0	25,1		1,5		
2034	10,2	59,7	79,5	39,6	39,8	0,0	228,8 2		2,3	26,0	0,0	15,7	0,0	12,3	0'0	25,1		6'0		F
033	6,7	1,5	1,5	0,0	0,0	0,0	9,7 2	5	3,7	2,2	0,0	0,0	0,0	0,0	0,0	0,0		0,0		
2032 2	8,9	1,5	1,5	0,0	0,0	0,0	8'6		3,8	2,2	0,0	0,0	0,0	0,0	0,0	0,0		0,0		
2031 2	6,3	0,8	8,0	0,0	0,0	0,0	6,7		3,3	1,2	0,0	0,0	0,0	0,0	0,0	0,0		0,0		
Total 2	113,2	424.8	742,3	305,3	294,9	0,0	1.880,4		57,9	185,1	12,3	187,9	67,2	138,6	89,2	514,3	A	46,7		
To	H	4	┡	_	2		H	-		17	-			H		5		Ĺ		
	EPZ Personnel: Engineer 1	Engineer 2	Technician, Foreman, Accountant	Craftsman	Worker	Guard	Sum EPZ Personnel:	External Personnel:	Engineer 1	Engineer 2	Engineer 1 (shift)	Technician, Foreman, Accountant	Technician, Foreman (shift)	Craftsman	Craftsman (shift)	Worker	Guard	Experts/Authorities	Sum External Personnel:	Total:

Table 9-16: Variant KONRAD - number and qualification of personnel





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9.5.3.2 COVRA variant

The results for the personnel (required man-hours, dose rate) are given below:

- Table 9-17: Variant COVRA man-hours and dose rate per project
- Figure 9-8: Variant COVRA EPZ and external personnel per year
- Table 9-20: Variant COVRA number and qualification of personnel

WBS	Dose Rate [mSv]	Man-Years
01 PRE-DECOMMISSIONING ACTIONS	-	28,3
02 PREPARATORY WORK	110	118,9
03 OPERATIONAL WASTE	370	71,4
04 DISMANTLING OUTSIDE CONTROLLED AREA	-	75,3
05 DISMANTLING CONTAMINATED MATERIAL	645	105,5
06 DISMANTLING PRIMARY LOOP COMPONENTS	611	105,6
07 DISMANTLING RPV INTERNALS	194	76,6
08 DISMANTLING RPV	157	53,5
09 DISMANTLING BIOLOGICAL SHIELD	44	86,4
10 DISMANTLING REMAINING SYSTEMS	90	88,6
11 CLEARANCE OF BUILDING STRUCTURES	144	122,4
12 SITE RESTORATION, CLEANUP AND LANDSCAPING	-	63,8
13 PROJECT MANAGEMENT, ENGINEERING AND SITE SUPPORT	-	857,9
14 SITE SECURITY, SURVEILLANCE AND MAINTENANCE	10.1.b	
15 WASTE PROCESSING, STORAGE AND DISPOSAL	787	384,7
Total	10.1.b	veed out that I

Table 9-17: Variant COVRA - man-hours and dose rate per project

WBS	Qualification	Ma Ye
01 PRE-DECOMMISSIONING ACTIONS	EPZ Engineer 1	3
	EPZ Engineer 2	6
	EPZ Foreman/Technician/Accounts	int 6
	External Engineer 1	3
	External Engineer 2	9
)2 PREPARATORY WORK	EPZ Craftsman	8
2 THE ANATONI WORK	EPZ Engineer 1	1
	3	
	3	13
	EPZ Foreman/Technician/Accounts	
	EPZ Worker	5
	External Exp./Auth.	4
	External Craftsman	26
	External Engineer 1	(
	External Engineer 2	22
	External Foreman/Technician/Accounts	nt 13
	External Craftsman (shift)	(
	External Engineer 1 (shift)	(
	External Foreman/Technician (shift)	
	External Worker	13
3 OPERATIONAL WASTE	EPZ Craftsman	- 1
5 OPERATIONAL WASTE		
	, , ,	
	EPZ Worker	13
	External Craftsman	1
	External Worker	10
4 DISMANTLING OUTSIDE CONTROLLED AREA	EPZ Craftsman	3
	EPZ Engineer 2	:
	EPZ Foreman/Technician/Account	int 3
	External Exp./Auth.	3
	External Craftsman	
	External Engineer 2	9
	External Foreman/Technician/Account	
	External Worker	47
	External Foreman/Technician (shift)	-
5 DISMANTLING CONTAMINATED MATERIAL		
5 DISMANTLING CONTAMINATED MATERIAL		12
	EPZ Engineer 2	
	EPZ Foreman/Technician/Account	
	EPZ Worker	- '
	External Exp./Auth.	4
	External Craftsman	43
	External Engineer 2	10
	External Foreman/Technician/Account	int 2
	External Worker	10
6 DISMANTLING PRIMARY LOOP COMPONENTS	EPZ Craftsman	12
	EPZ Engineer 2	
	EPZ Foreman/Technician/Accounts	
	External Exp./Auth.	1.
	1	
	External Craftsman	22
	External Engineer 2	13
	External Foreman/Technician/Account	
	External Worker	1
7 DISMANTLING RPV INTERNALS	EPZ Craftsman	(
	EPZ Engineer 1	:
	EPZ Foreman/Technician/Accounts	
	External Exp./Auth.	
	External Engineer 1	
	· ·	
	External Engineer 2	
	External Foreman/Technician/Accounts	
	External Worker	!
	External Craftsman (shift)	24
	External Engineer 1 (shift)	1

Table 9-18: Variant COVRA – man-years per project (01-07) and qualification



08 DISMANTLING RPV	EPZ	Craftsman	6,3
	EPZ	Engineer 2	1,3
	EPZ	Foreman/Technician/Accountant	7,
	External	Exp./Auth.	3,:
	External	Craftsman	23,
	External	Engineer 1	7,
	External	Engineer 2	2,
	External	Foreman/Technician/Accountant	1,
09 DISMANTLING BIOLOGICAL SHIELD	EPZ	Craftsman	9,
	EPZ	Engineer 2	2,
	EPZ	Foreman/Technician/Accountant	11,
	External	Exp./Auth.	4,
	External	Engineer 2	7,
	External	Foreman/Technician/Accountant	5,
		Foreman/Technician (shift)	46,
10 DISMANTLING REMAINING SYSTEMS	EPZ	Craftsman	10,
	EPZ	Engineer 2	1,
	EPZ	Foreman/Technician/Accountant	12,
		Exp./Auth.	5,
		Craftsman	15,
		Engineer 2	8,
		Foreman/Technician/Accountant	3,
		Worker	11,
			20,
14. CLEARANCE OF BUILDING STRUCTURES	EPZ	Foreman/Technician (shift) Craftsman	12,
11 CLEARANCE OF BUILDING STRUCTURES	EPZ		3,
	I	Engineer 2	
	EPZ	Foreman/Technician/Accountant	8,
	l	Exp./Auth.	8,
	1	Engineer 1	17,
	l	Engineer 2	6,
	l	Foreman/Technician/Accountant	3,
		Craftsman (shift)	63,
12 CONVENTIONAL DEMOLITION AND SITE RESTORATION	EPZ	Engineer 2	0,
	l	Exp./Auth.	5,
	External	Engineer 2	1,
	l	Foreman/Technician/Accountant	0,
	External	Worker	55,
13 PROJECT MANAGEMENT, ENGINEERING AND SITE SUPPORT	EPZ	Craftsman	4,
	EPZ	Engineer 1	68,
	EPZ	Engineer 2	221,
	EPZ	Foreman/Technician/Accountant	290,
	EPZ	Worker	46,
	External	Engineer 1	28,
	External	Engineer 2	97,
	External	Foreman/Technician/Accountant	100,
14 SITE SECURITY, SURVEILLANCE AND MAINTENANCE	10.1		
	507	Continue	
15 WASTE PROCESSING, STORAGE AND DISPOSAL	EPZ	Craftsman	4
	EPZ	Foreman/Technician/Accountant	104
	EPZ	Worker	8,
		Foreman/Technician/Accountant	45,
	External	Worker Worker	222

Table 9-19: Variant COVRA - man-years per project (08-15) and qualification

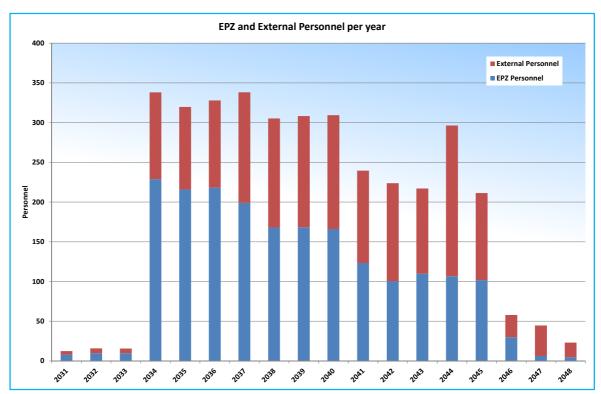


Figure 9-8: Variant COVRA - EPZ and external personnel per year

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	Total	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
EPZ Personnel:																			
Engineer 1	115,3	6,3	8,9	6,7	10,2	9,7	9,7	11,9	12,4	12,3	12,0	6,2	2,0	2,0	2,0	2,0	1,3	1,0	0,7
Engineer 2	436,5	8'0	1,5	1,5	59,7	54,3	52,2	43,1	34,1	34,7	34,3	25,9	20,0	19,5	21,8	19,8	7,7	3,3	2,4
Technician, Foreman, Accountant	787,4	8,0	1,5	1,5	79,5	76,4	77,4	73,7	71,0	70,9	70,0	54,4	47,6	53,1	49,3	46,1	12,6	1,0	0,7
Craftsman	331,8	0,0	0,0	0,0	39,6	38,8	41,2	36,5	28,4	28,5	27,8	18,2	14,9	19,3	17,6	18,0	3,0	0,0	0,0
Worker	303,2	0,0	0,0	0,0	39,8	36,7	37,5	33,7	22,0	21,9	22,0	18,5	16,0	16,0	16,0	15,9	5,3	1,0	0,7
Guard	0,0	0,0	0,0	0,0	0,0	0,0	0'0	0,0	0'0	0'0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Sum EPZ Personnel:	1.974,2	6'2	8'6	2'6	228,8	215,9	218,1	199,0	167,9	168,2	166,1	123,3	100,5	109,9	106,7	101,7	6'62	6,3	4,6
External Personnel:							100												
Engineer 1	59,2	3,3	3,8	3,7	2,3	3,2	2,5	2,7	2,2	3,3	7,4	2,6	1,0	1,0	5,7	12,7	1,8	0,0	0,0
Engineer 2	193,4	1,2	2,2	2,2	26,0	19,8	19,5	18,3	13,7	15,2	14,2	15,1	13,2	8,7	14,6	2,6	1,9	0,5	0,4
Engineer 1 (shift)	12,3	0,0	0,0	0'0	0,0	0,1	0,0	6'0	6,5	4,8	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Technician, Foreman, Accountant	203,5	0,0	0,0	0,0	15,7	13,9	16,4	16,3	15,0	15,4	14,4	22,8	23,0	14,3	17,5	14,3	4,0	0,3	0,2
Technician, Foreman (shift)	68,0	0,0	0,0	0,0	0,0	6'0	0,0	0'0	0'0	0,0	0,1	0,0	4,4	25,1	37,0	0,5	0,0	0,0	0,0
Craftsman	155,0	0,0	0,0	0,0	12,3	11,5	18,2	15,9	6,2	13,0	32,5	13,6	19,9	4,1	6'2	0,0	0,0	0,0	0,0
Craftsmen (shift)	89,2	0,0	0,0	0'0	0'0	6'0	0,0	1,8	13,0	9'6	0,0	0,0	0,0	0,0	43,9	19,9	0,0	0,0	0,0
Worker	570,0	0,0	0,0	0,0	25,1	25,1	24,0	53,5	48,2	46,3	43,3	45,0	52,8	43,7	52,3	42,5	17,3	35,0	15,9
Guard		0	0											0		0	•		
Experts/Authorities	49,4	0,0	0,0	0,0	6'0	1,5	2,1	2,8	5,6	5,5	4,3	2,2	2,8	5,2	4,8	6,0	1,3	2,7	2,0
Sum External Personnel:																			
Total													1	1		1	1	0	
Total:																			

Table 9-20: Variant COVRA - number and qualification of personnel

10 Comparison to the 2010's Cost Estimation

This chapter contains comparisons of the important milestones, costs, personnel requirements and collective dose rate. Finally an overview from the 2003's study till now is given.

10.1 Milestones

In Table 10-1 the important milestones of the 2010's and the actual KONRAD variant calculation are compared.

Milestones	KONRAD variant 2010	KONRAD variant 2015
Start of decommissioning project (Pre-decommissioning actions)	01/2031	01/2031
Final shut down	12/2033	12/2033
Fuel removed	07/2037	07/2037
Approval decommissioning license	07/2037	07/2037
Finalisation dismantling RPV	11/2042	04/2041
Building structures cleared	09/2045	10/2045
Green field status	02/2047	04/2048

Table 10-1: Milestones variant KONRAD 2010 and 2015 in comparison

The project start, the approval of the decommissioning license and the status, when the site is free of fuel, are expected to unchanged dates. Other than in 2010 the dismantling of the RPV Internals starts immediately after the approval of the decommissioning license. So the free from water status is realized earlier, which allows a sooner dismantling of several systems. Overall the RPV will be nearly two years earlier removed than expected in the 2010's study, which means a notable reduction of the duration till realising water free status effecting operational cost savings particularly. However the clearance of building structures will be reached nearly at the same time as in 2010. Especially additional decontamination efforts and the adjustment of clearance periods effect a longer period till the end of clearance. Finally the green field conditions will be reached approximately 1 year later as the removal of the piles as well as the demolition of all other buildings in the monitored area are now considered.

Milestones	COVRA variant 2010	COVRA variant 2015
Start of decommissioning project (Pre-decommissioning actions)	01/2031	01/2031
Final shut down	12/2033	12/2033
Fuel removed	07/2037	07/2037
Approval decommissioning license	07/2037	07/2037
Finalisation dismantling RPV	05/2043	06/2041
Building structures cleared	02/2046	04/2046
Green field status	08/2047	09/2048

Table 10-2: Milestones variant COVRA 2010 and 2015 in comparison

As in the 2010's study the additional dismantling efforts respecting the assumption and boundary conditions of the COVRA variant provoke a project extension of a half-year as shown in Table 10-2. The aspects described above apply also to COVRA variant. Finally the green field status of the COVRA variant 2015 will also be reached nearly one year later in comparison to the 2010's COVRA variant calculation.





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10.2 Costs

WBS	KONRAD c	ost [Mio€]	٨
WB3	2010	2015	Δ
01 PRE-DECOMMISSIONING ACTIONS			
02 PREPARATORY WORK			
03 OPERATIONAL WASTE			
04 DISMANTLING OUTSIDE CONTROLLED AREA			
05 DISMANTLING CONTAMINATED MATERIAL			
06 DISMANTLING PRIMARY LOOP COMPONENTS			
07 DISMANTLING RPV INTERNALS			
08 DISMANTLING RPV			
09 DISMANTLING BIOLOGICAL SHIELD			
10 DISMANTLING REMAINING SYSTEMS			
11 CLEARANCE OF BUILDING STRUCTURES			
12 SITE RESTORATION, CLEANUP AND LANDSCAPING			
13 PROJECT MANAGEMENT, ENGINEERING AND SITE SUPPORT			
14 SITE SECURITY, SURVEILLANCE AND MAINTENANCE			
15 WASTE PROCESSING, STORAGE AND DISPOSAL			
Total			

Table 10-3: Total costs of the KONRAD variant 2015 in comparison to 2010

Regarding the KONRAD variant the total costs increase at about representing a rate about 16%. This increase comprises on the one hand of the following price updates:

- caused by increase of wages
- caused by escalation of non-personnel prices
- caused by increase of container prices
- caused by increase of COVRA prices

On the other hand the consideration of additional tasks and new evaluations of decommissioning efforts causes an increase of costs. Following items raise the costs for more than

- consideration dismantling and removal of components and equipment in every building of the monitored area
- adaption decontamination and clearance efforts
- adaption conventional demolition efforts
- consideration all buildings of the monitored area for demolition
- consideration removal of the piles including the needed trench support
- consideration conventional removal and disposal especially of toxic materials (PCB)
- adaption of effort for multiple tasks with an amount below

Primary because of an earlier finalisation of the dismantling of the RPV the operational costs including site security, maintenance, project management, engineering and site support are nearly lower than in the 2010's study.

Table 10-3 shows a comparison between the 2010 and 2015 KONRAD variant per project.

Beside the containers and COVRA costs the above mentioned reasons apply to the changes regarding the COVRA variant. In sum the COVRA variant increases with an amount of nearly or a rate of nearly . Table 10-4 shows the comparison between 2010 and 2015 per project.

WBS	COVRA co	ost [Mio€]	٨
WBS	2010	2015	Δ
01 PRE-DECOMMISSIONING ACTIONS			
02 PREPARATORY WORK			
03 OPERATIONAL WASTE			
04 DISMANTLING OUTSIDE CONTROLLED AREA			
05 DISMANTLING CONTAMINATED MATERIAL			
06 DISMANTLING PRIMARY LOOP COMPONENTS			
07 DISMANTLING RPV INTERNALS			
08 DISMANTLING RPV			
09 DISMANTLING BIOLOGICAL SHIELD			
10 DISMANTLING REMAINING SYSTEMS			
11 CLEARANCE OF BUILDING STRUCTURES			
12 SITE RESTORATION, CLEANUP AND LANDSCAPING			
13 PROJECT MANAGEMENT, ENGINEERING AND SITE SUPPORT			
14 SITE SECURITY, SURVEILLANCE AND MAINTENANCE			
15 WASTE PROCESSING, STORAGE AND DISPOSAL			
Total			

Table 10-4: Total costs of the COVRA variant 2015 in comparison to 2010

10.3 Personnel requirement

Regarding the KONRAD variant the personnel requirements decrease at 110,8 Man-years representing a rate at about -3%. As mentioned in chapter 10.2 the considering of additional tasks as the dismantling und demolition of the complete monitored area or the more extensive clearance efforts increase the requirement for personnel. Due to the earlier finalisation of the RPV also the operational personnel requirements decrease because of the shorter duration of this period. But mostly the improvement of the waste management strategy respecting dismantling mass flows, capacity and waste amounts effects the decreasing of personnel efforts in general. In Table 10-5 the changes between 2010 and 2015 are shown per project.



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Wee	KONRAD N	lan-Years	A
WBS	2010	2015	Δ
01 PRE-DECOMMISSIONING ACTIONS	28,6	28,3	-0,3
02 PREPARATORY WORK	120,5	119,3	-1,2
03 OPERATIONAL WASTE	50,1	71,4	21,3
04 DISMANTLING OUTSIDE CONTROLLED AREA	35,4	75,3	40,0
05 DISMANTLING CONTAMINATED MATERIAL	74,2	84,9	10,7
06 DISMANTLING PRIMARY LOOP COMPONENTS	59,7	74,0_	14,3
07 DISMANTLING RPV INTERNALS	66,8	76,6	9,8
08 DISMANTLING RPV	44,0	46,2	2,2
09 DISMANTLING BIOLOGICAL SHIELD	60,7	80,5	19,9
10 DISMANTLING REMAINING SYSTEMS	46,3	80,2	33,8
11 CLEARANCE OF BUILDING STRUCTURES	87,5	122,4	34,8
12 SITE RESTORATION, CLEANUP AND LANDSCAPING	47,0	63,8	16,8
13 PROJECT MANAGEMENT, ENGINEERING AND SITE SUPPORT	867,3	830,7	-36,6
14 SITE SECURITY, SURVEILLANCE AND MAINTENANCE	10.1 b	DE CHEST	
15 WASTE PROCESSING, STORAGE AND DISPOSAL	473,3	320,4	-152,9
Total	10.1.b		

Table 10-5: Personnel requirements of the KONRAD variant 2015 in comparison to 2010

Also the personnel requirements of the actual COVRA variant are reduced. Because of the more extensive efforts especially for cutting the improvement of the waste management strategy leads higher savings. In sum the reduction is 226,8 Man-years.

THE STATE OF THE S	Man-Yea	rs COVRA	A
WBS	2010	2015	Δ
01 PRE-DECOMMISSIONING ACTIONS	28,6	28,3	-0,3
02 PREPARATORY WORK	123,6	118,9	-4,7
03 OPERATIONAL WASTE	32,6	71,4	38,8
04 DISMANTLING OUTSIDE CONTROLLED AREA	36,8	75,3	38,6
05 DISMANTLING CONTAMINATED MATERIAL	91,3	105,5	14,2
06 DISMANTLING PRIMARY LOOP COMPONENTS	83,8	105,6	21,9
07 DISMANTLING RPV INTERNALS	70,5	76,6	6,2
08 DISMANTLING RPV	46,3	53,5	7,3
09 DISMANTLING BIOLOGICAL SHIELD	62,5	86,4	23,9
10 DISMANTLING REMAINING SYSTEMS	48,6	88,6	40,0
11 CLEARANCE OF BUILDING STRUCTURES	95,8	122,4	26,6_
12 SITE RESTORATION, CLEANUP AND LANDSCAPING	47,0	63,8	16,8
13 PROJECT MANAGEMENT, ENGINEERING AND SITE SUPPORT	903,4	857,9	-45,5
14 SITE SECURITY, SURVEILLANCE AND MAINTENANCE	10.1 b		2-4-14
15 WASTE PROCESSING, STORAGE AND DISPOSAL	646,2	384,7	-261,4
Total	10.1.b		

Table 10-6: Personnel requirements of the COVRA variant 2015 in comparison to 2010

10.4 Historical Development

Starting in 1994, EPZ has charged NIS several times to elaborate a preliminary dismantling plan including the calculation of the related costs, see /1/ (1994), /2/ (2003), /3/ (2006) and /4/ (2010).





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The 1994 and 2003 studies were made under the following main boundary conditions:

- final shutdown of the reactor on 31th December 2013
- deferred dismantling after 40 years of safe enclosure

In 2006 the boundary conditions were changed to:

- final shutdown of the reactor on 31st December 2033
- immediate dismantling after final shutdown

In 2010 the day of final shut down and the immediate dismantling remained. Additionally a so called COVRA variant considering only COVRA and not KONRAD containers was performed. For completeness the results of the studies from 2003 till now are repeated in Table 10-7.

61	T-1-161-			Net present va	alue		Total Work	Col.Dose
Study	Total Costs	ir [% p.a.]	Ref. Date	Costs	Ref. Date	Costs	[Man-Years]	[mSv]
2003			01.01.2003		01.01.2014		10 1 b	200
2006			01.01.2006		01.01.2034		.0.1.0	
2010 KONRAD			01.01.2010		01.01.2034			
2010 COVRA			01.01.2010		01.01.2034			
2015 KONRAD			01.01.2015		01.01.2034		ANALYS	
2015 COVRA			01.01.2015		01.01.2034			

Table 10-7: Historical development 2003 – 2015

11 Cost Drivers, Sensitivities and remaining Risks in Cost

The cost calculation for a D&D project over some decades in future depends on certain assumptions, defined in chapter 9.4. Every assumption contains the uncertainty, whether it enters as planned or not.

Therefore it will be analysed which sensitivities are contained in the cost estimation and which risks will remain for the future.

11.1 Cost Drivers and accompanying Sensitivities

Following the partition of the estimated decommissioning costs, shown in Figure 11-1, the main direct cost drivers are the personnel costs and the COVRA costs (Other Costs).

Indirect cost drivers are the dismantling duration, the estimated mass of the inventory, the assumed radiological situation, and the necessary operational expenditures during the dismantling, respectively the decrease of the operational efforts while dismantling.

The cost calculation performed by NIS reflects the actual state of the art and the actual boundary conditions for decommissioning of nuclear facilities. The calculations of the decommissioning masses are made in a status of "best engineering judgement" and don't include contingencies for future risks or uncertainties.

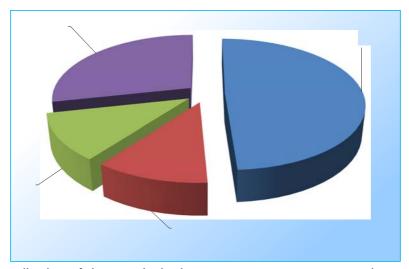


Figure 11-1: Contribution of decommissioning costs among cost categories

11.2 Sensitivities in mass and radiological data

The data collection and calculations for mass and surface made in earlier studies and actualised in this study is based on several data sources provided by EPZ but also on information from NIS experiences.

The mass data collected contains certainly tolerances, i.e. of about +/- 10% for the most important masses (parts of the RPV and Internals) and some more %-values for other groups of components. The possible tolerances affect the calculations for waste amount, repository volume and cost in different fields. The analysed results on storage volumes and/or masses are given in Table 11-1. Regarding the activation calculation results in case of an increase with factor 10 (x 10) more containers will be required resulting in a higher repository volume. The reduction with factor 10 (x 1/10) does not cause a notable decrease in the number of the required containers as the activation level of the components will be still higher than the release limits. Same applies for the contamination results. In case of higher and lower contamination results the load will be nearly the same.



The costs for waste management depend strongly on the COVRA requirements. The COVRA prices for KONRAD and MOSAIK container are related to the total number of containers (originally given for the Dodewaard containers only). A price reduction occurs possible in case that COVRA will take into account additionally the Borssele containers.

Risk / Chance	Assumption	Description	Changes in Repository Vol.
Mass	RPV, Internals, Biol. Shield +/-10%	Number of containers is directly linked to the	+/- 25 m³
Calculation	Contaminated Components +/- 20%	masses.	+/- 200 m³
	Non-radioactive Material +/- 30%	Additional non-radioactive rubble for	+/- 40.000 Mg
		conventional recycling or land filling.	
Radioactive	Activation Calculation results +/- 1.000%	Increase will be balanced by containers with	+ 20 m³
Inventory		extra shielding.	
Evaluation		The cost for containers is in-creased by .	
		Reduction of radioactivity will be balanced by	- 0 m³
		using the same containers but a slightly higher	
		load.	
	Contamination Comp. results +/- 1.000%	No significant changes of the load per container.	+/- 0 m³
	Contamination Build. results +/- 1.000%		

Table 11-1: Sensitivities and Risks of masses and volumes

11.3 Sensitivities in cost

The cost calculations for the decommissioning Borssele are made in a status of "best engineering judgement" without contingencies for future risks or uncertainties.

Nevertheless it is recognised that several sensitivities or risks are remains, i.e.:

- project duration
- manpower requirements
- dismantling efficiency
- price escalation, wages, external services and provisions
- decontamination and release of building structures
- spent fuel management
- waste treatment and packaging cost

11.3.1 Project Duration

This duration of the D&D project will be effected by some optimisation opportunities but also by several risks for delay:

- The period for the spent fuel transport can be reduced by an optimised packaging strategy or by an earlier start.
- The existing operational waste can be conditioned and packaged during the remaining operation period.
- The needed new facilities can be erected in the remaining operation period.

Time reduction affects the cost in the fields of project management, administration, operation, maintenance and others.

Delays in the D&D project are possible, e.g. needed licenses might not be available and unexpected technical problems may occur. Such effects include a risk in time extension in the mentioned working fields.



11.3.2 Manpower requirements

The D&D project is divided in more than thousand activities for the calculation of the manpower requirements, duration and cost. Each decommissioning activity is calculated separately concerning used tools, equipment, consumables and the needed number of staff. The existing qualification groups given by EPZ were considered.

Additional personal capacity is planned for some dismantling works carried out by external companies. The calculated number of staff can have a tolerance which concerns the project duration and the cost.

11.3.3 Dismantling efficiency

With respect to the cost, all participants in D&D projects are interested in optimising the working efficiency. This concerns dismantling and decontamination efficiency, but also the tasks "administration" and "operation support" should be minimised. The decommissioning cost could be reduced by increased efficiency.

11.3.4 Price escalation, wages, external services and provisions

The personnel costs, as an important factor for the decommissioning costs, are calculated based on the wages provided by EPZ. It is recognized that these wages are cheaper than for the external companies. A decrease in the partition of the EPZ personnel will probably increase the cost.

11.3.5 COVRA costs

As the COVRA costs are based on actual costs respecting a very low amount of waste packages in comparison to the D&D period a reduction of these tariffs due to depression of the fix costs is feasible. So in 2014 a bit more than were sent to COVRA, during the decommissioning project more than 1.000 packages are expected (cp. Annex /E/). Furthermore the special tariff for handling the KONRAD container is relative high in comparison to the COVRA containers respecting required disposal volume. The substitution of 1.730 m³ KONRAD containers nearly doubles the required disposal volume (+1.410 m³). But the COVRA costs decrease by an amount of . Expressed in a specific value the COVRA costs for KONRAD containers are . The substitution leads to specific COVRA costs of

11.3.6 Decontamination and release of building structures

An increase of the calculated efforts for the decontamination of the concrete surfaces has been recognised in the last years in Germany. This aspect was considered by a conservative cost assessment in that working field.

A risk for additional working expenditures will remain because it can't be excluded that radioactivity has penetrated deeper into the building structure as assumed.

11.3.7 Spent fuel management

The removal of the spent fuel elements from the site is an important milestone for the D&D project. A delay will prolong the Post Operational Phase.



11.3.8 Change of release levels

Stricter rules for the release of material can lead to a higher effort for decontamination to get the same material free, or to higher quantities of radioactive waste. In both cases the cost will increase.

11.4 Risk calculation and results

The risks, sensitivities, and uncertainties mentioned above were calculated and evaluated separately. The results are given in the table below:

Risk / Chance	Assumption	Cost Changes [Mio€]	Propability for Risk/Chance
Mass	RPV, Internals, Biol. Shield +10%	[iviiocj	25%
Calculation	Contaminated Components +20%		25%
	Non-radioactive Material +30%		25%
	RPV, Internals, Biol. Shield -10%		25%
	Contaminated Components -20%		25%
	Non-radioactive Material -30%		25%
Radioactive	Activation Calculation results +1.000%		10%
Inventory Evaluation	Contamination Comp. Calculation results +1.000%		10%
Calculation	Contamination Build. Calculation results +1.000%		10%
	Activation Calculation results -1.000%		10%
	Contamination Comp. Calculation results -1.000%		10%
	Contamination Build. Calculation results -1.000%		10%
Waste Treatment and	Number of Containers +10%		20%
Packaging	Number of Containers -10%		20%
	Onsite treatment expenditures +30%		20%
	Onsite treatment expenditures -30%		20%
	Reduction COVRA prices		20%
Project duration	12 month delay in general		30%
	24 months delay in general		10%
Manpower requirements	Manpower operation and administration +10%		30%
	Manpower operation and administration -10%		30%
Dismantling Efficiency	Dismantling Efficiency +10%		15%
	Dismantling Efficiency +20%		10%
Price Escalation, Wages,	Wages +10% total staff		30%
External Services, Provisions	Wages +20% total staff		10%
Decontamination and Release of Building Structures	Surfaces and deepness to scarify +30%		20%
Spent fuel management	6 months delay		25%
Change of Release level	Co-60: Factor 10 lower (0,1 Bq/g)		80%

Table 11-2: Sensitivities, risks and chances

Because not all risks will occur at the same time it is necessary to take into account the probabilities from Table 11-2. The resulting total risk calculated by the combination of the defined risks shows Figure 11-2. With a probability of 30% cost increase will not exceed . At the same time some chances like reduction of COVRA costs or increasing dismantling efficiency may come off. The resulting total chance calculated by the combination of the defined chances shows Figure 11-3. With a probability of 30% the cost decrease will not exceed

In total, the risks exceed the chances at round about

	0.1.199.197
	Probability [%]
Figure 11 2: Probabil	
Figure 11-2: Probabil	lity of cost increase by defined risks
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Figure 11-3: Probability of cost decrease by defined chances

Probability [%]



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12 Conclusions

Based upon long and wide experience with this matter NIS has come to the following general conclusions and recommendations.

NIS is confident that the general decommissioning plan is on the state of the art and gives a solid base for the later decommissioning. It follows the world-wide practice in decommissioning and dismantling of nuclear power plants. NIS recommends to observe international experience and to update the study from time to time.

During the planning work no critical technical problems were found, and they are not expected to occur. All needed techniques for the dismantling are industrial standard for this kind of work and no research work is needed any more. There may be a need for some special developments (special tools, special equipment) but this is usual and the costs for it, which are known from experience, were included in the calculated investment costs.

Due to the accumulated experience and the use of sufficient conservatism NIS is confident that the calculations have no significant financial risk. On the contrary, the conservatism applied to the calculation suggests lower cost values when uncertainties can be reduced.

Actual and in the next years NIS will gain lots of experiences especially concerning the changes from the (post) operational to the dismantling phase due to the current situation in Germany. Therefore NIS proposes to use this information for the next actualization and to specify the planning and evaluation of the POP in the Borssele D&D project more precisely.



13 Referenced Documents

No.	Document No.:	Titel
/1/	1362/3179/0	Costs of decommissioning of the nuclear power plant at Borssele, NIS, October 1994
/2/	6182 / CA / F 0036740 / 02	Site Specific Decommissioning Cost Calculation for the Borssele NPP, NIS, August 2003
/3/	7464 / CA / F 006208 6 / 00	Site Specific Decommissioning Cost Calculation for the Borssele NPP, NIS, August 2006
/4/	8532 / CA / F 008398 0 / 02	Site Specific Decommissioning Cost Calculation for the Borssele NPP, NIS, November 2010
/5/	Annual Meeting on Nuclear Technology, 2010	Determination of the Activation Level in the Decommissioning Inventory of the NPP KRSKO
/6/	Staatsblad van het Koninkrijk der Nederlanden, 2001, Nr. 397	Besluit van 16 juli 2001, houdende vaststelling van het Besluit stralingsbescherming (Radiation Protection Regulations)
/7/	COVRA	Algemene voorwaarden (ingangsdatum 1 januari 2009) in zake de overdracht van radioactief afval aan COVRA
/8/	COVRA	Technische voorwaarden (ingangsdatum 1 januari 2009) voor overdracht van standard radioactief afval aan COVRA
/9/	COVRA	COVRA Tariffs for Waste Processing (2015)
/10/	ANSI/ANS-57.9- 1992;R2000;W2010	Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type)
/11/	OECD 2012 / NEA No. 7088	International Structure for Decommissioning Costing (ISDC) of Nuclear Installations

14 Appendices

No.	Name
/A/	List of distribution factor sets
/B/	Time schedule
/C/	Complete work breakdown structure
/D/	Waste packages
/E/	Number of waste packages per year



Appendix A: List of distribution factor sets

- KONRAD variant
- COVRA variant



No.	Distribution Factor Set						
	Portion [%] Disposal Way						
103	100% Release / no treatment		100,00	Release + No Treatment			
05	Cables		60,00	Release + No Treatment			
			30,00	Deposition + No Treatment			
			10,00	Rad. Waste + Super Compaction	1		
		Packaging:	Portion [%	6] Cask Type	Waste Category	Capacity [kg]	
			100,00	COVRA 200 I drum	Standard 4 Pellets	250,0	✓
			100,00	COVRA 090 I drum	Standard Component	62,5	
06	mixed material		50,00	Release + No Treatment			
			15,00	Rad. Waste + No Treatment			
		Packaging:	Portion [%	6] Cask Type	Waste Category	Capacity [kg]	
			20,00	COVRA 200 I drum	Standard Component	170,0	✓
			30,00	Konrad II (NC)	Components light (without supercompaction)	1.800,0	✓
			50,00	Konrad II (NC)	Standard Component	5.500,0	
			15,00	Release + HD-Water			
			10,00	Release + Blasting			
			10,00	Deposition + No Treatment			

Hint: The Hook beside the Capacity field indicates whether the packing has to be considered in the calculation of interim or final storage volume.

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^{*)} The report only includes the Distribution Factor Sets assigned to the Components or the Secondary Masses.

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No.	Distribution Factor Set Portion [%] Disposal Way					
07	electric equipment		70,00 Deposition + No Treatment			
			15,00 Release + No Treatment			
			15,00 Rad. Waste + No Treatment			
		Packaging:	Portion [%] Cask Type	Waste Category	Capacity [kg]	
			20,00 COVRA 200 I drum	Standard Component	170,0	✓
			40,00 Konrad II (NC)	Components light (without supercompaction)	1.800,0	✓
			40,00 Konrad II (NC)	Standard Component	5.500,0	✓
80	Steel structures		80,00 Release + No Treatment			
			10,00 Rad. Waste + No Treatment			
		Packaging:	Portion [%] Cask Type	Waste Category	Capacity [kg]	
			100,00 Konrad II (NC)	Standard Component	5.500,0	✓
			5,00 Release + Blasting			
			5,00 Release + HD-Water			
09	ventilation equipment		50,00 Release + No Treatment			
			30,00 Deposition + No Treatment			
			20,00 Rad. Waste + No Treatment			
		Packaging:	Portion [%] Cask Type	Waste Category	Capacity [kg]	
			40,00 COVRA 200 I drum	Standard Component	170,0	✓
			60,00 Konrad II (NC)	Components light (without supercompaction)	1.800,0	✓
13	shielding blocks		100,00 Release + ManDec			

Hint: The Hook beside the Capacity field indicates whether the packing has to be considered in the calculation of interim or final storage volume.

^{*)} The report only includes the Distribution Factor Sets assigned to the Components or the Secondary Masses.

No.	Distribution Factor Set Portion [%] Disposal Way						
20	RPV head		80,00	Nucl. Recycling + Melting			
			20,00	Rad. Waste + No Treatment			
		Packaging:	Portion [%]	Cask Type	Waste Category	Capacity [kg]	
			100,00	Konrad II (HC) 030mm Fe	RPV	4.600,0	✓
23	Lower core structure		100,00	Rad. Waste + No Treatment			
		Packaging:	Portion [%]	Cask Type	Waste Category	Capacity [kg]	
			20,00	MOSAIK Type II / 060mm Fe	RPV internals	380,0	✓
			30,00	MOSAIK Type II (Type-A)	RPV internals	500,0	✓
			50,00	Konrad II (HC) 100mm Fe	RPV internals	2.000,0	✓
26	RPV flange		70,00	Nucl. Recycling + Melting			
		30,00 Rad. Waste + No Treatment					
		Packaging:	Portion [%]	Cask Type	Waste Category	Capacity [kg]	
			100,00	Konrad II (HC) 030mm Fe	RPV	4.600,0	✓
27	RPV cylindric part		100,00	Rad. Waste + No Treatment			
		Packaging:	Portion [%]	Cask Type	Waste Category	Capacity [kg]	
			50,00	MOSAIK Type II (Type-A)	RPV	800,0	✓
			50,00	Konrad II (HC) 030mm Fe	Standard Component	4.800,0	✓
29	RPV insulation		100,00	Rad. Waste + Super Compaction			
		Packaging:	Portion [%]	Cask Type	Waste Category	Capacity [kg]	
			100,00	Konrad II (HC) 030mm Fe	Components light (without supercompaction)	1.600,0	✓
131	Valves < 100 kg		60,00	Release + No Treatment			
			40,00	Rad. Waste + No Treatment			
		Packaging:	Portion [%]	Cask Type	Waste Category	Capacity [kg]	
			30,00	COVRA 200 I drum	Standard Component	170,0	✓
			70,00	Konrad II (NC)	Standard Component	5.500,0	✓

^{*)} The report only includes the Distribution Factor Sets assigned to the Components or the Secondary Masses.

Hint: The Hook beside the Capacity field indicates whether the packing has to be considered in the calculation of interim or final storage volume.

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No.	Distribution Factor Set				
400	Portion [%] Disposal Way		5000 B L		
132	Valves > 100 kg		50,00 Release + No Treatment		
			30,00 Rad. Waste + No Treatment		
		Packaging:	Portion [%] Cask Type	Waste Category	Capacity [kg]
			100,00 Konrad II (NC)	Standard Component	5.500,0
			10,00 Nucl. Recycling + Melting		
			10,00 Release + Blasting		
			10,00 Release 1 Diasting		
133	Biol. Shield		60,00 Rad. Waste + No Treatment		
		Packaging:	Portion [%] Cask Type	Waste Category	Capacity [kg]
			20,00 COVRA 200 I drum	Concrete rubble	270,0
			80,00 Konrad II (NC)	Concrete rubble	3.000,0
			40,00 Deposition + No Treatment		
134	Pipes Large		50,00 Release + No Treatment		
			20,00 Release + Blasting		
			20,00 Release + Diasting		
			20,00 Rad. Waste + No Treatment		
		<u>Packaging:</u>	Portion [%] Cask Type	Waste Category	Capacity [kg]
			100,00 Konrad II (NC)	Standard Component	5.500,0
			10,00 Nucl. Recycling + Melting		

Hint: The Hook beside the Capacity field indicates whether the packing has to be considered in the calculation of interim or final storage volume.

^{*)} The report only includes the Distribution Factor Sets assigned to the Components or the Secondary Masses.

No.	Distribution Factor Set						
	Portion [%] Disposal Way						
35	Vessel / Filter / Heat Exchanger		50,00	Release + No Treatment			
			20,00	Release + HD-Water			
			20,00	Rad. Waste + No Treatment			
		<u>Packaging:</u>	Portion [%]	Cask Type	Waste Category	Capacity [kg]	
			20,00	COVRA 200 I drum	Standard Component	170,0	✓
			80,00	Konrad II (NC)	Standard Component	5.500,0	✓
			10,00	Nucl. Recycling + Melting			
36	Insulations		80,00	Deposition + No Treatment			
			20,00	Rad. Waste + Super Compaction			
		Packaging:	Portion [%]	l Cask Type	Waste Category	Capacity [kg]	
			100,00	COVRA 200 I drum	Packaging 4 EPZ Standard Pellets	170,0	✓
			100,00	COVRA 090 I drum	EPZ experience factor	42,6	
37	Operational Media		100,00	Rad. Waste + Evapouration			
		Packaging:	Portion [%]	l Cask Type	Waste Category	Capacity [kg]	
			0,10	COVRA 200 I drum	Concentrates	120,0	✓
38	Operational Material		100,00	Rad. Waste + No Treatment			
		Packaging:	Portion [%]	l Cask Type	Waste Category	Capacity [kg]	
			20,00	COVRA 200 I drum	Standard Component	170,0	✓
			80,00	Konrad II (NC)	Standard Component	5.500,0	✓
139	Concrete Controlled Area		97,00	Release + No Treatment			
			3,00	Rad. Waste + No Treatment			
		Packaging:	Portion [%]	l Cask Type	Waste Category	Capacity [kg]	
			20,00	COVRA 200 I drum	Concrete rubble	270,0	✓
			80,00	Konrad II (NC)	Concrete blocks, shielding blocks	4.300,0	✓

^{*)} The report only includes the Distribution Factor Sets assigned to the Components or the Secondary Masses.

Hint: The Hook beside the Capacity field indicates whether the packing has to be considered in the calculation of interim or final storage volume.

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No.	Distribution Factor Set		
	Portion [%] Disposal Way		
103	100% Release / no treatment	100,00 Release + No Treatment	
105	Cables	60,00 Release + No Treatment	
		30,00 Deposition + No Treatment	
		10,00 Rad. Waste + Super Compaction	
		Packaging: Portion [%] Cask Type Waste Category	Capacity [kg]
		100,00 COVRA 200 I drum Standard 4 Pellets	250,0
		100,00 COVRA 090 I drum Standard Component	62,5
106	mixed material	50,00 Release + No Treatment	
		15,00 Rad. Waste + No Treatment	
		Packaging: Portion [%] Cask Type Waste Category	Capacity [kg]
		20,00 COVRA 1.000 I (NC) Standard Component	450,0
		80,00 COVRA 200 I drum Standard Component	170,0
		15,00 Release + HD-Water	
		10,00 Release + Blasting	
		10,00 Deposition + No Treatment	
107	electric equipment	70,00 Deposition + No Treatment	
		15,00 Release + No Treatment	
		15,00 Rad. Waste + No Treatment	
		Packaging: Portion [%] Cask Type Waste Category	Capacity [kg]
		20,00 COVRA 1.000 I (NC) Standard Component	450,0 ✓
		80,00 COVRA 200 I drum Standard Component	170,0
			-,- •

^{*)} The report only includes the Distribution Factor Sets assigned to the Components or the Secondary Masses.

Hint: The Hook beside the Capacity field indicates whether the packing has to be considered in the calculation of interim or final storage volume.

0.	Distribution Factor Set Portion [%] Disposal Way						
8	Steel structures		80,00	Release + No Treatment			
			10,00	Rad. Waste + No Treatment			
		Packaging:	Portion [%	6] Cask Type	Waste Category	Capacity [kg]	
			100,00	COVRA 200 I drum	Standard Component	170,0	✓
			5,00	Release + Blasting			
			5,00	Release + HD-Water			
9	ventilation equipment		50,00	Release + No Treatment			
			30,00	Deposition + No Treatment			
			20,00	Rad. Waste + No Treatment			
		Packaging:	Portion [%	6] Cask Type	Waste Category	Capacity [kg]	
			10,00	COVRA 1.000 I (NC)	Standard Component	450,0	
			90,00	COVRA 200 I drum	Standard Component	170,0	✓
13	shielding blocks		100,00	Release + ManDec			
20	RPV head		80,00	Nucl. Recycling + Melting			
			20,00	Rad. Waste + No Treatment			
		Packaging:	Portion [%	6] Cask Type	Waste Category	Capacity [kg]	
			100,00	COVRA 1.000 I (NC) / 30mm Fe	Standard Component	340,0	✓
3	Lower core structure		,	Rad. Waste + No Treatment			
		<u>Packaging:</u>		6] Cask Type	Waste Category	Capacity [kg]	
			20,00	MOSAIK Type II / 060mm Fe	RPV internals	380,0	_
			30,00	MOSAIK Type II (Type-A)	RPV internals	500,0	✓
			50,00	COVRA 1.000 I (NC) / 60mm Fe	Standard Component	260,0	✓

^{*)} The report only includes the Distribution Factor Sets assigned to the Components or the Secondary Masses.

No.	Distribution Factor Set Portion [%] Disposal Way					
126	RPV flange		70,00 Nucl. Recycling + Melting			
			30,00 Rad. Waste + No Treatment			
		Packaging:	Portion [%] Cask Type	Waste Category	Capacity [kg]	
			100,00 COVRA 1.000 I (NC) / 30mm Fe	Standard Component	340,0	✓
27	RPV cylindric part		100,00 Rad. Waste + No Treatment			
		Packaging:	Portion [%] Cask Type	Waste Category	Capacity [kg]	
			50,00 MOSAIK Type II (Type-A)	RPV	800,0	✓
			50,00 COVRA 1.000 I (NC) / 30mm Fe	Standard Component	340,0	✓
29	RPV insulation		100,00 Rad. Waste + Super Compaction			
		Packaging:	Portion [%] Cask Type	Waste Category	Capacity [kg]	
			100,00 COVRA 1.000 I (NC) / 30mm Fe	Standard Component	340,0	✓
31	Valves < 100 kg		60,00 Release + No Treatment			
			40,00 Rad. Waste + No Treatment			
		Packaging:	Portion [%] Cask Type	Waste Category	Capacity [kg]	
			30,00 COVRA 1.000 I (NC)	Standard Component	450,0	✓
			70,00 COVRA 200 I drum	Standard Component	170,0	✓
132	Valves > 100 kg		50,00 Release + No Treatment			
			30,00 Rad. Waste + No Treatment			
		Packaging:	Portion [%] Cask Type	Waste Category	Capacity [kg]	
			40,00 COVRA 1.000 I (NC)	Standard Component	450,0	✓
			60,00 COVRA 200 I drum	Standard Component	170,0	✓
			10,00 Nucl. Recycling + Melting			
			10,00 Release + Blasting			

^{*)} The report only includes the Distribution Factor Sets assigned to the Components or the Secondary Masses.

No.	Distribution Factor Set Portion [%] Disposal Way					
133	Biol. Shield		60,00 Rad. Waste + No Treatment			
		<u>Packaging:</u>	Portion [%] Cask Type 20,00 COVRA 1.000 I (NC) 80,00 COVRA 200 I drum	Waste Category Concrete blocks, shielding blocks Concrete rubble		✓
			40,00 Deposition + No Treatment			
134	Pipes Large		50,00 Release + No Treatment			
			20,00 Release + Blasting			
			20,00 Rad. Waste + No Treatment			
		<u>Packaging:</u>	Portion [%] Cask Type	Waste Category	Capacity [kg]	
			40,00 COVRA 1.000 I (NC) 60,00 COVRA 200 I drum	Standard Component Standard Component	_	✓
			10,00 Nucl. Recycling + Melting	Clandard Component	170,0	V
135	Vessel / Filter / Heat Exchanger		50,00 Release + No Treatment			
			20,00 Release + HD-Water			
			20,00 Rad. Waste + No Treatment			
		<u>Packaging:</u>	Portion [%] Cask Type	Waste Category	Capacity [kg]	
			20,00 COVRA 1.000 I (NC) 80.00 COVRA 200 I drum	Standard Component Standard Component		✓
			80,00 COVRA 200 I drum	Standard Component	170,0	✓

^{*)} The report only includes the Distribution Factor Sets assigned to the Components or the Secondary Masses.

lo.	Distribution Factor Set						
	Portion [%] Disposal Way						
36	Insulations		80,00	Deposition + No Treatment			
			20,00	Rad. Waste + Super Compaction			
		Packaging:	Portion [%]	l Cask Type	Waste Category	Capacity [kg]	
			100,00	COVRA 200 I drum	waste from storage pool	140,0	✓
			100,00	COVRA 090 I drum	Insulation	25,0	
37	Operational Media		100,00	Rad. Waste + Evapouration			
		Packaging:	Portion [%]	l Cask Type	Waste Category	Capacity [kg]	
			0,10	COVRA 200 I drum	Concentrates	120,0	✓
38	Operational Material		100,00	Rad. Waste + No Treatment			
		Packaging:	Portion [%]	l Cask Type	Waste Category	Capacity [kg]	
			20,00	COVRA 1.000 I (NC)	Standard Component	450,0	✓
			80,00	COVRA 200 I drum	Standard Component	170,0	✓
39	Concrete Controlled Area		97,00	Release + No Treatment			
			3,00	Rad. Waste + No Treatment			
		Packaging:	Portion [%]	l Cask Type	Waste Category	Capacity [kg]	
			20,00	COVRA 1.000 I (NC)	Concrete blocks, shielding blocks	500,0	✓
			80,00	COVRA 200 I drum	Concrete rubble	270,0	<u></u>

^{*)} The report only includes the Distribution Factor Sets assigned to the Components or the Secondary Masses.

Appendix B: Time schedule

- KONRAD variant
- COVRA variant



Document No.: 9569 / CA / F 009970 3 / 00 Appendix B-KONRAD Variant Nr. 1 PSP-Code Vorgangsname
01 BORSSELE NPP 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 07 01 1 2 01.01 PRE-DECOMMISSIONING ACTIONS 07.01 03.07 3 01.01.01 Start of Project 07.01 07.01 4 01.01.02 Collection Technical Data 07.01 5 01.01.02.01 Radiological Status 07.01 6 01.01.02.02 Technical Plant Status 407.01 7 01.01.02.03 PCB research programm 07.01 07.01 8 01.01.03 Project Planning and Engineering 06.01 Preliminary Plan, Strategy, Cost, Personnel Requirements 9 01.01.03.01 07.0 06.01 10 06.01 01.01.04 Licensing Procedure 03.07 11 01.01.04.01 Preparation of Licensing Documents 06.01 03107 12 01.01.04.01.01 Safety Assessment 06.01 405.01 13 01.01.04.01.02 Environmental Impact 05.01 14 01.01.04.01.03 Technical Documents 05.01 15 01.01.04.02 Authority and Experts 16 01.01.04.02.01 Technical Expertises 03.07 03.07 17 01.01.04.02.02 Authority expenditures 03.07 403.07 03.07 18 01.01.05 Approval D&D License 19 01.01.06 Final Shut Down 31.12 🔷 31.12 20 01.02 PREPARATORY WORK 02.01 26.12 21 01.02.01 Shut Down of Systems 02.01 **01.01** 22 01.02.01.01 Systems not needed anymore 02.0 **Q1.01** 23 16.10 15.06 01.02.02 Modification of Equipment 24 01.02.02.01 **Modification Heating System** 16.10 🕶 02.03 16.10 01.03 16.10 01.03 16.10 09.11 25 01.02.02.01.01 Planning and Engineering 26 Project management / Engineering / Detail planning 01.02.02.01.01.01 27 01.02.02.01.01.02 Studies, Conceptual Planning Work, Project Specification 28 09.11 02.01 01.02.02.01.01.03 Contractings, Negociations 02.01 01.03 29 01.02.02.01.02 Attendant Measures 30 01.02.02.01.02.01 Supervision 02.01 31 02.01 01.03 01.02.02.01.02.02 Experts and Authorities 32 02.01 02.03 01 02 02 01 03 Execution Project Dismantling Heater 33 02.0111.01 01.02.02.01.03.01 34 Installation new Heater 12.01 01.03 01.02.02.01.03.02 35 01.02.02.01.03.03 Finalisation Changing Heater 02.03 02.03 36 01 02 02 02 Modification Evapourator System 29.12 08.06 37 01.02.02.02.01 29.12 Planning and Engineering 38 01.02.02.02.01.01 Project management / Engineering / Detail planning 29.12 19.04 39 01.02.02.02.01.02 Studies, Conceptual Planning Work, Project Specification 29.12 122.01 22.01 02.03 40 01.02.02.02.01.03 Contractings, Negociations 41 01.02.02.02.02 **Attendant Measures** 02.03 42 02.03 07.06 01.02.02.02.02.01 Supervision 43 02.03 07.06 01.02.02.02.02.02 **Experts and Authorities** 44 01.02.02.02.03 **Execution Project** 02.03 45 01.02.02.02.03.01 Preparation Installation Area 02.03 23.03 46 01.02.02.02.03.02 Installation new Evapourator 26.03 19.04 47 01.02.02.02.03.03 Commission and Test Evapourator 20.04 07.06 48 01.02.02.02.03.04 Finalisation Changing Evapourator 08.06 49 01.02.02.03 Modification Compressed Air Supply 12.01 50 01.02.02.03.01 Planning and Engineering 12.01 29.03 51 01.02.02.03.01.01 Project management / Engineering / Detail planning 12.01 29.03 52 01.02.02.03.01.02 Studies, Conceptual Planning Work, Project Specification 12.01 05.02 05.02 02.03 53 01.02.02.03.01.03 Contractings, Negociations 54 01.02.02.03.02 **Attendant Measures** 02.03 🗰 29.03 55 01.02.02.03.02.01 Supervision 02.03 29.03 02.03 29.03 56 01.02.02.03.02.02 **Experts and Authorities** 57 02.03 🗰 30.03 01.02.02.03.03 **Execution Project** 02.03 09.03 58 01.02.02.03.03.01 Dismantling components for new equipment 12.03 22.03 59 01.02.02.03.03.02 Installation new Air supply 60 23.03 29.03 01.02.02.03.03.03 Commission and Test Air Supply 30.03 30.03 61 01.02.02.03.03.04 Finalisation Changing Air Supply

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Document No.: 9569 / CA / F 009970 3 / 00 Appendix B-KONRAD Variant PSP-Code 01.02.09.02.05 Nr. 184 Vorgangsname 2029 2030 2031 2032 2033 2034 2035 2036 2037 **26.12** 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 Experts and Authorities 185 01 02 09 03 Execution Project 02.01 26.12 186 01.02.09.03.01 Removal Asbestos 02.01 26.12 187 01.02.09.03.02 Treatment/Storage Asbestos 02.01 26.12 188 01.02.10 Improvement Infrastructure 02.01 31.10 189 01.02.10.01 Planning and Engineering 02.01 31.10 190 01.02.10.01.01 Project management / Engineering / Detail planning 02.01 31.10 191 01.02.10.01.02 02.0 Studies, Conceptual Planning Work, Project Specification 192 01.02.10.01.03 Contractings, Negociations 02.011 13.01 193 01.02.10.02 Attendant Measures 02.01 194 01.02.10.02.01 Supervision 02.01 195 01.02.10.02.02 On Site Radiological Protection 02.01 31.10 196 01.02.10.02.03 Internal Transport 02.01 31.10 197 01.02.10.02.04 Accompanying Decontamination 02.0 31.10 198 01.02.10.02.05 Experts and Authorities 02.01 31.10 199 01.02.10.03 Preparation Work 02.01 24.02 200 01.02.10.03.01 Modification Equipment 02.0 201 01.02.10.04 **Execution Project** 27.02 202 01.02.10.04.01 Reconstruction Work 27.02 31.10 203 01.02.10.04.02 Lifting Devices 27.02 31.10 **FUEL AND NUCLEAR MATERIAL** 204 01.03 02.01 09.07 205 01.03.01 Transport of Spent Fuels from Reactor to Fuel Pool 02.01 206 Packaging of SF in Storage Container 01.03.02 04.08 207 01.03.03 Transport to Reprocessing 04.08 03.07 03!07 208 01.03.04 Fuel removed 209 01.03.05 Removal Operational Waste and Material 02.01 09.07 210 01.03.05.03 02.02 29.03 **Preparation Work** 211 01.03.05.03.01 02.02 29.03 Modification Equipment 212 01.03.05.04 02.01 **Execution Project** 09,07 213 01.03.05.04.01 Conditioning of existing Operational Waste 02.01 02.07 214 01.03.05.04.02 Clearance of Storage Area 03.07 09.07 215 COVRA Cost 01.03.05.04.03 02.01 02.07 216 01 04 DISMANTLING OUTSIDE CONTROLLED AREA 28.03 ■ 18 07 217 Turbine Building 28.03 01.04.01 18.12 218 01.04.01.01 Planning and Engineering 28.03 18.12 219 01.04.01.01.01 Project management / Engineering / Detail planning 28.03 18.12 220 01.04.01.01.02 Studies, Conceptual Planning Work, Project Specification 28.03 126.09 221 01.04.01.01.03 Contractings, Negotiations 26.09 19.12 19.12 222 01.04.01.02 Attendant Measures 18.12 223 01.04.01.02.01 Supervision 19.12M 18.12 224 01.04.01.02.02 Internal Transport 19.12 18.12 19.12 225 01.04.01.02.03 Experts and Authorities 18.12 19.12 226 01.04.01.03 **Execution Project** 18.12 227 01.04.01.03.01 Cutting and Packaging Components 04.12 228 01.04.01.03.02 Clearing Site 04.12 18.12 229 01.04.01.03.03 Finalisation Turbine Hall I 18.12 230 01.04.02 Other Buildings in Monitored Area 231 01.04.02.01 Planning and Engineering 18.07 232 01.04.02.01.01 Project management / Engineering / Detail planning 18.07 31.07 25.09 233 01.04.02.01.02 Studies, Conceptual Planning Work, Project Specification 25.09 18.12 234 01.04.02.01.03 Contractings, Negotiations 235 01.04.02.02 Attendant Measures 18.07 18.12 236 01.04.02.02.01 Supervision 18.07 237 01.04.02.02.02 Internal Transport 18.12 18.07 238 01.04.02.02.03 Experts and Authorities 18.07 239 01.04.02.03 **Execution Project** 18.12 **18.07** 240 18.12 07.01 01.04.02.03.01 Removal of Insulations and batteries 241 **Cutting and Packaging Components** 01.04.02.03.02 07.01 11.07 11.07 18.07 242 01.04.02.03.03 Clearing Site 243 01.04.02.03.04 Finalisation Other Buildings 18.07 18.07 01.05 DISMANTLING CONTAMINATED MATERIAL 244 04.08

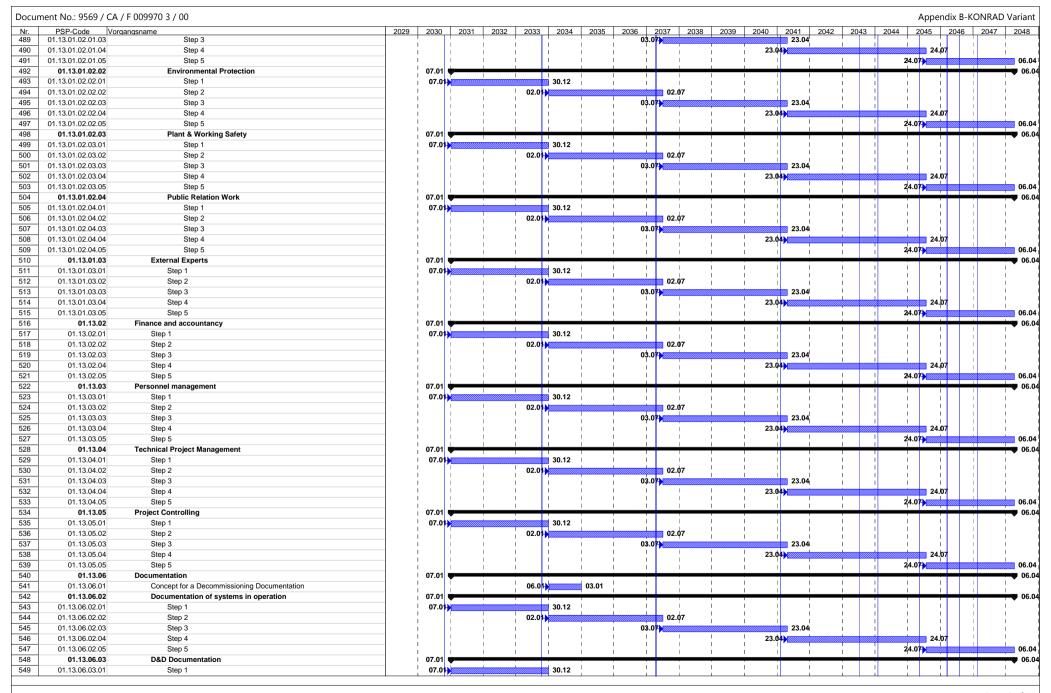
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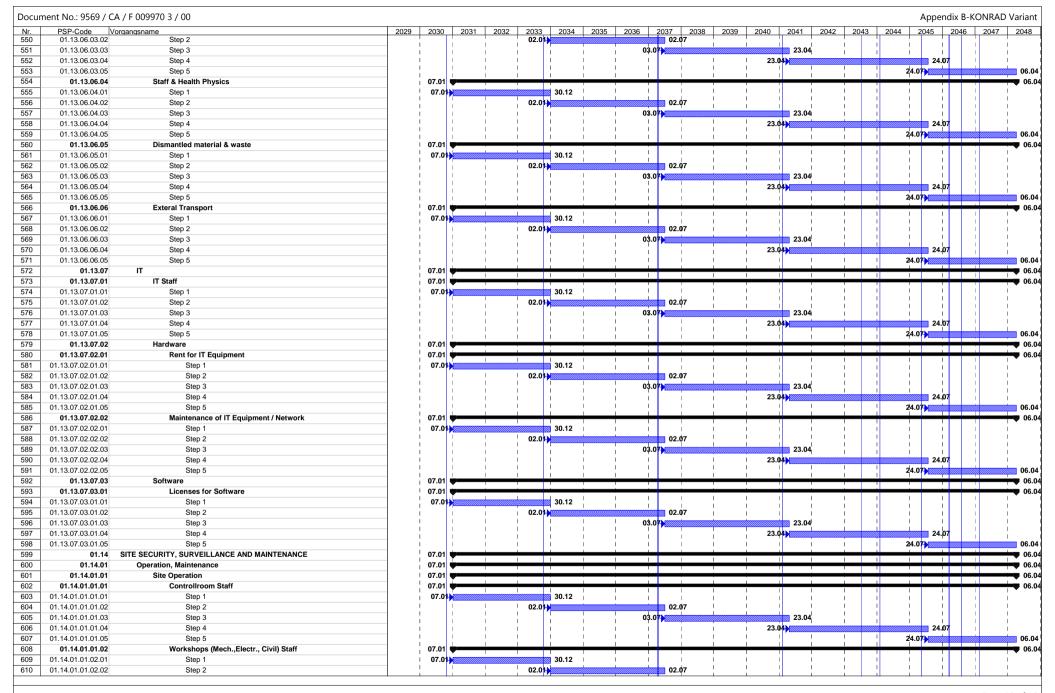
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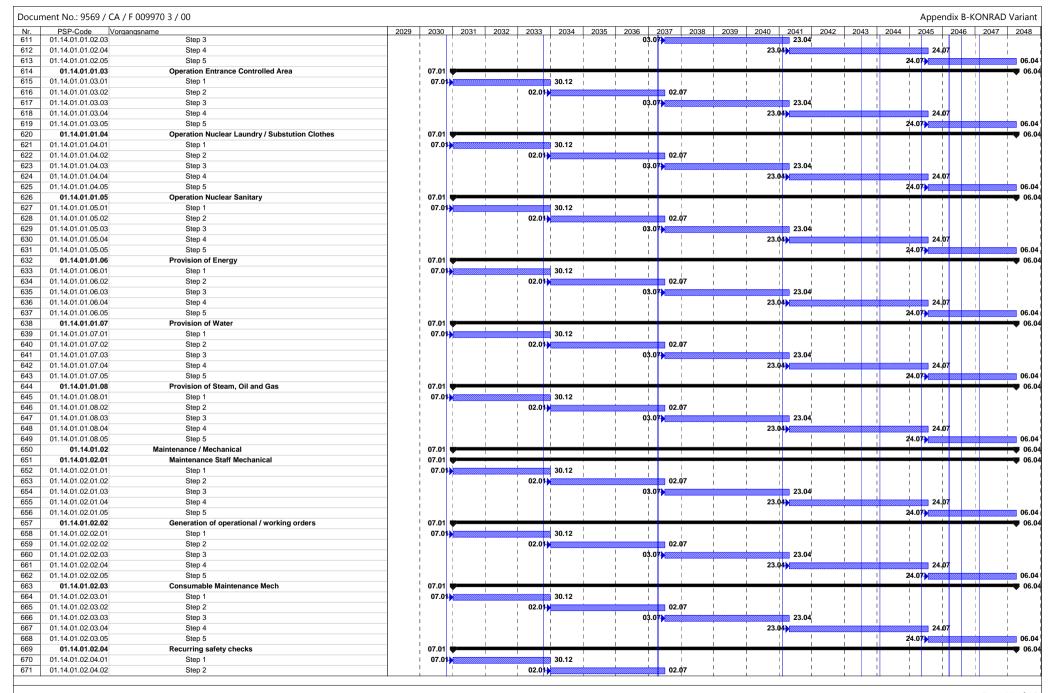
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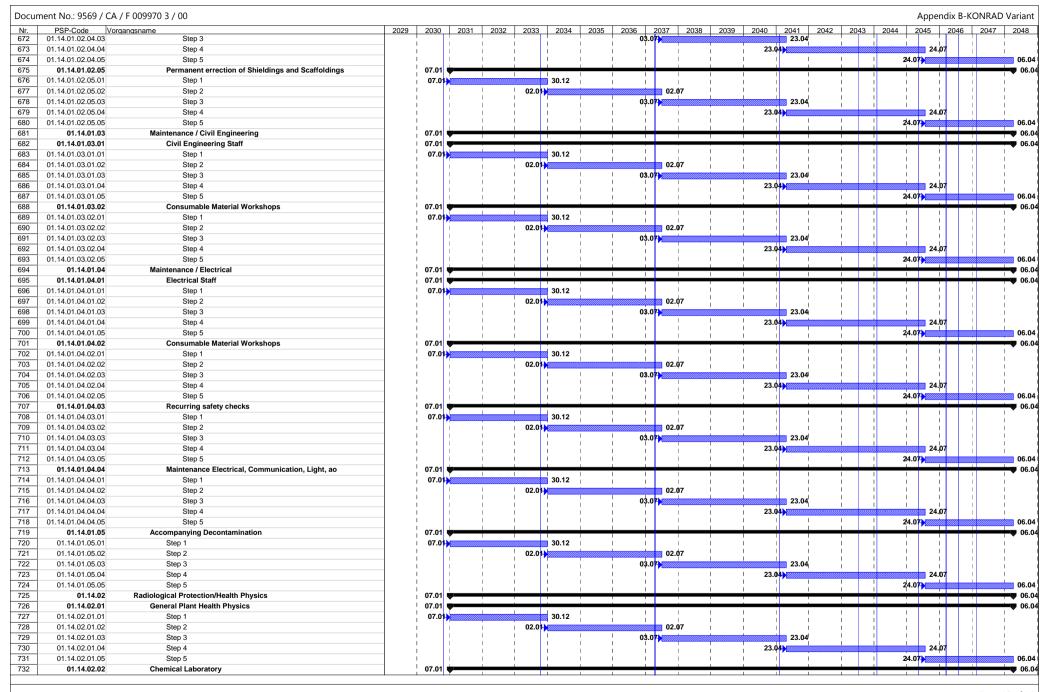
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369	01.09.02.04	Accompanying Decontamination		1	1	1	l .	I	1 1	I	1 1	1 1		08.01
370	01.09.02.05	Experts and Authorities		1	1	1	1	1	1 1					08.01
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374	01.09.03.03	Installation and Test of Equipment		1	1	1	1	1	1 1		! !			16.04 4.05
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378	01.09.04.02	Dismantling Reactor Pool Structures		1	1	1	1	1	1 1	- 1	1 1	1 1		21.04 22.07
379	01.09.04.03	Dismantling Biological shield (non activated)		!	1	!	!	!	1 !	!	. !			29.06—1422.07
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383	01.09.04.07	Finalisation Biological Shield		!	1	1	!	!	1 1		. !			20.11
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397	01.10.03.01.01	Preparation Working Place		i	i	i	i	i	1 1	ï				15.02
398	01.10.03.01.02	Dismantling remaining systems		1	1	1	1	I	1 1	1	1 1	1 1		14.03
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400	01.10.03.01.04	Clearing Site		1	1	1		1	1 1			1 1		12.04 10.05
401	01.10.03.01.05	Finalisation Aux Building		i	i	i	ì	i	i i	ï				10.05 10.05
402	01.10.03.02	Reactor Building Containment		1	1	1	1	1	1 1	ı	1 1	1 1		22.07
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424	01.10.03.05.04	Finalisation Other Building		l l	1	L	1	I	ı i	i	ı i	ı i		24.03
425	01.11	CLEARANCE OF BUILDING STRUCTURES		1	1	1	1	1	1 1	- 1	1			27.05
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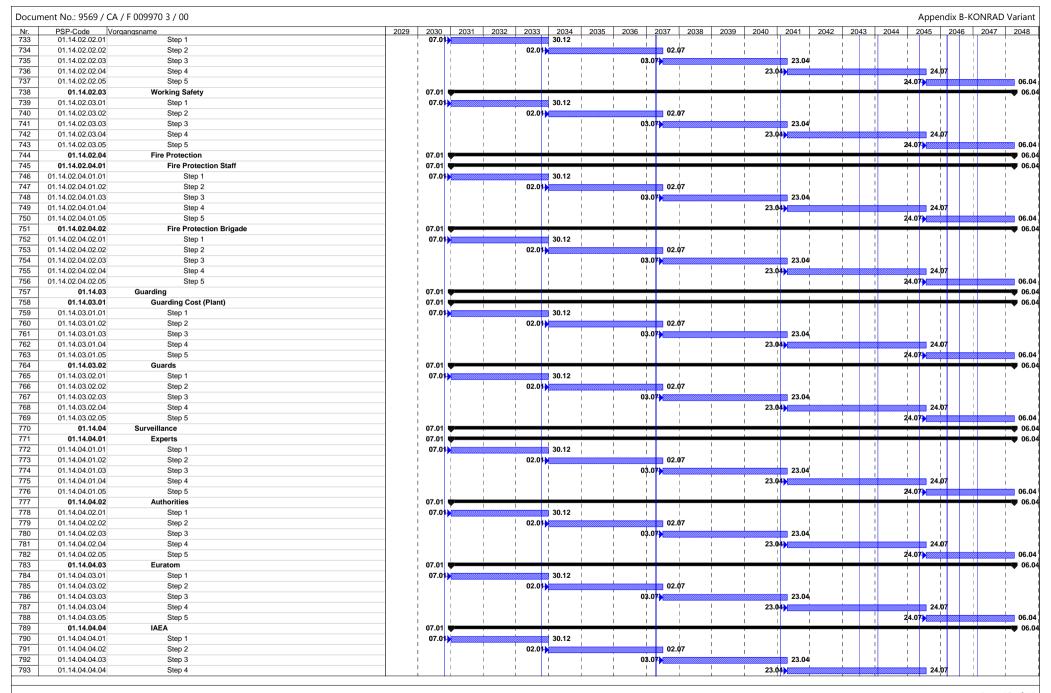
Document No.: 9569 / CA / F 009970 3 / 00 Appendix B-KONRAD Variant | Vorgangsname | Studies, Conceptual Planning Work, Project Specification PSP-Code 01.11.01.02 42 2043 2044 27.05 4 27.05 Nr. 428 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2045 2046 2047 2048 429 01 11 01 03 Contractings, Negotiations 27,05 19.08 430 01.11.02 Attendant Measures 14.03 ■ 24 07 431 01.11.02.01 Supervision 14.03 24.07 432 01.11.02.02 On Site Radiological Protection 14.03 24.07 433 01.11.02.03 Internal Transport 14.03 24.07 434 01.11.02.04 Accompanying Decontamination 14.03 24.07 435 01.11.02.05 Experts and Authorities 14.03 24.07 436 01.11.03 **Execution Project** 437 01.11.03.01 Auxiliary Building 14.03 438 01.11.03.01.01 Preparation Working Place 14.03 11.04 439 01.11.03.01.02 Decont Auxiliary Building 11.04N 02.01 440 01.11.03.01.03 Removal PCB 11.041 19.04 441 01.11.03.01.04 Clearing Site 19.04M 17.05 442 01.11.03.01.05 Clearance measurement 443 01.11.03.01.07 Finalisation Decont Auxiliary Building 24.07 24.07 444 01.11.03.02 Reactor Building 19.08 445 01.11.03.02.01 Preparation Working Place 19.08 16.09 16.09 27.05 446 01.11.03.02.02 Decont Reactor Building 16.09 22.09 447 Removal PCB 01.11.03.02.03 448 22.09 20.10 01.11.03.02.04 Clearing Site 449 01.11.03.02.05 Clearance measurement 1 20.10 23.10 23.10 450 01.11.03.02.06 Finalisation Decont Reactor Building 23.10 451 01.11.03.03 Release from controlled area constrains 21.05 CONVENTIONAL DEMOLITION AND SITE RESTORATION 452 01.12 23.02 453 01.12.01 23.02 Planning and Engineering 06.0 454 01.12.01.01 Project management / Engineering / Detail planning 23 02 06.04 455 23.02 426.02 01.12.01.02 Studies, Conceptual Planning Work, Project Specification 456 01.12.01.03 26.02 21.05 Contractings, Negotiations 457 01.12.02 Attendant Measures 26.02 □ 06.0 458 01.12.02.01 **Experts and Authorities** 26.02 06.04 459 01.12.03 Execution Project 21.05 06.0 460 01.12.03.01 All Buildings (incl. foundation) 21.05 461 01.12.03.01.01 Preparation Working Place 21,051 04.06 462 01.12.03.01.02 Demolition Reactor Building 22.10 11.03 463 01.12.03.01.03 Demolition Auxiliary Building 22.10 11.02 464 01.12.03.01.04 Demolition Turbin Building 04₁06 04₁06 22.10 465 01.12.03.01.05 Demolition Other Buildings 466 01.12.03.01.06 Trench supporting work 11.03 06.05 467 06.05 23.09 01.12.03.01.07 Demolition Piles 468 01.12.03.01.08 Demolition Fence, Streets 23.09 21.10 469 23.09 13.01 01.12.03.01.09 Filling building pits 470 01.12.03.01.10 13.01 06.04 Landscaping 471 01.12.03.01.11 Finalisation Site Restauration 06.04 06.0 472 01.13 PROJECT MANAGEMENT, ENGINEERING AND SITE SUPPORT 07.01 473 01.13.01 Administration 07.01 **06.0** 474 01.13.01.01 Plant Administration 07.01 475 01.13.01.01.01 Step 1: Start Project to Plant Shut Down 07.01 30.12 476 01.13.01.01.02 End of Step 1 02.01 02.01 477 01.13.01.01.03 Step 2: Plant Shut Down to Removal of Spent Fuels 02.0 02.07 03,07 4 03,07 478 01.13.01.01.04 End of Step 2 479 01.13.01.01.05 Step 3: Fuels removed to Dismantling RPV 03.07 23.04 23.04 480 01.13.01.01.06 End of Step 3 481 01.13.01.01.07 Step 4: RPV removed to Building Structures cleared 23.04 24.07 482 01.13.01.01.08 End of Step 4 24.07 24.07 483 Step 5: Clear Buildings to "Green Field" 24.07N 01.13.01.01.09 484 End of Step 5 06.04 4 06.0 01.13.01.01.10 485 Special management systems 01.13.01.02 07.01 06.0 486 07.01 01.13.01.02.01 **Quality Assurance** 487 01.13.01.02.01.01 07.01 30.12 Step 1 02.0 488 01.13.01.02.01.02 Step 2 02.07

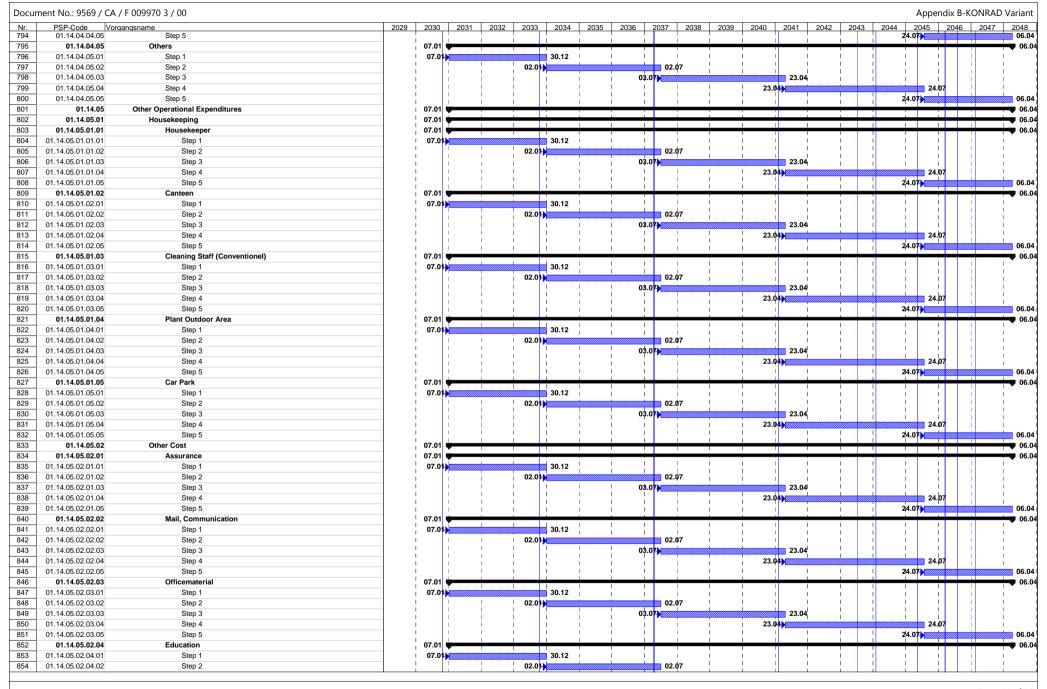


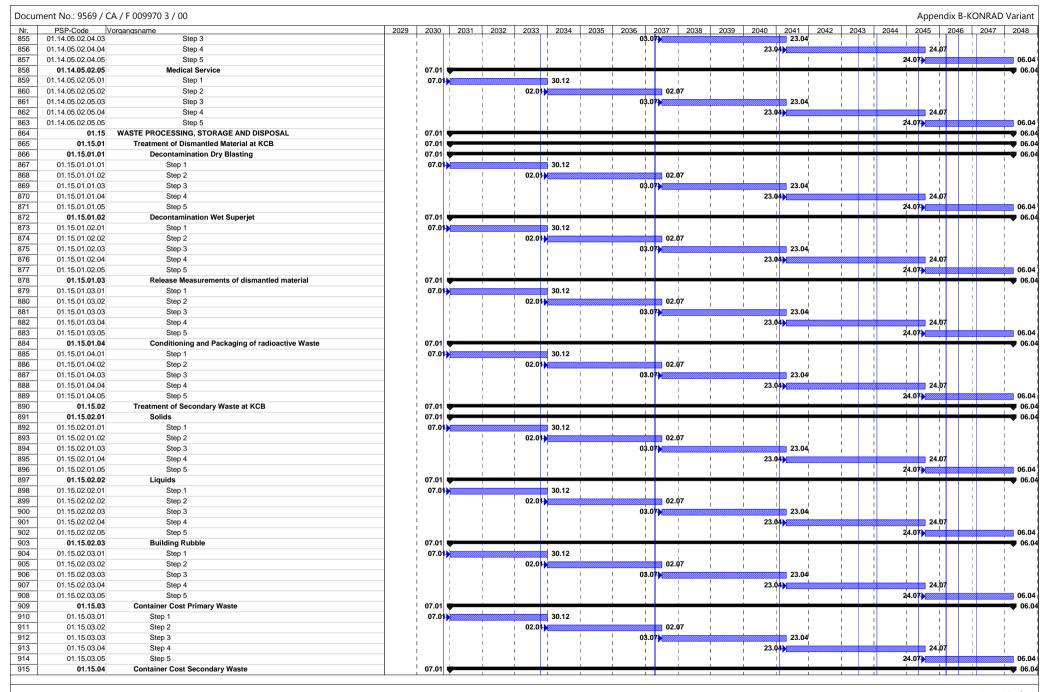


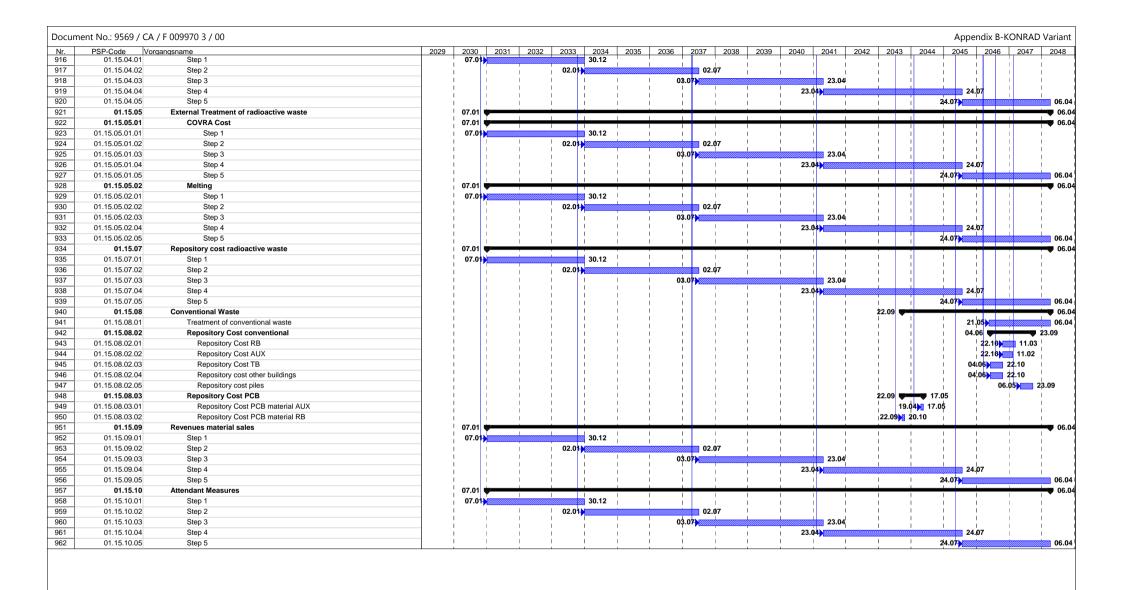












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116 01.02.04.02.03	Installation Cutting Machine	!	1 1	- ! II	21.04 02.0	5	1 1	1	1	1	1	1	1	l .	ŀ
117 01.02.04.03	Attendant Measures	1	1 1		31.12	.06	1 1	1	1	1	1	1	1	1	l l
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121 01.02.04.03.04	Accompanying Decontamination	;			31.12 19.0		1 1	1	1	1	1	1	1	ı I	ı

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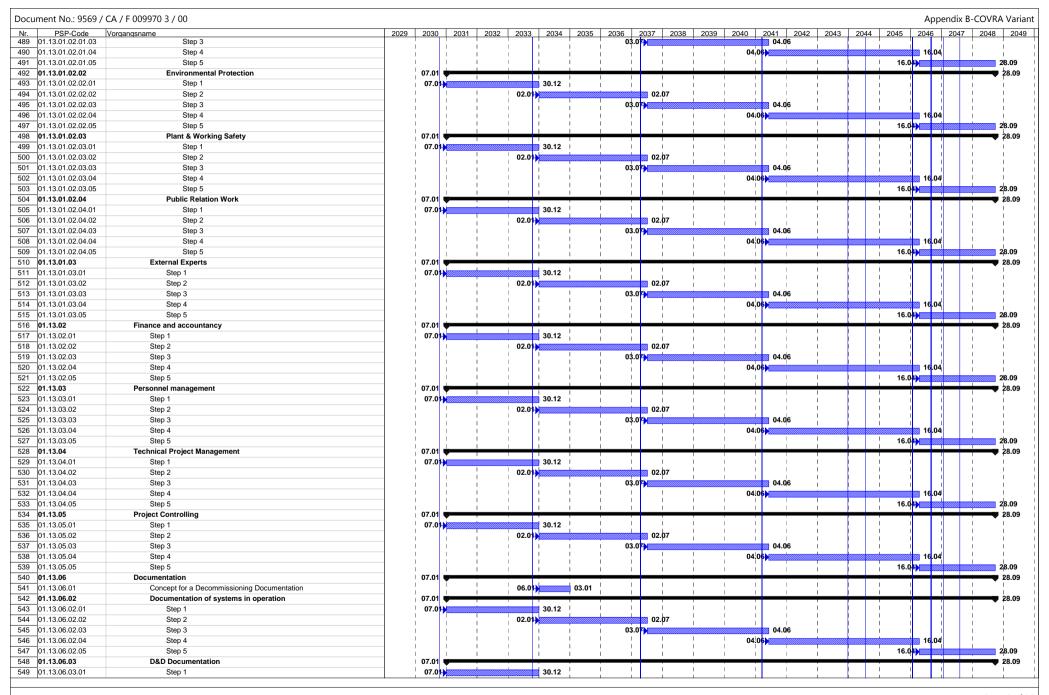
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	01.05	DISMANTLING CONTAMINATED MATERIAL		1	1				04.08							25.12			1 1			

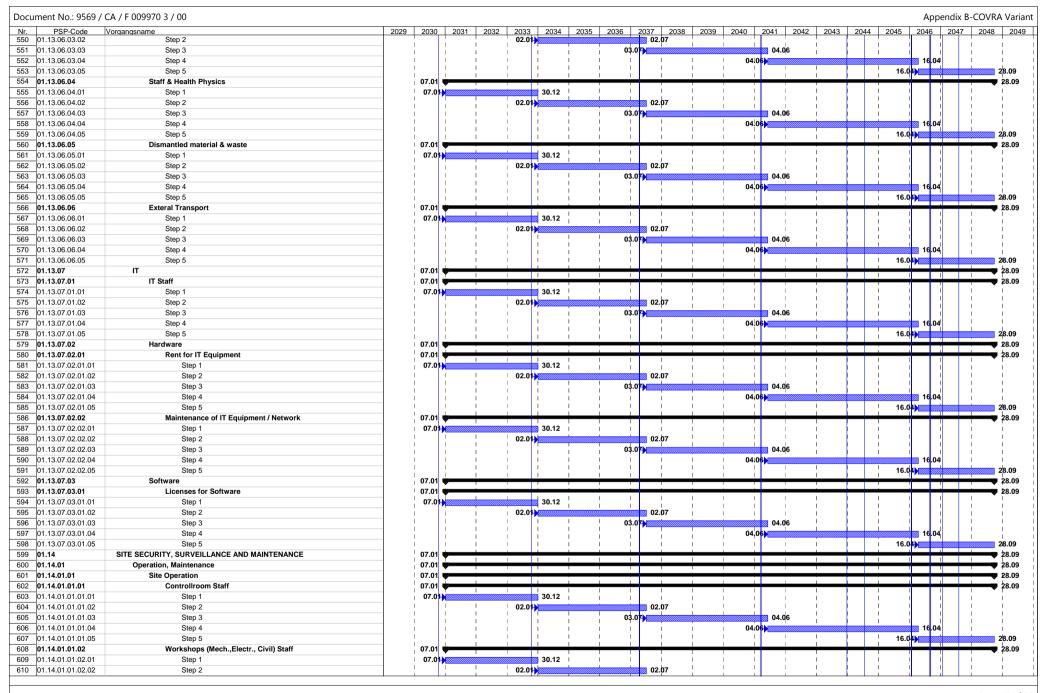
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	2036 2037 2036 2039 2040	2041
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5.01.01.01 Project management / Engineering / Detail planning		
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5.01.01.03 Contractings, Negotiations	.11 3.02	1
5.01.02 Attendant Measures	3.02	-!
5.01.02.01 Supervision	13.02	
15.01.02.02 On Site Radiological Protection	13.02	
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15.01.02.03 Internal Transport 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	13.02	
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15.01.02.05 Experts and Authorities		1
5.01.03.01 Modification Equipment	3.02 03.07 13.02 03.07	1
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15.01.04 Execution Project		i
5.01.04.01 Preparation Working Place	03.07 28,07	1
5.01.04.02 Dismantling Areas for waste management	29.07	
15.01.04.03 Dismantling Systems after free water	13.09	2
15.01.04.04 Dismantling further components		1
5.01.04.05 Finalisation Auxiliary Building	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1
5.01.04.06 Dismantling shielding bricks/blocks	13.05 29.07	d.
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5.02.02 Attendant Measures	3.02	0.06
15.02.02.01 Supervision	29.07	0.06
5.02.02.02 On Site Radiological Protection	13.02	0.06
5.02.02.03 Internal Transport	13.02	0.06
15.02.02.04 Accompanying Decontamination	13.02	0.06
15.02.02.05 Experts and Authorities	13.02	0.06
5.02.03 Preparation Work	3.02 03.07	
15.02.03.01 Modification Equipment	13.02 03.07	i
5.02.04 Execution Project		0.06
15.02.04.01 Preparation Working Place	03.0	
15.02.04.02 Dismantling Components Annulus	29.07 26.08	i
5.02.04.03 Dismantling Systems after free water	13.09	.06
15.02.04.04 Clearing Site	06:06	
5.02.04.05 Finalisation Reactor Building	20.06	
5.02.04.06 Dismantling shielding bricks/blocks	03.07 28.07	
66 DISMANTLING PRIMARY LOOP COMPONENTS	· 1.	-
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16.01.01 Project management / Engineering / Detail planning 11.00 Project Constitution 11.00 Project Management / Engineering / Detail planning 11.00 Project Specification 11.00 Project Specificatio		
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6.01.03 Contractings, Negotiations	6.01 10.04	1
6.02 Attendant Measures	10.04	
6.02.01 Supervision	10.04	
6.02.02 On Site Radiological Protection	10.04)	
6.02.03 Internal Transport	10.04	
6.02.04 Accompanying Decontamination	10.04	
6.02.05 Experts and Authorities	10.04	
6.03 Preparation Work	10.04 03.07	1
6.03.01 Modification Equipment	10.04 03.07	1
6.04 Execution Project	03.07	÷
6.04.01 Installation of Dismantling Equipment	03.07 99.07	1
16.04.02 Dismantling Primary Loop Part 1	10.07	1
6.04.03 Installation of Dismantling Equipment		4.06
6.04.04 Dismantling Steam Generator		25.0
6.04.05 Dismantling Primary Loop Part 2		-11
6.04.06 Clearing Site		-; [
6.04.07 Finalisation Primary Loop		- i [

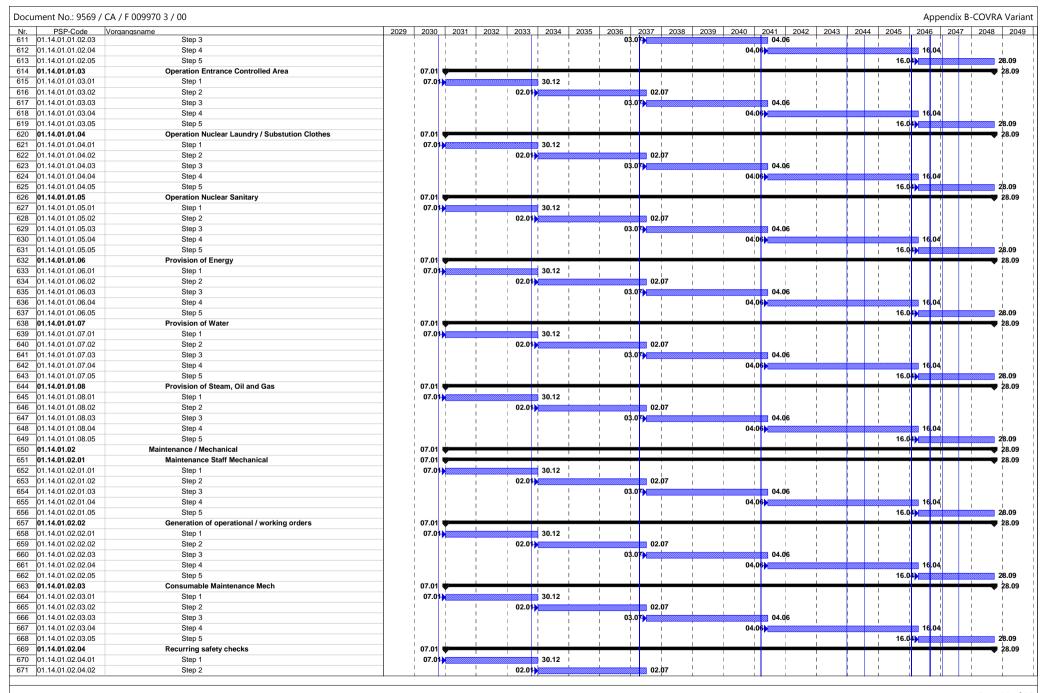
Nr. PSP-Code	Vorgangsname
06 01.07	DISMANTLING RPV INTERNALS
01.07.01	Planning and Engineering
1.07.01.01	Project management / Engineering / Detail planning
01.07.01.02	Studies, Conceptual Planning Work, Project Specification
01.07.01.02 01.07.01.03	Contractings, Negotiations
01.07.02	Attendant Measures
01.07.02.01	Supervision
	On Site Radiological Protection
01.07.02.02 01.07.02.03	Internal Transport
01.07.02.03	
	Accompanying Decontamination
	Experts and Authorities
01.07.03	Preparation Work
01.07.03.01	Preparation Reactor Pool
01.07.03.02	Dismantling Equipment
01.07.03.02.01	Construction Dismantling Equipment RPV Pool
01.07.03.02.02	Installation and Test of Equipment RPV Pool
01.07.03.03	Training of Staff
01.07.04 01.07.04.01	Execution Project
01.07.04.01	Dismantling RPV Head
01.07.04.02	Cutting RPV Head
01.07.04.03	Dismantling Upper RPV Internals
01.07.04.04	Dismantling Lower RPV Internals
01.07.04.05	Dismantling Core Support
01.07.04.06	Clearing Site
01.07.04.07	Finalisation RPV Internals
01.07.04.08	Free from water
01.08	DISMANTLING RPV
01.08.01	Planning and Engineering
	Project management / Engineering / Detail planning
	Studies, Conceptual Planning Work, Project Specification
6 01.08.01.03	Contractings, Negotiations
7 01.08.02	Attendant Measures
01.08.02.01	Supervision
01.08.02.02	On Site Radiological Protection
01.08.02.03	Internal Transport
1 01.08.02.04 2 01.08.02.05	Accompanying Decontamination
01.08.02.05	Experts and Authorities
01.08.03	Preparation Work
01.08.03.01	Preparation Reactor Pool
01.08.03.02	Construction of Dismantling Equipment
01.08.03.03	Installation and Test of Equipment
01.08.03.04	Training of Staff
01.08.04	Execution Project
01.08.04.01	Disassemply RPV
01.08.04.02	Lifting RPV for 1m
01.08.04.03	Cutting RPV upper part (flange)
01.08.04.04	Add Cut RPV (flange)
01.08.04.05 01.08.04.06	Lifting RPV for 1m (6 times)
01.08.04.06	Cutting RPV cylindrical part (6 times)
01.08.04.07	Add Cut RPV cylindrical part (6 times)
01.08.04.08	Disassemply and Lifting RPV calotte
01.08.04.09	Add Cutting RPV calotte
01.08.04.10	Clearing Site
01.08.04.11	Finalisation RPV
01.09	DISMANTLING BIOLOGICAL SHIELD
01.09.01	Planning and Engineering
01.09.01.01	Project management / Engineering / Detail planning
1.09.01.02	Studies, Conceptual Planning Work, Project Specification
01.09.01.03	Contractings, Negotiations
01.09.02	Attendant Measures
.09.02.01	Supervision

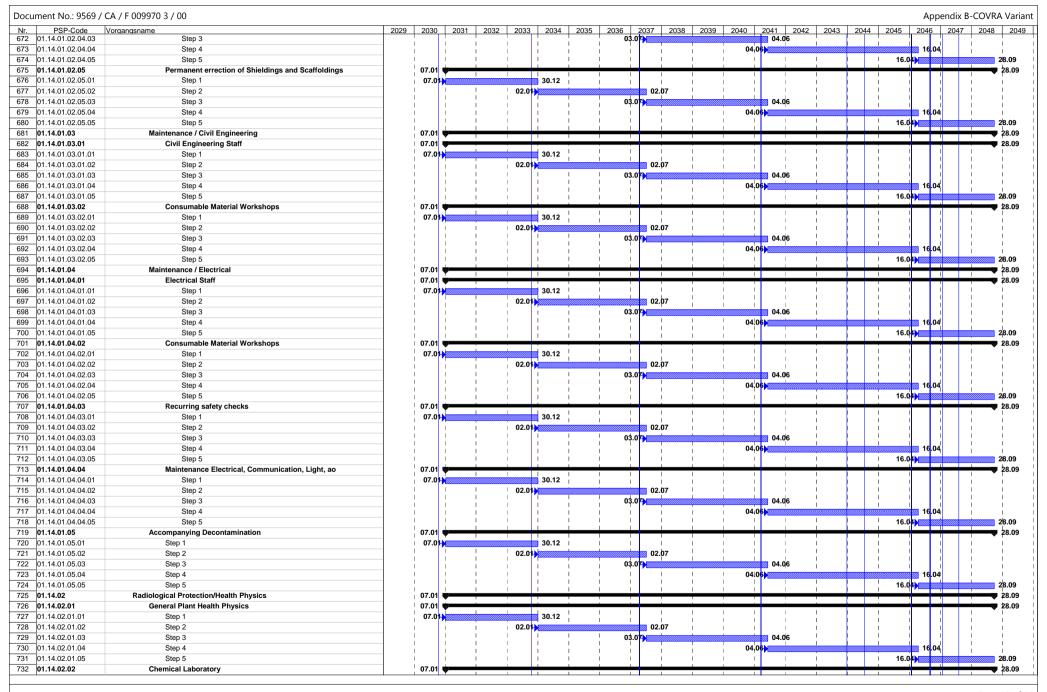
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PSP-Code .09.02.02	Vorgangsname On Site Rediclogical Protection
09.02.02	On Site Radiological Protection
.03	Internal Transport
1 5	Accompanying Decontamination
	Experts and Authorities
	Preparation Work
1	Preparation Reactor Pool
	Construction of Dismantling Equipment
2	Installation and Test of Equipment
	Training of Staff
.04	Execution Project
4	
)1	Dismantling Fuel Pool Structures
4.02	Dismantling Reactor Pool Structures
.03	Dismantling Biological shield (non activated)
.04	Dismantling Biological shield (activated)
05	Segmentation and Packaging
4.06	Clearing Site
.07	Finalisation Biological Shield
	DISMANTLING REMAINING SYSTEMS
01	Planning and Engineering
01	Project management / Engineering / Detail planning
.02 .03	Studies, Conceptual Planning Work, Project Specification
	Contractings, Negotiations
	Attendant Measures
1	Supervision
	On Site Radiological Protection
	Internal Transport
)4	Accompanying Decontamination
	Experts and Authorities
	Execution Project
01	Auxiliary Building
01.01	Preparation Working Place
1.02	Dismantling remaining systems
01.03	Dismantling Equipment
.04	Clearing Site
1.05	Finalisation Aux Building
	Reactor Building Containment
2.01	Preparation Working Place
02.02	Dismantling remaining systems
3.02.03	Dismantling remaining Equipment
3.02.04	Dismantling building masses in containment
3.02.04	
	Clearing Site
3.02.06	Finalisation Containment
13	Reactor Building Anulus
.01	Preparation Working Place
2	Dismantling Components
.03	Dismantling Equipment
3.04	Clearing Site
.05	Finalisation Containment
.03	Turbine Building
14	
.01	Preparation Working Place
.02	Dismantling Components and Equipment
04.03	Clearing Site
04	Finalisation Dismantling Monitored Area
	Other Buildings
.01	Preparation Working Place
5.02	Dismantling Components and Equipment
.05.03	Clearing Site
05.04	Finalisation Other Building
	CLEARANCE OF BUILDING STRUCTURES
	Planning and Engineering
	Project management / Engineering / Detail planning

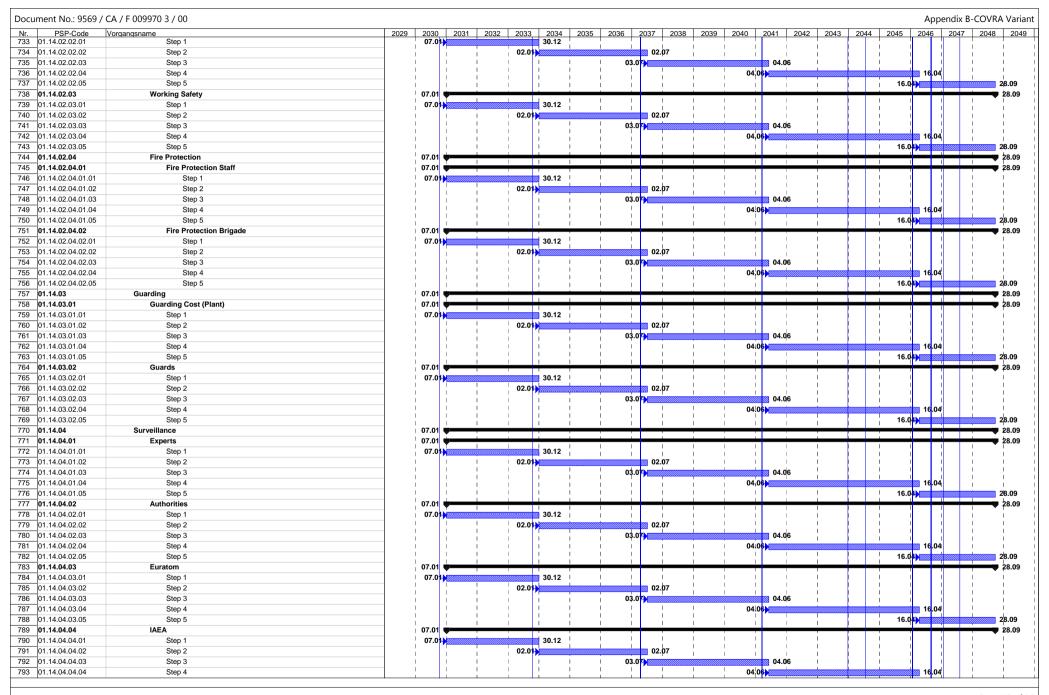
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PSP-Code 01.11.01.02	Vorgangsname Studies, Conceptual Planning Work, Project Specification	2029 2030	2031	2032 2033	2034 2	35 2036	3 2037 203	8 2039	2040 2041 2	042 2043 18.11	2044	2045 2046	+
01.11.01.03	Contractings, Negotiations	\dashv \vdots \vdash	1	1 1	1 1	1	1 1	1		18 11	10.02	1	1
01.11.02	Attendant Measures	-	1		1 :	1				10.11	07.09	17.01	i
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1 01.11.02.04	Accompanying Decontamination	i	İ	i i	i i	İ	i i	İ	i i i	i	07.09	17.01	i
01.11.02.05	Experts and Authorities	_ ! !	1	! !	1 1	Į.	1 1	1	! ! !	1	07.09	17.01	1
01.11.03	Execution Project		i		li i			i I		10.02	11* 11 1		1
7 01.11.03.01	Auxiliary Building	i	i	i i	i i	i	i i	i	i i i	i	07.09	17.01	i
01.11.03.01.01	Preparation Working Place		1	1 1	1 1	1	1 1	1	1 1	1	07.09 05	.10	1
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01.11.03.01.05	Clearance measurement	- ! !	1	1 1	1 1	!	1 1	1			05.10	17.01	1
01.11.03.01.07	Finalisation Decont Auxiliary Building	-	1			1		1		1	11 1 7	17.01 17.01	1
01.11.03.02	Reactor Building	\dashv \vdash \vdash	Ì	i i	li i	i	i i	i	i i i	10.03	2	16.	
01.11.03.02.01	Preparation Working Place	\dashv	1	1 1	1 1	1	1 1	1	1 1		09.03	10.	1
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01.11.03.02.05	Clearance measurement	_	1		[1	1 1			12	.04)	16.0	
01.11.03.02.06	Finalisation Decont Reactor Building	_	ì	i i	li i	i	ii	Ì	i i i	i		16.04	
01.11.03.03	Release from controlled area constrains	_	1	į I	1 1	1	1 1	1	1 1 1	1	1	16.04	⊢ 12
01.12	CONVENTIONAL DEMOLITION AND SITE RESTORATION		1	1	! !	1	1 1	1		!	1 !	17.08	_
01.12.01	Planning and Engineering		1			1	1 1	i I		1		17.08	÷
1 01.12.01.01	Project management / Engineering / Detail planning		i	i i	i i	i	i i	i	i i i	i	i i	17.08	
01.12.01.02	Studies, Conceptual Planning Work, Project Specification		1	1 1	1 1	I	1 1	T.	I I I	1	1	17.08	10.0
01.12.01.03	Contractings, Negotiations		1			ļ.		!		!		20.08	12
01.12.02	Attendant Measures		i	i i	i i	i	i i	i	i i i	i		20.08	-
01.12.02.01	Experts and Authorities	- i	İ	i i	i i	İ	i i	İ	i i i	i	i i	20.08	
01.12.03	Execution Project	- ! !	1	1 1	1 1	I .	1 1	1	1 1	1	1 !	12.11	
	All Buildings (incl. foundation)	- : !	1			1	1	- 1		- 1		12.11	• "
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	Preparation Working Place		1	1	1 1	1	1 1	1	1 1	1	1	1 12	
01.12.03.01.02	Demolition Reactor Building	_	1			l l	1 1	l l		!			04
01.12.03.01.03	Demolition Auxiliary Building	_	i	1 1	i i	i	1 1	i	1 1 1	i		15	.04
01.12.03.01.04	Demolition Turbine Building		1	1 1	1 1	1	1 1	1	1 1	1	1	26.1	
01.12.03.01.05	Demolition Remaining Buildings monitored area	_ ! !	1	1	! !	1	1 1	1				26.1	
01.12.03.01.06	Trench supporting work		i					i I		i		<u> </u>	02.0
01.12.03.01.07	Demolition Piles	i	1	i i	i i	1	i i	İ	i i i	i i	1	i	28
01.12.03.01.08	Demolition Fence, Streets		1	1 1	1 1	!	1 1	1		1	1 !	!	1
01.12.03.01.09	Filling building pits		1			1	1 1	i i		1		1	
01.12.03.01.10 01.12.03.01.11	Landscaping		İ	i i	i i	i	i i	i	i i i	i	1 1	i	i
01.12.03.01.11	Finalisation Site Restauration		1	1 1	1 1	1	1 1	1	1 1	1	1	!	1
01.13	PROJECT MANAGEMENT, ENGINEERING AND SITE SUPPORT	07.01	-			_	+			-	+	+	#
01.13.01	Administration	07.01	-	 	+ +	-	+ +	-	· · · · · · · · · · · · · · · · · · ·		+	 	+
01.13.01 01.13.01.01	Plant Administration	07.01	-		-	_		-					_
01.13.01.01.01	Step 1: Start Project to Plant Shut Down	07.04			30.12	I I	1 1	1		1		!	
01.13.01.01.02	End of Step 1	- 1		02.01	02.01	i	1			i			1
01.13.01.01.03	Step 2: Plant Shut Down to Removal of Spent Fuels	\dashv i \mid	1	02.0			-02.07	i	ı i i	i	i	i	il.
01.13.01.01.04	End of Step 2	⊣ ! !	1	! ! 02.0			03.07 03.07	1	[[[1		!	1
01.13.01.01.04		\dashv	1		[1	03.07	I	-04.06	- 1		<u> </u>	1
	Step 3: Fuels removed to Dismantling RPV	-	ì	1 1	Li i	i	03.07	I	1	i			il.
01.13.01.01.06	End of Step 3	i	1	ı i	ı i	1	i i	1	04.06 04.06	1	i i	<u> </u>	.1
01.13.01.01.07	Step 4: RPV removed to Building Structures cleared	_ ! !	1	1 1	1 !	1		1	04,06			_16.0	
01.13.01.01.08	End of Step 4	_	1		H +	1		1		1		16.04 📢 16	04
01.13.01.01.09	Step 5: Clear Buildings to "Green Field"		i	i i	Li i	i	- i - i	i	i il i	i		16.04	
01.13.01.01.10 01.13.01.02	End of Step 5	1	Į.	<u>I</u> I	1 1	1	1 1	1	, , <u>, , , , , , , , , , , , , , , , , </u>	1	i	4	1
01.13.01.02	Special management systems	07.01	-			-		_			+	- 	_
		07.01			+					_			-
01.13.01.02.01	Quality Assurance		▼										
01.13.01.02.01 01.13.01.02.01.01	Step 1	07.01	Y	'	30.12	i I		İ		i			ï

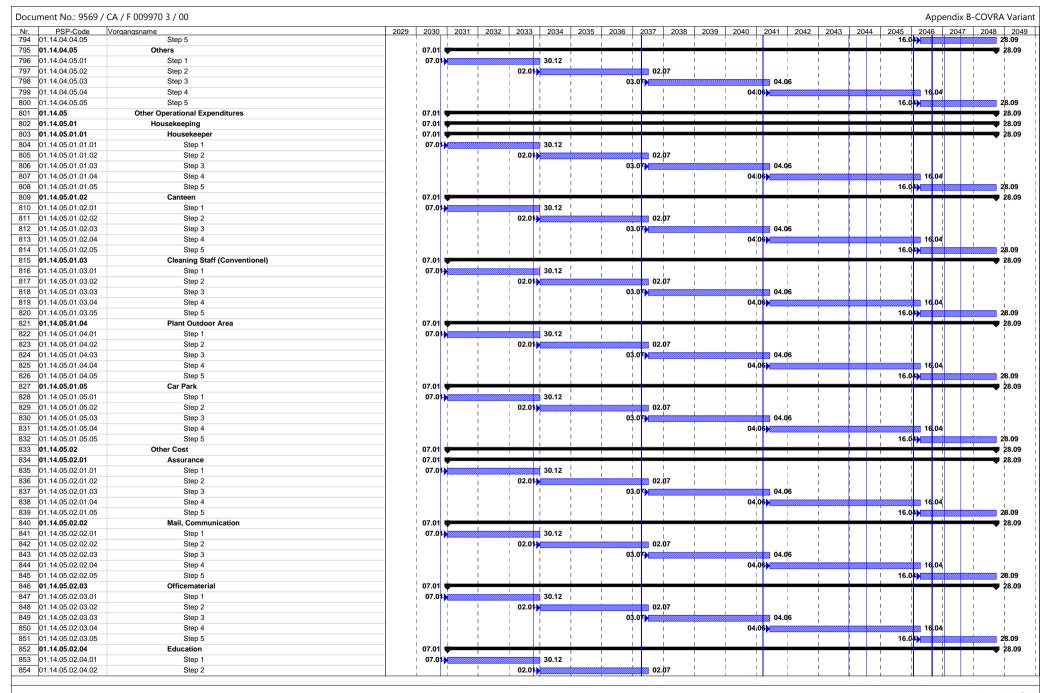


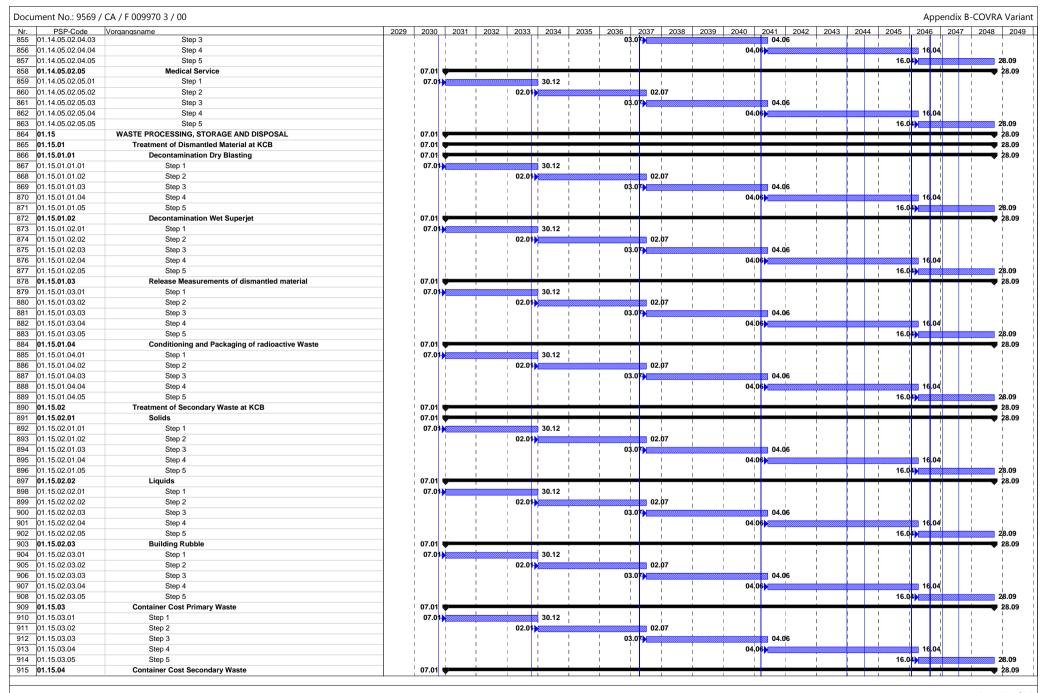


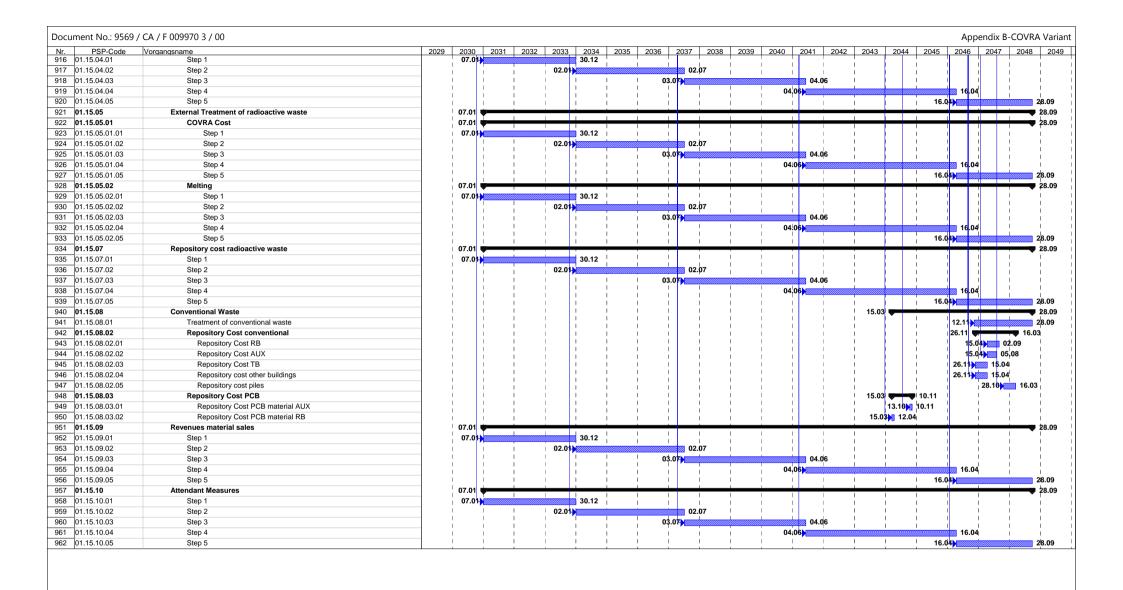












Appendix C: Complete work breakdown structure

KONRAD and COVRA variant



WBS code	name
01	PRE-DECOMMISSIONING ACTIONS
01.01	Start of Project
01.02	Collection Technical Data
01.02.01	Radiological Status
01.02.02	Technical Plant Status
01.02.03	PCB research programm
01.03	Project Planning and Engineering
01.03.01	Preliminary Plan, Strategy, Cost, Personnel Requirements
01.04	Licensing Procedure
01.04.01	Preparation of Licensing Documents
01.04.01.01	Safety Assessment
01.04.01.02	Environmental Impact
01.04.01.03	Technical Documents
01.04.02	Authority and Experts
01.04.02.01	Technical Expertises
01.04.02.02	Authority expenditures
01.05	Approval D&D License
01.06	Final Shut Down
02	PREPARATORY WORK
02.01	Shut Down of Systems
02.01.01	Systems not needed anymore
02.02	Modification of Equipment
02.02.01	Modification Heating System
02.02.01.01	Planning and Engineering
02.02.01.01.01	Project management / Engineering / Detail planning
02.02.01.01.02	Studies, Conceptual Planning Work, Project Specification
02.02.01.01.03	Contractings, Negociations
02.02.01.02	Attendant Measures
02.02.01.02.01	Supervision
02.02.01.02.02	Experts and Authorities
02.02.01.03	Execution Project
02.02.01.03.01	Dismantling Heater
02.02.01.03.02	Installation new Heater
02.02.01.03.03	Finalisation Changing Heater
02.02.02	Modification Evapourator System
02.02.02.01	Planning and Engineering
02.02.02.01.01	Project management / Engineering / Detail planning
02.02.02.01.02	Studies, Conceptual Planning Work, Project Specification
02.02.02.01.03	Contractings, Negociations
02.02.02.02	Attendant Measures
02.02.02.02.01	Supervision
02.02.02.02.02	Experts and Authorities
02.02.02.03	Execution Project
02.02.02.03.01	Preparation Installation Area
02.02.02.03.02	Installation new Evapourator
02.02.02.03.03	Commission and Test Evapourator
02.02.02.03.04	Finalisation Changing Evapourator
02.02.03	Modification Compressed Air Supply
02.02.03.01	Planning and Engineering

WBS code	name
02.02.03.01.01	Project management / Engineering / Detail planning
02.02.03.01.02	Studies, Conceptual Planning Work, Project Specification
02.02.03.01.03	Contractings, Negociations
02.02.03.02	Attendant Measures
02.02.03.02.01	Supervision
02.02.03.02.02	Experts and Authorities
02.02.03.03	Execution Project
02.02.03.03.01	Dismantling components for new equipment
02.02.03.03.02	Installation new Air supply
02.02.03.03.03	Commission and Test Air Supply
02.02.03.03.04	Finalisation Changing Air Supply
02.02.04	Modification Entrance Controlled Area
02.02.04.01	Planning and Engineering
02.02.04.01.01	Project management / Engineering / Detail planning
02.02.04.01.02	Studies, Conceptual Planning Work, Project Specification
02.02.04.01.03	Contractings, Negociations
02.02.04.02	Attendant Measures
02.02.04.02.01	Supervision
02.02.04.02.02	Experts and Authorities
02.02.04.03	Execution Project
02.02.04.03.01	Modification Controlled Area Entrance
02.02.04.03.02	Commission and Test Entrance Controlled Area
02.02.04.03.03	Finalisation Entrance Controlled Area
02.02.05	Modification Sanitary Area
02.02.05.01	Planning and Engineering
02.02.05.01.01	Project management / Engineering / Detail planning
02.02.05.01.02	Studies, Conceptual Planning Work, Project Specification
02.02.05.01.03	Contractings, Negociations
02.02.05.02	Attendant Measures
02.02.05.02.01	Supervision
02.02.05.02.02	Experts and Authorities
02.02.05.03	Execution Project
02.02.05.03.01	Installation new sanitary equipment
02.02.05.03.02	Commission and Test Evapourator
02.02.05.03.03	Finalisation Entrance Controlled Area
02.03	Decontamination Primary Circuit
02.03.01	Planning and Engineering
02.03.01.01	Project management / Engineering / Detail planning
02.03.01.02	Studies, Conceptual Planning Work, Project Specification
02.03.01.03	Contractings, Negociations
02.03.02	Preparation Work
02.03.02.01	Chemical Test Project
02.03.02.02	Modification Primary Pumps
02.03.03	Attendant Measures
02.03.03.01	Supervision
02.03.03.02	On Site Radiological Protection
02.03.03.03	Internal Transport
02.03.03.04	Accompanying Decontamination
02.03.03.05	Experts and Authorities

WBS code	name
02.03.04	Execution Project
02.03.04.01	Preparation Working Place/Installation Equipment
02.03.04.02	Decontamination Work 3 Cycles
02.03.04.03	Additional Decontamination Cycles
02.03.04.04	Clearing Site
02.03.04.05	Container for Primary Circuit Deco + Covra Cost
02.03.04.06	Finalisation Primary Loop
02.03.05	Shut Down of the Primary Circuit
02.04	Removal of mobile Core Internals
02.04.01	Planning and Engineering
02.04.01.01	Project management / Engineering / Detail planning
02.04.01.02	Studies, Conceptual Planning Work, Project Specification
02.04.01.03	Contractings, Negociations
02.04.02	Preparation Work
02.04.02.01	Radiological Characterisation
02.04.02.02	Preparation Reactor Pool
02.04.02.03	Installation Cutting Machine
02.04.03	Attendant Measures
02.04.03.01	Supervision
02.04.03.02	On Site Radiological Protection
02.04.03.03	Internal Transport
02.04.03.04	Accompanying Decontamination
02.04.03.05	Experts and Authorities
02.04.04	Execution Project
02.04.04.01	Cutting and Packaging mobile Internals
02.04.04.02	Clearing Site
02.04.04.03	Finalisation Mobile Reactor Internals
02.05	Erection Container Storage Area
02.05.01	Planning and Engineering
02.05.01.01	Project management / Engineering / Detail planning
02.05.01.02	Studies, Conceptual Planning Work, Project Specification
02.05.01.03	Contractings, Negociations
02.05.04	Execution Project
02.05.04.01	Preparation Working Place
02.05.04.02	Errection Storage Area
02.05.04.03	Clearing Working Site
02.06	Preparation of Material Treatment Facility
02.06.01	Planning and Engineering
02.06.01.01	Project management / Engineering / Detail planning
02.06.01.02	Studies, Conceptual Planning Work, Project Specification
02.06.01.03	Contractings, Negociations
02.06.03	Execution Project
02.06.03.01	Preparation Working Place
02.06.03.02	Dismantling Components
02.06.03.03	Modification Building
02.06.03.04	Installation of Dismantling Equipment
02.06.03.05	Clearing Working Site
02.07	Clearance Measurement Facility
02.07.01	Planning and Engineering

WBS code	name
02.07.01.01	Project management / Engineering / Detail planning
02.07.01.02	Studies, Conceptual Planning Work, Project Specification
02.07.01.03	Contractings, Negociations
02.07.03	Execution Project
02.07.03	Preparation Working Place
02.07.03.01	Modification Building
02.07.03.02	Clearing Working Site
02.07.03	Installation Clearance Measurement Facility
02.07.05	Commission and Test, Calibration
02.07.06	Material Treatment Facility Workable
02.07.00	Material Sluice
02.08.01 02.08.01.01	Planning and Engineering
	Project management / Engineering / Detail planning
02.08.01.02	Studies, Conceptual Planning Work, Project Specification
02.08.01.03	Contractings, Negociations
02.08.02	Attendant Measures
02.08.02.01	Supervision
02.08.02.02	On Site Radiological Protection
02.08.02.03	Internal Transport
02.08.02.04	Accompanying Decontamination
02.08.02.05	Experts and Authorities
02.08.03	Preparation Work
02.08.03.01	Modification Equipment
02.08.04	Execution Project
02.08.04.01	Preparation Working Place
02.08.04.02	Substitution Material Sluice
02.08.04.03	Clearing Working Site
02.09	Asbestos Material
02.09.01	Planning and Engineering
02.09.01.01	Project management / Engineering / Detail planning
02.09.02	Attendant Measures
02.09.02.01	Supervision
02.09.02.02	On Site Radiological Protection
02.09.02.03	Internal Transport
02.09.02.04	Accompanying Decontamination
02.09.02.05	Experts and Authorities
02.09.03	Execution Project
02.09.03.01	Removal Asbestos
02.09.03.02	Treatment/Storage Asbestos
02.10	Improvement Infrastructure
02.10.01	Planning and Engineering
02.10.01.01	Project management / Engineering / Detail planning
02.10.01.02	Studies, Conceptual Planning Work, Project Specification
02.10.01.03	Contractings, Negociations
02.10.02	Attendant Measures
02.10.02.01	Supervision
02.10.02.02	On Site Radiological Protection
02.10.02.03	Internal Transport
02.10.02.04	Accompanying Decontamination

WBS code	name
02.10.02.05	Experts and Authorities
02.10.03	Preparation Work
02.10.03.01	Modification Equipment
02.10.04	Execution Project
02.10.04.01	Reconstruction Work
02.10.04.02	Lifting Devices
03	OPERATIONAL WASTE
03.01	Transport of Spent Fuels from Reactor to Fuel Pool
03.02	Packaging of SF in Storage Container
03.03	Transport to Reprocessing
03.04	Fuel removed
03.05	Removal Operational Waste and Material
03.05.03	Preparation Work
03.05.03.01	Modification Equipment
03.05.04	Execution Project
03.05.04.01	Conditioning of existing Operational Waste
03.05.04.02	Clearance of Storage Area
03.05.04.03	COVRA Cost
04	DISMANTLING OUTSIDE CONTROLLED AREA
04.01	Turbine Building
04.01.01	Planning and Engineering
04.01.01.01	Project management / Engineering / Detail planning
04.01.01.02	Studies, Conceptual Planning Work, Project Specification
04.01.01.03	Contractings, Negotiations
04.01.02	Attendant Measures
04.01.02.01	Supervision
04.01.02.02	Internal Transport
04.01.02.03	Experts and Authorities
04.01.03	Execution Project
04.01.03.01	Cutting and Packaging Components
04.01.03.02	Clearing Site
04.01.03.03	Finalisation Turbine Hall I
04.02	Other Buildings in Monitored Area
04.02.01	Planning and Engineering
04.02.01.01	Project management / Engineering / Detail planning
04.02.01.02	Studies, Conceptual Planning Work, Project Specification
04.02.01.03	Contractings, Negotiations
04.02.02	Attendant Measures
04.02.02.01	Supervision
04.02.02.02	Internal Transport
04.02.02.03	Experts and Authorities
04.02.03	Execution Project
04.02.03.01	Removal of Insulations and batteries
04.02.03.02	Cutting and Packaging Components
04.02.03.03	Clearing Site
04.02.03.04	Finalisation Other Buildings
05	DISMANTLING CONTAMINATED MATERIAL
05.01	Auxiliary Building
05.01.01	Planning and Engineering

WBS code	name
05.01.01.01	Project management / Engineering / Detail planning
05.01.01.02	Studies, Conceptual Planning Work, Project Specification
05.01.01.03	Contractings, Negotiations
05.01.02	Attendant Measures
05.01.02.01	Supervision
05.01.02.02	On Site Radiological Protection
05.01.02.03	Internal Transport
05.01.02.04	Accompanying Decontamination
05.01.02.05	Experts and Authorities
05.01.03	Preparation Work
05.01.03.01	Modification Equipment
05.01.04	Execution Project
05.01.04.01	Preparation Working Place
05.01.04.02	Dismantling Areas for waste management
05.01.04.03	Dismantling Systems after free water
05.01.04.04	Dismantling further components
05.01.04.05	Finalisation Auxiliary Building
05.01.04.06	Dismantling shielding bricks/blocks
05.02	Reactor Building
05.02.01	Planning and Engineering
05.02.01.01	Project management / Engineering / Detail planning
05.02.01.02	Studies, Conceptual Planning Work, Project Specification
05.02.01.03	Contractings, Negotiations
05.02.02	Attendant Measures
05.02.02.01	Supervision
05.02.02.02	On Site Radiological Protection
05.02.02.03	Internal Transport
05.02.02.04	Accompanying Decontamination
05.02.02.05	Experts and Authorities
05.02.03	Preparation Work
05.02.03.01	Modification Equipment
05.02.04	Execution Project
05.02.04.01	Preparation Working Place
05.02.04.02	Dismantling Components Annulus
05.02.04.03	Dismantling Systems after free water
05.02.04.04	Clearing Site
05.02.04.05	Finalisation Reactor Building
05.02.04.06	Dismantling shielding bricks/blocks
06	DISMANTLING PRIMARY LOOP COMPONENTS
06.01	Planning and Engineering
06.01.01	Project management / Engineering / Detail planning
06.01.02	Studies, Conceptual Planning Work, Project Specification
06.01.03	Contractings, Negotiations
06.02	Attendant Measures
06.02.01	Supervision
06.02.02	On Site Radiological Protection
06.02.03	Internal Transport
06.02.04	Accompanying Decontamination
06.02.05	Experts and Authorities

WBS code	name
06.03	Preparation Work
06.03.01	Modification Equipment
06.04	Execution Project
06.04.01	Installation of Dismantling Equipment
06.04.02	Dismantling Primary Loop Part 1
06.04.03	Installation of Dismantling Equipment
06.04.04	Dismantling Steam Generator
06.04.05	Dismantling Primary Loop Part 2
06.04.06	Clearing Site
06.04.07	Finalisation Primary Loop
07	DISMANTLING RPV INTERNALS
07.01	Planning and Engineering
07.01.01	Project management / Engineering / Detail planning
07.01.02	Studies, Conceptual Planning Work, Project Specification
07.01.03	Contractings, Negotiations
07.02	Attendant Measures
07.02.01	Supervision
07.02.02	On Site Radiological Protection
07.02.03	Internal Transport
07.02.04	Accompanying Decontamination
07.02.05	Experts and Authorities
07.03	Preparation Work
07.03.01	Preparation Reactor Pool
07.03.02	Dismantling Equipment
07.03.02.01	Construction Dismantling Equipment RPV Pool
07.03.02.02	Installation and Test of Equipment RPV Pool
07.03.03	Training of Staff
07.04	Execution Project
07.04.01	Dismantling RPV Head
07.04.02	Cutting RPV Head
07.04.03	Dismantling Upper RPV Internals
07.04.04	Dismantling Lower RPV Internals
07.04.05	Dismantling Core Support
07.04.06	Clearing Site
07.04.07	Finalisation RPV Internals
07.04.08	Free from water
08	DISMANTLING RPV
08.01	Planning and Engineering
08.01.01	Project management / Engineering / Detail planning
08.01.02	Studies, Conceptual Planning Work, Project Specification
08.01.03	Contractings, Negotiations
08.02	Attendant Measures
08.02.01	Supervision
08.02.02	On Site Radiological Protection
08.02.03	Internal Transport
08.02.04	Accompanying Decontamination
08.02.05	Experts and Authorities
08.03	Preparation Work
08.03.01	Preparation Reactor Pool

WBS code	name
08.03.02	Construction of Dismantling Equipment
08.03.03	Installation and Test of Equipment
08.03.04	Training of Staff
08.04	Execution Project
08.04.01	Disassemply RPV
08.04.02	Lifting RPV for 1m
08.04.03	Cutting RPV upper part (flange)
08.04.04	Add Cut RPV (flange)
08.04.05	Lifting RPV for 1m (6 times)
08.04.06	Cutting RPV cylindrical part (6 times)
08.04.07	Add Cut RPV cylindrical part (6 times)
08.04.08	Disassemply and Lifting RPV calotte
08.04.09	Add Cutting RPV calotte
08.04.10	Clearing Site
08.04.11	Finalisation RPV
09	DISMANTLING BIOLOGICAL SHIELD
09.01	Planning and Engineering
09.01.01	Project management / Engineering / Detail planning
09.01.02	Studies, Conceptual Planning Work, Project Specification
09.01.03	Contractings, Negotiations
09.02	Attendant Measures
09.02.01	Supervision
09.02.02	On Site Radiological Protection
09.02.03	Internal Transport
09.02.04	Accompanying Decontamination
09.02.05	Experts and Authorities
09.03	Preparation Work
09.03.01	Preparation Reactor Pool
09.03.02	Construction of Dismantling Equipment
09.03.03	Installation and Test of Equipment
09.03.04	Training of Staff
09.04	Execution Project
09.04.01	Dismantling Fuel Pool Structures
09.04.02	Dismantling Reactor Pool Structures
09.04.03	Dismantling Biological shield (non activated)
09.04.04	Dismantling Biological shield (activated)
09.04.05	Segmentation and Packaging
09.04.06	Clearing Site
09.04.07	Finalisation Biological Shield
10	DISMANTLING REMAINING SYSTEMS
10.01	Planning and Engineering
10.01.01	Project management / Engineering / Detail planning
10.01.02	Studies, Conceptual Planning Work, Project Specification
10.01.03	Contractings, Negotiations
10.02	Attendant Measures
10.02.01	Supervision
10.02.02	On Site Radiological Protection
10.02.03	Internal Transport
10.02.04	Accompanying Decontamination

WBS code	name
10.02.05	Experts and Authorities
10.03	Execution Project
10.03.01	Auxiliary Building
10.03.01.01	Preparation Working Place
10.03.01.02	Dismantling remaining systems
10.03.01.03	Dismantling Equipment
10.03.01.04	Clearing Site
10.03.01.05	Finalisation Aux Building
10.03.02	Reactor Building Containment
10.03.02.01	Preparation Working Place
10.03.02.02	Dismantling remaining systems
10.03.02.03	Dismantling remaining Equipment
10.03.02.04	Dismantling bulding masses in containment
10.03.02.05	Clearing Site
10.03.02.06	Finalisation Containment
10.03.03	Reactor Building Anulus
10.03.03.01	Preparation Working Place
10.03.03.02	Dismantling Components
10.03.03.03	Dismantling Equipment
10.03.03.04	Clearing Site
10.03.03.05	Finalisation Containment
10.03.04	Turbine Building
10.03.04.01	Preparation Working Place
10.03.04.02	Dismantling Components and Equipment
10.03.04.03	Clearing Site
10.03.04.04	Finalisation Dismantling Monitored Area
10.03.05	Other Buildings
10.03.05.01	Preparation Working Place
10.03.05.02	Dismantling Components and Equipment
10.03.05.03	Clearing Site
10.03.05.04	Finalisation Other Building
11	CLEARANCE OF BUILDING STRUCTURES
11.01	Planning and Engineering
11.01.01	Project management / Engineering / Detail planning
11.01.02	Studies, Conceptual Planning Work, Project Specification
11.01.03	Contractings, Negotiations
11.02	Attendant Measures
11.02.01	Supervision
11.02.02	On Site Radiological Protection
11.02.03	Internal Transport
11.02.04	Accompanying Decontamination
11.02.05	Experts and Authorities
11.03	Execution Project
11.03.01	Auxiliary Building
11.03.01.01	Preparation Working Place
11.03.01.02	Decont Auxiliary Building
11.03.01.03	Removal PCB
11.03.01.04	Clearing Site
11.03.01.05	Clearance measurement

WBS code	name
11.03.01.07	Finalisation Decont Auxiliary Building
11.03.02	Reactor Building
11.03.02.01	Preparation Working Place
11.03.02.02	Decont Reactor Building
11.03.02.03	Removal PCB
11.03.02.04	Clearing Site
11.03.02.05	Clearance measurement
11.03.02.06	Finalisation Decont Reactor Building
11.03.03	Release from controlled area constrains
12	CONVENTIONAL DEMOLITION AND SITE RESTORATION
12.01	Planning and Engineering
12.01.01	Project management / Engineering / Detail planning
12.01.02	Studies, Conceptual Planning Work, Project Specification
12.01.03	Contractings, Negotiations
12.02	Attendant Measures
12.02.01	Experts and Authorities
12.03	Execution Project
12.03.01	All Buildings (incl. foundation)
12.03.01.01	Preparation Working Place
12.03.01.02	Demolition Reactor Building
12.03.01.03	Demolition Auxiliary Building
12.03.01.04	Demolition Turbine Building
12.03.01.05	Demolition Remaining Buildings monitored area
12.03.01.06	Trench supporting work
12.03.01.07	Demolition Piles
12.03.01.08	Demolition Fence, Streets
12.03.01.09	Filling building pits
12.03.01.10	Landscaping
12.03.01.11	Finalisation Site Restauration
13	PROJECT MANAGEMENT, ENGINEERING AND SITE SUPPORT
13.01	Administration
13.01.01	Plant Administration
13.01.01.01	Step 1: Start Project to Plant Shut Down
13.01.01.02	End of Step 1
13.01.01.03	Step 2: Plant Shut Down to Removal of Spent Fuels
13.01.01.04	End of Step 2
13.01.01.05	Step 3: Fuels removed to Dismantling RPV
13.01.01.06	End of Step 3
13.01.01.07	Step 4: RPV removed to Building Structures cleared
13.01.01.08	End of Step 4
13.01.01.09	Step 5: Clear Buildings to "Green Field"
13.01.01.10	End of Step 5
13.01.02	Special management systems
13.01.02.01	Quality Assurance
13.01.02.01.01	Step 1
13.01.02.01.02	Step 2
13.01.02.01.03	Step 3
13.01.02.01.04	Step 4
13.01.02.01.05	Step 5

13.01.02.02	WBS code	name
13.01.02.02.01		
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13.01.02.02.04		
13.01.02.02.05		,
13.01.02.03 Plant & Working Safety 13.01.02.03.01 Step 1 13.01.02.03.02 Step 2 13.01.02.03.03 Step 3 13.01.02.03.05 Step 5 13.01.02.04 Public Relation Work 13.01.02.04.01 Step 1 13.01.02.04.02 Step 2 13.01.02.04.03 Step 3 13.01.02.04.04 Step 4 13.01.02.04.05 Step 5 13.01.03.01 Step 1 13.01.03.01 Step 1 13.01.03.02 Step 2 13.01.03.01 Step 1 13.01.03.02 Step 2 13.01.03.03 Step 3 13.01.03.04 Step 4 13.01.03.05 Step 5 13.02 Finance and accountancy 13.02.01 Step 1 13.02.02 Step 2 13.02.03 Step 3 13.02.04 Step 4 13.02.05 Step 5 13.09 Personnel management 13.02.05 Step 5 13.03 Personnel management 13.03.01 Step 1 13.03.03 Step 3 13.03.04 Step 4 13.03.05 Step 5 13.03 Personnel management 13.03.01 Step 1 13.03.02 Step 2 13.03.03 Step 3 13.04 Step 4 13.03.05 Step 5 13.04 Step 4 13.03.05 Step 5 13.05 Step 5 13.06 Step 5 13.07 Step 1 13.08 Step 1 13.09.09 Step 2 13.09.09 Step 2 13.09.09 Step 2 13.09.00 Step 3 13.09.00 Step 1 13.09.00 Step 1 13.09.00 Step 1 13.09.00 Step 1 13.09.00 Step 1 13.09.00 Step 1 13.09.00 Step 1 13.09.00 Step 1 13.09.00 Step 1 13.09.00 Step 1 13.09.00 Step 1 13.09.00 Step 1 13.09.00 Step 1 13.09.00 Step 1 13.09.00 Step 1 13.09.00 Step 1 13.09.00 Step 3 13.09.00 Step 3 13.09.00 Step 5 13.00 Step 5 13.00 Step 5 13.00 Step 5 13.00 Step 5 13.00 Step 5 13.00 Step 5 13.00 Step 5 13.00 Step 5 13.00 Step 5 13.00 Step 5 13.00 Step 1 13.00.00 Step 1 13.00.00 Step 1 13.00.00 Step 1 13.00.00 Step 3 13.00.00 Step 5		,
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13.01.02.04 Public Relation Work 13.01.02.04.01 Step 1 13.01.02.04.02 Step 2 13.01.02.04.03 Step 3 13.01.02.04.04 Step 5 13.01.03 External Experts 13.01.03.01 Step 1 13.01.03.02 Step 2 13.01.03.03 Step 3 13.01.03.04 Step 4 13.01.03.05 Step 5 13.02 Finance and accountancy 13.02.01 Step 1 13.02.02 Step 2 13.02.03 Step 3 13.02.03 Step 3 13.02.04 Step 4 13.02.05 Step 5 13.09 Personnel management 13.03.01 Step 1 13.03.01 Step 1 13.03.02 Step 2 13.03.03 Personnel management 13.03.01 Step 1 13.03.02 Step 3 13.03.01 Step 1 13.03.02 Step 3 13.03.01 Step 1 13.03.02 Step 2 13.03.03 Step 3 13.03.04 Step 4 13.03.05 Step 5 13.04 Step 4 13.03.05 Step 5 13.04 Step 4 13.03.05 Step 5 13.04 Step 4 13.03.05 Step 5 13.04 Step 4 13.03.05 Step 5 13.04 Step 4 13.04.01 Step 1 13.04.01 Step 1 13.04.02 Step 2 13.04.03 Step 3 13.04.03 Step 3 13.04.03 Step 3 13.04.05 Step 5 13.04 Step 4 13.05.05 Step 5 13.05 Project Controlling 13.05.01 Step 1 13.05.01 Step 1 13.05.02 Step 2 13.05.03 Step 3 13.05.04 Step 4		•
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13.04.01 Step 1 13.04.02 Step 2 13.04.03 Step 3 13.04.04 Step 4 13.04.05 Step 5 13.05 Project Controlling 13.05.01 Step 1 13.05.02 Step 2 13.05.03 Step 3 13.05.04 Step 4 13.05.05 Step 5	13.03.05	Step 5
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13.04.03 Step 3 13.04.04 Step 4 13.04.05 Step 5 13.05 Project Controlling 13.05.01 Step 1 13.05.02 Step 2 13.05.03 Step 3 13.05.04 Step 4 13.05.05 Step 5	13.04.01	Step 1
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13.05 Project Controlling 13.05.01 Step 1 13.05.02 Step 2 13.05.03 Step 3 13.05.04 Step 4 13.05.05 Step 5	13.04.04	Step 4
13.05.01 Step 1 13.05.02 Step 2 13.05.03 Step 3 13.05.04 Step 4 13.05.05 Step 5	13.04.05	Step 5
13.05.02 Step 2 13.05.03 Step 3 13.05.04 Step 4 13.05.05 Step 5	13.05	Project Controlling
13.05.03 Step 3 13.05.04 Step 4 13.05.05 Step 5	13.05.01	Step 1
13.05.04 Step 4 13.05.05 Step 5	13.05.02	Step 2
13.05.04 Step 4 13.05.05 Step 5	13.05.03	Step 3
13.05.05 Step 5	13.05.04	
	13.05.05	Step 5
13.06 Documentation	13.06	Documentation

WBS code	name
13.06.01	Concept for a Decommissioning Documentation
13.06.02	Documentation of systems in operation
13.06.02.01	Step 1
13.06.02.02	Step 2
13.06.02.03	Step 3
13.06.02.04	Step 4
13.06.02.05	Step 5
13.06.03	D&D Documentation
13.06.03.01	Step 1
13.06.03.02	Step 2
13.06.03.03	Step 3
13.06.03.04	Step 4
13.06.03.05	Step 5
13.06.04	Staff & Health Physics
13.06.04.01	Step 1
13.06.04.02	Step 2
13.06.04.03	Step 3
13.06.04.04	Step 4
13.06.04.05	Step 5
13.06.05	Dismantled material & waste
13.06.05.01	Step 1
13.06.05.02	Step 2
13.06.05.03	Step 3
13.06.05.04	Step 4
13.06.05.05	Step 5
13.06.06	Exteral Transport
13.06.06.01	Step 1
13.06.06.02	Step 2
13.06.06.03	Step 3
13.06.06.04	Step 4
13.06.06.05	Step 5
13.07	IT
13.07.01	IT Staff
13.07.01.01	Step 1
13.07.01.02	Step 2
13.07.01.03	Step 3
13.07.01.04	Step 4
13.07.01.05	Step 5
13.07.02	Hardware
13.07.02.01	Rent for IT Equipment
13.07.02.01.01	Step 1
13.07.02.01.02	Step 2
13.07.02.01.03	Step 3
13.07.02.01.04	Step 4
13.07.02.01.05	Step 5
13.07.02.02	Maintenance of IT Equipment / Network
13.07.02.02.01	Step 1
13.07.02.02.02	Step 2
13.07.02.02.03	Step 3

WBS code	name
13.07.02.02.04	Step 4
13.07.02.02.05	Step 5
13.07.03	Software
13.07.03.01	Licenses for Software
13.07.03.01.01	Step 1
13.07.03.01.02	Step 2
13.07.03.01.03	Step 3
13.07.03.01.04	Step 4
13.07.03.01.05	Step 5
14	SITE SECURITY, SURVEILLANCE AND MAINTENANCE
14.01	Operation, Maintenance
14.01.01	Site Operation
14.01.01.01	Controllroom Staff
14.01.01.01.01	Step 1
14.01.01.01.02	Step 2
14.01.01.01.03	Step 3
14.01.01.01.04	Step 4
14.01.01.01.05	Step 5
14.01.01.02	Workshops (Mech.,Electr., Civil) Staff
14.01.01.02.01	Step 1
14.01.01.02.02	Step 2
14.01.01.02.03	Step 3
14.01.01.02.04	Step 4
14.01.01.02.05	Step 5
14.01.01.03	Operation Entrance Controlled Area
14.01.01.03.01	Step 1
14.01.01.03.02	Step 2
14.01.01.03.03	Step 3
14.01.01.03.04	Step 4
14.01.01.03.05	Step 5
14.01.01.04	Operation Nuclear Laundry / Substution Clothes
14.01.01.04.01	Step 1
14.01.01.04.02	Step 2
14.01.01.04.03	Step 3
14.01.01.04.04	Step 4
14.01.01.04.05	Step 5
14.01.01.05	Operation Nuclear Sanitary
14.01.01.05.01	Step 1
14.01.01.05.02	Step 2
14.01.01.05.03	Step 3
14.01.01.05.04	Step 4
14.01.01.05.05	Step 5
14.01.01.06	Provision of Energy
14.01.01.06.01	Step 1
14.01.01.06.02	Step 2
14.01.01.06.03	Step 3
14.01.01.06.04	Step 4
14.01.01.06.05	Step 5
14.01.01.07	Provision of Water

WBS code	name						
14.01.01.07.01	Step 1						
14.01.01.07.02	Step 2						
14.01.01.07.03	Step 3						
14.01.01.07.04	Step 4						
14.01.01.07.05	Step 5						
14.01.01.08	Provision of Steam, Oil and Gas						
14.01.01.08.01	Step 1						
14.01.01.08.02	Step 2						
14.01.01.08.03	Step 3						
14.01.01.08.04	Step 4						
14.01.01.08.05	Step 5						
14.01.02	Maintenance / Mechanical						
14.01.02.01	Maintenance Staff Mechanical						
14.01.02.01.01	Step 1						
14.01.02.01.02	Step 2						
14.01.02.01.03	Step 3						
14.01.02.01.04	Step 4						
14.01.02.01.05	Step 5						
14.01.02.02	Generation of operational / working orders						
14.01.02.02.01	Step 1						
14.01.02.02.02	Step 2						
14.01.02.02.03	Step 3						
14.01.02.02.04	Step 4						
14.01.02.02.05	Step 5						
14.01.02.03	Consumable Maintenance Mech						
14.01.02.03.01	Step 1						
14.01.02.03.02	Step 2						
14.01.02.03.03	Step 3						
14.01.02.03.04	Step 4						
14.01.02.03.05	Step 5						
14.01.02.04	Recurring safety checks						
14.01.02.04.01	Step 1						
14.01.02.04.02	Step 2						
14.01.02.04.03	Step 3						
14.01.02.04.04	Step 4						
14.01.02.04.05	Step 5						
14.01.02.05	Permanent errection of Shieldings and Scaffoldings						
14.01.02.05.01	Step 1						
14.01.02.05.02	Step 2						
14.01.02.05.03	Step 3						
14.01.02.05.04	Step 4						
14.01.02.05.05	Step 5						
14.01.03	Maintenance / Civil Engineering						
14.01.03.01	Civil Engineering Staff						
14.01.03.01.01	Step 1						
14.01.03.01.02	Step 2						
14.01.03.01.03	Step 3						
14.01.03.01.04	Step 4						
14.01.03.01.05	Step 5						

WBS code	name
14.01.03.02	Consumable Material Workshops
14.01.03.02.01	Step 1
14.01.03.02.02	Step 2
14.01.03.02.03	Step 3
14.01.03.02.04	Step 4
14.01.03.02.05	Step 5
14.01.04	Maintenance / Electrical
14.01.04.01	Electrical Staff
14.01.04.01.01	Step 1
14.01.04.01.02	Step 2
14.01.04.01.03	Step 3
14.01.04.01.04	Step 4
14.01.04.01.05	Step 5
14.01.04.02	Consumable Material Workshops
14.01.04.02.01	Step 1
14.01.04.02.02	Step 2
14.01.04.02.03	Step 3
14.01.04.02.04	Step 4
14.01.04.02.05	Step 5
14.01.04.03	Recurring safety checks
14.01.04.03.01	Step 1
14.01.04.03.02	Step 2
14.01.04.03.03	Step 3
14.01.04.03.04	Step 4
14.01.04.03.05	Step 5
14.01.04.04	Maintenance Electrical, Communication, Light, ao
14.01.04.04.01	Step 1
14.01.04.04.02	Step 2
14.01.04.04.03	Step 3
14.01.04.04.04	Step 4
14.01.04.04.05	Step 5
14.01.05	Accompanying Decontamination
14.01.05.01	Step 1
14.01.05.02	Step 2
14.01.05.03	Step 3
14.01.05.04	Step 4
14.01.05.05	Step 5
14.02	Radiological Protection/Health Physics
14.02.01	General Plant Health Physics
14.02.01.01	Step 1
14.02.01.02	Step 2
14.02.01.03	Step 3
14.02.01.04	Step 4
14.02.01.05	Step 5
14.02.02	Chemical Laboratory
14.02.02.01	Step 1
14.02.02.02	Step 2
14.02.02.03	Step 3
14.02.02.04	Step 4

WBS code	name
14.02.02.05	Step 5
14.02.03	Working Safety
14.02.03.01	Step 1
14.02.03.02	Step 2
14.02.03.03	Step 3
14.02.03.04	Step 4
14.02.03.05	Step 5
14.02.04	Fire Protection
14.02.04.01	Fire Protection Staff
14.02.04.01.01	Step 1
14.02.04.01.02	Step 2
14.02.04.01.03	Step 3
14.02.04.01.04	Step 4
14.02.04.01.05	Step 5
14.02.04.02	Fire Protection Brigade
14.02.04.02.01	Step 1
14.02.04.02.02	Step 2
14.02.04.02.03	Step 3
14.02.04.02.04	Step 4
14.02.04.02.05	Step 5
14.03	Guarding
14.03.01	Guarding Cost (Plant)
14.03.01.01	Step 1
14.03.01.02	Step 2
14.03.01.03	Step 3
14.03.01.04	Step 4
14.03.01.05	Step 5
14.03.02	Guards
14.03.02.01	Step 1
14.03.02.02	Step 2
14.03.02.03	Step 3
14.03.02.04	Step 4
14.03.02.05	Step 5
14.04	Surveillance
14.04.01	Experts
14.04.01.01	Step 1
14.04.01.02	Step 2
14.04.01.03	Step 3
14.04.01.04	Step 4
14.04.01.05	Step 5
14.04.02	Authorities
14.04.02.01	Step 1
14.04.02.02	Step 2
14.04.02.03	Step 3
14.04.02.04	Step 4
14.04.02.05	Step 5
14.04.03	Euratom
14.04.03.01	Step 1
14.04.03.02	Step 2

WBS code	name
14.04.03.03	Step 3
14.04.03.04	Step 4
14.04.03.05	Step 5
14.04.04	IAEA
14.04.04.01	Step 1
14.04.04.02	Step 2
14.04.04.03	Step 3
14.04.04.04	Step 4
14.04.04.05	Step 5
14.04.05	Others
14.04.05.01	Step 1
14.04.05.02	Step 2
14.04.05.03	Step 3
14.04.05.04	Step 4
14.04.05.05	Step 5
14.05	Other Operational Expenditures
14.05.01	Housekeeping
14.05.01.01	Housekeeper
14.05.01.01.01	Step 1
14.05.01.01.02	Step 2
14.05.01.01.03	Step 3
14.05.01.01.04	Step 4
14.05.01.01.05	Step 5
14.05.01.02	Canteen
14.05.01.02.01	Step 1
14.05.01.02.02	Step 2
14.05.01.02.03	Step 3
14.05.01.02.04	Step 4
14.05.01.02.05	Step 5
14.05.01.03	Cleaning Staff (Conventionel)
14.05.01.03.01	Step 1
14.05.01.03.02	Step 2
14.05.01.03.03	Step 3
14.05.01.03.04	Step 4
14.05.01.03.05	Step 5
14.05.01.04	Plant Outdoor Area
14.05.01.04.01	Step 1
14.05.01.04.02	Step 2
14.05.01.04.03	Step 3
14.05.01.04.04	Step 4
14.05.01.04.05	Step 5
14.05.01.05	Car Park
14.05.01.05.01	Step 1
14.05.01.05.02	Step 2
14.05.01.05.03	Step 3
14.05.01.05.04	Step 4
14.05.01.05.05	Step 5
14.05.02	Other Cost
14.05.02.01	Assurance

14.05.02.01.01	WBS code	name
14.05.02.01.02 Step 2 14.05.02.01.03 Step 3 14.05.02.01.04 Step 4 14.05.02.02 Mail, Communication 14.05.02.02.01 Step 1 14.05.02.02.02 Step 2 14.05.02.02.03 Step 3 14.05.02.02.04 Step 4 14.05.02.03 Officematerial 14.05.02.03.01 Step 1 14.05.02.03.02 Step 2 14.05.02.03.03 Step 1 14.05.02.03.01 Step 1 14.05.02.03.02 Step 2 14.05.02.03.03 Step 1 14.05.02.03.04 Step 3 14.05.02.03.05 Step 3 14.05.02.03.04 Step 4 14.05.02.03.05 Step 5 14.05.02.03.04 Step 4 14.05.02.03.05 Step 5 14.05.02.03.05 Step 1 14.05.02.04.01 Step 1 14.05.02.04.02 Step 2 14.05.02.04.03 Step 3 14.05.02.04.04 Step 4 14.05.02.05.05 Step 1		
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14.05.02.03.02	14.05.02.03	Officematerial
14.05.02.03.02	14.05.02.03.01	Step 1
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14.05.02.03.04 Step 4 14.05.02.03.05 Step 5 14.05.02.04 Education 14.05.02.04.01 Step 1 14.05.02.04.02 Step 2 14.05.02.04.04 Step 3 14.05.02.04.05 Step 5 14.05.02.05 Medical Service 14.05.02.05.01 Step 1 14.05.02.05.02 Step 2 14.05.02.05.03 Step 3 14.05.02.05.04 Step 4 14.05.02.05.05 Step 5 15 WASTE PROCESSING, STORAGE AND DISPOSAL 15.01 Treatment of Dismantled Material at KCB 15.01.01 Decontamination Dry Blasting 15.01.01.01 Step 1 15.01.01.02 Step 2 15.01.01.03 Step 3 15.01.01.04 Step 4 15.01.01.05 Step 5 15.01.02.01 Step 1 15.01.03 Step 3 15.01.04 Step 4 15.01.02.01 Step 5 15.01.02.02 Step 5 15.01.02.03 Step 2		
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15.01.01 Decontamination Dry Blasting 15.01.01.01 Step 1 15.01.01.02 Step 2 15.01.01.03 Step 3 15.01.01.04 Step 4 15.01.01.05 Step 5 15.01.02 Decontamination Wet Superjet 15.01.02.01 Step 1 15.01.02.02 Step 2 15.01.02.03 Step 3 15.01.02.04 Step 4 15.01.02.05 Step 5 15.01.03 Release Measurements of dismantled material 15.01.03.01 Step 1 15.01.03.02 Step 2 15.01.03.03 Step 3 15.01.03.04 Step 4	15	WASTE PROCESSING, STORAGE AND DISPOSAL
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15.01.01.02 Step 2 15.01.01.03 Step 3 15.01.01.04 Step 4 15.01.01.05 Step 5 15.01.02 Decontamination Wet Superjet 15.01.02.01 Step 1 15.01.02.02 Step 2 15.01.02.03 Step 3 15.01.02.04 Step 4 15.01.02.05 Step 5 15.01.03 Release Measurements of dismantled material 15.01.03.01 Step 1 15.01.03.02 Step 2 15.01.03.03 Step 3 15.01.03.04 Step 4	15.01.01	Decontamination Dry Blasting
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15.01.01.05 Step 5 15.01.02 Decontamination Wet Superjet 15.01.02.01 Step 1 15.01.02.02 Step 2 15.01.02.03 Step 3 15.01.02.04 Step 4 15.01.02.05 Step 5 15.01.03 Release Measurements of dismantled material 15.01.03.01 Step 1 15.01.03.02 Step 2 15.01.03.03 Step 3 15.01.03.04 Step 4	15.01.01.03	Step 3
15.01.02 Decontamination Wet Superjet 15.01.02.01 Step 1 15.01.02.02 Step 2 15.01.02.03 Step 3 15.01.02.04 Step 4 15.01.02.05 Step 5 15.01.03 Release Measurements of dismantled material 15.01.03.01 Step 1 15.01.03.02 Step 2 15.01.03.03 Step 3 15.01.03.04 Step 4	15.01.01.04	Step 4
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15.01.02.02 Step 2 15.01.02.03 Step 3 15.01.02.04 Step 4 15.01.02.05 Step 5 15.01.03 Release Measurements of dismantled material 15.01.03.01 Step 1 15.01.03.02 Step 2 15.01.03.03 Step 3 15.01.03.04 Step 4	15.01.02	Decontamination Wet Superjet
15.01.02.03 Step 3 15.01.02.04 Step 4 15.01.02.05 Step 5 15.01.03 Release Measurements of dismantled material 15.01.03.01 Step 1 15.01.03.02 Step 2 15.01.03.03 Step 3 15.01.03.04 Step 4	15.01.02.01	Step 1
15.01.02.04 Step 4 15.01.02.05 Step 5 15.01.03 Release Measurements of dismantled material 15.01.03.01 Step 1 15.01.03.02 Step 2 15.01.03.03 Step 3 15.01.03.04 Step 4	15.01.02.02	Step 2
15.01.02.05 Step 5 15.01.03 Release Measurements of dismantled material 15.01.03.01 Step 1 15.01.03.02 Step 2 15.01.03.03 Step 3 15.01.03.04 Step 4	15.01.02.03	
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15.01.03 Release Measurements of dismantled material 15.01.03.01 Step 1 15.01.03.02 Step 2 15.01.03.03 Step 3 15.01.03.04 Step 4	15.01.02.05	Step 5
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15.01.03.03 Step 3 15.01.03.04 Step 4	15.01.03.02	
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	15.01.03.04	·
	15.01.03.05	

WBS code	name
15.01.04	Conditioning and Packaging of radioactive Waste
15.01.04.01	Step 1
15.01.04.02	Step 2
15.01.04.03	Step 3
15.01.04.04	Step 4
15.01.04.05	Step 5
15.02	Treatment of Secondary Waste at KCB
15.02.01	Solids
15.02.01.01	Step 1
15.02.01.02	Step 2
15.02.01.03	Step 3
15.02.01.04	Step 4
15.02.01.05	Step 5
15.02.02	Liquids
15.02.02.01	Step 1
15.02.02.02	Step 2
15.02.02.03	Step 3
15.02.02.04	Step 4
15.02.02.05	Step 5
15.02.03	Building Rubble
15.02.03.01	Step 1
15.02.03.02	Step 2
15.02.03.03	Step 3
15.02.03.04	Step 4
15.02.03.05	Step 5
15.03	Container Cost Primary Waste
15.03.01	Step 1
15.03.02	Step 2
15.03.03	Step 3
15.03.04	Step 4
15.03.05	Step 5
15.04	Container Cost Secondary Waste
15.04.01	Step 1
15.04.02	Step 2
15.04.03	Step 3
15.04.04	Step 4
15.04.05	Step 5
15.05	External Treatment of radioactive waste
15.05.01	COVRA Cost
15.05.01.01	Step 1
15.05.01.02	Step 2
15.05.01.03	Step 3
15.05.01.04	Step 4
15.05.01.05	Step 5
15.05.02	Melting
15.05.02.01	Step 1
15.05.02.02	Step 2
15.05.02.03	Step 3
15.05.02.04	Step 4

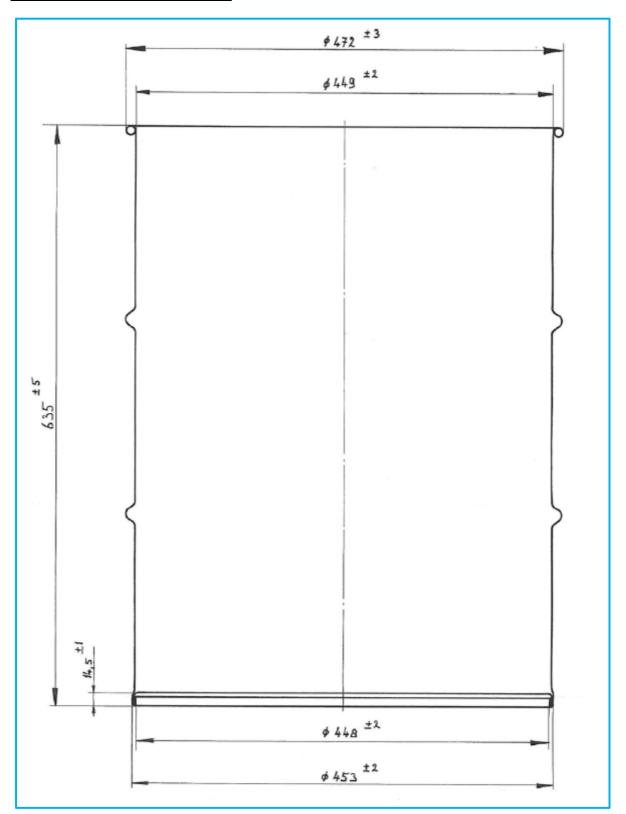
WBS code	name					
15.05.02.05	Step 5					
15.07	Repository cost radioactive waste					
15.07.01	Step 1					
15.07.02	Step 2					
15.07.03	Step 3					
15.07.04	Step 4					
15.07.05	Step 5					
15.08	Conventional Waste					
15.08.01	Treatment of conventional waste					
15.08.02	Repository Cost conventional					
15.08.02.01	Repository Cost RB					
15.08.02.02	Repository Cost AUX					
15.08.02.03	Repository Cost TB					
15.08.02.04	Repository cost other buildings					
15.08.02.05	Repository cost piles					
15.08.03	Repository Cost PCB					
15.08.03.01	Repository Cost PCB material AUX					
15.08.03.02	Repository Cost PCB material RB					
15.09	Revenues material sales					
15.09.01	Step 1					
15.09.02	Step 2					
15.09.03	Step 3					
15.09.04	Step 4					
15.09.05	Step 5					
15.10	Attendant Measures					
15.10.01	Step 1					
15.10.02	Step 2					
15.10.03	Step 3					
15.10.04	Step 4					
15.10.05	Step 5					

Appendix D: Waste packages

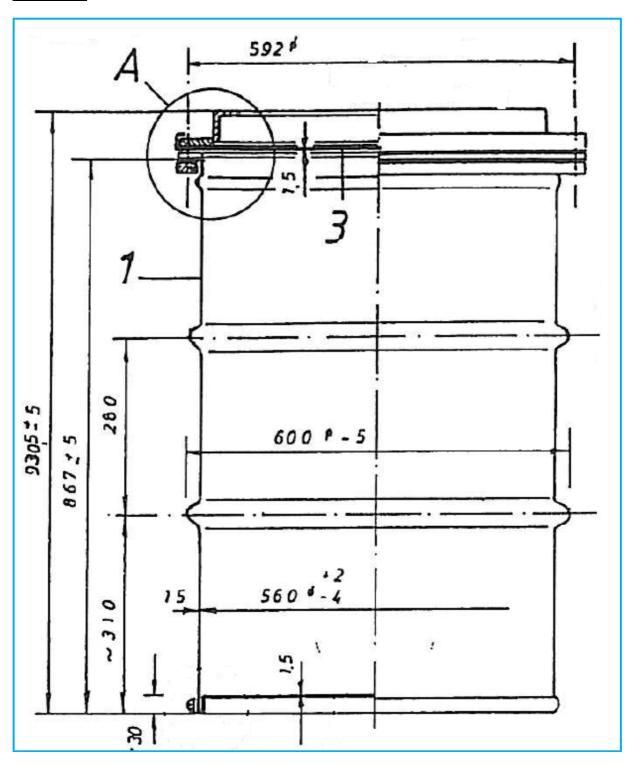
- 90-I drum for super-compaction
- 200-l drum
- 1.000 I container
- KONRAD Type II containers and storage
- MOSAIK Type II containers and cross-section



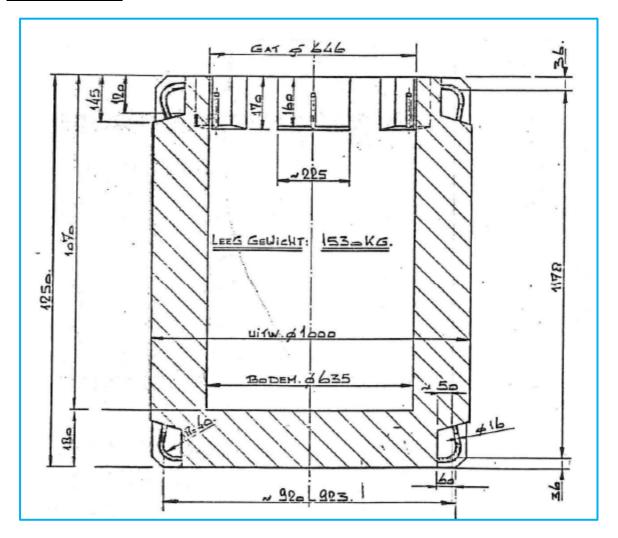
90-I drum for super-compaction



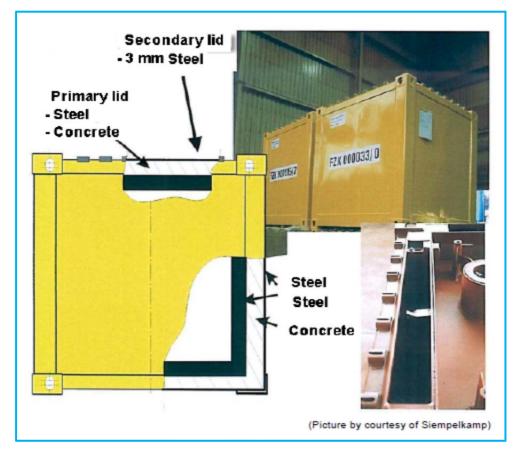
200-l drum



1.000-l container



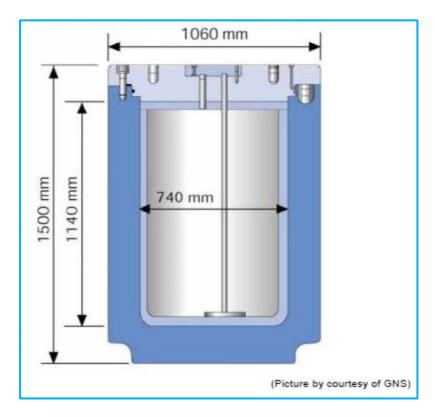
KONRAD Type II – container and storage





MOSAIK Type II – container and cross-section





Appendix E: Number of waste packages per year

- KONRAD variant
- COVRA variant



Number of waste packages per year - KONRAD variant

Year Number of Packages per Year Volume per Year 2034 150 3 2035 150 3 2036 150 5 21 2037 225 45 4 5 2038 225 45 4 5 10 8	
2034 150 3 2035 150 3 2036 150 5 21 2037 225 45 4 5 2038 225 45 4 5 10 8	50 50
2034 150 3 2035 150 3 2036 150 5 21 2037 225 45 4 5 2038 225 45 4 5 10 8	50
2035 150 3 2036 150 5 21 2037 225 45 4 5 2038 225 45 4 5 10 8	50
2036 150 5 21 2037 225 45 4 5 2038 225 45 4 5 10 8	
2037 225 45 4 5 2038 225 45 4 5 10 8	07
2038 225 45 4 5 10 8	
	286
	328
2039 225 45 4 5 10 8	328
2040 250 40 5 8 20 10 2041 250 30 5 8 22 10	346 302
2041 250 30 5 8 22 10 2042 230 40 2 22 3	282
2042 230 40 2 22 3 3 4 3	212
2044 105 20	118
2045 80 14	83
Year Commulated Number of Packages Cumulat	
Volum	
(m³)	
2034 150 3 0 0 0 0	50
2035 300 6 0 0 0 0	101
2036 450 11 0 0 21 0	188
2037 675 56 0 4 26 0	474
2038 900 101 4 9 36 8	802
	.130
	476
	778
	.059
	271
	.389 .472
2043 2210 323 20 30 114 42 2.	4/2

Number of waste packages per year - KONRAD variant

	COVRA 200 l drum	COVRA 1000 I	COVRA 1000 I / 30mm Fe	COVRA 1000 I / 60mm Fe	MOSAIK Type II (Type A)	MOSAIK Type II / 060mm Fe	
Year	Nu	mber	of Pack	ages p	er Year	•	Volume
							per Year
							(m³)
2034	150	8					44
2035	150	10					46
2036	150	25			2		64
2037	1400	130	20	5			492
2038	1400	125	50	5	7	8	537
2039	1400	125	50	10	7	8	542
2040	1300	110	40	60	20	10	562
2041	1000	80	30	60	30	10	463
2042	1100	100	35	6	24	3	442
2043	900	90	30	6	4	3	352
2044	500	50	23				193
2045	412	11	10				121
Year	Comr	nulate	d Num	ber of	Packag	es	Cumulated
							Volume
							(m³)
2034	150	8	0	0	0	0	44
2035	300	18	0	0	0	0	91
2036	450	43	0	0	2	0	154
2037	1850	173	20	5	2	0	647
2038	3250	298	70	10	9	8	1.184
2039	4650	423	120	20	16	16	1.725
2040	5950	533	160	80	36 66	26 26	2.287
2041 2042	6950	613	190	140	66 00	36	2.750
2042	8050 8950	713	225	146 152	90 94	39 42	3.192 3.543
2043	9450	803 853	255 278	152 152	94 94	42 42	3.737
2044	9862	864	288	152	94 94	42 42	3.737 3.857
2043	J002	00 4	200	132	J 4	42	3.037



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@epz.nl

Betreft: aanvulling op het ontmantelingsplan

Geachte heer Van den Heuvel,

In uw brief vraagt u om een aanvulling op het ontmantelingsplan onder verwijzing naar artikel 3, lid 1, onder c, van de Regeling buitengebruikstelling en ontmanteling nucleaire inrichtingen. U verlangt met name een beschrijving van de wijze waarop EPZ van plan is de in de inrichting aanwezige splijtstoffen af te voeren. In deze brief ontvangt u de gevraagde aanvulling.

In de inrichting bevinden zich splijtstoffen in de vorm van splijtstofelementen. Bestraalde splijtstofelementen worden na gebruik enkele jaren ter afkoeling in het splijtstofopslagbassin bewaard en vervolgens naar Frankrijk verzonden om opgewerkt te worden. De splijtstofplanning is dusdanig opgezet dat per einde van de bedrijfsvoering geen onbestraalde en zo min mogelijk bestraalde splijtstofelementen aanwezig zullen zijn in het splijtstofopslagbassin. In cursief geven wij u hierbij een aanvulling op hoofdstuk 8.3.2.10, Operational waste, van het ontmantelingsplan KCB 2016. Deze aanvulling geeft een nadere toelichting op de afvoer van de splijtstofelementen tijdens de PO fase van het ontmantelingsproject en de tijdsduur daarvan. Project 3 beschrijft de afvoer van Operational waste tijdens de PO fase. Tijdens deze fase worden ook de splijtstofelementen afgevoerd.

Before the final shutdown, the fuel elements in the fuel pool are reduced to a minimum. At the end of 2033 the fuel pool contains only fuel elements that could not yet be sent to the reprocessing plant because of the decay heat of the elements is still to large for the transport. This concerns 56 "U assemblies" en 24 "MOX assemblies".

The last core contains 121 assemblies and is made up of 1-, 2-, 3-, 4- en 5-year old assemblies. It is possible to transport the 1-year old assemblies after 1 year, the 2- and 3-year old assemblies after 2 years and the 4- and 5-year old assemblis after 3 years. Three transport containers, each with a capacity of 7 elements of which 3 elements can be MOX elements, are used for the transport of the spent fuel elements. The turn-around time is 8 weeks. During the holidays there will be no transports. With these assumptions it is realistic to have 4 transports per year, each transport consists of 3 containers. Because of the possibility that fuelhandling can cause fuel damage, a "quiver" (basket with defective fuel rods) is taken into account.

The time needed to decay and cool down the fuel elements with the highest burn-up determines the last date for the transports. Thus it is a realistic possibility to have removed all the fuel elements within 3,5 years after the final shut down.

EPZ heeft het opwerken gecontracteerd van alle bestraalde splijtstof die wordt geproduceerd tot de uitbedrijfname van de centrale per 1-1-2034. Het opwerken van bestraalde splijtstoffen resulteert in herbruikbare splijtstof (recycling) en een fractie hoogradioactief afval. Het hoogradioactief afval wordt in Frankrijk geconditioneerd en vervolgens in canisters naar Nederland teruggezonden voor opslag in het HABOG van COVRA. Hergebruik door EPZ van al het vrijkomende plutonium in de vorm van MOX splijtstofelementen is gecontracteerd zodat er geen plutonium overblijft. Ook het vrijkomende reprocessed uranium wordt door EPZ hergebruikt voor de productie van nieuwe splijtstofelementen.

De kosten van het aftransporteren van alle bestraalde splijtstofelementen zijn voorzien in de reguliere brandstofplanning- en kosten en vormen derhalve onderdeel van de bedrijfsvoering en niet van de buitengebruikstelling en ontmanteling. Ook de overige kosten van de backend maken onderdeel uit van de reguliere brandstofplanning- en kosten en vormen derhalve onderdeel van de bedrijfsvoering en niet van de buitengebruikstelling en ontmanteling. Deze kosten omvatten het opwerken van alle bestraalde splijtstofelementen, de kosten voor de benodigde opslagcapaciteit in het HABOG bij COVRA, de productie van MOX brandstofelementen en de kosten van alle benodigde transporten.

Indien en voor zover aan brandstof gerelateerde werkzaamheden buiten de reguliere brandstofplanning en -kosten na uit bedrijf name voorzien zijn, zijn deze opgenomen in het ingediende ontmantelingsplan. Hiervoor verwijzen we u naar de PSP codes 01-03 en de WBS codes 03.01 tot en met 03.04 in het genoemde plan

Wij vertrouwen erop dat u hiermee voldoende informatie hebt ontvangen om onze aanvraag goedkeuring ontmantelingsplan verder in behandeling te nemen.

Hoogachtend,

